Introduction

The Bridges in Mathematics 1st edition Grade 4 CCSS Supplement is a collection of activities designed to help Bridges 1st edition students meet the Common Core State Standards for Mathematics published in 2010. These activities were drawn from Bridges Grade 4 Supplement Sets A3, A4, A5, A6, A9, A10, B1, B2, C1, C3, D1, D3, D6, D10 & E2. The full versions of these sets are available as free downloadable PDFs on The Math Learning Center website (bridges1.mathlearningcenter.org/b4sup).

**Note:** This document is set up to print double-sided (back-to-back).

Here's what you'll find in this packet:

1. **CCSS Summary – page 4**
A summary of the supplement and the Common Core State Standards they address, covering the entire school year.

2. **Recommended Timing for Activities & Independent Worksheets – pages 5–7**
A chart outlining the teaching order of the activities and worksheets found in this supplement.

3. **Unit Planners – pages 9–24**
Planners designed to replace the Planning Guides found at the beginning of each unit in the Bridges Teachers Guides. These planners identify sessions that were omitted to make room for the supplement sets and describe the timing and direction for inserting supplement Activities and Independent Worksheets, including Homework. We suggest you insert these planners into your Bridges Teacher Guides so you can see at a glance when to teach the supplement activities throughout the school year.

4. **Materials List – pages 25 & 26**
A complete list of materials required to teach the activities in each supplement set. Materials include those contained in the Bridges kits and common materials found in the classroom or at home.

5. **Activities and Independent Worksheets – pages 27–408**
Activities and worksheets organized around a mathematical domain and cluster (e.g., domain: Measurement & Data; cluster: Area). Many of the activities will take an hour of instructional time, though some are shorter, requiring 30–45 minutes. Almost all the activities are hands-on and require various math manipulatives or common classroom supplies. The blacklines needed to make display masters, game materials, and student sheets are included after each activity. Some of the supplement sets in this collection include independent worksheets, designed to be completed by students in class or assigned as homework after related activities.

**Note:** The activities and worksheets are presented in teaching order by unit. Sets may not follow standard page order. See timing chart for reference.

6. **Correlations – pages 409–420**
The Common Core State Standards correlations to Bridges in Mathematics 1st edition Grade 4 include correlations to Bridges sessions, Supplement Activities & Independent Worksheets, Practice Book pages, and informal and formal assessment suggestions found in the Bridges materials and on the Bridges 1st edition support web pages.
## Bridges in Mathematics & the Common Core State Standards (CCSS) Summary – Grade 4

### OPERATIONS & ALG THINKING
- Solve Problems with all 4 Operations
- Factors & Multiples
  - Bridges Units: 1, 2, 3, 7
  - Number Corner: Oct–Feb, Mar, May
  - Supplement Sets: A4, A5, A6, B1, B2

### NUMBER &OPS BASE 10
- Place Value for Multi-Digit Whole Number & Operations
  - Bridges Units: 1–3, 8
  - Number Corner: Sep–May
  - Supplement Sets: A3, A4, A5

### FRACTIONS
- Fraction Equivalence
- Ordering
- Early Operations
- Decimal Notation for Fractions
  - Bridges Units: 1, 2, 3, 6, 11
  - Number Corner: Sep–Dec, Mar–May
  - Supplement Sets: D1, D3, D6, D10, E2

### MEASUREMENT & DATA
- Measurement Conversions
- Represent & Interpret Data
- Angle Measurement
  - Bridges Units: 1, 2, 3, 4, 6
  - Number Corner: Sep–Jan, Mar–May
  - Supplement Sets: D1, D3, D6, D10, E2

### GEOMETRY
- Draw & Identify Lines & Angles
- Classify Shapes
  - Bridges Units: 1, 4
  - Number Corner: April
  - Supplement Sets: C1, C3

### Pacing Guide (159 sessions total; school calendars determine specific timing)

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<tr>
<th>Units</th>
<th>SEP</th>
<th>OCT to MID-NOV</th>
<th>MID-NOV to DEC</th>
<th>JAN</th>
<th>FEB</th>
<th>MAR to MID-APR</th>
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### CCSS Supplemental Sets

- SET A3: Place Value to Millions
  - 3 Sessions, 3 IWS
- SET A4: Estimating to Multiply & Divide
  - 3 IWS
- SET B2: Multiplication Comparisons & Equations
  - 1 Session, 2 IWS
- SET D6: Area & Perimeter
  - 4 Sessions, 2 IWS
  - IWS = Ind. Worksheets for homework or seatwork

### Number Corner

- Numbers to 10,000; expanded notation; basic facts (x), multiples, patterns and functions, length
- Place value; basic facts (x, ÷); multiples; story problems; growing patterns; capacity
- Basic facts (x, ÷); multiples; story problems; multi-digit (x, ÷); repeating patterns; transformations; length
- Rounding and estimating; basic facts (x, ÷); growing patterns; multi-digit (x, ÷); elapsed time; probability and data; story problems; time, perimeter, patterns, money
- Basic facts (x, ÷); factors and multiples; story problems (multi-digit (x) and ÷); patterns and functions; probability and data
- Rounding; basic facts (÷); story problems (computation, area, perimeter, and fractions); factors and decimals; number patterns; capacity; line graphs; story problems (graphs, tables, and charts)
- Basic facts (+, - x ÷); fractions and decimals; story problems (multi-step computation); coordinate grids; reading and constructing; tables and graphs

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### Recommended Timing for Activities & Independent Worksheets

Activities listed in recommended teaching order.

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<td>Activity 2: Charting One Million</td>
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<td>Activity 3: Millions of Sport Spectators</td>
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<td>Ind. Worksheet 1: The Dodgers &amp; the Yankees</td>
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<td>Ind. Worksheet 2: Big Numbers</td>
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<td>Ind. Worksheet 3: Another Look at Big Numbers</td>
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<td>Activity 2: Multiplying by 10, 100, &amp; 1000</td>
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<td>Activity 7: Splat</td>
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<td>Activity 9: Double-Digit Multiplication with Pictures &amp; Numbers</td>
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# Unit One Planner (Bridges Sessions)

**Note:** No changes made.

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**SESSION 6**


**SESSION 11**


**SESSION 16**

| Problems & Investigations Seeing the Strategies, Part 2 of 2 | Work Places 1A Arrays to 100 1B Spinning Around Multiplication | Problems & Investigations Spaghetti & Meatballs for All, Part 1 of 2 Home Connection 8 | Problems & Investigations Spaghetti & Meatballs for All, Part 2 of 2 Home Connection 9 |

**SESSION 21**

| Assessment Unit One Post-Assessment | | | | Problems & Investigations Calculating Area & Perimeter Home Connection 10 |
# Unit Two Planner (Bridges & CCSS Grade 4 Supplement Sets A3, A4, B2 & D6)

**Note:** Sessions 1, 2, 17 & 18 have been omitted to accommodate Supplement Sets A3, A4, B2 & D6.

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<td>Activity 4: Hexarights</td>
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### Unit Three Planner (Bridges & CCSS Grade 4 Supp. Sets A4, A6, A9, D1 & D10)

**Note:** No Bridges sessions removed.

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<td>Problems &amp; Investigations Larger Division with Base Ten Pieces</td>
<td>Problems &amp; Investigations Dividing Larger Numbers: The 120 Series</td>
<td>Assessment Unit Three Post-Assessment</td>
<td>Supplement Set D10 Activity 1: Converting Measurements</td>
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<td>Homework Supplement Set D10 Ind. Worksheet 1: Equivalent Tables</td>
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<td>Supplement Set D1 Activity 5: Kitten &amp; Cat Weights</td>
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<td>Homework Supplement Set D10 Ind. Worksheet 2: Conversion Tables</td>
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# Unit Four Planner (Bridges & CCSS Grade 4 Supplement Sets C1 & C3)

**Note:** Sessions 6–8 & 11–20 have been omitted to accommodate Supplement Sets C1 & C3.

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<td>Assessment&lt;br&gt;Unit Four Pre-Assessment</td>
<td>Supplement Set C3&lt;br&gt;Activity 1: Pattern Block Angles</td>
<td>Supplement Set C3&lt;br&gt;Activity 2: Human Angles</td>
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<td>Home Connection 29</td>
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<td>Supplement Set C3&lt;br&gt;Ind. Worksheet 1: Measuring Interior Angles of Polygons</td>
<td>Supplement Set C3&lt;br&gt;Ind. Worksheet 2: Angles in the Classroom</td>
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<td>Supplement Set C3&lt;br&gt;Activity 5: Drawing Stars</td>
<td>Supplement Set C1&lt;br&gt;Activity 1: Dots &amp; Lines</td>
<td>Problems &amp; Investigations&lt;br&gt;Coordinate Grids</td>
<td>Problems &amp; Investigations&lt;br&gt;Reflections</td>
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<td>Supplement Set C3&lt;br&gt;Ind. Worksheet 6: Measuring Angles</td>
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### SESSION 10

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<td>Problems &amp; Investigations&lt;br&gt;Pattern Block Symmetry</td>
<td>Problems &amp; Investigations&lt;br&gt;Introducing Area Bingo</td>
<td>Assessment&lt;br&gt;Unit Four Post-Assessment</td>
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<td>Home Connection 31</td>
<td>Work Places&lt;br&gt;48 Area Bingo</td>
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**Unit Five Replacement Planner (CCSS Grade 4 Supp. Sets A5, B1 & D3)**

**Reminder**: Introduce Activities 1 & 2 from Supplement Set D3, Capacity in Metric Units, in place of two of the Problem Solving workouts during Number Corner in March. Set up the materials for both activities somewhere in the room so that each student can complete them. Once most students have had a chance to do these activities, assign Independent Worksheet 1 as homework.

<table>
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<td>Supplement Set A5 Activity 1: Multi-Digit Multiplication Pre-Assessment</td>
<td>Supplement Set A5 Activity 2: Multiplying by 10, 100, &amp; 1000</td>
<td>Supplement Set A5 Activity 3: Multiplying Single Digits by Multiples of Ten</td>
<td>Supplement Set A5 Activity 4: Single-Digit Multiplication with Pictures &amp; Numbers</td>
<td>Supplement Set A5 Activity 5: Introducing the Standard Multiplication Algorithm</td>
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<td>Homework Supplement Set A5 Ind. Worksheet 1: More Practice Multiplying by 10, 100, &amp; 1000</td>
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<tr>
<td>Supplement Set A5 Activity 6: Think before You Multiply</td>
<td>Supplement Set A5 Activity 7: Splat!</td>
<td>Supplement Set A5 Activity 8: Sketching Arrays &amp; Partial Products</td>
<td>Supplement Set A5 Activity 9: Double-Digit Multiplication with Pictures &amp; Numbers</td>
<td>Supplement Set A5 Activity 10: Multiplication Menus</td>
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<tr>
<td>Homework Supplement Set A5 Ind. Worksheet 5: Choose Your Strategy</td>
<td>Homework Supplement Set A5 Ind. Worksheet 2: More Tens, Hundreds, &amp; Thousands</td>
<td>Homework Supplement Set A5 Ind. Worksheet 3: Double-Digit by Single-Digit Multiplication</td>
<td>Homework Supplement Set A5 Ind. Worksheet 4: Using the Standard Algorithm for Two-Digit by One-Digit Multiplication</td>
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## Unit Six Planner (Bridges & CCSS Grade 4 Supplement Sets A10 & E2)

**Note:** Sessions 5–8 have been omitted to accommodate Supplement Sets A10 & E2.

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<td><strong>Assessment</strong>&lt;br&gt;Unit Six Pre-Assessment &amp; Geoboard Figures with an Area of 2</td>
<td>Problems &amp; Investigations Exploring Fractions on the Geoboard</td>
<td>Problems &amp; Investigations Revisiting &amp; Recording Geoboard Discoveries</td>
<td>Problems &amp; Investigations Shifting the Unit of Area on the Geoboard</td>
<td>Supplement Set A10 Activity 1: Multiplying Fractions on the Geoboard</td>
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<td>Problems &amp; Investigations Adding &amp; Subtracting Decimal Numbers</td>
<td>Problems &amp; Investigations Ordering Decimals on a Number Line</td>
<td>Work Places 6C Round &amp; Add Tenths</td>
<td>Problems &amp; Investigations Decimal Race to Three</td>
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<td>Supplement Set E2 Activity 2: Endurance Run Results</td>
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Unit Seven Planner (Bridges Sessions)

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<td>Problems &amp; Investigations Linear Piece Patterns</td>
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<td>Unit Eight Pre-Assessment &amp; Read-Aloud Book</td>
<td>Measuring Hand Spans &amp; Arm Spans</td>
<td>Examining Data &amp; Planning Wingspan Displays</td>
<td>Completing Wingspan Displays</td>
<td>Using Displays to See the Shape of the Data</td>
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<td>Wingspans of Owls</td>
<td>Creating Line Plots of Arm Span Data</td>
<td>Converting between Inches &amp; Feet</td>
<td>Looking for Shorebird Correlations</td>
<td>Trend Lines</td>
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<td>Converting between Ounces &amp; Pounds</td>
<td>Amazing Bird Facts</td>
<td>Calculating Average Wingspans</td>
<td>Making Paper Airplanes</td>
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<td>Plotting &amp; Analyzing Paper Airplane Flight Data</td>
<td>Flight Day 2</td>
<td>Unit Eight Post-Assessment</td>
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# Grade 4 CCSS Supplement Materials List

| MANIPULATIVES | A3 | A4 | A5 | A6 | A9 | A10 | B1 | B2 | C1 | C3 | D1 | D3 | D6 | D10 | E2 |
|---------------|----|----|----|----|----|-----|----|----|----|----|----|----|-----|-----|
| PGT           | ✓  | ✓  |    |    |    |     |    |    |    |    |    |    |     |     |
| PLT           | ✓  |    |    |    |    |     |    |    |    |    |    |    |     |     |
| G15C          | ✓  | ✓  | ✓  | ✓  | ✓  |     |    |    |    |    |    |    |     |     |
| PPBT          | ✓  |     |    |    |    |     |    |    |    |    |    |    |     |     |
| D45NUM        | ✓  | ✓  | ✓  | ✓  | ✓  |     |    |    |    |    |    |    |     |     |
| M100          | ✓  |    |    |    |    |     |    |    |    |    |    |    |     |     |
| SPOHS         | ✓  | ✓  | ✓  | ✓  | ✓  |     |    |    |    |    |    |    |     |     |
| SPOH-TEMP     | ✓  | ✓  | ✓  | ✓  | ✓  |     |    |    |    |    |    |    |     |     |
| OH10          | ✓  | ✓  | ✓  | ✓  | ✓  |     |    |    |    |    |    |    |     |     |
| T101          | ✓  | ✓  | ✓  | ✓  | ✓  |     |    |    |    |    |    |    |     |     |
| MTC           | ✓  | ✓  | ✓  | ✓  | ✓  |     |    |    |    |    |    |    |     |     |
| QZ77          | ✓  | ✓  | ✓  | ✓  | ✓  |     |    |    |    |    |    |    |     |     |
| T400T         | ✓  | ✓  | ✓  | ✓  | ✓  |     |    |    |    |    |    |    |     |     |
| BOTQT         | ✓  | ✓  | ✓  | ✓  | ✓  |     |    |    |    |    |    |    |     |     |
| BWRC          | ✓  | ✓  | ✓  | ✓  | ✓  |     |    |    |    |    |    |    |     |     |

*All manipulatives available from Math Learning Center. Those items marked with an asterisk are included in the Bridges Grade 4 Package.

| GENERAL MATERIALS (PROVIDED BY THE TEACHER) | A3 | A4 | A5 | A6 | A9 | A10 | B1 | B2 | C1 | C3 | D1 | D3 | D6 | D10 | E2 |
|--------------------------------------------|----|----|----|----|----|-----|----|----|----|----|----|----|-----|-----|
| Computers/Internet Access                  | ✔  |    |    |    |    |     |    |    |    |    |    |    |     |     |
| Overhead or document camera                | ✓  | ✔  | ✔  |    |    |     |    |    |    |    |    |    |     |     |
| Blank overhead transparencies if you are using an overhead projector rather than a doc camera | 5  | 13 | 1  |    |    |     |    |    |    |    |    |    |     |     |
| 8.5” x 11” pastel copy paper, sheets per student |    |    |    |    |    |     |    |    |    |    |    |    |     |     |
| 8.5” x 11” lined or grid paper, sheets per student |    |    |    |    |    |     |    |    |    |    |    |    |     |     |
| 9” x 12” and 12” x 18” construction paper | ✓  |    |    |    |    |     |    |    |    |    |    |    |     |     |
| 12” x 18” newsprint                        |    |    |    |    |    |     |    |    |    |    |    |    |     |     |
| 3” x 3” sticky notes                       | ✓  |    |    |    |    |     |    |    |    |    |    |    |     |     |
| 6” x 9” manila or legal size envelopes (1 per student) | ✓  |    |    |    |    |     |    |    |    |    |    |    |     |     |
| Overhead pens (black, blue, red)           | ✓  |    |    |    |    |     |    |    |    |    |    |    |     |     |
| Dry-Erase markers                          | ✓  |    |    |    |    |     |    |    |    |    |    |    |     |     |
| Red and blue colored pencils or fine-tipped felt pens for student use | ✓  | ✔  | ✓  | ✓  | ✓  |     |    |    |    |    |    |    |     |     |
| Crayons                                    | ✓  | ✔  | ✓  | ✓  | ✓  |     |    |    |    |    |    |    |     |     |
| Scissors, class set                        | ✔  |    |    |    |    |     |    |    |    |    |    |    |     |     |
| Glue sticks, class set                     | ✔  |    |    |    |    |     |    |    |    |    |    |    |     |     |
| Scotch tape                                | ✓  |    |    |    |    |     |    |    |    |    |    |    |     |     |
| Masking Tape                               | ✓  |    |    |    |    |     |    |    |    |    |    |    |     |     |
| Protractors (class set)                    | ✓  |    |    |    |    |     |    |    |    |    |    |    |     |     |
| String (2 feet for each student pair)      |    |    |    |    |    |     |    |    |    |    |    |    |     |     |
| Rulers marked in inches & centimeters      |    |    |    |    |    |     |    |    |    |    |    |    |     |     |
| Yardstick(s)                               |    |    |    |    |    |     |    |    |    |    |    |    |     |     |
| Timer                                      |    |    |    |    |    |     |    |    |    |    |    |    |     |     |
| Helper jar containing a stick for each student labeled with his or her name |    |    |    |    |    |     |    |    |    |    |    |    |     |     |

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### Materials List

#### GENERAL MATERIALS (PROVIDED BY THE TEACHER)

<table>
<thead>
<tr>
<th>Item</th>
<th>A3</th>
<th>A4</th>
<th>A5</th>
<th>A6</th>
<th>A9</th>
<th>A10</th>
<th>B1</th>
<th>B2</th>
<th>C1</th>
<th>C3</th>
<th>D1</th>
<th>D3</th>
<th>D6</th>
<th>D10</th>
<th>E2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individual whiteboards, pens, and erasers (class set)</td>
<td></td>
<td></td>
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<td>Opt</td>
</tr>
<tr>
<td>20–24 cans and/or packages of food</td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>2 grocery sacks with handles</td>
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<td></td>
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<tr>
<td>2–3 bathroom scales</td>
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<tr>
<td>6 plastic containers of different sizes</td>
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<td>√</td>
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<tr>
<td>Pitcher that holds about 2 liters</td>
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</tr>
<tr>
<td>Cafeteria tray</td>
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<td>√</td>
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<tr>
<td>Towel</td>
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</tr>
<tr>
<td>An assortment of 8 or more beverage containers</td>
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</tbody>
</table>

#### CHILDREN'S BOOKS (PROVIDED BY THE TEACHER)

<table>
<thead>
<tr>
<th>Book Title</th>
<th>A3</th>
<th>A4</th>
<th>A5</th>
<th>A6</th>
<th>A9</th>
<th>A10</th>
<th>B1</th>
<th>B2</th>
<th>C1</th>
<th>C3</th>
<th>D1</th>
<th>D3</th>
<th>D6</th>
<th>D10</th>
<th>E2</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>How Much is a Million?</em> by David Schwartz</td>
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<tr>
<td><em>If You Made a Million</em> by David Schwartz</td>
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<td>Opt</td>
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<tr>
<td><em>On Beyond a Million</em> by David Schwartz</td>
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<tr>
<td><em>Can You Count to a Google?</em> by Robert E. Wells</td>
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<td>Opt</td>
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<tr>
<td><em>Is a Blue Whale the Biggest Thing There Is?</em> by Robert E. Wells</td>
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<td>Opt</td>
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<tr>
<td><em>Once Upon a Dime</em> by Nancy Kelly Allen*</td>
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</tr>
</tbody>
</table>

*Those items marked with an asterisk are included in the Bridges Grade 4 Package.*
GRADE 4 – UNIT 2

CCSS SUPPLEMENT ACTIVITIES & INDEPENDENT WORKSHEETS

Set A3: Numbers & Operations: Place Value to Millions
  Activity 1: Target Five .................................................... A3.1
  Activity 2: Charting One Million ........................................ A3.5
  Activity 3: Millions of Sport Spectators ............................... A3.9
  Ind. Worksheet 1: The Dodgers & the Yankees ....................... A3.15
  Ind. Worksheet 2: Big Numbers ........................................ A3.19
  Ind. Worksheet 3: Another Look at Big Numbers ..................... A3.21

Set A4: Numbers & Operations: Estimating to Multiply & Divide
  Ind. Worksheet 1: Using Compatible Numbers ....................... A4.1

Set B2: Algebra: Multiplication Comparisons & Equations
  Activity 1: Farmer Worth's Crops Extension ......................... B2.1
  Ind. Worksheet 1: Multiplication Comparisons & Equations ........ B2.3

Set A4: Numbers & Operations: Estimating to Multiply & Divide
  Ind. Worksheet 2: More Compatible Numbers ....................... A4.3

Set B2: Algebra: Multiplication Comparisons & Equations
  Ind. Worksheet 2: Multiplicative Comparisons with Coins ........ B2.5

Set D6: Measurement: Area & Perimeter
  Activity 1: Measuring Area .............................................. D6.1
  Activity 2: Measuring Perimeter ...................................... D6.9
  Activity 3: The Ladybugs’ Garden ..................................... D6.15
  Ind. Worksheet 1: Area & Perimeter Review ......................... D6.29
  Activity 4: Hexarights .................................................. D6.21
  Ind. Worksheet 2: Measuring Rectangles ............................ D6.33

*Published by The MATH LEARNING CENTER Salem, Oregon*
Set A3 ★ Activity 1

**Target 5**

**Overview**
Students play a game in which they build 5-digit numbers using dice, arranging them to form a number closest to a target. Then they read, write, compare, and order these whole numbers.

**Skills & Concepts**
- read, write, order, and compare whole numbers
- use expanded notation to represent numbers in different forms
- understand place value to 99,999 in various contexts

**You’ll need**
- Target 5 Record Sheet (page A3.3, run 1 copy on a transparency and a class set.)
- 2 dice marked 1–6
- 3 dice marked 4–9
- Student Math Journals or 1 piece of lined or grid paper per student

**Instructions for Target 5**
1. Let students know that you’re going to play a game with big numbers today. They will work as a team against you to see who can get closest to a 5-digit target number. Then select a student to roll 5 dice, one at a time. As the dice are rolled, line them up, left to right, to form a 5-digit target number. Write the target number at the top of the Target 5 Record Sheet overhead. Read the number with the class.

2. Give students each a copy of the Target 5 Record Sheet and ask them to write the target number at the top of the sheet. Explain that they’ll be keeping track of the numbers for both teams on their sheet as you do so at the overhead.

3. Decide who will go first, you or the students. Team 1 rolls all 5 dice and records the numbers. Team 1 then finds the combination of numbers that is closest to the 5-digit target number.
Activity 1 Target 5 (cont.)

Amy We rolled a 3, 5, 9, 2, 1.

Bryan The target number is 49,251. That means we’ll want the 3 in the ten thousands place.

Tamika But 5 is just as close to 4 as a 3.

Chae She’s right. I think we have to figure out the first two numbers together. Like 51 would be a lot closer to the 49 in our target number than the closest we could get with a 3…just 39.

Jen I agree. 39,000 is a lot further from 49,000 than 51,000 is.

After Team 1 settles on a number closest to the target, they need to say the number aloud so that you can record their answer for round one. Then, Team 2 (you, in this case) takes a turn.

<table>
<thead>
<tr>
<th>49,251</th>
</tr>
</thead>
<tbody>
<tr>
<td>Team 1: 3, 5, 9, 2, 1</td>
</tr>
<tr>
<td>Number We Made: 51,239</td>
</tr>
</tbody>
</table>

4. After both teams have finished the first round, work together to determine which team came the closest to the target number. That team wins round 1. Circle the winning number for the round. Take turns rolling the dice and recording solutions until each team has taken five turns. The team that gets closest to the target number in the most rounds, wins.

5. After the game is finished, ask the students to put their team’s 5 numbers in order, from least to greatest, recording their answers in their math journals. Ask them to read the numbers to their neighbors when they’re done to check their work.

Extensions

- Run multiple copies of the record sheet for students to play the game again with a partner. If some pairs finish early, provide them with extra dice and challenge them to play the game to the hundred thousands place or higher.
- Check your school library to see if you have any of the books listed below. If so, read one or more to the class to further explore place value with large numbers.
  - Can You Count to a Googol? by Robert E. Wells
  - How Much is a Million? by David Schwartz
  - If You Made a Million by David Schwartz
  - Is a Blue Whale the Biggest Thing There Is? by Robert E. Wells
  - Millions to Measure by David Schwartz
  - On Beyond a Million by David Schwartz
## Target 5 Record Sheet

<table>
<thead>
<tr>
<th></th>
<th>Digits We Rolled</th>
<th>Number We Made</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Team 1</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Team 2</strong></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Final Score</strong></td>
<td><strong>Team 1</strong></td>
<td><strong>Team 2</strong></td>
</tr>
</tbody>
</table>
Charting One Million

Overview
Students work together to make a chart of one million tiny squares. This activity is designed to help students understand some of the relationships between hundreds, thousands, ten thousands, hundred thousands, and millions.

Skills & Concepts
★ read, write, order, and compare whole numbers to one million and beyond
★ use expanded notation to represent numbers in different forms
★ understand place value to millions in various contexts

You'll need
★ Tiny Squares Grid (page A3.8, run 1 copy on a transparency and 100 copies)
★ several blank transparencies
★ overhead pens
★ tape
★ scissors

Instructions for Charting One Million
1. Place the Tiny Squares Grid on the overhead. Call students’ attention to the smallest square in the top left-hand corner. Ask them to think privately about how many of these tiny squares there are on the entire grid and give them about 15–20 seconds to examine the overhead quietly.
Activity 2  Charting One Million (cont.)

2. Turn off the overhead and ask them to pair-share their estimates. Invite volunteers to share their estimates with the class as you record them at the board.

<table>
<thead>
<tr>
<th>How many tiny squares are there on the grid? Estimates:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,000</td>
</tr>
<tr>
<td>1,000,000</td>
</tr>
<tr>
<td>2,500</td>
</tr>
</tbody>
</table>

3. Ask students to pair up, or assign partners. Give each pair 1 copy of the Tiny Squares Grid and ask them to work together to find out how many tiny squares there are. Encourage students to use efficient but accurate counting strategies. Let them know it’s fine to loop groups of squares or make other marks on the grids if that seems helpful. After they’ve had a few minutes to work, ask volunteers to share their answers as well as their counting methods. Place a blank transparency on top of the grid overhead so students can demonstrate their methods for the class.

Devon  When we first looked at the grid, we saw that the tiny square in the corner was part of a 10-by-10 square, like a hundreds mat in the base 10 pieces.

Brittany  Then we saw there were 10 of those little mats across the top, so that made 1,000.

Devon  After that, we counted the rows of 1,000 all the way down and it made 10,000 in all.

Ravi  We did kind of the same thing but we found 1,000 going down and then counted across. There are 10 lines of 1,000 so it’s 10,000 in all.

4. Divide the class into 10 groups. Some groups may have two students while others have three or even four depending on the size of your class. Ask them to keep their grids, and distribute enough extra copies so that each group has 10 grids in all. Have them cut out the 10 grids and tape them together to create one long strip. How many tiny squares are there in the strip of 10 grids? How do they know?

Jose  It’s 100,000 because each grid is 10,000. That’s 10, 20, 30, 40, 50, 60, 70, 80, 90, 100 thousand.

5. Have each group bring their grid to the bulletin board as you pin or tape them side-by-side to form a large square. How many tiny squares are there in this giant square? Ask students to pair-share their ideas and then invite volunteers to share and explain their answers. It may not be obvious to some students that the total is 1,000,000. Some may count by hundreds to determine that there are “a thousand thousands.” If, after some discussion, students haven’t mentioned a million, explain that a thousand thousands, or $1,000 \times 1,000$, is the same as one million. You might also ask students to identify the dimensions of the giant square (1,000 by 1,000) and multiply the numbers on their calculators to see the result.
Activity 2 Charting One Million (cont.)

6. Ask students to pair-share any observations they can make about the completed square of one million. Then have volunteers share their observations with the class. You may want to record some of their observations, print them out, and add them to the display. You might also have each student write an observation to post near the giant grid.

Extensions

- Glue the giant grid, along with students’ comments to butcher paper. Display on a classroom wall or in the hall.
- Read How Much is a Million? or If You Made a Million by David Schwartz to your class after you conduct this activity. Other books your students might enjoy include:
  - Can You Count to a Googol? by Robert E. Wells
  - Is a Blue Whale the Biggest Thing There Is? by Robert E. Wells
  - On Beyond a Million by David Schwartz
- Ask students to imagine the size and shape of a grid that had 10 million tiny squares, 100 million tiny squares, or even 1 billion tiny squares. Would a grid of a billion fit on your classroom wall? Why or why not? If not, where would it fit?
Tiny Squares Grid
Set A3 ★ Activity 3

Millions of Sport Spectators

Overview
Students explore place value into the millions during this activity.

Skills & Concepts
★ read, write, order, and compare whole numbers to one million and beyond
★ use expanded notation to represent numbers in different forms
★ understand place value to millions in various contexts

You’ll need
★ Sports Fans the World Over (pages A3.11–A3.13, run a class set)
★ calculators (class set)
★ overhead pens
★ Student Math Journals or 1 piece of lined or grid paper per student

Instructions for Millions of Sports Spectators
1. Open the activity with a brief discussion about sports. Which sports do the students in your class play? Which sports do they like to watch? Do they watch sports on TV or go to live games?

2. Explain that people enjoy sporting events the world over, and surprisingly large numbers attend live sporting events each year. Invite students to estimate how many people they think go to live college football games in the United States each year. Then write 36,814,468 on the whiteboard without reading the number to the class. Explain that this is the number of people who attended live college football games in 2006. Ask students to pair-share their ideas about what the number says. Then work with input from the class to label the number as shown below. Explain that the word “units” is crossed out because we know it but we don’t say it.

3. Read the number with your students and have them copy it into their journals. To help them get some sense of just how large this number is, tell them that the Astrodome in Houston, Texas, holds 62,439 football fans. About how many times would 36,814,468 people fill the Astrodome? Have them pair-share estimates and then ask them to use their calculators to find out. (36,814,468 football fans would fill the Astrodome almost 590 times!)

4. Now write the number 27,008,920 on the board without reading it to the class. Explain that this is the number of people who attended college basketball games in 2006. Work with student input to label the number. Then ask them to compare 36,814,468 and 27,008,920. Which number is greater? How do they know?
Activity 3  Millions of Sport Spectators (cont.)

5. Give each student a copy of Sports Fans the World Over. Review the instructions with the class and let them go to work. Encourage them to share and compare their answers. Circulate to provide help as needed.

INDEPENDENT WORKSHEET

See Set A3 Independent Worksheets 1–3 for more practice reading, writing, comparing, and ordering numbers to 999,999,999.
Sports Fans the World Over  page 1 of 3

Many people around the world enjoy going to sporting events such as baseball, soccer, and football games. In the United States 36,814,468 people went to college football games during the 2006–2007 season. You can use place value to help understand this number.

38,814,468 college football fans

If you were to read this number to someone over the phone, you’d say, “Thirty-six million, eight hundred fourteen thousand, four hundred sixty-eight.”

1 In the United States, 7,686,275 people went to women’s college basketball games during the 2006–2007 season. Label this number with its place values.

7,686,275 women’s college basketball fans

2 Write the number 7,686,275 out in words, the way you'd read it over the phone.

3 Soccer is one of the most popular games in the world. 5,501,381 people went to see the World Cup games in 2006. Label this number with its place values.

5,501,381 World Cup soccer fans

4 Write the number 5,501,381 out in words, the way you’d read it over the phone.

(Continued on back.)
Every 4 years, people from around the world gather to watch the Summer Olympics. The Olympics are held in a different country each year. The chart below shows the estimated populations of some of the countries that have hosted the Olympics. Use the information to solve the problems below.

<table>
<thead>
<tr>
<th>Name of Country</th>
<th>Year They Hosted the Summer Olympics</th>
<th>Estimated Population in 2006</th>
</tr>
</thead>
<tbody>
<tr>
<td>Greece</td>
<td>2004</td>
<td>10,688,058</td>
</tr>
<tr>
<td>Australia</td>
<td>2000</td>
<td>20,264,082</td>
</tr>
<tr>
<td>United States</td>
<td>1996</td>
<td>300,000,000</td>
</tr>
<tr>
<td>Spain</td>
<td>1992</td>
<td>40,397,842</td>
</tr>
<tr>
<td>South Korea</td>
<td>1988</td>
<td>48,846,823</td>
</tr>
</tbody>
</table>

a Which country on the chart had the largest estimated population in 2006? Which had the smallest?

b Compare the populations of some of these countries by writing the numbers and putting a greater than (> or less than (<) sign between them.

<table>
<thead>
<tr>
<th>Greece and Australia</th>
<th>10,688,058 &lt; 20,264,082</th>
<th>South Korea and Spain</th>
<th>The United States and Australia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spain and Greece</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Write the populations of the 5 countries in order from least to greatest on the lines below. Write the name of each country below its population number. Use abbreviations if you need to.

____________ < ____________ < ____________ < ____________ < ____________

(Continued on next page.)
Sports Fans the World Over  page 3 of 3

6  Go online to find out what the estimated population of the world is right now. Record the answer here.

The population of the world on ________________ is _________________________.

(month, day, year)
The Dodgers & The Yankees

20,137,408 people went to see the Los Angeles Dodgers play baseball between 2001 and 2006. That's twenty million, one hundred thirty-seven thousand, four hundred eight baseball fans!

Here's a chart that shows the place value of every digit in the number 20,137,408. Use the information on the chart to answer questions a–i below.

<table>
<thead>
<tr>
<th>100 Millions</th>
<th>10 Millions</th>
<th>Millions</th>
<th>100 Thousands</th>
<th>10 Thousands</th>
<th>Thousands</th>
<th>Hundreds</th>
<th>Tens</th>
<th>Ones</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>0</td>
<td>1</td>
<td>3</td>
<td>7</td>
<td>4</td>
<td>0</td>
<td>8</td>
<td></td>
</tr>
</tbody>
</table>

a The digit in the millions place is:

b The digit in the ten thousands place is:

c The digit in the hundred thousands place is:

d The digit in the ten millions place is:

e Are there any hundred millions in this number?

f The digit in the hundreds place is:

g The digit in the thousands places is:

h The digit in the ones place is:

i The digit in the tens place is:

(Continued on back.)
Independent Worksheet 1 The Dodgers & The Yankees (cont.)

2 The chart below shows the number of people who went to see the New York Yankees play baseball between 2001 and 2006. Use the information on the chart to answer questions a–d below.

<table>
<thead>
<tr>
<th>100 Millions</th>
<th>10 Millions</th>
<th>Millions</th>
<th>100 Thousands</th>
<th>10 Thousands</th>
<th>Thousands</th>
<th>Hundreds</th>
<th>Tens</th>
<th>Ones</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>2</td>
<td>2</td>
<td>6</td>
<td>2</td>
<td>5</td>
<td>6</td>
<td>4</td>
<td></td>
</tr>
</tbody>
</table>

a How many people watched the New York Yankees play baseball between 2001 and 2006? Write the number here with the commas placed correctly.

b Now write the number out in words, the way you'd read it over the phone.

c Are there any ten millions in this number? If so, how many?

d The digit in the hundreds place is

3 Did more people go to Dodgers or Yankees games between 2001 and 2006? Write the numbers on the lines below. Then put a greater than (>) or less than (<) symbol between them to compare the two.

_________________________  Dodgers  __________________________

Yankees

(Continued on next page.)
Independent Worksheet 1  The Dodgers & The Yankees (cont.)

4 Complete the chart to write and name some other very large numbers. The first one is done for you.

<table>
<thead>
<tr>
<th>Number</th>
<th>Number Written Out in Words</th>
</tr>
</thead>
<tbody>
<tr>
<td>example</td>
<td>Seven hundred twenty-four million, five hundred eighty-nine thousand, seven hundred forty-three</td>
</tr>
<tr>
<td>a 658,902,456</td>
<td></td>
</tr>
<tr>
<td>b 426,113,042</td>
<td>Five hundred sixty-two million, three hundred twenty-nine thousand, two hundred fifty-one</td>
</tr>
<tr>
<td>d</td>
<td>Five hundred sixty-two million, three hundred twenty-nine thousand, two hundred fifty-one</td>
</tr>
</tbody>
</table>

5 Write the five numbers above in order from least to greatest on the lines below.

_________ < __________ < __________ < __________ < __________
Big Numbers

1 Each weekend, Dylan and his dad go fishing. Dylan checks the odometer reading before each trip and records it in their mileage book. (An odometer is an instrument on the dashboard of a car that tells how far you’ve driven altogether.) Put these readings in the order that they would appear in the book, from least to greatest. The first one has been done for you.

- 93,102
- 89,776
- 95,004
- 91,204
- 90,089
- 91,438
- 99,173

2a Look at the following numbers. Circle the number that is the closest to 60,034.

- 60,000
- 60,100
- 60,200
- 60,300

b Circle the number closest to 194,321.

- 190,000
- 191,000
- 192,000
- 193,000
- 194,000
- 195,000

c Circle the number closest to 233,904.

- 230,000
- 231,000
- 232,000
- 233,000
- 234,000
- 135,000

d Circle the number closest to 234,900,032.

- 232,000,000
- 233,000,000
- 234,000,000
- 235,000,000

(Continued on back.)
Independent Worksheet 2  Big Numbers (cont.)

3a Amanda is sure she got the high score on a video game. But she's not sure what the number is. Please write it down for her.

She scored nine hundred forty-three million, two hundred sixty-one thousand, five hundred eighty-six.

b Caleb is positive he beat her score. His score was 925,298,199. Who got the highest score? How do you know?
Another Look at Big Numbers

1 The state of Texas has the second highest population in the U.S. with 22,859,968 people. Fill in the answers below, and then use the key to decode the name of the Texas state tree. Look at the key and write the letter that matches each number to the right of the number.

<table>
<thead>
<tr>
<th>Key: 5=A, 9=N, 2=C, 6=P, 8=E</th>
<th>Number</th>
<th>Letter</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>a</strong> Which digit is in the tens place?</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>b</strong> Which digit is in the hundred thousands place?</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>c</strong> Which digit is in the ten millions place?</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>d</strong> Which digit is in the ten thousands place?</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>e</strong> Which digit is in the thousands place?</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>f</strong> The Texas state tree is the</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2 Fill in the missing numbers.

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>a</strong> 90,106</td>
<td>90,107</td>
<td>____________</td>
<td>90,109</td>
</tr>
<tr>
<td><strong>b</strong> 826,998,996</td>
<td>____________</td>
<td>826,998,998</td>
<td></td>
</tr>
<tr>
<td><strong>c</strong> 2,384,209</td>
<td>____________</td>
<td>____________</td>
<td>2,384,212</td>
</tr>
<tr>
<td><strong>d</strong> 3,581,998</td>
<td>____________</td>
<td>____________</td>
<td>3,582,001</td>
</tr>
</tbody>
</table>

(Continued on back.)
3 Go on a big number hunt. Find at least one number greater than 100,000. Find at least one number greater than 1,000,000. Hint: Look in science books, around your classroom, on-line, and in the newspaper. Record the numbers below and write at least 2 sentences to describe what each one is about.
Using Compatible Numbers

Some people estimate answers to multiplication and division problems by using compatible numbers. Compatible numbers are numbers that make it easier to estimate the answer to a problem.

**example a**  A page has 11 words in one line and 28 lines on the page. About how many words on the whole page? If you don’t need an exact answer, you can estimate what $11 \times 28$ is by using compatible numbers.

11 is close to 10
28 is close to 30

$10 \times 30 = 300$, so the page has about 300 words.

**example b**  10 kids want to share 97 marbles equally. About how many marbles will they each get? If you don’t need an exact answer, you can estimate by using compatible numbers.

97 is close to 100.
10 is already a friendly number. You don’t have to change both numbers.

$100 \div 10 = 10$, so they’ll each get about 10 marbles.

**1a** Choose a chapter book from your classroom. Turn to a page in the middle of the book. About how many words do you think there are on the page? To find out, count the number of words in one line. Next, count the number of lines on the page. Record the information:

Words in one line: __________

Lines on the page: __________

(Continued on back.)
1b Use compatible numbers to estimate the number of words on the page. Show your work.

2 The 4th grade is taking a field trip to the zoo. There are 86 students. The bus company plans to use 3 buses. Estimate how many students will ride in each bus. Use compatible numbers to help you. Show your work.

3 Estimate the answers to the following division problems. Use compatible numbers to help you. Show your work. The first one is done for you.

| example      | 89 ÷ 10
|--------------|--------
| 89 is close to 90. | 90 ÷ 10 = 9, so the answer is about 9. |
| a            | 25 ÷ 4
| b            | 39 ÷ 4
| c            | 48 ÷ 10

4 Use compatible numbers to estimate the answer to 24 × 21. Use a calculator to check your answer. How close was your estimate?
**Set B2 ★ Activity 1**

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**Farmer Worth's Crops Extension**

**Overview**
After students complete Farmer Worth's Crops Student Book page invite them to interpret a multiplication equation as a comparison and a verbal statement of a comparison as an equation on a white board or journal page.

**Skills & Concepts**
- Interpret a multiplication equation as a comparison (CCSS 4.OA.1)
- Represent verbal statements of multiplicative comparisons as multiplication equations. (CCSS 4.OA.1)

**You'll Need**
- ★ Once Upon a Dime by Nancy Kelly Allen
- ★ Farmer Worth’s Crops Student Book page 38
- ★ Whiteboards or journal page

**Instructions for Farmer Worth’s Crops Extension**

1. Have students complete Farmer Worth’s Crops Student Book page

2. Pose the following problems orally to the class. Ask students to write the comparison as a multiplication equation on a white board with markers or in a journal page. Do the first problem together.
   - a. $5.00 is 100 times as much as 5 cents.
   - b. $5.00 is also 5 times as much as 100 pennies.
   - c. $10.00 is ______ times as much as 10 cents.
   - d. $10.00 is also 10 times as much as ______.
   - e. $25.00 is ______ times as much as 25 cents.
   - f. $25.00 is also 25 times as much as ______
   - g. $100 is ______ times as much as $1

3. Invite students to share their equation and explain their reasoning with the class.

<table>
<thead>
<tr>
<th>PROBLEM</th>
<th>ANSWER</th>
<th>EQUATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>a $5.00 is 100 times as much as 5 cents.</td>
<td>$100 \times 5\text{c} = $5.00</td>
<td>100 \times 5\text{c} = $5.00</td>
</tr>
<tr>
<td>b $5.00 is also 5 times as much as 100 pennies</td>
<td></td>
<td>5 \times 100\text{c} = $5.00</td>
</tr>
<tr>
<td>c $10.00 is ______ times as much as 10 cents.</td>
<td>100</td>
<td>100 \times 1\text{d} = $10.00</td>
</tr>
<tr>
<td>d $10.00 is also 10 times as much as ______.</td>
<td>$100 \times 1\text{d} = $10.00</td>
<td>10 \times 1\text{d} = $10.00</td>
</tr>
<tr>
<td>e $25.00 is ______ times as much as 25 cents.</td>
<td>100</td>
<td>100 \times 25\text{c} = $25.00</td>
</tr>
<tr>
<td>f $25.00 is also 25 times as much as ______</td>
<td>$100 \times 25\text{c} = $25.00</td>
<td>25 \times 1\text{d} = $25.00</td>
</tr>
<tr>
<td>g $100 is ______ times as much as $1.</td>
<td>100</td>
<td>100 \times 1\text{d} = $100</td>
</tr>
</tbody>
</table>
4. Repeat steps 2 and 3 using the multiplicative comparisons with money listed below.

<table>
<thead>
<tr>
<th>PROBLEM</th>
<th>ANSWER</th>
<th>EQUATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>a $15.00 is ______ times as much as $5.</td>
<td>3</td>
<td>$3 \times $5.00 = $15.00</td>
</tr>
<tr>
<td>b $15.00 is also 5 times as much as ________</td>
<td>$3.00</td>
<td>$5 \times $3.00 = $15.00</td>
</tr>
<tr>
<td>c $1.00 is ______ times as much as 25 cents.</td>
<td>4</td>
<td>$4 \times 25¢ = $1.00</td>
</tr>
<tr>
<td>d $1.00 is also 25 times as much as ________</td>
<td>$0.04</td>
<td>$25 \times $0.04 = $1.00</td>
</tr>
<tr>
<td>e $1.00 is ______ times as much as 20 cents.</td>
<td>5</td>
<td>$5 \times 20¢ = $1.00</td>
</tr>
<tr>
<td>f $1.00 is also 20 times as much as ________</td>
<td>$0.05</td>
<td>$20 \times 5¢ = $1.00</td>
</tr>
</tbody>
</table>

**CHALLENGE**

Challenge students to write their own multiplicative comparison with money. Suggest they use international money (like Australian) that deals with dollars, or other currency like pounds/pesos. Students can locate necessary information on the internet. Have students share their problems and invite the class to write equations to solve them.
Set B2 ★ Independent Worksheet 1

**Multiplication Comparisons & Equations**

Choose at least 3 of the problems below to solve in your journal. Record each problem number then write an equation to show your work.

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Ben is three years old. His brother is four times older. How old is his brother?</td>
</tr>
<tr>
<td>2</td>
<td>Anna's dad is 40. He is eight times her age. How old is Anna?</td>
</tr>
<tr>
<td>3</td>
<td>Jose's puppy joined the family 3 months ago. His older dog has been with the family five times that long. How long has the older dog been with the family?</td>
</tr>
<tr>
<td>4</td>
<td>Our class has recess for 15 minutes each day. The first graders have recess four times longer. How long do they have recess?</td>
</tr>
<tr>
<td>5</td>
<td>Sally washes her hands for 10 seconds before lunchtime. I wash my hands 5 times longer. How long do I wash my hands?</td>
</tr>
<tr>
<td>6</td>
<td>Rene has six times more baseball cards than Joey. If Joey has 4 cards, how many does Rene have?</td>
</tr>
<tr>
<td>7</td>
<td>I collected 5 times as many pieces of candy from the piñata as Jolie. If she collected 7, how many did I get?</td>
</tr>
<tr>
<td>8</td>
<td>Caleb takes six times longer to clean his room than it takes his friend, John. If it takes John ten minutes, how long does it take Caleb?</td>
</tr>
</tbody>
</table>
Set A4 ★ Independent Worksheet 2

More Compatible Numbers

1 Which 2 numbers in the box could you multiply to come closest to 420? Show your thinking.

39  47  5  11  62  87  26

2 Estimate the answers to the following multiplication problems. Use compatible numbers to help you. Show your work.

Example 19 × 6 =

- 19 is close to 20
- 6 is close to 5
- 20 × 5 = 100
- My estimate is 100

a 39 x 12

b 84 × 9 =

3 Estimate the answers to the following division problems. Use compatible numbers to help you. Show your work.

a About how much does each can of soda cost if a 6-pack costs $1.19?

b Abbie and her 3 friends want to split a bag of 72 peanuts equally. About how many peanuts will each of the 4 children get?

(Continued on back.)
CHALLENGE

4 Estimate 726 ÷ 11. Record and explain your estimate. Use a calculator to check your answer. How close was your estimate?
Multiplication Comparisons with Coins

1 Write a multiplication equation for each problem. Then write a multiplicative comparison to show how much each group of coins is worth.

<table>
<thead>
<tr>
<th>Group of Coins</th>
<th>Multiplication Equation</th>
<th>Multiplicative Comparison</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ex</strong> 5 nickels</td>
<td>$5 \times 5\text{¢} = 25\text{¢}$</td>
<td>25¢ is 5 times as much as a nickel</td>
</tr>
<tr>
<td><strong>a</strong> 15 nickels</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>b</strong> 20 dimes</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>c</strong> 30 dimes</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>d</strong> 8 quarters</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>e</strong> 12 quarters</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>f</strong> 17 quarters</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

CHALLENGE

2 Write your own problem. Tell what coin is used and how many coins are in the group. Write a multiplication equation and multiplicative comparison.
Set D6 ★ Activity 1

Measuring Area

Overview
Students review the term area and work together to generate a formula for determining the area of rectangles and squares. In the process, they have an opportunity to see and handle a square inch and a square foot. Then they apply the information as they work in pairs to find the area of various items around the classroom.

Skills & Concepts
★ determine the perimeters and areas of squares and other rectangles using formulas and explain why the formulas work

You’ll need
★ Measuring Area (page D6.4, run a class set)
★ one 12” × 12” piece of red construction paper
★ 10” × 18” blue construction paper (1 piece for every 4 students)
★ rulers (class set)
★ yardsticks and measuring tapes
★ masking tape
★ calculators (optional, class set)
★ Student Math Journals or 1 piece of lined or grid paper per student
★ Word Resource Cards Area, Dimension (pages D6.5 and D6.6 & D6.7 and D6.8, run 1 copy back to back on cardstock, cut out each card)

Instructions for Measuring Area
1. Post the Word Resource Card for area on the board. Ask students to pair-share what they know about this term. After a minute or two, invite volunteers to share their ideas with the class. As the discussion unfolds, review the following concepts:
   • area is a measure of how much surface something takes up.
   • area is measured in square units such as square inches, square feet, or square miles.

2. Hold up a single tile and ask students to report its area in square inches. If necessary, have a volunteer measure the dimensions of the tile and work with the class to establish the fact that it's exactly 1 square inch. Use a loop of masking tape to fasten the tile to the board. Work with class input to label its dimensions and area.

3. Distribute sets of tile. Ask students to work in groups of four to build a square with an area of exactly 144 square inches. After they've had a few minutes to work, have them share and compare their results.
Students We thought it was going to be really big, but it's not so big after all.
We knew it was going to be a 12" × 12" square because 12 × 12 is 144.
We each made 3 rows of 12 and put them together. It went pretty fast for us.

4. Ask each group to measure the dimensions of the square they've just built with the inch side of their ruler. What can they tell you about the square now? As volunteers share with the class, press them to explain their thinking.

Alex It's 12 inches on both sides.

Teacher What is the area of your square, and how do you know?

Students It's 144 square inches because that's what you told us to do.
It's 144 square inches because we used 144 tiles, and each tile is 1 square inch.
You can see a 10 × 10 square inside the 12 × 12. Then just add 12 on the top and bottom, and 10 on both sides. It makes 144 in all.
It's 12 rows of 12. If you just multiply 12 × 12, you get 144.

5. Show students the 12" × 12" square of red construction paper you've prepared. Ask a volunteer to compare the paper to the tile square at his or her table. After confirming that the two are the same size, fasten the paper square to the board. Work with class input to label its dimensions and area. Explain that because it is 12" or 1 foot on each side, it's called a square foot, and record this information on the board.

6. Give each group a 10" × 18" piece of blue construction paper. Ask them to find the area of this rectangle, using their rulers and/or the tile to help. Challenge them to find a more efficient method than covering the entire rectangle with tile. Have them each record the answer, along with any computations they made, in their journals.

7. When they've had a few minutes to work, ask students to share their answers and explain how they found the area of the rectangle. Record their strategies at the board.
18”

It’s 10 tiles along the side and 18 along the top. 10 rows of 18 is 180.
If you count by 10’s it’s 180.
10” × 18” = 180 sq. in.

8. Chances are, some students will have compared the paper rectangle to the tile square at their table to find the side lengths, and then used some kind of counting strategy to find the area. Others may have done the same but multiplied the dimensions to find the area. Still others may have measured the dimensions with their rulers and multiplied. If the third strategy doesn’t come from the students, tape one of the 10” × 18” pieces of paper to the board and model it yourself.

9. Post the Word Resource Card for dimension on the board. Explain that to find the area of a square or a rectangle, we measure its dimensions and multiply the 2 numbers. Press students to explain how and why this works, and then work with input from the class to write the general formula for the area of a rectangle: area = length × width or $A = lw$.

10. Explain that in a minute, students will be working in pairs to find the area of some things around the classroom. Ask them to look around. Can they spot anything they’d measure in square inches? What about the calendar grid pocket chart or the whiteboard? Would they find the area of these in square inches or square feet?

   Students I’d use square inches to find out the area of small stuff like my math journal or probably my desk.
   I’d maybe use square feet instead of square inches to get the area of the calendar chart.
   I’d definitely use square feet to measure the area of the rug or the whole room.

11. Give students each a copy of the Measuring Area worksheet. Examine the chart together and explain the tasks as needed. Make sure they know where to find the yardsticks and measuring tapes as they need them. Then ask them to work in pairs to complete the sheet.

   Note Advise students to work to the nearest inch in measuring the dimensions of the items listed on the worksheet. You might also allow them to use calculators to help with the computation, especially if some of your students aren’t yet completely fluent with 2-digit by 2-digit multiplication.
# Measuring Area

<table>
<thead>
<tr>
<th>Find the area of each item listed below.</th>
<th>Dimensions (Measure to the nearest inch and show your units: inches or feet)</th>
<th>Area (Show your work and label the answer with the correct units.)</th>
</tr>
</thead>
</table>
| example A piece of blue construction paper | Length = 18”  
Width = 10” | $18” \times 10” = 180 \text{ sq. in.}$ |
| 1 Your math journal | | |
| 2 Your desk or table | | |
| 3 A geoboard | | |
| 4 Calendar Grid pocket chart | | |
| 5 The top of a bookshelf | | |
| 6 The front of a chapter book | | |
| 7 A Calendar Grid marker | | |
| 8 A work table larger than the one where you sit | | |
| 9 The whiteboard | | |
| 10 The classroom | | |
Set D6 Measurement: Area & Perimeter Blackline  Run 1 copy back to back with D6.6 on cardstock, cut out the card.

area
Working Definition

area: the total number of square units needed to cover a 2-dimensional surface
Run 1 copy back to back with D6.8 on cardstock, cut out the card.
Working Definition

**dimension:** length, width, or depth
Set D6 ★ Activity 2

Measuring Perimeter

Overview
Students review the terms area and perimeter, and find the perimeter of a rectangular and a square piece of construction paper. Together, they generate formulas for determining the perimeter of rectangles and squares. Then they apply the information as they work in pairs to find the perimeter of various items around the classroom.

Skills & Concepts
★ determine the perimeters and areas of squares and other rectangles using formulas and explain why the formulas work

Recommended Timing
Anytime after Set D6 Activity 1

Instructions for Measuring Perimeter
1. Post the Word Resource Cards for area and perimeter on the board. Ask student pairs to compare and contrast the two terms. How are they alike? How are they different? After a minute or two, invite volunteers to share their ideas with the class. As the discussion unfolds, review the following concepts:
   • area and perimeter are both measurements.
   • area is a measure of how much surface something takes up.
   • area is measured in square units such as square inches, square feet, or square miles.
   • perimeter is a measure of the total distance around something.
   • perimeter is measured in linear units such as inches, feet, yards, or miles.

2. Explain that you’ll be working with perimeter today. Have students pair up or assign partners, and ask them to get out their rulers and math journals. Give each pair a 9” × 12” sheet of construction paper without mentioning the dimensions. Ask them to use the inch side of their ruler to find the perimeter, or the total distance around the paper. Have them each record the answer, along with any computations they made, in their journals.
3. When they've had a couple of minutes to work, ask students to share their answers and explain how they found the perimeter of the paper. Use numbers and labeled sketches to record the strategies they share.

4. Chances are, some students will have added all 4 side lengths, while others may have multiplied each of the lengths by 2 and then added. If the second strategy doesn't come from the students, model it yourself. Then work with input from the class to write a general formula for finding the perimeter of a rectangle: perimeter = 2 × the width + 2 × the length, or \( P = 2w + 2l \).

5. Hold up the 12" square of construction paper. Ask students to estimate the perimeter of this square based on the measurements they just made. It's fine if they want to set one of the 9" × 12" sheets directly on top of the square to help make a more accurate estimate. Record their estimates on the board. Then have a volunteer measure one of the sides of the square and share the measurement with the class. Ask students how they can use that information to find the perimeter. Is it possible to do so without measuring the other 3 side lengths?

   **Students**  
   Sure! It's a square, so all the sides are the same.
   Just add 12 four times.
   Or you could multiply 12 × 4 to get the answer. It's 48 inches.

6. Work with input from the class to write a general formula for finding the perimeter of a square: perimeter = 4 × the length of one side, or \( P = 4s \).

7. Ask students to consider the following question: If there are 12" in a foot, what is the perimeter of the paper square in feet? Have them give the thumbs-up sign when they have the answer and then invite a couple of volunteers to share their thinking.

   **Students**  
   Each side is a foot, so it's 4 feet all the way around.
   Also, it's 48 inches and 48 ÷ 12 = 4, so that's 4 feet.
   Wow! That's pretty big around. My little sister isn't much taller than about 4 feet.

8. Explain that in a minute, students will be working in pairs to measure the perimeter of some things around the classroom. Ask them to look around. Can they spot anything they’d measure in inches? What about the calendar grid pocket chart or the whiteboard? Would they find the perimeter of these in inches or feet? Hold up a yardstick and ask them if there's anything in the room with a perimeter it would make most sense to measure in yards.

   **Students**  
   I'd use inches to find out the perimeter of small stuff like a book or probably my desk.
   I'd definitely use feet instead of inches to get the perimeter of the whiteboard.
   I'd use yards to measure the perimeter of the rug or the whole room.
9. Give students each a copy of the Measuring Perimeter worksheet. Examine the chart together and explain the tasks as needed. Ask students if they need to measure the length of every side in order to find the perimeter of their math journal or their desk. Why not?

Make sure they know where to find the yardsticks and measuring tapes as they need them. Then ask them to work in pairs to complete the sheet.

**Note**  Advise students to work to the nearest inch in measuring the side lengths of the items listed on the worksheet.
### Measuring Perimeter

<table>
<thead>
<tr>
<th>Find the perimeter of each item listed below.</th>
<th>Side Lengths (Include units: inches, feet, or yards)</th>
<th>Circle the formula you need to find the perimeter.</th>
<th>Perimeter (Show your work and label the answer with the correct units.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>example A piece of green construction paper</td>
<td>9&quot; and 12&quot;</td>
<td>( P = 2w + 2l )</td>
<td>( (2 \times 9) + (2 \times 12) = 42&quot; )</td>
</tr>
<tr>
<td>1 Your math journal</td>
<td></td>
<td>( P = 2w + 2l )</td>
<td>( P = 4s )</td>
</tr>
<tr>
<td>2 Your desk or table</td>
<td></td>
<td>( P = 2w + 2l )</td>
<td>( P = 4s )</td>
</tr>
<tr>
<td>3 A geoboard</td>
<td></td>
<td>( P = 2w + 2l )</td>
<td>( P = 4s )</td>
</tr>
<tr>
<td>4 Calendar Grid pocket chart</td>
<td></td>
<td>( P = 2w + 2l )</td>
<td>( P = 4s )</td>
</tr>
<tr>
<td>5 The top of a bookshelf</td>
<td></td>
<td>( P = 2w + 2l )</td>
<td>( P = 4s )</td>
</tr>
<tr>
<td>6 A base 10 mat</td>
<td></td>
<td>( P = 2w + 2l )</td>
<td>( P = 4s )</td>
</tr>
<tr>
<td>7 The whiteboard</td>
<td></td>
<td>( P = 2w + 2l )</td>
<td>( P = 4s )</td>
</tr>
<tr>
<td>8 The classroom</td>
<td></td>
<td>( P = 2w + 2l )</td>
<td>( P = 4s )</td>
</tr>
</tbody>
</table>
perimeter
Working Definition

perimeter: the distance in linear units around a figure

perimeter: the distance in linear units around a figure
Set D6 ★ Activity 3

The Ladybugs’ Garden

Overview
The Ladybugs are planning their spring garden. They have exactly 24 centimeters of fencing, and they want to make a rectangular garden. Students investigate relationships between area and perimeter as they develop the best plan for the Ladybugs’ garden.

Skills & Concepts
★ determine the perimeters and areas of squares and other rectangles using formulas and explain why the formulas work
★ demonstrate that rectangles with the same area can have different perimeters, and that rectangles with the same perimeter can have different areas
★ solve single- and multi-step contextual problems involving perimeters and areas, and justify the solutions

Recommended Timing
Anytime after Set D6 Activity 2

You’ll need
★ The Ladybugs’ Garden (page D6.18, 1 copy on a transparency)
★ Centimeter Grid Paper (page D6.19, class set)
★ overhead pens
★ a piece of paper to mask parts of the overhead
★ rulers (class set)

Instructions for The Ladybugs’ Garden
1. Give students each a sheet of Centimeter Grid Paper and ask them to get out their pencils and rulers. Show the prompt at the top of the Ladybugs’ Garden overhead. Read it with the class and clarify as needed. Give them a few minutes to draw a rectangle on their grid paper that has a perimeter of exactly 24 centimeters.

2. Then invite a volunteer up to the overhead to share his or her work with the class.

Beckett  I started by drawing a line that was 10 centimeters along the top. That just seemed like a good length. Then I drew 2 centimeters down. That added up to 12, and I realized that it would take 12 more to make the rest of the rectangle. It turned out kind of skinny, but it worked.
3. Have your volunteer label each side of his or her rectangle with its length and sit down again. Then ask the rest of the class to write 2 equations on the back of their grid paper, one for the perimeter and one to determine the area of the rectangle. Remind them to label their answers with the correct units. Have them pair-share their work as they finish. Work with input from the class to label the rectangle with its area and write the two needed equations at the overhead. Take the opportunity to review the formulas for finding the perimeter and area of a rectangle, and ask students to correct their work if necessary.

4. Have a student who responded differently to the original prompt draw and label his or her rectangle at the overhead. (If no one had a different response, volunteer one of your own.)

**Delia** I started with 8 centimeters along the top and then drew 4 down. I saw that was 12, so I just did the same thing for the bottom and the other side. It’s 24 in all.

5. Confirm with the class that both rectangles have a perimeter of 24 centimeters. Even before they calculate the area of the second rectangle, would they say the areas are the same or different?

**Students** The second one looks bigger.

*I’m pretty sure there’s more space in the second one.*

*That’s weird because they both have the same amount of fence around the outside.*
6. Ask students to write 2 equations for the second rectangle on the back of their grid paper, one for the perimeter and one for the area. Then work with their input to label the second rectangle with its area and write both equations at the overhead. Is the area of the second rectangle the same as the first or different? Ask students to pair share ideas about why the areas are different even though the perimeters are the same. Then invite volunteers to share their thinking with the class.

**Students**  
The one that's long and skinny doesn't have as much area.  
It's like when you make the sides shorter, you get more room in the middle.  
The first rectangle I drew has even more space in the middle.

7. Then reveal the rest of the overhead. Read it with the class and clarify as needed. Let them know that they need to find at least 4 different rectangles, and it's fine if one is a square because squares are also rectangles. Make sure students understand that a 2 × 10 and a 10 × 2 don't count as 2 different rectangles. Ask them to respond to questions 3 and 4 on the back of their grid paper.

8. When most students have finished, reconvene the class to share and compare their results. They'll find that there are 6 different rectangles with a perimeter of 24 cm: 1 × 11, 2 × 10, 9 × 3, 8 × 4, 7 × 5, and 6 × 6. Each has a different area (11 sq cm, 20 sq cm, 27 sq cm, 32 sq cm, 35 sq cm, and 36 sq cm respectively), the square having the most. Encourage students to continue to explain why the areas vary from one rectangle to the next. (The closer rectangles with the same perimeter get to being square, the larger their area. Some students may be interested to know that a circle is the shape that has the maximum area for any given perimeter.) Also encourage students to discuss and debate the best rectangle for the Ladybugs' garden. Some may feel that the 6 × 6 is best because it offers the most space. Others may believe that the 3 × 9 or 4 × 8 is better because it's easier to water all the plants, including ones in the middle.

**INDEPENDENT WORKSHEET**

See Set D6 Independent Worksheets 1 and 2 for more practice selecting and using appropriate units and formulas to determine area and perimeter.
The Ladybugs’ Garden

1 The Ladybugs are planning to plant a garden this spring. They want it to be rectangular. They have exactly 24 centimeters of fencing put around the perimeter of their garden. Sketch a plan for them on your grid paper.

2 Now sketch as many different rectangles as you can find that have a perimeter of 24 centimeters. Label each one with its perimeter and area, along with equations to show how you got the answers. Note: The sides of your rectangle must lie on the grid lines.

3 All of your rectangles have a perimeter of 24 centimeters. Do they all have the same area? Why or why not?

4 Which rectangle would work best for the Ladybugs’ garden? Explain your answer.
Centimeter Grid Paper
Set D6 ★ Independent Worksheet 1

### Area & Perimeter Review

**Perimeter** is the distance all the way around a figure. Perimeter is measured in linear units like centimeters, meters, inches, feet, and yards.

**Area** is the amount of surface a figure covers. Area is measured in square units like square centimeters, square meters, square inches, square feet, and square yards.

![Area and Perimeter Diagram](image)

1. Use the centimeter side of your ruler to measure the dimensions (the length and width) of each rectangle on the next page. Then find its area and perimeter using the formulas below. Show your work.

   - **Perimeter** = \((2 \times \text{the width}) + (2 \times \text{the length})\)  
     
   - **Area** = \(\text{length} \times \text{width}\)

   **example**

   ![Example Rectangle](image)

   Perimeter: \((2 \times 3) + (2 \times 12) = 30 \text{ cm}\)

   Area: \(12 \times 3 = 36 \text{ sq. cm}\)

(Continued on back.)
2 Jamie says you only need to measure one side of a square to find its perimeter. Do you agree with her? Why or why not? Use numbers, labeled sketches, and words to explain your answer.
3 Hector says you have to measure the length of every side of this figure to find its perimeter. Do you agree with him? Why or why not? Use numbers, labeled sketches, and words to explain your answer.

4 Which equation shows how to find the perimeter of this rectangle?

- $3 \times 8 = 24 \text{ ft.}$
- $(2 \times 3) + 8 = 14 \text{ ft.}$
- $(2 \times 3) + (2 \times 8) = 22 \text{ ft.}$
- $4 + 8 = 12 \text{ ft.}$

5 Mr. Hunter is trying to find the distance from one end of his whiteboard to the other. Mr. Hunt is measuring:

- the board's area
- the board's length
- the board's perimeter

6 Which of these situations is about perimeter?

- determining the number of tiles needed to cover a floor
- determining how many feet of fencing is needed to surround a rectangular yard
- determining the width of a table

7 Beckett and his mom are going to paint the living room. They need to measure the room so they know how much paint to buy. They should measure the wall in:

- square centimeters
- square feet
- square inches
- square miles

(Continued on back.)
8. This rectangle has an area of 45 square feet. What is the missing measure? Show your work.

? ft.

5 ft. 45 sq. ft.

9. Tom wants to find the area of his school's basketball court. Which formula should he use? (circle one)

\[ A = l + w \quad A = l \times w \quad A = l - w \quad A = (2 \times w) + (2 \times l) \]

10. Alexandra and her dad build a deck in their backyard. It had an area of 48 square feet and a perimeter of 28 feet. Circle the drawing that shows the deck they built. Use numbers, labeled sketches, and words to explain your answer.
Set D6 ★ Activity 4

Hexarights

Overview
Students continue to investigate relationships between area and perimeter as they measure and construct polygons called "hexarights" (hexagons with pairs of adjacent sides that meet at right angles).

Skills & Concepts
★ determine the perimeters and areas of squares and other rectangles using formulas and explain why the formulas work
★ determine the areas of nonrectangular figures that can be composed or decomposed into rectangles
★ demonstrate that rectangles with the same area can have different perimeters, and that rectangles with the same perimeter can have different areas
★ solve single- and multi-step contextual problems involving perimeters and areas, and justify the solutions

Instructions for Hexarights
1. Show the top portion of Introducing Hexarights at the overhead, masking the rest with a piece of paper. Give students a minute to pair-share any observations they can make. Then invite volunteers to share their thinking with the class. Record some of their ideas in the space to the left of the shape.

2. Then reveal the definition below the shape, still keeping the rest of the overhead covered. Read and discuss it with the class. As you do so, review the meanings of the terms hexagon, perpendicular, and right angles.

Recommended Timing
Anytime after Set D6 Activity 2

You’ll need
★ Introducing Hexarights (page D6.24, 1 copy on a transparency)
★ Measuring Hexarights (page D6.25, half-class set, cut in half)
★ Hexarights, Perimeter = 24 cm (page D6.26, class set)
★ Centimeter Grid Paper (page D6.27, class set, plus a few extra)
★ piece of paper to mask parts of the overhead
★ 2 or 3 transparencies and overhead pens
★ rulers marked with both centimeters and inches (class set)

Introducing Hexarights
1. Describe this shape.
   • has 6 sides
   • has 5 maybe 6 right angles
   • has parallel lines
   • some of the lines are perpendicular
   • kind of like 2 rectangles stuck together
   • none of the lines are the same length

This shape is a hexagon because it has 6 sides, but let’s call it a hexaright. A hexaright is a hexagon in which sides that touch each other are perpendicular (That is, they meet at right angles.)
3. Next, reveal the two counter-examples shown in the middle of the overhead. Can students explain why neither of these are hexarights? Have them share at the overhead so their classmates can see what they’re talking about.

**Introducing Hexarights**

1. Describe this shape.
   - has 6 sides
   - has 5 maybe 6 right angles
   - has parallel lines
   - some of the lines are perpendicular
   - kind of like 2 rectangles stuck together
   - none of the lines are the same length

   This shape is a hexagon because it has 6 sides, but let's call it a hexaright. A hexaright is a hexagon in which sides that touch each other is perpendicular (That is, they meet at right angles.)

2. Here are 2 examples of shapes that are not hexarights. Can you see why?

   ![hexaright examples](image)

**Students**

Shape a isn't a hexaright because there are 2 angles that aren't right angles.

I thought they were wrong about shape b because it's all right angles, but then I realized there are 10 sides! A hexaright can only have 6 sides.

4. Now show the 2 hexarights at the bottom of the overhead and briefly discuss strategies for finding the area and perimeter of each. Then give students each a copy of the Measuring Hexarights half-sheet. Ask them to experiment with both the inch side and the centimeter side of their rulers. Which unit of measure works best? Students will quickly discover that most of the measurements don't come out evenly unless they use centimeters.

5. Solicit agreement from the class that they’ll work in centimeters and square centimeters rather than inches and square inches, and let them get started. Encourage them to share and compare their strategies and solutions as they work.

6. When most students have finished finding the perimeter and area of at least one of the hexarights, place a blank transparency on top of the overhead and invite volunteers to share their work with the class. Move or replace the transparency each time a new volunteer comes up to the overhead to accommodate several different presentations. Here is an example of the sort of work you might expect from students, although some will divide the hexarights differently.
7. As students share, discuss the methods they're using to find the area and perimeter of these shapes. Did they use the perimeter formulas they developed during Set D6 Activity 2? Why not? (Because these are irregular polygons. All you can do is simply add all the different side lengths.) Did they use the area formula they developed during Measurement—Area Perimeter Activity 1? How? (To find the area without covering the shape with centimeter square units or drawing them in, you need to divide each hexaright into 2 rectangles. Then you can use \( A = lw \) to find the area of each rectangle and add these areas to get the area of the hexaright.)

8. After 2 or 3 strategies have been shared for each hexaright, explain that there is more than one hexaright with a perimeter of 24 centimeters. Give students each a copy of Hexarights, Perimeter = 24 cm. Review the instructions together and clarify as needed. Place a small stack of the Centimeter Grid Paper on each table and give students the remainder of the math period to work. Encourage them to share and compare their strategies for finding other hexarights with perimeters equal to 24 centimeters. What are some of the areas that result? Are they all equal?

Reconvene the class to share strategies and solutions either at the end of the period or at another time.

**Note**  “Hexaright” is not some long-forgotten concept from your high school geometry days. It is a made-up term borrowed from Measuring Up: Prototypes for Mathematics Assessment (Mathematical Sciences Education Board National Research Council, 1993. Washington, DC: National Academy Press). You may want to let students know this so that they won’t expect to see, or use it on standardized tests.
Introducing Hexarights

1 Describe this shape.

This shape is a hexagon because it has 6 sides, but let's call it a *hexaright*. A *hexaright* is a hexagon in which sides that touch each other are perpendicular. (That is, they meet at right angles.)

2 Here are 2 examples of shapes that are *not* hexarights. Can you see why?

3 Find the area and perimeter of the hexarights below.
Measuring Hexarights

Find the area and perimeter of the hexarights below. Show all your work.
Hexarights, Perimeter = 24 cm

1 Draw 2 different hexarights with a perimeter of 24 cm, and find the area of each. Then draw a third hexaright with a perimeter of 24 cm. This time, make the area as large as you can.

2 You can use the space below and the back of this sheet. Or, you can draw your hexarights on centimeter grid paper, cut them out, and glue them to this sheet. Use your ruler to help make the lines straight and accurate.

3 Label your hexarights with their dimensions, perimeter, and area. Use numbers, sketches, and/or words to show how you found the perimeter and area of each hexaright.

4 On the back of the sheet, write at least 2 sentences to describe what you found out about the areas of hexarights with a perimeter of 24 cm.
Centimeter Grid Paper
Set D6 ★ Independent Worksheet 2

Measuring Rectangles

1a Which formula shows how to find the area of this rectangle?

- Area = \((2 \times \text{width}) + (2 \times \text{length})\)
- \(A = 2w + 2l\)

b Use the formula you selected to find the area of the rectangle. Show your work.

2a Which formula shows how to find the perimeter of this rectangle?

- Perimeter = \((3 \times \text{width}) + (3 \times \text{length})\)
- \(P = w + 3l\)

(Continued on back.)
Independent Worksheet 2  Measuring Rectangles (cont.)

2b  Use the formula you selected to find the perimeter of the rectangle. Show your work.

- [Diagram of a rectangle with dimensions 8 cm by 2 cm]

3a  Which formula shows how to find the area of this rectangle?

- [Diagram of a rectangle with dimensions 4 meters by 3 meters]

  - ○ Area = length ÷ width  
    \[ A = l \div w \]
  - ○ Area = length – width  
    \[ A = l - w \]
  - ○ Area = length × width  
    \[ A = l \times w \]
  - ○ Area = length + width  
    \[ A = l + w \]

b  Use the formula you selected to find the area of the rectangle. Show your work.
4a Which formula shows how to find the perimeter of this rectangle?

40 ft.
20 ft.

○ Perimeter = (2 × width) + (2 × length)
  \[ P = 2w + 2l \]

○ Perimeter = length × width
  \[ P = l \times w \]

○ Perimeter = length × width × height
  \[ P = l \times w \times h \]

○ Perimeter = (2 × width) – length
  \[ P = 2w - l \]

b Use the formula you selected to find the perimeter of the rectangle. Show your work.
GRADE 4 – UNIT 3
CCSS SUPPLEMENT ACTIVITIES & INDEPENDENT WORKSHEETS

Set A6: Numbers & Operations: Fractions & Mixed Numbers
Activity 1: Fractions & Mixed Numbers ........................................ A6.1
Activity 2: Simplify & Compare ..................................................... A6.7

Set A9: Numbers & Operations: Adding & Subtracting Fractions
Activity 1: Last Equation Wins! ...................................................... A9.1
Ind. Worksheet 1: Fractions through the School Day ...................... A9.7
Ind. Worksheet 2: Fractions on the Trail ........................................ A9.11
Ind. Worksheet 3: Adding & Subtracting Fractions ................. A9.15

Set D10: Measurement: Conversions
Activity 1: Converting Measurements ....................................... D10.1
Ind. Worksheet 1: Equivalent Tables ........................................ D10.5

Set D1: Measurement: Weight & Mass
Activity 4: The Sack of Groceries .............................................. D1.15

Set D10: Measurement: Conversions
Ind. Worksheet 2: Conversion Tables ....................................... D10.7

Set D1: Measurement: Weight & Mass
Activity 5: Kitten & Cat Weights .............................................. D1.19
Set A6 ★ Activity 1

Fractions & Mixed Numbers

Overview
Students work with guidance from the teacher to make a set of construction paper fraction strips. Then they use their fraction kits to learn about converting fractions to mixed numbers, and vice versa.

Skills & Concepts
★ convert a mixed number to a fraction and vice versa, and visually represent the number
★ write a fraction equivalent to a given fraction

You’ll need
★ Fractions & Mixed Numbers (pages A6.5 and A6.6, run a class set)
★ 1.5" x 12" construction paper strips, class set plus a few extra in each of the following colors: white, light brown, purple, green, and orange
★ class set of 6" x 9" manila or legal size envelopes
★ class set of scissors

Instructions for Fractions & Mixed Numbers
1. Explain that today everyone in class will make a set of construction paper fraction strips, and use them to learn some new things about fractions. Ask students to get out their scissors and pencils, and then give them each a set of 5 construction paper strips, one each in the following colors: white, light brown, purple, green, and orange, and reserve a set for yourself. Holding up the white strip, label it with a 1 as students do the same on their white strips.

2. Ask students to fold their light brown strip in half and cut it along the fold line as you do so with your light brown strip. What is the value of these 2 pieces relative to the white strip? After a bit of discussion, have students label each of the light brown pieces with the fraction \( \frac{1}{2} \).

3. Now ask students to fold the purple strip in half and then in half again. Before they open it out, ask them to pair-share the number of segments they’ll see and the value of each, relative to the white strip. Then ask them to unfold the strip, check their predictions, cut it along the fold lines, and label each part, as you do the same with your purple strip.

4. As they work, encourage students to compare and contrast the different colored pieces. In doing so, you may be able to get some sense of students' current understandings (and misconceptions) about fractions.
How do the purple pieces you've cut compare to the others you've cut and labeled so far?

Teacher

Students

The purple ones, the fourths, are half the size of the halves.

Yeah, a fourth is like half of a half.

Right! It's like a half folded in half again.

If you put 2 of the fourths together, they're the same as a half.

5. Next, ask students to fold their green strip in half, in half again, and in half a third time. Before they open it out, have them pair-share their ideas about how many segments they’ll see and how the size of each will compare to the white strip, the designated “whole”. You may discover in doing this that while some students believe they’ll see 8 segments when they unfold the strip, some may be equally convinced that they’ll see 6. In either case, ask students to explain their thinking.

6. When students unfold their green strips, they’ll discover that, in fact, they’re able to see 8 segments. If there’s been debate beforehand, continue the discussion as students cut and label each of the green pieces.

Students

I think what’s doubling is the number of pieces. Every time you fold the strip, you get double the number of pieces you got the last time, like 2 is double 1, 4 is double 2, and 8 is double 4.

So it is a doubling pattern, just different from how some of us thought.

7. Now ask students to fold their orange strip in half 4 times. Again, have them make predictions about the number of segments they’ll see when they unfold the strip and the size of each of the segments relative to the others they’ve cut. After some discussion, have them cut the orange strip along the folds and label each of the pieces.

8. As they finish cutting and labeling their pieces, have students each arrange the fraction pieces from largest to smallest in front of them, as shown below.

9. Give the children a minute or two to pair share any mathematical observations they can make about these pieces and then invite volunteers to share their thinking with the class.

Then write the fractions shown below on the board or the overhead, one at a time. As you record each fraction, read it with the class and ask students to use their pieces to build it. Encourage them to share observations with one another and the class as they work.

\[
\frac{3}{16} \hspace{1cm} \frac{5}{8} \hspace{1cm} \frac{3}{4} \hspace{1cm} \frac{5}{16} \hspace{1cm} \frac{7}{16}
\]
Activity 1 Fractions & Mixed Numbers (cont.)

Students $\frac{3}{16}$ is the same as an eighth and a sixteenth.
Yes, but there's no one piece that matches $\frac{3}{16}$ exactly.
It's the same with $\frac{5}{8}$. You can make the same amount with one half and one eighth, but there's not just one piece that matches.
$\frac{5}{16}$ is just one more sixteenth than $\frac{1}{4}$, and $\frac{7}{16}$ is just one sixteenth less than $\frac{1}{2}$.

10. Write the fraction $\frac{3}{2}$ on the board. Ask student pairs to share their pieces to make this fraction. Then invite their comments. What observations can they make about this fraction? Is there a way they can build the same quantity with fewer pieces?

Students It's bigger than 1.
It's just 3 halves – it's easy to make.
You can also just put a whole strip and a half to make the same amount. $\frac{3}{2}$ is the same as $1 \frac{1}{2}$.
$\frac{3}{2}$ is a weird fraction because the number on top is more than the number on the bottom.

11. Write the following equation on the board:

$$\frac{3}{2} = 1 \frac{1}{2}$$

Explain that when a fraction has a numerator greater than the denominator, it is sometimes called an improper fraction. There's really nothing “improper” at all about fractions like these, but people often change such a fraction to a mixed number, or a number that includes both a whole number and a proper fraction that is less than 1.

12. Write the fractions shown below on the board or overhead one at a time. Ask student pairs to build each one as written and then build it a second time in the form of a mixed number. Note with them that it takes fewer pieces to build each fraction as a mixed number. Encourage them to share observations with one another and the class as they work.

$$\frac{6}{4}, \quad \frac{10}{8}, \quad \frac{20}{16}, \quad \frac{12}{8}, \quad \frac{8}{4}$$

Students You can make $\frac{6}{4}$ with a whole strip and $\frac{2}{4}$, but it's also the same as $1 \frac{1}{2}$.
It's way faster to make a mixed number for $\frac{10}{8}$. It's just a whole strip and 2 more eighths.
We said it was the same as $1 \frac{1}{4}$, because $\frac{2}{8}$ is the same as a fourth.
I don't think $\frac{6}{4}$ is a mixed number because it's just 2. There's no fraction left.

13. Next, write the mixed numbers shown below. Ask student pairs to build each and then build it a second time in the form of a fraction. Can they begin to predict how many fractional pieces of the same size it will take to make a mixed number without laying them all out?

$$1 \frac{3}{4}, \quad 1 \frac{6}{8}, \quad 1 \frac{8}{16}, \quad 2 \frac{2}{4}, \quad 2 \frac{5}{8}$$

Tressa We don't have enough fourths to make $2 \frac{2}{4}$. Why not?

Ian Because it's 4 fourths for each whole and then 2 more. We need 10 fourths, but we only have 8 fourths.

Hillary It's going to be the same with $2 \frac{3}{8}$. That would take 8 eighths for each whole strip, and then 5 more. $8 + 8 + 5 = 21$ eighths. We don't have that many.
Activity 1 Fractions & Mixed Numbers (cont.)

14. Finally, give students each a copy of Fractions and Mixed Numbers. Review the instructions on the sheet with the class. When they understand what to do, let them go to work. Circulate to provide assistance as needed. Encourage students to use their fraction strips and help one another.

15. Give each student a manila or legal sized envelope in which to store his or her fraction kit. Let them know that it's fine to fold the white strip so it will fit into the envelope. Then have students label their envelopes with their names and store them safely so they can use these fraction kits for the next activity in this set.
1 Change each of the fractions below into a mixed number. Use a labeled sketch and words to explain your answers. Use your fraction pieces to help if you want.

<table>
<thead>
<tr>
<th>example</th>
<th>( \frac{7}{4} = 1 \frac{3}{4} )</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>( \frac{1}{4} ) ( \frac{1}{4} ) ( \frac{1}{4} ) ( \frac{1}{4} ) ( \frac{1}{4} ) ( \frac{1}{4} ) ( \frac{1}{4} ) ( \frac{1}{4} ) ( \frac{1}{4} ) ( \frac{1}{4} ) ( \frac{1}{4} ) ( \frac{1}{4} )</td>
</tr>
<tr>
<td>a</td>
<td>( \frac{9}{8} = )</td>
</tr>
<tr>
<td>b</td>
<td>( \frac{19}{16} = )</td>
</tr>
<tr>
<td>c</td>
<td>( \frac{10}{4} = )</td>
</tr>
</tbody>
</table>
For each of the problems on this page:

• Solve the problem and show your thinking with numbers, words, and/or labeled sketches. Use your fraction pieces to help if you want.

• If the answer turns out to be an improper fraction (like $\frac{3}{2}$ or $\frac{7}{4}$) rename it as a mixed number (like $1\frac{1}{2}$ or $1\frac{3}{4}$).

a Carlos and his mom went out on a bike ride. They rode $\frac{5}{8}$ of a mile to the park, and then $\frac{5}{8}$ of a mile back home. How far did they ride in all?

b It takes $\frac{3}{4}$ of a cup of orange juice to make 1 smoothie. Erin wants to make 2 smoothies. How much orange juice will she need?

3 Change each of the mixed numbers below into a fraction. Use your fraction pieces to help.

\[
\begin{array}{ccc}
\text{ex.} & \quad & \\
1\frac{3}{4} & = & \frac{7}{4} \\
1\frac{3}{8} & = & \quad \\
1\frac{5}{16} & = & \\
2\frac{1}{2} & = & \\
2\frac{2}{4} & = & \\
1\frac{7}{8} & = & \\
\end{array}
\]
Set A6 ★ Activity 2

Simplify & Compare

Overview
Students use their fraction kits from the previous activity to learn to simplify fractions. Then the teacher introduces a new game to provide more practice with simplifying and comparing fractions. Simplify & Compare can be used as a partner game once it has been introduced to the class, or played several times as a whole group.

Skills & Concepts
★ simplify fractions using common factors
★ convert a mixed number to a fraction and vice versa, and visually represent the number
★ compare fractions and mixed numbers using the symbols <, >, or =
★ write a fraction equivalent to a given fraction

You’ll need
★ Simplify & Compare Game Board (page A6.11, run 1 copy on a transparency)
★ Simplify & Compare Record Sheet (page A6.12, run a class set)
★ students’ fraction kits from Set A6, Activity 1
★ overhead double spinner
★ a more/less cube
★ overhead pens
★ 1.5” x 12” pink construction paper strips, one per student plus a few extra
★ rulers, class set
★ scissors, class set

Instructions for Simplify & Compare
1. Explain that students are going to use their fraction kits to learn some more about fractions and play a new game today. Have them take all the fraction strips out of their envelopes and stack them in neat piles by size on their desks.

2. Write the fraction $\frac{6}{8}$ at the overhead. Read it with the students and ask them to build the fraction with their pieces. Then challenge them to lay out an equivalent fraction with fewer pieces that are all the same size. Most will set out three fourths in response. If some students set out one half and one fourth, remind them that all the pieces in the equivalent fraction have to be the same size.

3. Ask students to share any observations they can make about the two sets of pieces. Record the equation $\frac{6}{8} = \frac{3}{4}$ on the overhead, and have students return the pieces they have just used to their stacks. Then write $\frac{8}{16}$, and have students show this fraction with their pieces. When most have finished, ask them to build all the equivalent fractions they can find, using only same-sized pieces for each one. Give them a minute to work and talk with one another, and then invite volunteers to share their results.
Students I got \( \frac{8}{16}, \frac{4}{8}, \frac{2}{4}, \text{ and } \frac{1}{2} \).
They're all the same as \( \frac{1}{2} \).
When you use bigger pieces, you don't need as many.

4. Write a series of numbers and arrows on the board to represent the sequence. Ask students to pair-share any observations they can make about the sequence of fractions, and then have volunteers share their ideas with the class. Can they find and describe any patterns? How do the numbers relate to one another? Which requires the fewest pieces to build?

\[
\begin{align*}
\frac{8}{16} & \rightarrow \frac{4}{8} & \rightarrow \frac{2}{4} & \rightarrow \frac{1}{2}
\end{align*}
\]

Students The numbers on the top, the numerators, go 8, 4, 2, and 1. It's like they keep getting cut in half.
It's the same with the numbers on the bottom. 16 ÷ 2 is 8. 8 ÷ 2 is 4. 4 ÷ 2 is 2.
A half was the fastest way to build the fraction.
I knew \( \frac{8}{16} \) was a half to begin with because 8 is half of 16.
Every number on the top is half the number on the bottom.

5. Press students to consider the last fraction in the sequence, \( \frac{1}{2} \). Is there any way to build \( \frac{8}{16} \) with even fewer pieces than the one half piece? Why not? Give them a minute to discuss the question, and then explain that \( \frac{1}{2} \) is the simplest way to show \( \frac{8}{16} \). Tell the class that a fraction is in its simplest form when its numerator and denominator have no common factors other than 1.

6. Remind students that a factor is a whole number that divides exactly into another number. One way people find factors of a number is to think of the pairs of numbers that can be multiplied to make that number. Work with input from the students to list the factors of 8 and 16.

Factors of 8 are 1, 2, 4, and 8. You can divide 8 by each of these numbers.
\[
1 \times 8 = 8 \quad 2 \times 4 = 8
\]

Factors of 16 are 1, 2, 4, 8, and 16. You can divide 16 by each of these numbers.
\[
1 \times 16 = 16 \quad 2 \times 8 = 16 \quad 4 \times 4 = 16
\]

7. Work with input from the class to identify and circle the factors 8 and 16 have in common: 1, 2, 4, and 8. Then draw students' attention back to \( \frac{1}{2} \). Since 1 and 2 have no common factor other than 1, there's no way to further simplify the fraction.

8. Explain that you can find the simplest form of a fraction by building it with the fewest number of pieces. But you can also simplify a fraction by identifying the greatest common factor, or the biggest number by which you can divide both the numerator and the denominator. Write \( \frac{12}{16} \) on the board. Can this fraction be simplified? Ask students to pair-share ideas about the largest number by which both 12 and
Activity 2  Simplify & Compare (cont.)

16 can be divided. When they have identified 4 as the greatest common factor of 12 and 16, record the operation shown below at the overhead, and ask students to confirm it with their pieces. Is it true that 12/16 cannot be built with any fewer pieces than 3 fourths?

![Diagram of fraction division]

9. Repeat step 8 with 10/16, 3/16, and 6/4. Students will note that 3/16 cannot be simplified because 3 and 16 have no factors in common other than 1. They will also discover that 6/4 simplifies to 3/2 and then converts to a mixed number, 1 1/2.

10. Now explain that you’re going to play a new game with students that will give them more opportunities to simplify fractions. Ask them to carefully re-stack all their fraction strips by size, and tell them that they’re going to need to cut one more strip to have all the pieces they need for the game. Ask them to get out their rulers, pencils, and scissors. Then give them each a 1.5" by 12" strip of pink construction paper. Have them use the inch side of their ruler to mark and cut the strip at 4" intervals. If the entire strip represents 1, what fraction does each of the pink pieces represent? Why?

11. Place the Simplify & Compare game board on display at the overhead. Give students a few moments to examine it quietly, and then read the game rules with the class. Explain that they are going to play as Team 2, and you will play as Team 1. You will play a trial round so everyone can learn the rules, and then play the whole game with them.

12. Place the double spinner overlay on top of the spinners, spin both, and record the results under “Team 1”. Work with students to simplify your fraction by identifying the greatest number by which both the numerator and the denominator can be divided. Encourage them to check the results with their pieces as well.

13. Invite a volunteer up to the overhead to spin for the class. Record the students’ fraction under “Team 2” and work with their input to simplify it. Then ask students to compare their fraction with yours. If they are not sure which fraction is greater, have them build both with their fraction pieces. Use a <, >, or = sign to show the results. Then have a second volunteer roll the more/less cube to determine the winner. Circle the winning fraction on the overhead.

Teacher  I really lucked out on this first trial. I thought you were going to win because 3/4 is greater than 1/2, but Kendra rolled “less” instead of “more”.

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14. Once the trial round is completed, erase the overhead. Give students each a copy of the Simplify & Compare record sheet and play 6 rounds with the class. You will need to erase the overhead between each round, but students will have a record of the complete game on their sheets. At the end of the game, have students take turns rolling the more/less cube for each pair of fractions. Have them circle the winning fraction for each round, fill in the scoreboard on their papers, and determine the winning team. If any of the pairs of fractions are equal, both teams score a point for the round.

**Extensions**

- Play Simplify & Compare several times with the class. The game provides an engaging context in which to practice simplifying and comparing fractions, and you don't have to play all 6 rounds at once.
- Run extra copies of the record sheet and game board, and have the students play the game in pairs. Encourage them to use their fraction kits to confirm their answers if necessary.
- Additional exercises and problems for students to simplify fractions and move back and forth between fractions and mixed numbers can be found in the Bridges Grade 4 Practice Book on The Math Learning Center website: www.mathlearningcenter.org. The Practice Book can be found under the link for Bridges Support for Teachers>Grade 4>Supplements 4.
Take turns:

- Spin the top spinner to get your numerator. Spin the bottom spinner to get your denominator.
- Record your fraction. Simplify it if you can. Change it to a mixed number if it is greater than 1.
- Use a <, =, or > sign to compare the two fractions.
- Play 6 rounds. Then roll a More/Less cube to see which team wins each round. Circle the winning fraction and mark a point for the correct team on the scoreboard each time.
# Simplify & Compare Record Sheet

<table>
<thead>
<tr>
<th>Round 1</th>
<th>Round 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Team 1</td>
<td>Team 2</td>
</tr>
<tr>
<td></td>
<td></td>
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<tr>
<td></td>
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<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Simplify and Compare</td>
<td>Simplify and Compare</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Round 3</th>
<th>Round 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Team 1</td>
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<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Simplify and Compare</td>
<td>Simplify and Compare</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Round 5</th>
<th>Round 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Team 1</td>
<td>Team 2</td>
</tr>
<tr>
<td></td>
<td></td>
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<tr>
<td></td>
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<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Simplify and Compare</td>
<td>Simplify and Compare</td>
</tr>
</tbody>
</table>

## Scoreboard

<table>
<thead>
<tr>
<th>Team 1</th>
<th>Team 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Set A9 ★ Activity 1

Last Equation Wins!

Overview
The class works together to find multiple ways to decompose a visual fraction model into a sum of fractions with the same denominator. Then the class plays a game in which players take turns decomposing a given fraction into a sum of fractions with the same denominator, proving equations with sketches.

Skills & Concepts
- decompose a fraction into a sum of fractions with the same denominator in multiple ways (CCSS 4.NF.3b)
- use fraction models to represent the addition of fractions with like denominators and record each decomposition with an equation (CCSS 4.NF.3b)
- solve problems involving the addition of fractions with like denominators (CCSS 4.NF.3d)

You’ll Need
- class set of tile and a set for demonstration
- Use Student Math Journals or Grid Paper, page A9.6 (Run a double-sided class set, plus 1 copy for display)
- pens or colored pencils for use at display
- colored pencils for students
- die numbered 1 to 6, two for each pair of students and two for demonstration

Note When you represent the symbolic form for a fraction, please use a horizontal bar.

Instructions for Last Equation Wins!
1. Distribute tile for each pair of students. On the overhead or document camera, write \( \frac{4}{5} \), explaining that it’s been a very busy lunch hour, and this fraction represents what remains of your sub sandwich. Ask students to each build a tile model that represents \( \frac{4}{5} \), and explain their thinking to a partner. Ask a volunteer to share with the entire group.

Tim  I put down 5 tile. Each one is worth \( \frac{1}{5} \) of your sandwich. I used 4 blue to show the \( \frac{4}{5} \) that’s left and 1 red to show the \( \frac{1}{5} \) that you already ate. You must still be hungry!

Display a model with \( \frac{4}{5} \) in one color, \( \frac{1}{5} \) in another color. For clarity, consider using one consistent color as a placeholder for the portion of the sandwich that’s been eaten.

Teacher  For our work today, I’m going to use yellow to represent the missing part of my sub sandwich. So for \( \frac{4}{5} \) of a sandwich, I’ll show 4 in blue and 1 in yellow. Why do you think I want to show the part I’ve already eaten?

Laura  If you only used 4 pieces we wouldn’t know what each one was worth.

Jon  With just 4 pieces it might be \( \frac{4}{5} \) or one whole.
The yellow piece is like the missing piece. We need to count all the pieces to figure out what the denominator is. Your sandwich was cut into five pieces.

2. Tell students that you plan to cut up the leftover sandwich to eat in portions throughout the rest of the day. How many different combinations of leftover pieces are possible if the denominator stays the same? To show the combinations, ask students to work with a partner to make an equation representing the sum of the fractional pieces represented by \( \frac{4}{5} \). Discuss as a class.

A likely response is \( \frac{1}{5} + \frac{1}{5} + \frac{1}{5} + \frac{1}{5} = \frac{4}{5} \). If students don't bring it up, ask them to think of other equations that are modeled by the tile. Change the colors of the tile as needed to clearly show other sums. For example, \( \frac{2}{5} \) might be shown in green and then each remaining \( \frac{1}{5} \) will be shown in blue. The last \( \frac{1}{5} \) in yellow.

**Teacher** Work with a partner to create an addition equation to represent the \( \frac{4}{5} \) shown in your model. What fractional pieces of my sandwich can you add together to make \( \frac{4}{5} \)? For our work today, the denominator in the equation will stay the same. And I’ll keep the yellow piece to show what’s been eaten.

**Angie** We said that you have 4 pieces of sandwich that are each worth \( \frac{1}{5} \). \( \frac{1}{5} + \frac{1}{5} + \frac{1}{5} + \frac{1}{5} = \frac{4}{5} \).

**Teacher** Many of you said that \( \frac{1}{5} + \frac{1}{5} + \frac{1}{5} + \frac{1}{5} = \frac{4}{5} \). I could eat four little pieces during four breaks today. Are there other equations you could make?

**Suzie** Sure. You could say that \( \frac{1}{5} + \frac{3}{5} = \frac{4}{5} \). I can model it with tile. Each tile is worth \( \frac{1}{5} \). If 1 of the tile is red, that’s \( \frac{1}{5} \) of the sandwich. If 3 of the tile are blue, that’s three \( \frac{1}{5} \)ths or \( \frac{3}{5} \) of the sandwich. That makes 4 total tile that are each worth \( \frac{1}{5} \). So \( \frac{1}{5} + \frac{3}{5} = \frac{4}{5} \).

**Jess** We used two reds and two greens to show \( \frac{2}{5} + \frac{2}{5} = \frac{4}{5} \)

3. Using a new fraction, \( \frac{4}{6} \), give students several moments, working in pairs, to record in their Student Math Journals or on the Grid Paper all the possible combinations of sums in which the denominator stays the same and the total remains \( \frac{4}{6} \). Encourage students to build models with tile, then sketch their results on grid lines and record an equation that matches the model.

Model one sketch by tracing the perimeter of a \( 1 \times 6 \) rectangular area. Draw the lines in between each box so that 6 boxes are clearly outlined. Cross out the last two boxes to show the \( \frac{2}{6} \) that are not included. Then use two or more colors to define the areas being added.
Teacher Since the denominator is 6, I’ll begin by outlining a rectangle with an area of 6. Since I only have \( \frac{4}{6} \) of a sandwich, I’ll put x’s through the last two boxes to show that they’ve been eaten. Then I’ll color the 4 boxes to represent my addition equation. I’ll make one box red and the other 3 blue. \( \frac{1}{6} + \frac{3}{6} = \frac{4}{6} \). What other equations could we make?

4. As a class, compile a list of all the addition equations that students have made. Ask each volunteer pair to write the equation that matches the visual model at the display, and show a sketch from their Student Math Journals or Grid Paper to prove the answer.

Students We said \( \frac{4}{6} = \frac{1}{6} + \frac{1}{6} + \frac{2}{6} \). We colored 1 square red, 1 square blue, and 2 squares green. Each tile is worth \( \frac{1}{6} \).

5. Now introduce a game called “Last Equation Wins!” in which you and the class take turns decomposing a given fraction into a sum of fractions with the same denominator. Each answer must be proven with a sketch. Play continues until no additional equations can be made. The team with the final equation wins. In each round, players alternate who goes first.

Note Equations with the same addends but in a different order are considered the same because of the commutative property.

Begin by rolling 2 die. Use the smaller number as the numerator, the larger as the denominator. Write the fraction on the board. Draw a t-chart on a blank page of Student Math Journal or Grid Paper. Label the columns and sketch the outline of the total fraction in the teacher column.

Teacher I rolled a 6 and a 3, so I’m going to make the fraction \( \frac{3}{6} \). I’ll sketch an area with 6 boxes and cross out 3 of them since I only have \( \frac{3}{6} \). I will use colored pencils in the 3 boxes that remain to represent my fraction. I go first, so I’ll create the first equation. For this one, I’ll use 3 colors. \( \frac{1}{6} + \frac{1}{6} + \frac{1}{6} = \frac{3}{6} \)

Teacher Now it’s your turn. Work with your partner to create another sum of fractions with the same denominator that equal \( \frac{3}{6} \). Draw it in your journals. Who would like to share?

Jessie We have one. We needed 2 colors. \( \frac{1}{6} + \frac{2}{6} = \frac{3}{6} \)

Teacher Now it’s my turn. Let’s see. I already split it into fractions with a numerator of 1. And then you made \( \frac{1}{6} + \frac{2}{6} = \frac{3}{6} \). Hmm. Are there any more options?

Travis Nope. We got the last one. Last equation wins!
Additional Example: Fraction = $\frac{5}{6}$

**Students** $\frac{1}{6} + \frac{1}{6} + \frac{1}{6} + \frac{1}{6} + \frac{1}{6} = \frac{5}{6}$

**Teacher** $\frac{1}{6} + \frac{1}{6} + \frac{1}{6} + \frac{2}{6} = \frac{5}{6}$

**Student** $\frac{1}{6} + \frac{2}{6} + \frac{3}{6} = \frac{5}{6}$

**Teacher** $\frac{2}{6} + \frac{3}{6} = \frac{5}{6}$

**Student** $\frac{4}{6} + \frac{1}{6} = \frac{5}{6}$

**Teacher** $\frac{1}{6} + \frac{1}{6} + \frac{2}{6} = \frac{5}{6}$

**Students** We can’t find any more. Teacher gets the point.

One point is scored for each round. Play continues until one team reaches 3 points.
**Note** Students will likely notice that if they go first and get a fraction with a “1” in the numerator, they automatically win that round. Likewise, if a “2” is rolled in the numerator, the player who goes first will automatically lose. Do they have other observations? How will an odd or even numerator affect the game? Will an odd number always result in a win for the first player?

6. After one round with the entire class, students pair up to play one another, building models with tile or sketches and recording addition equations in their Student Math Journals or on Grid Paper.

**CHALLENGE**

If students want an additional challenge, use mixed numbers or improper fractions. Roll 3 dice and arrange the numbers to form a mixed number (1, 3, 6 become $3\ 1/6$ or any other arrangement of those three numbers) or roll 2 dice, using the larger number as the numerator. A roll of 5 and 3, for example, would become $5/3$.

**INDEPENDENT WORKSHEET**

See Adding and Subtracting Fractions on pages A9.15–A9.17 for more practice.
Grid Paper
Fractions through the School Day

Make a labeled sketch to solve each of the problems below. Use words to explain your answer, and write an equation to match. Use your fraction kit to help if you want.

Note: If the answer turns out to be an improper fraction, change it to a mixed number.

ex  Sam and Ali are friends. They're both in Mrs. Hill's fourth grade class. When Sam gets up on school days, it takes him $\frac{2}{4}$ of an hour to take a shower and get dressed, $\frac{1}{4}$ to eat breakfast, and $\frac{2}{4}$ of an hour to finish his homework. How long does it take Sam to get ready for school?

a  Labeled Sketch

b  Explanation (in words)

2 fourths plus 1 fourth plus 2 more fourths is 5 fourths in all. There are 4 fourths in an hour, so it takes him 1 and $\frac{1}{4}$ hours to get ready for school.

c  Equation

$$\frac{2}{4} + \frac{1}{4} + \frac{2}{4} = \frac{5}{4} \quad \frac{5}{4} = 1\frac{1}{4} \text{ hour}$$

(continued on next page)
1. Ali fixed eggs for her family this morning. She had \( \frac{5}{6} \) of a carton when she started, and \( \frac{2}{6} \) of a carton left when she finished. What fraction of the carton did Ali use?

   a. Labeled Sketch

   b. Explanation (in words)

   c. Equation

2. Sam and Ali’s class had P.E. first thing this morning. P.E. lasts \( \frac{4}{6} \) of an hour. They spent \( \frac{1}{6} \) of an hour running laps. What fraction of an hour did they have left after that?

   a. Labeled Sketch

   b. Explanation (in words)

   c. Equation

(continued on next page)
### Independent Worksheet 1  Fractions through the School Day (cont.)

**3** Ali had \(\frac{5}{6}\) of a granola bar in her lunchbox. She ate \(\frac{3}{6}\) of the bar at recess. What fraction of the bar did she have left for lunch?

<table>
<thead>
<tr>
<th>a</th>
<th>Labeled Sketch</th>
</tr>
</thead>
<tbody>
<tr>
<td>b</td>
<td>Explanation (in words)</td>
</tr>
<tr>
<td>c</td>
<td>Equation</td>
</tr>
</tbody>
</table>

**4** Sam and Ali had a math test after recess. Mrs. Hill said, “You have \(\frac{8}{12}\) of an hour to complete the test.” After \(\frac{6}{12}\) of an hour, Sam only had 1 page left to go. What fraction of an hour did he have left to finish the last page?

<table>
<thead>
<tr>
<th>a</th>
<th>Labeled Sketch</th>
</tr>
</thead>
<tbody>
<tr>
<td>b</td>
<td>Explanation (in words)</td>
</tr>
<tr>
<td>c</td>
<td>Equation</td>
</tr>
</tbody>
</table>

(continued on next page)
5 The 4th graders at Sam and Ali’s school take turns picking up trash on the playground after lunch each day. The chart below shows how many pounds of trash each class has picked up so far this week. How many pounds have they collected in all?

<table>
<thead>
<tr>
<th>Fifth Grade Class</th>
<th>Pounds of trash</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mrs. Hill’s Class</td>
<td>2 1/5 pounds</td>
</tr>
<tr>
<td>Mr. Wong’s Class</td>
<td>1 2/5 pounds</td>
</tr>
<tr>
<td>Mrs. Tejada’s Class</td>
<td>1 4/5 pounds</td>
</tr>
</tbody>
</table>

a Labeled Sketch

b Explanation (in words)

c Equation

6 The 4th graders are painting a mural about recycling on one of the walls by the playground. So far, they’ve used 1 2/7 gallons of red paint, 2 6/8 gallons of yellow paint, and 2 3/8 gallon of green paint. How many gallons of paint have they used in all?

a Labeled Sketch

b Explanation (in words)

c Equation
Fractions on the Trail

There is a 2-mile hiking trail behind Kennedy School. Make a labeled sketch to solve each of the problems below. Add more marks and fractions to the line if you need to. Use words to explain your answer, and write an equation to match.

Note: If the answer turns out to be an improper fraction change it to a mixed number.

**ex** Marissa and her mom ran the first 1 1/4 miles of the trail. They got tired, so they walked the rest of the way. How far did they walk?

**a** Labeled Sketch

<table>
<thead>
<tr>
<th>Start</th>
<th>1/2 mile</th>
<th>1 mile</th>
<th>1 1/7 mi.</th>
<th>1 1/2 mile</th>
<th>2 miles</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ran 1 1/4 mi.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Walked 3/4 mi.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**b** Explanation (in words)

They walked 3/4 of a mile because 2 - 1 leaves 1 mile, and then they ran another 1/4 of a mile. That left 3/4 of mile to go.

**c** Equation

2 - 1 1/4 = 3/4 mile

(continued on next page)
1. Tonio took his little brother for a walk on the trail. They walked $\frac{3}{4}$ of a mile. Then they turned around and went back to the start. How many miles did they walk in all?

<table>
<thead>
<tr>
<th>a Labeled Sketch</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>b Explanation (in words)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>c Equation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
</tbody>
</table>

(continued on next page)

2. Troy and Eric decided to run the whole 2 miles. Eric twisted his ankle after they’d gone $1\frac{1}{8}$ of a mile. They decided to walk the rest of the way and call Eric’s dad to come get them. How many eighths of a mile did they have to walk to get to the end of the trail?

<table>
<thead>
<tr>
<th>a Labeled Sketch</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>b Explanation (in words)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>c Equation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
</tbody>
</table>

(continued on next page)
3 Kendra and her grandma walked $1\frac{3}{8}$ of a mile down the trail. Then they turned around and walked back to the start. How many miles did they walk in all?

**a** Labeled Sketch

<table>
<thead>
<tr>
<th>Start</th>
<th>$\frac{1}{2}$ mile</th>
<th>1 mile</th>
<th>$1\frac{1}{2}$ mile</th>
<th>2 miles</th>
</tr>
</thead>
</table>

**b** Explanation (in words)

**c** Equation

4 Carter was walking down the trail. When he got to the $\frac{3}{4}$ mile marker, he realized that his glasses had slipped out of his pocket. He turned around and started to go back. He found his glasses right beside the $\frac{2}{3}$ mile marker. Then he turned around and walked to the end of the trail to meet his friend. How many miles did he walk in all?

**a** Labeled Sketch

<table>
<thead>
<tr>
<th>Start</th>
<th>$\frac{1}{2}$ mile</th>
<th>1 mile</th>
<th>$1\frac{1}{2}$ mile</th>
<th>2 miles</th>
</tr>
</thead>
</table>

**b** Explanation (in words)

**c** Equation

(continued on next page)
5 Everyday, Mrs. Goodman starts at the beginning of the trail and walks \(1 \frac{1}{4}\) miles. Then she turns around and walks back to the start. How many miles does she walk in 1 week (7 days)?

\[\text{a Labeled Sketch}\]

\[
\begin{array}{cccccc}
\text{Start} & \frac{1}{2} \text{ mile} & 1 \text{ mile} & 1 \frac{1}{2} \text{ mile} & 2 \text{ miles} \\
\end{array}
\]

\[\text{b Explanation (in words)}\]

\[\text{c Equation}\]

**CHALLENGE**

6 Make up your own story problem about the hiking trail. Then give it to a classmate to solve. Be sure to check it first to make sure it works.

\[\text{a My problem:}\]

\[\text{b Labeled Sketch}\]

\[\text{c Explanation (in words)}\]

\[\text{d Equation}\]
**Set A9 ★ Independent Worksheet 3**

**INDEPENDENT WORKSHEET**

**Adding & Subtracting Fractions**

Use numbers, words, and labeled sketches to solve each of the problems below. Show all of your work. Use your fraction kit to help if you want.

Note: If the answer turns out to be an improper fraction, change it to a mixed number.

<table>
<thead>
<tr>
<th>Problem</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ex</strong></td>
<td></td>
</tr>
<tr>
<td>$1\frac{3}{8} + 2\frac{6}{8} = 4\frac{1}{8}$</td>
<td>![Fraction Illustration] $\frac{5}{8} \times \frac{1}{8} = \frac{1}{8}$ makes $1\frac{1}{8}$ because there are $\frac{8}{8}$ in $1$, and then you have $\frac{1}{8}$ left over.</td>
</tr>
<tr>
<td>$\frac{5}{6} + \frac{3}{6} =$</td>
<td>$\frac{3}{6} + \frac{1}{6} = \frac{4}{6}$</td>
</tr>
</tbody>
</table>

(continued on next page)
<table>
<thead>
<tr>
<th>Problem</th>
<th>Explanation</th>
</tr>
</thead>
</table>
| 2       | \[
\frac{7}{8} + \frac{4}{8}
\] = |
| 3       | \[
2\frac{3}{4} + 3\frac{3}{4}
\] = |
| 4       | \[
1\frac{7}{8} - \frac{5}{8}
\] = |
### Independent Worksheet 3  Adding & Subtracting Fractions (cont.)

<table>
<thead>
<tr>
<th>Problem</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>5</strong></td>
<td>3 1/6 + 2 3/6</td>
</tr>
<tr>
<td><strong>6</strong></td>
<td>3 4/8 - 2 2/8</td>
</tr>
<tr>
<td><strong>7</strong></td>
<td>4 2/6 - 2 5/6</td>
</tr>
</tbody>
</table>

**CHALLENGE**
Converting Measurements

Overview
Students explore the structure and relationships while demonstrating fluency with measurement conversions. They use a two-column chart to convert from larger to smaller units, and smaller to larger units and then record the equivalent measurements.

Skills & Concepts
★ Know relative sizes of measurement units within one system of units including km, m, cm; kg, g; lb, oz.; l, ml.
★ Within a single system of measurement, express measurements in a larger unit in terms of a smaller unit.
★ Record measurement equivalents in a two-column table.
★ Interpret a multiplication equation as a comparison.
★ Generate a number pattern that follows a given rule.

Instructions for Converting Measurements
1. Invite students to consider some standard units of length privately, and then pair-share their ideas. Likely your students will mention inches, feet and yards, and centimeters and meters. Post word resource cards for a reference, if available.

2. Display the first scenario and ask students to consider what operation they would use to convert 4 feet into inches.

    Student  Well, I remember that 1 foot is 12 inches, so I skip counted, 12, 24, 36, and 48 on a number line.
**Activity 1 Converting Measurements (cont.)**

*Teacher*  So I might set that up as a t-chart like this:

<table>
<thead>
<tr>
<th>Feet</th>
<th>Inches</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 foot</td>
<td>12 inches</td>
</tr>
<tr>
<td>2 feet</td>
<td>24 inches</td>
</tr>
<tr>
<td>3 feet</td>
<td>36 inches</td>
</tr>
<tr>
<td>4 feet</td>
<td>48 inches</td>
</tr>
</tbody>
</table>

*Student*  I thought of it as $4 \times 12$ or 48 inches. I doubled 12, and then doubled 24 to get 48. I used a double-double strategy.

*Teacher* I wonder what else you notice about these numbers? Turn and share your thinking with your neighbor.

*Students*  They are all even numbers! They are multiples of 12. It grows by 12 each time. I wonder what the next one would be?

3. Post the second situation and ask students to work it out on their white boards. 13 feet of rope, how many yards? If you have some students that figure it out quickly, ask them to convert 13 feet to inches.

4. Invite students to share their mental math, number line and function tables as strategies for this scenario.

*Teacher*  I’m wondering how you solved this one?

*Student*  I know that 3 feet equal 1 yard, and 6 feet equal 2 yards, 9 feet equal 3 yards, and 12 feet equal 4 yards. I knew I was getting close. 13 feet is equal to 4 yards, and then you have 1 foot left over. I made a number line like Ajay did.
**Activity 1 Converting Measurements (cont.)**

**Student** I decided to try a t-chart ... I went passed 12, and figured I didn't have enough for 5 yards, so it has to be 4 yards and then you have 1 more foot.

<table>
<thead>
<tr>
<th>Yards</th>
<th>Feet</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 yard</td>
<td>3 feet</td>
</tr>
<tr>
<td>2 yards</td>
<td>6 feet</td>
</tr>
<tr>
<td>3 yards</td>
<td>9 feet</td>
</tr>
<tr>
<td>4 yards</td>
<td>12 feet</td>
</tr>
<tr>
<td>5 yards</td>
<td>15 feet</td>
</tr>
</tbody>
</table>

**Students** Hey, this time it grows by 3 times as much, and the numbers are odd and then even. Cool. So 10 yards are going to be 30 feet. 50 yards are going to be 150 feet. I get it.

**Teacher** Can I show you another way of keeping track? Sometimes mathematicians use pairs of numbers like this...(1 yard, 3 feet), (2, 6), (3, 9), (4, 12) to keep track of their conversions. Would you turn and talk to your partner? What is the next pair of numbers in this sequence? (5 yards, ? feet)

5. Continue through the measurement situations, monitoring the strategies that student use to keep track of their thinking. Share efficient, flexible and accurate ways of converting measurement units.

**Extension**
Challenge: Students who understand the concept can create multi-step riddles for one another to solve using units of measure. For example: *I am 16 inches from foot to knee and 37 inches from knee to head. How tall am I in feet and inches?*

**INDEPENDENT WORKSHEET**
Assign Set D10, Independent Worksheet 1, Equivalent Tables (page D10.5) and Independent Worksheet 2 Conversion Tables (page D.10.7) for additional practice with converting measurements.
Scenarios

1. A critter dug a four-foot tunnel in the back yard. How many inches did he dig?

2. If I have 13 feet of rope, how many yards do I have?

3. The lunchroom table measured six feet long. How many inches is that?

4. You want to build a fence for your new puppy. The fence needs to be 16 yards long. The wood for the fence is sold in foot long units. How many feet of fencing will you need to build your fence?

5. You and a friend are making a poster. You need two yards of ribbon to put around the edge of the poster. You have a piece of ribbon that is 60 inches long. Do you have enough to go around the poster?
INDEPENDENT WORKSHEET

Equivalent Tables

1. Complete the table below and record at least two mathematical observations about the rule and relationship between the measurement conversions.

<table>
<thead>
<tr>
<th>Meters (m)</th>
<th>Centimeters (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 m</td>
<td>100 cm</td>
</tr>
<tr>
<td>2 m</td>
<td>300 cm</td>
</tr>
<tr>
<td>4 m</td>
<td>500 cm</td>
</tr>
<tr>
<td>7 m</td>
<td>600 cm</td>
</tr>
</tbody>
</table>

I noticed:

2. A very large bag of frozen vegetables weighs 64 ounces (oz.). How many pounds (lb.) is this? Create a table to show your thinking.

<table>
<thead>
<tr>
<th>Ounces (oz.)</th>
<th>Pounds (lb.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>16 oz.</td>
<td>1 lb.</td>
</tr>
</tbody>
</table>

Show your thinking another way.

(Continued on next page.)
## Additional Practice

<table>
<thead>
<tr>
<th>Equivalent Tables (cont.)</th>
<th>3 Additional Practice</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 ft 7 in = _____ in</td>
<td>30 ft = _____yd _____ft</td>
</tr>
<tr>
<td>1 yd 2 ft = _____ ft</td>
<td>32 in = _____ ft _____ in</td>
</tr>
<tr>
<td>2 ft 4 in = _____ in</td>
<td>8 ft 6 in = _____ inches</td>
</tr>
</tbody>
</table>
Set D1 ★ Activity 4

The Sack of Groceries

Overview
Students estimate the weight of a sack of groceries, weigh it to find the actual weight, and then add the weights of the individual items to see if the total matches the scale reading.

Skills & Concepts
★ estimate and determine weight using U.S. customary units
★ explore the difference between weight and mass
★ carry out a simple conversion within a system of measurement such as ounces to pounds

Recommended Timing
Anytime after Set D1 Activity 1

You’ll need
★ 20–24 cans and/or packages of food (see Advance Preparation)
★ 2 grocery sacks with handles
★ bathroom scale
★ Student Math Journals
★ calculators (half-class set)

Advance Preparation
Look through your kitchen cupboards to find a variety of canned goods and packaged dry foods (i.e., beans, macaroni, and so on) that vary in weight from just a few ounces to about a pound. Make sure that each is clearly marked with its weight in U.S. customary units. Place one grocery sack inside the other and "double-bag" the items. Weigh the sack to be sure the combination of cans and packages totals about 12 pounds.

Instructions for The Sack of Groceries
1. Place your sack of groceries where students can see it clearly. Ask them to share some of their experiences with grocery shopping. Have they ever had to help load the sacks of groceries into the car at the store? Have they ever had to help carry the sacks into their house or apartment? How much do they think an average bag of groceries weighs?

2. Invite a volunteer to pick up the sack. How heavy does it feel? Record his or her estimate on the board. Repeat this with a second volunteer. Do their estimates match? Then explain that sometime during the day, you'd like each student to pick up the bag, estimate its weight, and add his or her estimate to the board.

3. Perhaps students have noticed that you're asking them to estimate the weight of the sack rather than its mass. What's the difference between weight and mass? Ask students to share anything they already know. If they don't have much to share, have several volunteers do a little research. Encourage them to read any math dictionaries you might have in class or in the school library and/or go online. (one way to narrow the search is to Google such phrases as “difference between weight and mass.”) Ask them to be prepared to report their findings the following day.

4. The next day, ask your volunteers to share what they learned. Record their discoveries on a T-chart at the board or the overhead as students do so in their math journals.
Activity 4  The Sack of Groceries (cont.)

何するかこのパッドのグロッセリーの重量は？
当の見積もり:
10ポンド 16ポンド 5ポンド
25ポンド 11ポンド 7ポンド
15ポンド 30ポンド 9ポンド
12ポンド 24ポンド 14ポンド

What’s the difference between weight and mass?

<table>
<thead>
<tr>
<th>Weight</th>
<th>Mass</th>
</tr>
</thead>
<tbody>
<tr>
<td>• How heavy something is</td>
<td>• How much matter is in something</td>
</tr>
<tr>
<td>• Usually measured on a scale</td>
<td>• Usually measured on a balance</td>
</tr>
<tr>
<td>• Measures how hard gravity is pulling on something. Can change if you go to a smaller planet where gravity doesn’t pull as hard.</td>
<td>• Never changes. It doesn’t matter where you go. Even on a different planet, an object’s mass doesn’t change.</td>
</tr>
<tr>
<td>• Weight equals the mass of an object times the force of gravity. Something with a mass of 1,000 kilograms will weigh 0 kilograms in outer space because there’s no gravity.</td>
<td></td>
</tr>
</tbody>
</table>

You can use customary units (like ounces and pounds) or metric units (like grams or kilograms) to measure both weight and mass.

5. Then show students the bathroom scale. Explain that you want them to each come up and weigh the sack of groceries sometime before the end of the day. When they find out what the actual weight is, they’ll need to keep it a secret until everyone in class has had a turn.

6. Toward the end of the day, record the actual weight of the sack of groceries on the board. How does this compare with students’ estimates? How does it compare with some of the sacks of groceries they’ve helped carry in from the car?

7. Now take several of the lighter items out of the sack and show students how to read the labels to find out how much they weigh. How do the weights of these items compare to a pound? Remind students that there are 16 ounces in a pound.

**Teacher**  This can of cat food weighs 5 and a half ounces. This box of macaroni and cheese weighs 7 ounces. The mushroom soup weighs about 11 ounces. Do any of these weigh a pound?

**Students**  No! They’re really light.
The macaroni and cheese weighs about half a pound.
Activity 4  The Sack of Groceries (cont.)

Students  If you put them together, they’re not even 2 pounds, because that would be 32 ounces. You must have some stuff in there that’s a lot heavier, or the bag wouldn’t weigh 12 pounds. There are lots of things in there, though. I looked.

8. Record the weights of the items you’ve selected on the board and work with input from the class to find the total. If it’s more than 16 ounces, have the students help you convert it to pounds and ounces.

![Image showing calculation]

These 3 items add up to 1 pound 7.5 ounces

9. Take all the cans and boxes out of the bag. Give each group of four students 2–4 of the items. Ask them to find the weight on the label of each and add the weights to find out how much their little set of items totals. (Be sure they read the weight in customary rather than metric units if some of the items are labeled both ways.) Record each group’s total on the board and then work with the class to add all the weights. Does the grand total match what the scale said? If not, how would students explain the difference?

Extension
- Go online with your class to further explore the difference between weight and mass. If you enter “difference between weight and mass” into a search engine such as Google, it will bring up a number of different web sites, some of which will calculate your weight (or the weight of a common animal or favorite dinosaur) on a variety of different planets. Many of these sites also feature explanations that are appropriate for elementary students about the differences between weight and mass.
Conversion Tables

1 Use >, <, or = to compare.

<table>
<thead>
<tr>
<th>12 inches</th>
<th>1 foot</th>
<th>36 inches</th>
<th>2 feet</th>
</tr>
</thead>
<tbody>
<tr>
<td>48 inches</td>
<td>6 feet</td>
<td>60 inches</td>
<td>3 feet</td>
</tr>
<tr>
<td>4 feet</td>
<td>36 inches</td>
<td>5 feet</td>
<td>72 inches</td>
</tr>
</tbody>
</table>

2 The milliliter (ml) is a metric unit of volume that is equal to $\frac{1}{1,000}$ of a liter. 1,000 ml = 1 liter. Use this information to solve the problems below.

a To make enough chocolate pudding for your family, you need 300 milliliters (ml) of milk. How many liters (l) will this be? Show your thinking.

___________ liters of milk

b How many liters of milk would you need if you tripled the recipe for chocolate pudding for a party?

___________ liters of milk
Conversion Tables (cont.)

3  Kilo is a prefix for thousand. 1 kilometer = 1,000 meters. Use this information to help solve the problem below.

Dan is on a road trip. He sees a sign that says 212 kilometers (km) to the nearest gas station. How many meters (m) away is the gas station? Show your thinking.

The gas station is ___________ meters away.

4  Remember the prefix kilo? 1 kilogram = 1,000 grams. Use this information to help solve the following problem.

Mom weighed the bag of carrots and said it weighed 2.7 kilograms (kg). How many grams (g) is this? Show your thinking.

The bag of carrots weighed ___________ grams
Set D1 ★ Activity 5

Kitten & Cat Weights

Overview
Students place food items in a grocery sack to approximate average kitten and cat weights, weigh the sack, make needed adjustments, and record their results. This activity is designed for use by student pairs during Work Places or other work periods.

Skills & Concepts
★ estimate and determine weight using U.S. customary units
★ carry out a simple conversion within a system of measurement such as ounces to pounds

Recommended Use
Anytime after Set D1 Activity 4

You’ll need
★ Kitten & Cat Weights (page D1.20, class set)
★ 20–24 cans and/or packages of food (see Set D1 Activity 4 Advance Preparation notes)
★ grocery bag with handles
★ bathroom scale
★ 2 calculators

Advance Preparation Set up the materials listed above in a location somewhere in the classroom where pairs of students can work independently over the next few weeks as time allows.

Instructions for Kitten & Cat Weights
1. Talk with students about kittens and cats. Do any of them own a kitten or a cat? Do they know how much it weighs? Do they have any idea how much a newborn kitten or a full-grown cat weighs? Then explain that you’ve set up some materials to help them find out, and to give them more experience estimating and measuring weight.

2. Show students a copy of the Kitten & Cat Weights sheet. Review the instructions on the sheet with the class and model the procedures described as needed.

3. Let students know where to find the materials and explain that they’ll be working in pairs to do this activity. Explain how they’ll know when it’s their turn, and establish any ground rules for using the materials, turning in their work, and so on.
Kitten & Cat Weights

A newborn kitten weighs about 4 ounces. By the time a kitten is 5 weeks, he or she should weigh about 16 ounces or 1 pound. The chart below lists average weights for kittens at 7 weeks and 10 weeks, and also for full-grown cats. For each entry on the chart:

- convert the weight to pounds and ounces. (There are 16 ounces in a pound.)
- load groceries into the sack until you think it’s about the same as the kitten or cat weight.
- put your sack on the scale and see how much it actually weighs.
- take some things out or add some until the sack weighs as close as you can get it to the kitten or cat weight.
- record the items that are in the sack.

<table>
<thead>
<tr>
<th>Age of Kitten or Cat</th>
<th>Average Weight in Ounces</th>
<th>Weight in Pounds and Ounces</th>
<th>Items in My Sack</th>
</tr>
</thead>
<tbody>
<tr>
<td>7-week old kitten</td>
<td>24 ounces</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10-week old kitten</td>
<td>32 ounces</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Full-grown female cat</td>
<td>128 ounces</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Full-grown male cat</td>
<td>160 ounces</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Set C3: Geometry: Circles & Angles
  Activity 1: Pattern Block Angles ........................................... C3.1
  Ind. Worksheet 1: Measuring Interior Angles of Polygons ................ C3.37
  Activity 2: Human Angles ....................................................... C3.7
  Ind. Worksheet 2: Angles in the Classroom ................................. C3.39
  Activity 4: From Pattern Blocks to Protractors ............................. C3.21
  Ind. Worksheet 6: Measuring Angles ......................................... C3.47
  Activity 5: Drawing Stars ......................................................... C3.29

Set C1: Geometry: Parallel, Perpendicular & Intersecting
  Activity 1: Dots & Lines ......................................................... C1.1
  Ind. Worksheet 1: Lines & Designs ........................................... C1.9
  Ind. Worksheet 2: Alphabet Lines ............................................ C1.11
**Set C3 ★ Activity 1**

**Pattern Block Angles**

**Overview**
Students review the terms right angle, straight angle, and interior angle. Then they use right and straight angles as benchmarks to determine the interior angles of each pattern block. Finally, they use pattern blocks to measure angles of rotation on a clock face and determine the fraction of a complete turn represented by each angle of rotation.

**Skills & Concepts**
- measure angles in geometric figures
- develop benchmark angles including 60°, 90°, and 120°
- identify the angles associated with different fractions of a complete turn

**You’ll need**
- Pattern Block Angles (page C3.4, 1 copy for display, plus a class set)
- Using Pattern Blocks to Measure Angles on a Clock Face (pages C3.5 and C3.6, 1 copy for display, plus a class set)
- a set of pattern blocks for each pair of students consisting of at least: 1 hexagon, 2 trapezoids, 2 squares, 3 triangles, 3 blue rhombuses, and 3 white rhombuses
- pattern blocks for display
- Word Resource Cards (right angle and straight angle) optional

**Advance Preparation** Consider assigning student pairs ahead of time so that students who may struggle with spatial relationships are paired with peers who can help them.

**Instructions for Pattern Block Angles**
1. Begin by displaying a copy of Pattern Block Angles. Explain that today students are going to work in pairs to determine what the measurements of the interior angles (angle on the inside of a shape) of each pattern block are. Use your Word Resource Cards to review the terms right angle (exactly 90 degrees), and straight angle (exactly 180 degrees).

2. Now give each pair of students a small set of pattern blocks and 2 copies of Pattern Block Angles. Ask them to talk to each other about how they could use the right and straight angles at the bottom of the page to determine the interior angle measurements of the triangle. Give them a few moments to work, and then invite a few pairs to share their ideas with the whole group. It’s fine if they have not yet calculated the exact angle measurements: the point is to make sure that everyone has some ideas about how to start this activity.

**Students** We put triangles on the straight angle until they filled it up. These three angles are each a third of a straight angle.
A straight angle is 180º, so each of the triangles must be 60º, right?
That’s what we think because 3 × 60 is 180.
3. Give students time to work in pairs to determine all the interior angles of the pattern blocks and label them on their sheets. Circulate around the room to see how students are working and to listen to their conversations. If you like, you might ask students to pause so you can share some helpful strategies you’ve observed. For example, “I saw some people finding angles on some of the pattern blocks that are equal to the angles they’d already figured out on another block. That helped them figure out those angles quickly.”

4. If some students finish quite a bit earlier than the rest of the group, you can invite them to tour the room and help others. Ask them to suggest strategies for finding the angle measurements rather than simply sharing the answers with their classmates. You might also ask them to turn over their papers and trace the sides of the pattern blocks to show how they can make other angles by adding the interior angles of different blocks. Here is an example:

![Pattern Block Angles Example](image)

We can make a 150-degree angle by putting these two angles together. $90 + 60 = 150$

5. When students have completed their sheets, reconvene the group and review the page to make sure everyone has their pattern block angles labeled correctly. Explain that they will use the blocks to measure other angles in this activity and the next, so it’s important that they are working with the correct angle measures.

6. Now explain that angles measure the amount of rotation. For example, in the course of an hour, the minute hand on the clock rotates all the way around the clock face. Ask students to follow along using a pencil as you model this on the projector. Start with the pencil at the 12 position and rotate it a full 360 degrees, keeping the eraser anchored in one place so that you’re not sliding the pencil, just rotating it about the eraser. Ask students how many degrees they rotated the pencil when they turned it one full turn. (360 degrees) Many students may connect this to a full turn on a skateboard or snowboard, referred to as a 360.

7. Now ask students to rotate their pencils one-fourth of a full turn. If they start at the 12 position, where does the pencil end up pointing after one-fourth of a turn? (the 3 position)

8. Post the display copy of Using Pattern Blocks to Measure Angles on a Clock Face and read the directions out loud. Explain that the students are now going to use the interior angles of the pattern blocks to measure different angles of rotation on the clock face. Use the square pattern block, and then three white rhombuses, to show how they can measure the example angle with different combinations of pattern blocks.
9. Invite students to ask any questions they might have, and then give them the rest of the period to complete the two pages. If students finish before the period is over, review the sheets as a whole group. If not, review the sheets at the beginning of the next activity in this set.

**Note**  Save, or have students save, their completed sheets for use in Activity 2.

**Extension**

- When reviewing the answers, invite students to express the rotations not only in terms of the fraction of a whole turn, but also as equivalent fractions based on the numbers on the clock face and on the number of degrees. You’ll need to gauge your students’ comfort level with fractions to determine whether this would be a worthwhile exercise for the group, or for just a few students.

\[
\frac{1}{4} = \frac{90}{360} \quad \text{and} \quad \frac{3}{12}
\]

**INDEPENDENT WORKSHEET**

Use Set C3 Independent Worksheet 1 (page C3.21) to provide students with practice measuring the interior angles of polygons using pattern blocks. Use Independent Worksheet 2 (page C3.23) to provide students with practice estimating angle measures against benchmarks of 90°, 60°, and 180°. Use Independent Worksheet 3 (pages C3.25 and C3.26) to provide students with practice drawing polygons with specified angles and side lengths.
## Pattern Block Angles

Label the interior angles of each pattern block shown below. Use the straight and right angles below to help determine what the angles are.

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>![Hexagon]</td>
<td>![Diamond]</td>
<td>![Triangle]</td>
</tr>
<tr>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>![Trapezoid]</td>
<td>![Square]</td>
<td>![Parallelogram]</td>
</tr>
</tbody>
</table>

---
Using Pattern Blocks to Measure Angles on a Clock Face

Use your pattern blocks to measure each angle on the clock faces below. Then write the fraction of a whole turn each angle represents.

**Example:**

<table>
<thead>
<tr>
<th>angle measure</th>
<th>fraction of a whole turn</th>
</tr>
</thead>
<tbody>
<tr>
<td>12 1 2 3 4 5 6 7 8 9 10 11</td>
<td>12 1 2 3 4 5 6 7 8 9 10 11</td>
</tr>
</tbody>
</table>

(continued on back.)
Using Pattern Blocks to Measure Angles on a Clock Face (cont.)

Use your pattern blocks to measure each angle on the clock faces below. Then write the fraction of a whole turn each angle represents.

<table>
<thead>
<tr>
<th>4a</th>
<th>Angle measure ________</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>fraction of a whole turn ________</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>5a</th>
<th>Angle measure ________</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>fraction of a whole turn ________</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>6a</th>
<th>Angle measure ________</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>fraction of a whole turn ________</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>7a</th>
<th>Angle measure ________</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>fraction of a whole turn ________</td>
</tr>
</tbody>
</table>
Set C3 ★ Independent Worksheet 1

Measuring Interior Angles of Polygons

Use your pattern blocks to measure the interior angles of each polygon below. Label each angle with its measurement. Then write the name of the polygon.

1 __________________________

2 __________________________

3 __________________________

4 __________________________
Set C3 ★ Activity 2

Human Angles

Overview
Students work in pairs to sketch and then estimate the angle of rotation for a number of different joints in their bodies, again using right angles, straight angles, and the interior angles of the pattern blocks as benchmarks. They also estimate the approximate fraction of a complete turn represented by each angle.

Skills & Concepts
★ measure angles in geometric figures  
★ use benchmark angles including 60°, 90°, and 120° to estimate angle measurements  
★ identify the fraction of a complete turn represented by different angles

You’ll need
★ Using Pattern Blocks to Measure Angles on a Clock Face (pages C3.5 and C3.6, completed copies from Activity 1)  
★ Range of Motion in Human Joints (page C3.10, run 1 copy for display)  
★ Measuring the Range of Motion of Your Joints, pages 1 and 2 (pages C3.11 and C3.12, 1 copy for display, plus a class set)  
★ a set of pattern blocks for each pair of students consisting of at least: 1 hexagon, 2 trapezoids, 2 squares, 3 triangles, 3 blue rhombuses, and 3 white rhombuses  
★ pattern blocks for display

Note: Since today’s activity involves students’ bodies, it is probably best to let students choose their own partners to ensure they are working with a classmate they like and feel comfortable with.

Instructions for Human Angles
1. If you did not have time in Activity 1 to review students' completed sheets, Using Pattern Blocks to Measure Angles on a Clock Face, do so now. Before working on today's activity, students will need to make sure that they have identified the angles and fractions of a turn correctly.

2. Now explain that in today's activity, students will be estimating the range of motion in some different joints in their bodies, including their wrists, elbows, knees, and shoulders. Explain that different kinds of joints can rotate different amounts. Sometimes, when people are injured, they go to physical therapy to help regain the full range of motion in the injured joint. For example, if a soccer player hurts her knee, she might need physical therapy to regain the full range of motion in her knee, and if a quarterback injures his shoulder, he also might need physical therapy to move his shoulder the way he needs to in order to make a long pass.

Physical therapists use a device called double-armed goniometer to measure the exact range of motion of their patients' joints. A goniometer consists of a stationary arm holding a protractor that is placed parallel with a stationary body segment, a pin (the axis of the goniometer) that is placed over the joint, and a movable arm that moves along a moveable body segment. (If you or the students do an Internet search for goniometer, you can find a variety of illustrations and photos of this measuring device.)
3. Place the Range of Motion in Human Joints sheet on display and explain that students will work in pairs to test the range of motion of different joints in their own bodies. Each student will move his or her joints as shown on this display, and his or her partner will sketch where the motion ended. Then they will use the pattern blocks and their sheets from yesterday to estimate the angle of rotation and fraction of a full turn for each joint movement.

4. Now invite a volunteer to show how to perform each movement shown on the display and help correct them if they don’t do it quite right. Emphasize that they are to rotate their joints only as far as it is comfortable. If they start to feel like they are straining, they must stop. Explain that they can injure themselves if they try to push their joints farther than they should go.

5. Now show the display copy of Measuring the Range of Motion of Your Joints. Have a volunteer show the knee motion again, and model how to sketch the ending point of that rotation. Then model how to use the interior angles of the pattern blocks to estimate the angle of rotation to the nearest ten degrees. While the volunteer is doing the motion and while you are sketching it, model how students can use 90 degrees as a benchmark in their sketch and in making their estimates. Ask students to refer to their sheets from yesterday to help estimate the fraction of a complete turn this angle represents.

6. Give each student a copy of the sheets and answer questions they have about the activity. Then give them most of the rest of the period to work in pairs. Circulate around the room to answer questions and to make sure students are conducting the activity safely and respectfully.

7. When you have five or ten minutes left in the period, reconvene the class and ask them to share their work by asking questions like the following:
   - Which joint had the greatest range of motion?
   - Which joint had the smallest range of motion?
   - Which fractions of a full turn were most difficult to estimate? How did you handle it?
   - Did any of your estimates surprise you?

You might also ask students to share and compare the estimates for the joints of their choice.

**Extensions**

- Have students research the different kinds of joints in the body. Each kind of joint performs a different kind of motion and, as a result, has a different possible range of motion.
- Invite students to research different birds, who have an impressive range of motion in their necks. Ask them to draw sketches of each bird’s range of neck motion.
- Invite students to make sketches showing different angles of rotation in skateboarding, ice skating, and snowboarding tricks. You might consider having them make posters and present the information to the class.

**INDEPENDENT WORKSHEET**

Use Independent Worksheet 4 (pages C3.27 and C3.28) to provide students with more practice identifying and drawing different angles of rotation and relating them to fractions of a complete turn about a circle.
### Range of Motion in Human Joints

<table>
<thead>
<tr>
<th></th>
<th>Joint Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Knee</td>
</tr>
<tr>
<td>2</td>
<td>Shoulder: To the Side</td>
</tr>
<tr>
<td>3</td>
<td>Elbow</td>
</tr>
<tr>
<td>4</td>
<td>Wrist</td>
</tr>
<tr>
<td>5</td>
<td>Shoulder: Back and Front</td>
</tr>
</tbody>
</table>
Measuring the Range of Motion of Your Joints

Work with a partner to test how much you can rotate each of the joints shown below. Each of you will sketch. First sketch the ending points of the joint's rotation. Then use your pattern blocks to estimate the degree of rotation to the nearest 10 degrees. When testing your joints, only bend as far as is comfortable: don’t rotate your joints until it feels difficult or painful!

1 Knee
   a approximate degrees of rotation ____________
   b approximate fraction of a complete turn ____________

2 Shoulder: To the Side
   a approximate degrees of rotation ____________
   b approximate fraction of a complete turn ____________

(continued on next page.)
Measuring the Range of Motion of Your Joints (cont.)

3 Elbow
   a approximate degrees of rotation ________________
   b approximate fraction of a complete turn ________________

4 Wrist
   a approximate degrees of rotation ________________
   b approximate fraction of a complete turn ________________

5 Shoulder: Back and Front
   a approximate degrees of rotation ________________
   b approximate fraction of a complete turn ________________

6 Your Choice _____________________
   a approximate degrees of rotation ________________
   b approximate fraction of a complete turn ________________
**Set C3 ★ Independent Worksheet 2**

**Angles in the Classroom**

Search your classroom for objects with the angles described below. Complete the chart by sketching each object, labeling it, and drawing an arrow to the angle that is less than, equal to, or greater than the benchmark angle. Use pattern blocks to help.

1. **Benchmark Angle: 90°**

<table>
<thead>
<tr>
<th>Less than 90°</th>
<th>Equal to 90°</th>
<th>Greater than 90°</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="angle.png" alt="Angle" /></td>
<td><img src="equal_angle.png" alt="Equal Angle" /></td>
<td><img src="greater_angle.png" alt="Greater Angle" /></td>
</tr>
</tbody>
</table>

This angle on the side of my eraser.

2. **Benchmark Angle: 60°**

<table>
<thead>
<tr>
<th>Less than 60°</th>
<th>About Equal to 60°</th>
<th>Greater than 60°</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="angle.png" alt="Angle" /></td>
<td><img src="equal_angle.png" alt="Equal Angle" /></td>
<td><img src="greater_angle.png" alt="Greater Angle" /></td>
</tr>
</tbody>
</table>

3. **Benchmark Angle: 180°**

<table>
<thead>
<tr>
<th>Less than 180°</th>
<th>Equal to 180°</th>
<th>Greater than 180°</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="angle.png" alt="Angle" /></td>
<td><img src="equal_angle.png" alt="Equal Angle" /></td>
<td><img src="greater_angle.png" alt="Greater Angle" /></td>
</tr>
</tbody>
</table>
Set C3 ★ Activity 4

From Pattern Blocks to Protractors

Overview
Students first review some terms related to angles and then use what they know about the angle measures of some pattern blocks to investigate the protractor. The sheets students complete today may be saved as work samples in their math portfolios.

Skills & Concepts
★ using a protractor to measure angles
★ selecting tools to construct angles
★ recognizing acute, right, and obtuse angles

You’ll need
★ Measuring Angles (page C3.28, run a class set plus 1 copy for display)
★ Experimenting with Angle Measurement (pages C3.26 and C3.27, run a class set)
★ Word Resource Cards (acute angle, obtuse angle, ray, right angle, straight angle, vertex, zero angle), optional
★ 180° protractor class set plus 1 for display
★ pattern blocks class set plus 1 for display
★ pens
★ piece of paper to mask portions of the display

Advance Preparation Display the Word Resource Cards listed above before the session starts.

Instructions for From Pattern Blocks to Protractors
1. Display the top portion of Measuring Angles and ask students to describe what they notice. While mathematicians commonly define an angle as the union of two rays (the sides of the angle) that have the same endpoint (the vertex), students will describe the angle in less formal terms.

Students It's an angle.
The angle is acute because it's smaller than 90°.
The angle has 2 arrows that go in different directions.
The lines start in the same place and then go different directions.
The place where they both start is the vertex, I think. It’s kind of like a corner for the angle. And the arrow lines are like the sides of the angle.

After a bit of discussion, draw students’ attention to the Word Resource Cards on display. Have them consider how the terms relate to the angle on the display by asking how the angle on the display compares to the angles pictured on the Word Resource Cards. Also ask them to locate the vertex and the rays on the display.

2. Pass out copies of Experimenting with Angle Measure. Ask students to get out pencils, protractors, and pattern blocks. Review the instructions on the sheet and explain that you’ll do the first angle together. Ask everyone to record an estimate of the measure of Angle 1 in the appropriate box at the top of their record sheet. Then ask volunteers to share and explain their estimates as you record them on the display beside Angle 1.

Students It’s less than 90º, that’s for sure, because it’s smaller than a right angle. I said it’s 70º. I said it was 65º. It looks bigger than half a right angle, somewhere between 45º and 90º. My estimate is 60º. It looks like it’s about \( \frac{2}{3} \) of the way to a 90º angle. Mine was close to that. I said 55º. Half of 90 is 45, and it looks bigger than half of a 90º angle, but not all that much bigger.

3. Now ask students to work in pairs to find at least 1 pattern block in the set that fits into the angle exactly. After a bit of experimentation, they’ll discover that any of the three angles on the green triangle, as well as the acute angles on the trapezoid and the blue rhombus, fit. What does that tell them about the measure of Angle 1? Allow students a few minutes to reconstruct and pair-share some of their findings concerning the measure of the various pattern block angles, and then call two or three volunteers to the display to share their conclusions.

Blanca We found out that the green triangle fits into Angle 1 exactly. But we couldn’t remember how big that angle was.
Yolanda  Then we remembered from the other day that if you add all the angles on a triangle together, you get 180°. Since all the angles on this triangle are the same, we figured each one must be 60° because $180 \div 3 = 60$.

Darius  That’s pretty close to what we estimated. Lots of people thought Angle 1 was going to be more than 50° but less than 90° for sure.

Nick  We found out that the trapezoid fits into Angle 1 like this. But we couldn’t remember how big that angle was on the trapezoid.

Armin  So here’s what we did. We put the trapezoid on top of the square to compare it to 90°, like this. Then we saw there was still room for one of those skinny rhombuses. But that still didn’t help because we didn’t know how big that one was either. Finally, we saw that we could fit exactly 3 of those skinny rhombuses into the square corner. Then we knew that each one of those was 30° because $90 \div 3 = 30$. That meant that the angle on the trapezoid that fit into Angle 1 had to be 60°.
Activity 4  From Pattern Blocks to Protractors (cont.)

4. Once the class has reached consensus that Angle 1 is 60°, ask students to use the protractors to show that the measure is 60°. Because most fourth graders are new to using protractors, you’ll want to give them some time to discover for themselves how they can position and read the protractor to get the same result. Encourage them to work in pairs and table groups to share their discoveries and help one another. After a few minutes of experimentation, ask one or more pairs to share their strategies, using a protractor on Angle 1 at the display.

**Kamela**  First we tried just lining up the protractor on the angle like this. The top of the angle kind of crossed over where it says 60° and 120° on the protractor, but it didn’t really seem to land right on the 60°.

![Protractor Image](image1)

**Jade**  Then we thought maybe if we put the middle of the protractor right on the corner of the angle it would work, like this, but it didn’t. We tried some other stuff and after we moved the protractor around for awhile, we saw that if you put the little hole right over the vertex and make sure the lines on both sides of the hole line up with the ray on the bottom, it comes out right.

![Protractor Images](image2)

**Kamela**  This didn’t work. This did! The other ray landed exactly on the 60°.

5. Give students the rest of the session to work with a partner to complete Experimenting with Angle Measurement. Reconvene the group as needed to talk about how the protractor can be used to confirm the pattern block measures. You might ask students who are comfortable using the protractor to help others who are experiencing difficulty. You might also work with a small group of students who are having difficulty.
Experimenting with Angle Measurement page 2 of 2

2. Lan says the angle below measures about 120°. Do you agree or disagree with her? Explain your answer.

3. Using a protractor, construct a 60° angle below or on a separate piece of paper. (If you use another sheet of paper, attach it to this assignment.) Check your work with a pattern block, and include the pattern block in your angle sketch.

CHALLENGE

4. Look around your classroom for acute angles. Choose several. For each angle you choose:
   a. Estimate how many degrees you think it measures.
   b. Measure it with your protractor.
   c. Record your work on the chart below.

<table>
<thead>
<tr>
<th>Acute Angles in the Classroom</th>
<th>How many degrees?</th>
<th>How many degrees?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Extension

Some students may have time to work on problem 4, which challenges them to estimate and measure acute angles they find around the classroom. If student interest in problem 4 is high, you may want to devote a section of your whiteboard to angle measurement, setting up a chart similar to the one shown below, which students can add to over the next few days.

Measuring Angles in Our Classroom

<table>
<thead>
<tr>
<th>Less than 90°</th>
<th>Exactly 90°</th>
<th>More than 90° but less than 180°</th>
</tr>
</thead>
<tbody>
<tr>
<td>Point on my collar = 75°</td>
<td>Corner of a piece of paper = 90°</td>
<td>Hexagon Pattern Block = 120°</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bench leg = 107°</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Trapezoid table corner = 120°</td>
</tr>
</tbody>
</table>

INDEPENDENT WORKSHEET

Use Set C3 Independent Worksheet 6 (on page C3.49) for additional practice with angle measurement.
1 For each angle below:

a Estimate how many degrees you think it measures.

b Use a pattern block to check the measure. (Each angle below matches one or more of the angles in your pattern blocks.)

c Measure it with your protractor and label it.

(Continued on back.)
Experimenting with Angle Measurement page 2 of 2

2 Lan says the angle below measures about 120°. Do you agree or disagree with her? Explain your answer.

![Angle Diagram]

3 Using a protractor, construct a 60° angle below. Check your work with a pattern block, and include the pattern block in your angle sketch.

CHALLENGE

4 Look around your classroom for acute angles. Choose several. For each angle you choose:

a Estimate how many degrees you think it measures.

b Measure it with your protractor.

c Record your work on the chart below.

<table>
<thead>
<tr>
<th>Acute Angles in the Classroom</th>
<th>How many degrees? (estimate)</th>
<th>How many degrees? (actual measure)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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Measuring Angles

Angle 1

Angle 2

Angle 3
Set C3 ★ Independent Worksheet 6

INDEPENDENT WORKSHEET

Find the Angle Measure

1 The sum of the angle measures in a triangle is 180 degrees. Below are 4 triangles, each with a missing angle measure labeled \( n \). For each one, choose the value of \( n \).

\[ a \] (20 degrees, 30 degrees, 50 degrees, 60 degrees)

\[ b \] (10 degrees, 20 degrees, 30 degrees, 40 degrees)

\[ c \] (130 degrees, 140 degrees, 150 degrees, 160 degrees)

\[ d \] (30 degrees, 45 degrees, 50 degrees, 60 degrees)

2a The 4 angles marked \( n \) below are congruent and have been put together to form a straight angle. Using sketches, numbers, and words, determine the value of each angle marked \( n \). Show your work below.

\[ n \]

\[ n \]

\[ n \]

\[ n \]

b The value of each angle marked \( n \) is ______ degrees.
Set C3 ★ Activity 5

Drawing Stars

Overview
Students discuss how to use the protractor to draw angles. Then they use the protractors and their understanding of rotations to create star designs.

Skills & Concepts
★ constructing figures with tools
★ using a protractor to measure angles
★ measuring angles
★ using measurement tools to accurately construct angles
★ describing rotational symmetry

You’ll need
★ 5-Point Star Template (page C3.34, run a class set plus 1 copy for display.)
★ Instructions for Drawing 5-Point Stars (page C3.35, run a class set)
★ Challenge 9-Point Star Template (page C3.36, run as needed. Optional.)
★ Student Journals or Journal Page Grid (page C3.37 run a class set, optional)
★ rulers, class set
★ protractors, class set
★ crayons, markers, or other art supplies for decorating designs

Instructions for Drawing Stars
1. Start the session by having students open their journals to the next available page. Then ask them to use their ruler to draw and label a 3 1⁄2˝ line segment, XY, as you do so at the display. Next, ask them to draw a second line segment that meets the first at a 45º angle, using a ruler to make sure the segment is straight, but estimating the size of angle itself. Encourage them to talk to their neighbors about how they made their estimates.

Nick  Here’s my angle. It looks like about 45º to me. I know it’s less than a right angle.

Rian  I know that 90º is a square corner and 45 is half of 90, so I made a diagonal right through the squares.
2. Ask how they could check the angles they have drawn and adjust them if they don’t measure 45°. Give them a moment to share ideas in pairs and then discuss their ideas as a whole class.

**Students** We said you could make a 90° angle and then cut it in half.
That’s what I did in my journal! I drew the first line across the page and drew the other one so it cut across the squares diagonally. It was like cutting 90° in half.
You could take a paper square, fold it on the diagonal, and use it to check your angle.
You could use a geoboard the same way. Just make a square and one of its diagonals and then set it on top of the angle you made in your journal to check it.
We said you could use a protractor to check your angle too.

3. After students have shared their ideas, ask them to measure their angles with a protractor. If their angle doesn’t measure 45°, have them leave their original angle but draw in a second line segment that does meet XY at a 45° angle. When they are finished, have them compare their results in pairs, and then invite 2 or 3 pairs of volunteers to share their work with the class, starting with the line segment XY you drew on the display.

**Jaime** The first angle I drew was way too skinny. To make a new one, I put that little hole at the bottom of the protractor at the end of the line where the X is. Then I went to the top point at 45°, made a mark, and drew my angle in.

**Josie** When Jaime showed me, I noticed that angle he got was obtuse, and a 45° has to be smaller than a right angle.

**Jaime** So then I fixed it by erasing my line and making my mark at the other 45° place on the protractor. When I drew the line and looked at it with the protractor on top again, I could see it had to be right because it’s half as big as a right angle.

**Justin** When Jon and I talked, we saw that we made the same angles, and they were reflections!
Kamela When I checked my first angle, the line was at about the 50° mark. All I had to do was make a little dot by the 45° mark and draw in my new angle. It was almost the same.

In the following activity, students will have more practice using the protractor as a drawing tool. If some students already find it easy to construct angles with a protractor, you might station at least one of them at each table to help classmates who find the task more challenging.

2. Distribute a copy of Instructions for Drawing Stars and of the 5-Point Star Template to each student.

<table>
<thead>
<tr>
<th>Instructions for Drawing 5-Point Stars</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Get a copy of the Template for a 5-Point Star. You’ll also need a pencil, a protractor, and a ruler.</td>
</tr>
<tr>
<td>2. From radius OA, create a 72º angle.</td>
</tr>
<tr>
<td>3. Mark the point where the angle intersects the circle as point B. Use your ruler to draw a straight line from point O to point B.</td>
</tr>
<tr>
<td>4. Using OB as a new starting line, create another 72º angle. Mark the point where it intersects the circle as point C. Use your ruler to draw a line from point O to point C.</td>
</tr>
<tr>
<td>5. Continue in this way until you have marked points A, B, C, D, and E, and drawn line segments OA, OB, OC, OD, and OE.</td>
</tr>
<tr>
<td>6. Use a ruler to make your lines straight. Connect A to C, then C to E, then E to B, then B to D, and then D to A.</td>
</tr>
<tr>
<td>7. When and if you have time, decorate the star in any way you like.</td>
</tr>
</tbody>
</table>

Have students read and follow the first 3 or 4 steps for drawing a 5-point star together as a group. Once each student has drawn at least one 72° angle, ask students to follow the rest of the instructions on their own, consulting with classmates as necessary for assistance. Give students extra copies of the template if they make mistakes that cannot be erased. Give students who finish their 5-point stars well ahead of their classmates the Challenge 9-Point Star Template. If you find students need help in getting started or following the directions, you can model how to draw a few points on the 5-Point Star Template.

3. When most or all students have completed the 5-point star, reconvene the class for a group discussion. Some students may need more time to decorate their 5-point stars. You might provide that additional time or ask students to complete and decorate their stars at home. When students' stars are completed, you might display them on the wall or in the hallway.
4. If you’re able to create a wall display of the completed stars, consider gathering students in front of the display to conduct the discussion. Begin by asking students to make some mathematical observations about their stars (both the 5-point stars and the challenge 9-point stars). Many will notice the line symmetry in their stars. During this discussion, you might also ask students why they drew 72° angles to make the 5-point star. Where did the number 72 come from?

**Teacher** What mathematical observations can you make about your stars?

**Yolanda** They all have a lot of symmetry to them. And all the 5-pointed stars are congruent.

**Raven** I noticed that in the 9-pointed stars, they had us make 3 triangles, and each triangle is equilateral.

**Teacher** How could you show that each triangle was equilateral? And now I’m really curious. Do you think the 9-pointed stars themselves are also equilateral?

**Raven** Well, I would have to show that all of the sides were the same. I could do that! All the points are equally spaced out along the circle. Look at triangle ADG. To get from A to D you go past 2 points. Same with D to G and then G to A. And if the triangles are equilateral, the star has to be, right?

### Extension

If students are interested, invite them to use the template to create a 9-Point star. They will use their protractor to identify 9 equally spaced points along the circle: A, B, C, D, E, F, G, H and I. Then use their rulers to connect the points to form triangles, ADG, BEH and CFI and decorate their stars.
5-Point Star Template

Explain below why you use 72 degree angles in the above construction. In other words, where does the number 72 come from?
Instructions for Drawing 5-Point Stars

1 Get a copy of the Template for a 5-Point Star. You’ll also need a pencil, a protractor, and a ruler.

2 From radius OA, create a 72° angle.

3 Mark the point where the angle intersects the circle as point B. Use your ruler to draw a straight line from point O to point B.

4 Using OB as a new starting line, create another 72° angle. Mark the point where it intersects the circle as point C. Use your ruler to draw a line from point O to point C.

5 Continue in this way until you have marked points A, B, C, D, and E, and drawn line segments OA, OB, OC, OD, and OE.

6 Use a ruler to make your lines straight. Connect A to C, then C to E, then E to B, then B to D, and then D to A.

7 When and if you have time, decorate the star in any way you like.
Challenge 9-Point Star Template

Instructions for Drawing 9-Point Stars

• Create 9 equally spaced points along the circle: A, B, C, D, E, F, G, H and I. (Hint: Think about the 72 degree angles in your 5-point star and where they came from.)

• Using your ruler, connect the points to form triangles ADG, BEH, and CFI.

• When and if you have time, decorate the star in any way you like.

Explain below how your protractor helped you space the points equally. In other words, where does the angle measurement come from?
Journal Page Grid
Set C1 ★ Activity 1

Dots & Lines

Overview
Students review the terms parallel, intersecting, and perpendicular, and then play a game with the teacher to practice building and drawing parallel and perpendicular lines.

Skills & Concepts
- Identify, compare, and analyze attributes of two-dimensional shapes
- Identify and describe parallel, perpendicular, and intersecting lines in two-dimensional shapes

You’ll need
- Parallel, Perpendicular & Intersecting Lines (page C1.5, run 1 copy on a transparency)
- Dots & Lines Gameboard (page C1.6, run 1 copy on a transparency)
- Dots & Lines Game Record Sheet (page C1.7, run a class set)
- Single spinner overlay
- Black overhead pen
- A piece of paper to mask parts of the overhead
- Game markers (16 red and 16 blue)
- 10 red and 10 blue rubber bands
- Geoboards and rubber bands (class set)
- A red and a blue colored pencil or marker for each student

Instructions for Dots & Lines
1. Display the top portion of Parallel, Perpendicular & Intersecting Lines, keeping the rest of the overhead covered for now. Ask students to pair-share any mathematical observations they can make about the display. Then invite volunteers to share their ideas with the class.

Students
There are 2 straight lines up there and they both have arrows at the ends. I think they’re never going to cross. They’re kind of like train tracks. Those lines are parallel. I know because you can tell they won’t cross.

2. Reveal the information below the 2 parallel lines on the overhead and read it with the class. Then give each student a geoboard and rubber bands. Ask them to build examples of parallel lines on their boards and share them with the people sitting nearest them.
3. Repeat steps 1 and 2 until you’ve reviewed all the information on the overhead. Be sure students take note of the square drawn at the intersection of the perpendicular lines. This is used to indicate that the two lines are crossing each other at right angles.

4. Collect students’ geoboards and bands, and give them each a Dots & Lines Record Sheet. Explain that you’re going to play a game that will help them remember the terms you just reviewed. They’ll play as the Red Team against you, and you’ll play as the Blue Team. Have them record the team color assignments on their sheet while you do so on the Dots & Lines Gameboard overhead.

5. Place the spinner overlay on top of the spinner and set a clear geoboard below the spinner. Use your overhead pen to draw a black line either vertically or horizontally across the board, following one of the lines of pegs. This is the starting line. Make an asterisk beside the line. Ask students to use a regular pencil to draw a line in the same location on their record sheet and mark it with an asterisk.

6. Explain that you’re going to take the first turn so students can see how to play the game. Spin the spinner. Read the results with the class, and use a blue rubber band to build a line all the way across the board, either parallel or perpendicular to the starting line, depending on what the spinner indicated. Ask students to use a blue pencil or marker to record the results of your turn on their sheets.

   **Teacher**  Okay, the spinner landed on “parallel.” That means I have to use a blue rubber band to make a line that’s parallel to the starting line. I can put it anywhere on the board, as long as it’s parallel to that line, but I think I’ll put it right beside the starting line.
7. Before students take their turn, explain that the object of the game is to capture the most small squares (i.e., squares without any pegs between their corners). Anytime a team forms 1 or more squares during their move, you'll mark those squares with game markers in the team's color. Ask them if they think they'll be able to form a square during this turn.

    **Isaac**  Nope. If we land on “parallel” there will just be 3 parallel lines in a row on the board. If we land on “perpendicular” we can build a line across, but it won’t make a square, no matter where we put it.

    **Erica**  Mr. R might be able to make a square on his next turn. I think it’s better to be the first team to go.

8. Have students take their turn, and then take turns back and forth until no more rubber bands can be placed and all 16 squares have been formed. If a team spins “parallel” and all the lines parallel to the starting line have already been made, they lose that turn.

   It's possible to form more than 1 square during a single move, and students may get more strategic about where they're placing their rubber bands as the game proceeds. Be sure to mark the squares with game markers and have students use colored dots to mark them on their record sheets. The sample record sheet on the next page shows how the game might look midway through and again at the end.
Activity 1  Dots & Lines (cont.)

Students  Mr. R really lucked out on that last move.
Too bad he didn't get “parallel” that last time. Then it would have been our turn again, and if we'd
gotten “perpendicular” we would have won.
Can we play it again?

9. Dots & Lines goes very quickly, and students have room to record the results of 4 games. Take turns
with the class to be the starting team. The team that starts first gets to erase the starting line and draw a
new one anywhere they want on the board.

Here are a few important rules to remember about Dots & Lines:
- The starting line has to go all the way across the board, either horizontally or vertically.
- A rubber band can be placed anywhere on the board, as long as it's oriented correctly with respect to
the starting line.
- Rubber bands have to go all the way across the board.
- The object of the game is to capture the most small squares; squares that have pegs between corners
are not allowed.
- Remember to mark every square a team forms on a given turn.
- Count the squares captured by each team at the end of the game to determine the winner.

Extensions
- If your students enjoy this game, run another set of the record sheets and play it again. A single game
makes a nice sponge activity, and you can have students save their record sheets for repeated use
over the course of a week.
- Challenge students to explain why there are no intersecting lines that are not perpendicular in this game.
- Leave the materials out, along with extra copies of the record sheet so students can play the game
with each other at the overhead during their free time.

INDEPENDENT WORKSHEET

See Set C1 Independent Worksheets 1 and 2 for more practice identifying and describing parallel, per-
pendicular, and intersecting lines using concrete objects and pictorial models.
Parallel, Perpendicular & Intersecting Lines

Parallel Lines are lines that are always the same distance apart. They will never cross or intersect. Can you explain why? Make 2 parallel lines on your geoboard. Make 3 lines on your geoboard that are all parallel.

Intersecting Lines are lines that intersect or cross each other. Make 2 intersecting lines on your geoboard.

Perpendicular Lines are special intersecting lines. Where they cross, they form a right angle. Make 2 lines on your geoboard that are perpendicular.
Dots & Lines Gameboard

Blue Team ___________________________  Red Team ___________________________

Parallel Lines

Perpendicular Lines

Perpendicular Lines

Parallel Lines
Dots & Lines Game Record Sheet

Blue Team

Game 1

Score: Blue _______ Red _______

Game 2

Score: Blue _______ Red _______

Game 3

Score: Blue _______ Red _______

Game 4

Score: Blue _______ Red _______

Red Team

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### Lines & Designs

1. Fill in the bubbles in front of the words that describes each set of lines below. Then explain your answer. How do you know? The first one is done for you.

#### Example

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td><img src="example.png" alt="Intersecting Lines" /></td>
<td><img src="example.png" alt="Parallel Lines" /></td>
<td><img src="example.png" alt="Perpendicular Lines" /></td>
</tr>
</tbody>
</table>

- **Intersecting lines**
- **Parallel lines**
- **Perpendicular lines**

**How do you know?**

I know these are intersecting lines because they cross. I know they're not perpendicular because they don't cross at right angles.

#### A

| ![Intersecting Lines](a.png) | ![Parallel Lines](a.png) | ![Perpendicular Lines](a.png) |

- **Intersecting lines**
- **Parallel lines**
- **Perpendicular lines**

**How do you know?**

#### B

| ![Intersecting Lines](b.png) | ![Parallel Lines](b.png) | ![Perpendicular Lines](b.png) |

- **Intersecting lines**
- **Parallel lines**
- **Perpendicular lines**

**How do you know?**

#### C

| ![Intersecting Lines](c.png) | ![Parallel Lines](c.png) | ![Perpendicular Lines](c.png) |

- **Intersecting lines**
- **Parallel lines**
- **Perpendicular lines**

**How do you know?**

(Continued on back.)
2 Get a geoboard and some colored rubber bands. Use them to make each of the designs described below. Then use regular and colored pencils to record your work on this sheet.

**example** Make a design with 6 gray parallel lines.

a Make a design with 6 red intersecting lines.

b Make a horizontal blue line all the way across the board. Then add 4 green lines that are all perpendicular to the blue line.

c Make a yellow diagonal line all the way across the board. Then add 4 blue lines that intersect with the yellow line.
Alphabet Lines

1 The kids in Mrs. Odell’s fourth grade were learning about different kinds of lines. Hector made the letter H on his geoboard and said, “Hey look! These 2 lines I’m pointing to are parallel.”

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</tbody>
</table>

a Get a geoboard and some colored rubber bands. On your geoboard, make 4 other capital letters that have 2 or 3 parallel lines in them. Use red rubber bands to make the lines that are parallel to each other. Use a ruler and colored pencils to record your work below. Show the parallel lines in red.

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</tbody>
</table>

b How do you know for sure that the lines you made in red are parallel?
Independent Worksheet 2  Alphabet Lines (cont.)

2 Then Lani said, “The two lines in the first letter of my name are perpendicular. You can see that they meet at a right angle on the board.”

On your geoboard, make 4 other capital letters that have perpendicular lines. Record your work below. Draw arrows to show where the lines meet at right angles.

3 Then Xavier said, “I think the first letter of my name has intersecting lines.”

Do you agree with him? Why or why not? If you do, draw an arrow to show where the 2 lines intersect.

(Continued on next page.)
Independent Worksheet 2  Alphabet Lines (cont.)

3b  Circle the letter that has 2 intersecting lines.

   c  j  x  i  s  l

4  Write the first letter of your first name in this box. Label it to show any lines that are parallel, perpendicular, or intersecting. If the first letter of your first name is completely curved (like O or C), choose a different letter in your first or last name that has straight lines.

CHALLENGE

5  Circle True or False to show which statements below correctly describe these lines.

a  The two lines above are parallel.  True  False
b  The two lines above are perpendicular.  True  False
c  The two lines above are intersecting.  True  False

6  Two lines that are not parallel and not perpendicular are called oblique lines. Circle all the pairs of oblique lines below.
Set D3: Measurement: Capacity in Metric Units
   Activity 1: Estimate, Order & Measure: Milliliters & Liters .................................. D3.1
   Activity 2: Which Container is Best? ................................................................. D3.5
   Ind. Worksheet 1: Capacity in Daily Life .......................................................... D3.9

Set A5: Numbers & Operations: Multi-Digit Multiplication
   Activity 1: Multi-Digit Multiplication Pre-Assessment ......................................... A5.1
   Activity 2: Multiplying by 10, 100, & 1000 ...................................................... A5.17
   Ind. Worksheet 1: More Practice Multiplying by 10, 100, & 1000 ................ A5.105
   Activity 3: Multiplying Single Digits by Multiples of Ten ................................ A5.23
   Ind. Worksheet 2: More Tens, Hundreds, & Thousands ................................ A5.107
   Activity 4: Single-Digit Multiplication with Pictures & Numbers .................... A5.29
   Ind. Worksheet 3: Double-Digit by Single-Digit Multiplication ....................... A5.109
   Activity 5: Introducing the Standard Multiplication Algorithm ...................... A5.35
   Ind. Worksheet 4: Using the Standard Algorithm for Two-Digit by
   One-Digit Multiplication ......................................................................................... A5.111
   Activity 6: Think before You Multiply ................................................................. A5.39
   Ind. Worksheet 5: Choose Your Strategy .......................................................... A5.113
   Activity 7: Splat .................................................................................................. A5.45
   Activity 8: Sketching Arrays & Partial Products ............................................... A5.55
   Ind. Worksheet 6: Multiplying Multiples of 10 & More ................................ A5.115
   Activity 9: Double-Digit Multiplication with Pictures & Numbers .................. A5.61
   Ind. Worksheet 7: Using Four Partial Products to Multiply Two-Digit
   Numbers ................................................................................................................... A5.117
   Activity 10: Multiplication Menus ..................................................................... A5.67
   Ind. Worksheet 8: More Multiplication Menus ................................................ A5.119
   Activity 11: Introducing a Two-Part Area Model ............................................. A5.73
   Activity 13: Reviewing & Evaluating Multiplication Strategies ...................... A5.87
   Ind. Worksheet 9: Pine Cones & School Supplies ........................................ A5.121
   Activity 14: Multi-Digit Multiplication Post-Assessment ................................. A5.95

Set B1: Algebra: Equations & Operations
   Activity 1: Bowling for Equations ...................................................................... B1.1
   Activity 3: Variables & Expressions ................................................................. B1.13
   Ind. Worksheet 2: Expressions, Variables & Situations .................................. B1.33
   Activity 4: Writing & Solving Equations .......................................................... B1.21
Set D3 ★ Activity 1

Estimate, Order & Measure Milliliters & Liters

Overview
Students estimate the capacity of 6 different containers, ordering them from least to most capacity. Then they determine the actual capacities to check their estimates. This activity is designed for use by student pairs during Work Places or other work periods.

Skills & Concepts
☆ estimate and measure capacity in metric units
☆ carry out simple conversations within a system of measurement, such as milliliters to liters

You’ll need
☆ Estimate, Order & Measure Instructions (page D3.3, run 1 copy)
☆ Estimate, Order & Measure Record Sheet (page D3.4, run a class set)
☆ 6 plastic containers (see Advance Preparation)
☆ 1-cup liquid measuring cup (see Advance Preparation)
☆ pitcher to hold about 2 liters of water
☆ cafeteria tray
☆ towel

Advance Preparation Gather 6 plastic containers of varying capacity (e.g., margarine, yogurt, peanut butter, cream cheese containers, kids’ cups from restaurants, and so on). If any of these are already marked with their capacity, black it out with a permanent marker. Label each container with an alphabet letter, A–F. Find the 1-cup measure that came with your Number Corner materials. If you haven’t done so already, use the Calibration Strip on Number Corner Blackline 7.5 to calibrate the cup in increments of 10 milliliters. Place the containers, measuring cup, and pitcher of water on a cafeteria tray. Set up the tray, towel, activity instructions, and record sheets in a location somewhere in the classroom where pairs of students can work independently over the next few weeks as time allows.

Instructions for Estimate, Order & Measure: Milliliters & Liters
1. Explain that you’ve set up some materials to give students practice estimating and measuring capacity in metric units. Review the terms capacity, milliliter, and liter with the class.
**Note**: If you’ve done the March Calendar Collector with your class, students will already be familiar with milliliters. If not, pass the measuring cup to a volunteer and ask her to find the mark on the cup that shows 200 milliliters. How does this mark compare with the mark on the other side that shows 1 cup? If students are unfamiliar with metric units of capacity, it may help them to see that 200 milliliters is a little less than 1 cup, while the 250 milliliter mark near the very top of the measuring cup is just a little over 1 cup. Review the fact that there are 4 cups in a quart and 1000 milliliters in a liter. Because 250 milliliters is just a little more than a cup, a liter is a little more than a quart.

2. Show students a copy of the Estimate, Order & Measure instructions and record sheet. Review the instructions with the class, and model the procedure of estimating and measuring as needed. Let students know where to find the materials and explain that they’ll be working in pairs to do this activity. Explain how they’ll know when it’s their turn, and establish any ground rules for using the materials, turning in their work, and so on.
Estimate, Order & Measure Instructions

To do this activity, you’ll need

★ Activity Instructions
★ Estimate, Order & Measure Milliliters & Liters Record Sheet
★ 6 plastic containers labeled with letters A–F
★ pitcher
★ 1-cup measuring cup
★ towel

Instructions for Estimate, Order & Measure: Milliliters & Liters

1. Record your name and the date at the top of a record sheet. Choose a partner to work with. You’ll both fill out your own record sheets for this activity.

2. Look at the 6 containers. Put them in the order you think they belong, from smallest to largest. Record your predictions.

3. Go to the sink with your partner and carefully measure 1–2 liters of water into the pitcher.

4. Estimate the capacity of Container A in milliliters or liters. (Remember that there are 1,000 milliliters in a liter, and the measuring cup holds 250 milliliters.) Record your estimate.

5. Use the water and the measuring cup to find out how much water Container A actually holds (to the nearest 10 milliliters). Record the actual capacity.

6. Find the difference between your estimate and the actual capacity. Record the difference in the last column.

7. Continue estimating, finding the capacity, and finding the difference for the other 5 containers. Use what you know about the capacity of the first container to help make your estimates.

8. When you’ve found out how much each container actually holds, put them in order from smallest to largest, and record their actual ranking.

9. Clean up. After you finish the activity, return all the water to the pitcher and empty the pitcher in the sink. Wipe down the table surface and clear any spills on the floor. Mix up the 6 containers so they’re out of order and ready for the next pair of students.
### Estimate, Order & Measure Record Sheet

Put the containers in the order you think they belong, from smallest to largest. Record your predictions. Then do the second part of the sheet. After you find out how much water each container holds, fill in the second row on this chart to show their actual order.

<table>
<thead>
<tr>
<th>Container</th>
<th>Your estimate (to the nearest 10mL)</th>
<th>Actual Measurement (to the nearest 10mL)</th>
<th>The Difference (to the nearest 10mL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B</td>
<td></td>
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<td></td>
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<td>E</td>
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<tr>
<td>F</td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>
Set D3 ★ Activity 2

Which Container is Best?

Overview
Students estimate which beverage containers are most likely to hold certain amounts of water. Then they test their ideas to find the best containers for several different situations. This activity is designed for use by student pairs during Work Places or other work periods.

Skills & Concepts
★ estimate and measure capacity in metric units
★ carry out simple conversations within a system of measurement, such as milliliters to liters

You’ll need
★ Which Container is Best? Record Sheets (pages D3.7 and D3.8, run a class set)
★ an assortment of 8 or more beverage containers (see Advance Preparation)
★ 1-cup liquid measuring cup (see Advance Preparation)
★ pitcher to hold about 2 liters of water
★ cafeteria tray
★ towel

Advance Preparation Gather 8 or more beverage containers of varying capacity (e.g., pop can, water bottles of various sizes, small children’s cup, drink containers from restaurants including an extra large or “super” size, and so on). Label each container with an alphabet letter. Find the 1-cup measure that came with your Number Corner materials. If you haven’t done so already, use the Calibration Strip on Number Corner Blackline 7.5 to calibrate the cup in increments of 10 milliliters. Place the containers, measuring cup, and pitcher of water on a cafeteria tray. Set up the tray, towel, and Record Sheets in a location somewhere in the classroom where pairs of students can work independently over the next few weeks as time allows.

Instructions for Which Container is Best?
1. Explain that you’ve set up some materials to give students more practice estimating and measuring capacity in metric units. Show them a copy of the Which Container is Best? Record Sheets. Review the instructions on the sheet with the class, and model the procedure of estimating and measuring as needed.

2. Let students know where to find the materials and explain that they’ll be working in pairs to do this activity. Explain how they’ll know when it’s their turn, and establish any ground rules for using the materials, turning in their work, and so on.
Activity 2 Which Container is Best? (cont.)

INDEPENDENT WORKSHEET

See Set D3 Independent Worksheet 1 for more practice estimating and measuring capacity in metric units.
Which Container Is Best? Record Sheet  page 1 of 2

Directions

a  Record your name and the date at the top of the record sheet. Choose a partner to work with. You'll both fill out your own record sheets for this activity.

b  For each problem below:
   • estimate and record which containers you think will hold the amount of water needed. (It's okay if you choose more than one container that might work.)
   • test your estimates using the liquid measuring cup.
   • decide which beverage container actually works best.
   • record your recommendation.

C  Clean up. After you finish the activity, return all the water to the pitcher. Wipe down the table surface and clean up any spills on the floor.

Problems

Sarah needs to bring some water for several different activities this week. Help her choose the best container for each activity.

1  For a car trip to her grandma's on Monday, Sarah needs to bring about 500 milliliters of water to drink.

   a  Estimate: Which of the containers look like they would hold about 500 milliliters?

   b  Use the liquid measuring cup to help you find the drink container that would work best for the car trip.

   c  Container ___________ holds about 500 milliliters.

2  For ballet class on Wednesday, Sarah needs to bring about 800 milliliters of water to drink.

   a  Estimate: Which of the containers look like they would hold about 800 milliliters? Are there any two containers that look like they would hold 800 milliliters combined?

   b  Use the liquid measuring cup to help you find the drink container (or pair of containers) that would work best for ballet class.

   c  Container(s) ___________ hold(s) about 800 milliliters.
3 For her track meet on Saturday, Sarah needs to bring about a liter of water to drink.

a Estimate: Which of the containers look like they would hold about 1 liter? Are there any combinations of 2 or more containers that might hold 1 liter?

b Use the liquid measuring cup to help you find the drink container (or combination of containers) that would work best for the track meet.

c Container(s) ___________ hold(s) about 1 liter.

CHALLENGE

4 On the way home from track meets, Sarah always buys a 2-liter bottle of juice. How many total milliliters of juice is she drinking if there are 6 track meets this season?
Capacity in Daily Life

1. Javier brought a thermos of tomato soup for lunch. He estimates that he brought about $\frac{3}{4}$ of a liter. His friend insists he brought about $\frac{3}{4}$ of a milliliter. Who is correct? Why? You may use measuring tools from your classroom to help you, if needed. Explain your answer using numbers, pictures, and/or words.

2. Julene is making fruit punch for her scout troup. There are 10 girls in the troup and each one will have at least 1 glass of punch. Should she use 2 milliliters, 2 liters, 20 liters, or 200 liters of water? Why? You may use measuring tools from your classroom to help you, if needed. Explain your answer using numbers, pictures, and/or words.
Set A5 ★ Activity 1

Multi-Digit Multiplication Pre-Assessment

Overview
This pre-assessment launches a set of activities that return to the multiplication work started in Unit 2. In the 12 activities that follow, students will move from building and sketching 2-digit by 1-digit multiplication combinations to using the standard algorithm to multiply up to 3-digit by 2-digit numbers. Additional practice with the skills introduced in these activities can be found on pages A5.109–A5.126 in the Independent Worksheet section of the Bridges Supplement.

Skills & Concepts
★ represent multiplication of two-digit by two-digit numbers
★ multiply by 10 and 100
★ multiply one- and two-digit numbers by numbers through 10 and by multiples of 10
★ estimate products to approximate solutions and determine reasonableness of answers
★ solve single-step word problems involving multi-digit multiplication

You’ll need
★ Multi-Digit Multiplication Pre-Assessment (pages A5.7–A5.9, run a class set)
★ Multi-Digit Multiplication Pre-Assessment Class Checklist (page A5.10, run 1 or 2 copies)
★ Multi-Digit Multiplication Pre- & Post-Assessment Scoring & Comparisons (optional, page A5.11 and A5.12, run a class set)
★ Base 10 Grid Paper (page A5.13, run as needed)
★ Student Reflection Sheet: Multiplication (pages A5.14–A5.16, optional, run a class set)
★ access to base 10 area and linear pieces

Instructions for Multi-Digit Multiplication Pre-Assessment
1. Explain to your students that over the next few weeks, the class will return to studying multi-digit multiplication. Today they’ll take a pre-assessment that will give you information about their current strategies for multiplying large numbers. Explain that they will take a similar assessment in several weeks, at which time they will have additional ways to handle problems that may seem challenging today.

2. Give students each a copy of the pre-assessment. Ask them to write their name and the date at the top of each page. Read and review the problems together and have students circle the “doing” words as you go. Remind them that once they get started, they’ll need to mark each checkpoint with an × or a ✓ to show that they have completed the task.
1. Ben and his mom got 5 cases of bottled water for the soccer game. There were 24 bottles of water in each case. How many bottles of water was that altogether?
   a. Solve the story problem above. Show your work with labeled sketches, numbers, and/or words.
   b. Ben and his mom got _____ bottles of water in all.

2. Choose one of the problems below and circle it.
   10 × 16 18 × 10 13 × 20 20 × 26
   a. Make a labeled sketch on the grid below to show the problem you chose.
   b. Find the answer to the problem you chose using your sketch. Show all of your work.

3. These base 10 linear pieces show the dimensions of a rectangle.
   a. Label each dimension and fill in the rectangle.
   b. Use the information to find the area of the rectangle. Show your work.

4. Write the answer to each problem.
   30 50 40 60 24 22
   × 10  × 10  × 10  × 10  × 26  × 50

5. Choose one of the multiplication problems below and circle it. Pick the one that seems best for you—not too hard and not too easy.
   12 15 22 26 38 236
   × 14  × 13  × 23  × 23  × 27  × 39
   a. Find the answer to the problem you circled. Be sure to show all of your work.
   b. Write a story problem to match the multiplication problem you just solved.
3. Before students start to work, be sure they understand that they only need to circle and solve one of the multiplication combinations in both problems 2 and 7. Tell students that you’ll place a small stack of base ten grid paper near each table or cluster of desks if they want to use it for any of the problems, and they can also get out their base ten area and linear pieces for use during the assessment.

Remind students that although you can't explain the tasks to them, you will read any of the problems to them again if needed during the assessment period. Although they may not be sure how to solve some of the problems, encourage them to attempt each one. Partial solutions are fine, and if they are unable to answer a particular problem they can write, “I don't know yet.”

---

**LOOKING AT STUDENT WORK**

Students will complete a similar assessment in Set A5, Activity 14, at which time a scoring guide will be included for your use. We recommend that you use the results of today’s pre-assessment to help guide your instruction as you teach this set of activities. To help, you can use the Multi-Digit Multiplication Class Checklist on page A5.10 if you like. By compiling results for your entire class, you can get a sense of the areas in which the class as a whole needs more work.

---

Students' responses to this pre-assessment should give you a good sense of how much they have retained from Unit Two, and where they stand with regard to the skills you'll be teaching over the coming sessions. Problem 1 gives you an opportunity to see how students deal with 2-digit by 1-digit multiplication right now. Some of them will probably make a sketch on base 10 grid paper or a free-hand sketch similar to the one shown on the next page to handle this kind of computation. Some may break 24 into tens and ones and multiply each part, while others use the standard algorithm. Chances are, some of your students will use repeated addition to solve the problem. These students may still be working to develop multiplicative reasoning, and will probably need more support than others to move toward efficient and effective methods for multi-digit multiplication.
1. Ben and his mom got 5 cases of bottled water for the soccer game. There were 24 bottles of water in each case. How many bottles of water was that altogether?

   a. Solve the story problem above. Show your work with labeled sketches, numbers, and/or words.

   
   
   \[
   \begin{align*}
   5 \times 24 &= 120 \\
   5 \times 20 &= 100 \\
   5 \times 4 &= 20 \\
   100 + 20 &= 120 \\
   \end{align*}
   \]

   b. Ben and his mom got 120 bottles of water in all.

Problems 2 and 3 give you an opportunity to see how your students are doing with the area model. Can they make a labeled sketch on base ten grid paper and use it to find the answer to a problem that involves multiplying by 10 or multiples of 10? Can they fill in a frame and use the sketch to find the solution to 13 \times 17? The area model, introduced in Units One and Two will serve as a scaffold for developing more efficient numeric methods for multi-digit multiplication in the activities to follow.

Problem 4 will help you see whether or not your students can estimate products and justify their estimates. Are they able to consider the results of multiplying tens and ones, or hundreds, tens, and ones, by a single digit to make reasonable estimates? Are they able to explain their thinking?

Problems 5 and 6 will help you see how well your students are able to multiply single- and double-digit numbers by 10, 100, and other multiples of 10. These skills were introduced in Unit Two, and are heavily featured in the upcoming activities, as they are central to developing efficient methods for multi-digit multiplication.

Students' responses to problem 7 will help you understand how they are currently dealing with 2-digit by 2-digit multiplication. While a few may not be able to respond in any way, you'll probably see a number of different methods, some of which are summarized on the chart below:
### Activity 1 Multi-Digit Multiplication Pre-Assessment (cont.)

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Example</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Working from Known Facts</td>
<td>$14 \times 2 = 28$ $14 \times 10 = 140$ $140 + 28 = 168$</td>
<td>Some students may break the numbers apart into more manageable chunks. Such student-invented methods demonstrate good number sense and a solid understanding of the place values involved in multi-digit computation.</td>
</tr>
<tr>
<td>Mis-Memorized or Mis-Applied</td>
<td>$14 \times 12$ $28$ $14 \times 12$ $12$ $28$ $14 \times 12$ $42$ $410$ $14 \times 12$ $32$ $108$</td>
<td>Any of the errors shown here will be familiar to fourth grade teachers, and tend to crop up among students who have been encouraged to memorize multi-step procedures without adequate conceptual preparation. Such students, many of whom are still reasoning in an additive rather than a multiplicative manner, are often untroubled by the fact that answers like 32 and 42 do not make sense.</td>
</tr>
</tbody>
</table>

If you have students who get the correct answer using the standard algorithm, you might probe their understanding by asking them to explain their steps. Some may comprehend the process very well, while others may be manipulating the numbers carefully and accurately but with little understanding. Such students are likely to explain their work as follows: “When you do $12 \times 14$, first you multiply $2 \times 4$, that’s 8. Then you multiply $2 \times 1$, which is 2, so you have 28. Then you go down to the next row and put a 0 (or skip a space). Then you just go $1 \times 4$ is 4 and $1 \times 1$ is 2, so it’s 14 with a zero (or a space) after it. You add the two rows, and it comes to 168.”

You might also ask students who are using the standard algorithm correctly to estimate the results of a problem like $23 \times 15$. Students who give an estimate between 300 and 400 and can explain why without resorting to paper and pencil are clearly working with good understanding.

After you have marked the pre-assessments, let your students look them over before you file them away so they have some sense of what they need to work on over the coming weeks. You might also ask them to fill out a Multiplication Student Reflection Sheet. Students may have fairly strong feelings about their own skills, and the experience of solving these kinds of problems will be fresh in their minds. If you decide to use these form, remind students that these are learning targets for the coming weeks, and it’s okay if they can’t do everything on the list right now. Plan to have them fill out the form again at the end of the activity set, and possibly another copy again later in the year after they’ve had additional time to practice the skills.
Activity 1 Multi-Digit Multiplication Pre-Assessment (cont.)

Multi-Digit Multiplication Reflection Sheet  page 1 of 3

Here are some of the things you need to know to be able to multiply large numbers quickly and easily. Rate your own understandings and skills right now using the following marks.

+ I know how to do this already.
✓ I’m learning to do this, and I feel confident that I’ll be able to do it soon.
← I’m learning to do this, but it still seems pretty confusing.
0 I don’t get it, and it seems frustrating to try to understand it.

<table>
<thead>
<tr>
<th>SKILLS AND UNDERSTANDINGS</th>
<th>START OF THE ACTIVITY SET</th>
<th>END OF THE ACTIVITY SET</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multiplication</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Can write a multiplication story problem</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Can multiply by 5 and 10 in my head (Examples: 8 × 5 or 60 × 10)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Can multiply a single digit number by a multiple of 10 in my head (Examples: 8 × 40 or 75 × 5)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Can use base 10 pieces to model and solve a double digit problem like 23 × 27</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Can use a labeled sketch on base 10 grid paper to solve a problem like 24 × 18</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Can break a double digit multiplication problem into 2 parts to solve it more easily (Example: 5 × 37 = (5 × 30) + (5 × 7))</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Can use the standard algorithm to solve a 2 digit by 1 digit problem like 7 × 38</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Can break a double digit multiplication problem into 4 or 2 parts to solve it more easily (Example: 26 × 35 = (20 × 30) + (6 × 5) + (20 × 5) + (6 × 5))</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Can use the standard algorithm to solve a 2 digit by 2 digit problem like 40 × 56</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Can make estimates to predict how big the answer will be or to see if my answer seems reasonable</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Multiplication & Division Reflection Sheet  page 2 of 3

Here’s how I feel about solving multiplication problems like 6 × 52 or 27 × 23, and 37 × 148:

<table>
<thead>
<tr>
<th>Start of the Activity Set</th>
<th>End of the Activity Set</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

What are two goals for multiplication that are important to you? (What could you improve?)

<table>
<thead>
<tr>
<th>Start of the Activity Set</th>
<th>End of the Activity Set</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

How will you meet each goal above?

<table>
<thead>
<tr>
<th>Start of the Activity Set</th>
<th>End of the Activity Set</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

2                        |                         |
1. Ben and his mom got 5 cases of bottled water for the soccer game. There were 24 bottles of water in each case. How many bottles of water was that altogether?

   a. Solve the story problem above. Show your work with labeled sketches, numbers, and/or words.

   b. Ben and his mom got _____ bottles of water in all.

2. Choose one of the problems below and circle it.

   10 \times 16 \quad 18 \times 10 \quad 13 \times 20 \quad 20 \times 26

   a. Make a labeled sketch on the grid below to show the problem you chose.

   b. Find the answer to the problem you chose using your sketch. Show all of your work.
3 These base 10 linear pieces show the dimensions of a rectangle.

a Label each dimension and fill in the rectangle.

b Use the information to find the area of the rectangle. Show your work.

4 Fill in the bubble to show the best estimate for each problem. Explain your choice.

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>26</td>
<td>6</td>
<td>100</td>
</tr>
<tr>
<td>b</td>
<td>134</td>
<td>5</td>
<td>500</td>
</tr>
</tbody>
</table>

Why?

5 Write the answer to each problem.

<p>| | | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>32</td>
<td>68</td>
<td>30</td>
<td>34</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>10</td>
<td>10</td>
<td>10</td>
<td>100</td>
<td>26</td>
<td>100</td>
<td></td>
</tr>
</tbody>
</table>
Multi-Digit Multiplication Pre-Assessment  page 3 of 3

6  Write the answer to each problem.

\[
\begin{array}{ccccccc}
30 & 50 & 40 & 60 & 24 & 22 \\
\times 3 & \times 7 & \times 30 & \times 50 & \times 20 & \times 30 \\
\hline \\
\end{array}
\]

7  Choose one of the multiplication problems below and circle it. Pick the one that seems best for you—not too hard and not too easy.

\[
\begin{array}{ccccccc}
12 & 15 & 22 & 26 & 38 & 236 \\
\times 14 & \times 13 & \times 23 & \times 23 & \times 27 & \times 39 \\
\hline \\
\end{array}
\]

a  Find the answer to the problem you circled. Be sure to show all of your work.

b  Write a story problem to match the multiplication problem you just solved.
## Multi-Digit Multiplication Pre-Assessment Class Checklist

| Student name | 1a Shows work for $5 \times 24$ | 1b Gives the answer for 1a, 120 | 2a Makes a labeled sketch on base 10 grid paper to multiply a 2-digit number by 10 or a multiple of 10 | 2b Uses the sketch from 2a to find the correct answer | 3a Completes and correctly labels a free-hand sketch of a $13 \times 17$ array | 3b Uses the sketch from 3a to find the correct answer, 221 | 4a Chooses the best estimate for $6 \times 26$ (150), and justifies estimate in a way that makes sense | 4b Chooses the best estimate for $5 \times 134$ (700), and justifies estimate in a way that makes sense | 5 Multiplies 2-digit numbers by 10 and 100 (Solves ___ out of 6 problems correctly.) | 6 Multiplies 1- and 2-digit numbers by multiples of 10 (Solves ___ out of 6 problems correctly.) | 7a Shows work and finds the answer to a 2-digit $\times$ 2-digit multiplication problem | 7b Writes a story problem to match the multiplication problem from 7a |

* + completely correctly, ✓ partially correct, – incorrect

Most students appear confident with these areas: 

I’ll need to focus instruction in this unit on these weaker areas:
## Multi-Digit Multiplication Pre-Assessment Scoring & Comparisons

**Date of Pre-Assessment ____________________**

<table>
<thead>
<tr>
<th>Performance Indicator</th>
<th>Performance *</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1a Shows work for 5 × 24</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1b Gives the answer for 1a (120)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2a Makes a labeled sketch on base 10 grid paper to multiply a 2-digit number by 10 or a multiple of 10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2b Uses the sketch from 2a to find the correct answer</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3a Completes &amp; labels a free-hand sketch of a 13 × 17 array</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3b Uses the sketch from 3a to find the correct answer (221)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4a Chooses the best estimate for 6 × 26 (150), and justifies estimate in a way that makes sense</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4b Chooses the best estimate for 5 × 134 (700), and justifies estimate in a way that makes sense</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 Multiplies 2-digit numbers by 10 and 100 (Solves ___ out of 6 problems correctly.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 Multiplies 1- and 2-digit numbers by multiples of 10 (Solves ___ out of 6 problems correctly.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7a Shows work and finds the answer to a 2-digit × 2-digit multiplication problem</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7b Writes a story problem to match the multiplication problem from 7a</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* + completely correctly, ✓ partially correct, – incorrect
## Multi-Digit Multiplication Post-Assessment Scoring & Comparisons

**Date of Post-Assessment ________________________**

<table>
<thead>
<tr>
<th>Problem</th>
<th>Possible Points</th>
<th>Points Earned</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1a</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1b</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2a</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2b</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2c</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3a</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3b</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4a</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4b</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>6</td>
<td></td>
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</tr>
<tr>
<td>7a</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7b</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>5</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **A** Advanced (working above grade level) 29–32 points (90–100% correct)
- **P** Proficient (working at grade level) 24–28 points (75–89% correct)
- **B** Basic (working toward grade level) 17–23 points (53–74% correct)
- **N** Novice (working below grade level) 16 points or fewer (50% or less correct)

**Total Points __________________**

**Percentage __________________**

**Proficiency Level ____________**
Base Ten Grid Paper
Multi-Digit Multiplication Reflection Sheet  page 1 of 3

Here are some of the things you need to know to be able to multiply large numbers quickly and easily. Rate your own understandings and skills right now using the following marks.

+  I know how to do this already.
✓  I’m learning to do this, and I feel confident that I’ll be able to do it soon.
✓–  I’m learning to do this, but it still seems pretty confusing.
0  I don’t get it, and it seems frustrating to try to understand it.

<table>
<thead>
<tr>
<th>SKILLS AND UNDERSTANDINGS</th>
<th>START OF THE ACTIVITY SET</th>
<th>END OF THE ACTIVITY SET</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multiplication</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I can write a multiplication story problem.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I know my basic multiplication facts through 12 × 12.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I can multiply by 10 and 100 in my head. (Examples: 10 × 52 or 100 × 85)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I can multiply one multiple of 10 by another in my head. (Examples: 20 × 30 or 50 × 60)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I can multiply a single-digit number by a multiple of 10 in my head. (Examples: 6 × 40 or 70 × 5)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I can use base 10 pieces to model and solve a double-digit problem like 23 × 27.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I can make a labeled sketch on base 10 grid paper to solve a problem like 24 × 38.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I can break a double- by single-digit multiplication problem into 2 parts to solve it more easily. (Example: 5 × 37 = (5 × 30) + (5 × 7))</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I can use the standard algorithm to solve a 2-digit by 1-digit problem like 7 × 38.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I can break a double-digit multiplication problem into 4 or 2 parts to solve it more easily. (Example: 26 × 35 = (20 × 30) + (20 × 5) + (6 × 30) + (6 × 5))</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I can use the standard algorithm to solve a 2-digit by 2-digit problem like 46 × 58.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I can use the standard algorithm to solve a 3-digit by 2-digit problem like 34 × 247.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I can make estimates to predict how big the answer will be or to see if my answer seems reasonable.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Here’s how I feel about solving multiplication problems like $6 \times 52$ or $27 \times 23$, and $37 \times 148$:

<table>
<thead>
<tr>
<th>Start of the Activity Set</th>
<th>End of the Activity Set</th>
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<tbody>
<tr>
<td></td>
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</tbody>
</table>

What are two goals for multiplication that are important to you? (What could you improve?)

<table>
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<tr>
<th>Start of the Activity Set</th>
<th>End of the Activity Set</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>
How will you meet each goal above?

<table>
<thead>
<tr>
<th>Start of the Activity Set</th>
<th>End of the Activity Set</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>
Set A5 ★ Activity 2

Multiplying by 10, 100 & 1000

Overview
Students build and discuss some combinations that involve multiplying by 10. Then they make some generalizations about what happens when 10 serves as the multiplier, and extend their thinking to multiplying by 100 and 1000.

Skills & Concepts
★ represent multiplication of a two-digit by a two-digit number with place value models
★ multiply by 10, 100, and 1000
★ compare the values represented by digits in whole numbers using place value
★ solve single- and multi-step word problems involving multi-digit multiplication and verify the solutions

Instructions for Multiplying by 10, 100 & 1000
1. Use your overhead linear pieces to frame a 12 by 10 rectangle as shown below. Ask students to pair-share what the dimensions of the figure are and what the area of the figure would be if you filled it in with base ten pieces. After they have had a moment to discuss the questions, fill in the frame with a mat and 2 strips, and work with student input to label the dimensions and area of the rectangle. Then write an equation to show the relationship between the dimensions and the area.

```
12 cm 12 x 10 = 120
```

```
10 cm
```

```
Area = 120 sq cm
```

2. Have students pair up. Give each pair a set of base ten area and linear pieces. Ask each pair to work together to frame a 16 by 10 rectangle between them as you do so at the overhead. Have them pair-share what the area of the figure would be if it was filled in with base ten pieces. Ask 2–3 volunteers to share their answers with the class and explain their reasoning.

Students
It’ll be 160 because it will take a mat and then 6 strips to fill in the frame.
We said 160 square centimeters because 16 x 10 is 160.
Activity 2 Multiplying by 10, 100 & 1000 (cont.)

3. Have each pair use their base ten pieces to fill in the area as you do so at the overhead. Work with input from the class to label the dimensions and area of the rectangle, and write an equation to match. Ask a volunteer to record the equations on the whiteboard for both rectangles you’ve examined so far.

4. Repeat Steps 2 and 3 with a 23 by 10, and then a 34 by 10 rectangle.

5. Next, ask students to pair-share what happens when you multiply any number by 10 and invite volunteers to share their thinking with the class.

   Students If you multiply by 10, all you have to do is add a 0 at the end. Like if you have 23 × 10, you just know the answer is 230 because you add a 0 to the end of 23. It works that way with all of the problems up there. It’s the same if you multiply by 100, but then you add 2 zero’s to the end.

   Chances are, your students will make reference to adding a zero to the end of any number multiplied by 10 to get the answer. Help them tease out the idea that multiplying tens times tens results in hundreds in all cases. For example, multiplying the 2 tens in 23 by 10 results in 200. Here are some questions you might ask to spur their thinking:
   • How does the starting number compare with the answer in each equation? How do 12 and 120 compare? How do 34 and 340 compare?
   • What happens to the value of each digit when a number is multiplied by 10?

6. Then draw a 13 by 100 frame on the whiteboard. Work with the class to label the dimensions and ask students to pair-share what the area of the figure would be if you filled it in with base ten pieces.

   Students We said it’s going to be 1000 across the top because you would have to fill that part with 10 mats. It’s harder to figure out the strips. There are 3 and then 3 more and then 3 more. It will be 10 times 3, so that’s 30 strips. Ten strips is 100.
Activity 2  Multiplying by 10, 100 & 1000 (cont.)

Students  It’s going to be 1000 and then 300, I think.
It’s going to be like you have ten 130s going across.

7. Fill in the area with a quick sketch and discuss the result with the class. Work with their input to write a matching multiplication equation. Discuss the fact that thirteen hundred is the same as one thousand three hundred.

8. Erase the whiteboard and repeat Steps 6 and 7 with a 24 by 100 rectangle. This time, encourage students to generate a number of different equations to show the total.

9. Erase the whiteboard. Record 13 × 100, 24 × 100, and several other combinations that involve multiplying by 100. Ask students to supply the answers to each as you go. Have them express the answers in thousands and hundreds as well as just hundreds (i.e., twenty-four hundred or two thousand four hundred).

10. Then ask students to explain what happens when you multiply any number times 100. It’s likely that some will say you just have to add 2 zeros to the end of the number. Help them understand how the tens times 100 results in thousands.
11. Distribute copies of Multiplying by 10, 100, and 1000. Give students the rest of the math period to work on these sheets independently. Provide assistance as needed, and encourage students to share and compare their answers as they finish.

### Activity 2  Multiplying by 10, 100 & 1000 (cont.)

1. For each problem, a–c
   - label the dimensions
   - fill in the area and label it
   - write a multiplication equation to match.

#### Example

<table>
<thead>
<tr>
<th>10</th>
<th>80</th>
<th>40</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### a

#### b

#### c

2. Write the answers.

<table>
<thead>
<tr>
<th>31</th>
<th>17</th>
<th>100</th>
<th>89</th>
<th>61</th>
<th>10</th>
<th>400</th>
</tr>
</thead>
<tbody>
<tr>
<td>x 10</td>
<td>x 10</td>
<td>x 72</td>
<td>x 10</td>
<td>x 10</td>
<td>x 50</td>
<td>x 10</td>
</tr>
</tbody>
</table>

3. Fill in the rest of this sentence.
When you multiply any number by 10,

4. Write the answers.

<table>
<thead>
<tr>
<th>29</th>
<th>13</th>
<th>100</th>
<th>46</th>
<th>20</th>
<th>61</th>
<th>300</th>
</tr>
</thead>
<tbody>
<tr>
<td>x 100</td>
<td>x 100</td>
<td>x 62</td>
<td>x 100</td>
<td>x 100</td>
<td>x 100</td>
<td>x 100</td>
</tr>
</tbody>
</table>

| 35 x 1,000 = _____ | 1,000 x 10 = _____ | 40 x 1,000 = _____ |

5. The Ladybugs are planting a garden. They have a 25 cm by 10 cm rectangle for flowers. Each flower needs exactly 1 square centimeter of space. How many flowers can they plant? Show your work.

The Ladybugs can plant _____ flowers.

6. The Ladybugs have a 30 cm by 10 cm rectangle for pumpkins. Each pumpkin needs exactly 25 square centimeters of space. How many pumpkins can they plant? Show your work on another piece of paper. Include a labeled sketch.

The Ladybugs can plant _____ pumpkins.

### INDEPENDENT WORKSHEET

Use Set A5 Independent Worksheet 1 to provide students with more practice multiplying by 10, 100, and 1000.
1. For each problem, a–c
   - label the dimensions.
   - fill in the area and label it.
   - write a multiplication equation to match.

```
example

<table>
<thead>
<tr>
<th></th>
<th>10</th>
<th>100</th>
<th>40</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td></td>
<td>14</td>
<td></td>
</tr>
</tbody>
</table>

10 × 14 = 140
```

```
a

b


c


```
Multiplying by 10, 100 & 1000 page 2 of 2

2 Write the answers.

<p>| | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>31</td>
<td>17</td>
<td>10</td>
<td>89</td>
<td>68</td>
<td>10</td>
</tr>
<tr>
<td>× 10</td>
<td>× 10</td>
<td>× 72</td>
<td>× 10</td>
<td>× 10</td>
<td>× 50</td>
</tr>
<tr>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

3 Fill in the rest of this sentence.

When you multiply any number by 10,

4 Write the answers.

<p>| | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
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<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>29</td>
<td>13</td>
<td>100</td>
<td>46</td>
<td>20</td>
<td>61</td>
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<tr>
<td>× 100</td>
<td>× 100</td>
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<td>× 100</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

35 × 1,000 = ______ 1,000 × 19 = ______ 40 × 1,000 = ______

5 The Ladybugs are planting a garden. They have a 25 cm by 10 cm rectangle for flowers. Each flower needs exactly 1 square centimeter of space. How many flowers can they plant? Show your work.

The Ladybugs can plant ______ flowers.

6 The Ladybugs have a 30 cm by 10 cm rectangle for pumpkins. Each pumpkin needs exactly 25 square centimeters of space. How many pumpkins can they plant? Show your work on another piece of paper. Include a labeled sketch.

The Ladybugs can plant ______ pumpkins.
More Practice Multiplying by 10, 100 & 1000

1 Write the answers.

\[
\begin{array}{ccccccc}
43 & 15 & 10 & 67 & 40 & 10 & 600 \\
\times & 10 & \times & 10 & \times & 29 & \times & 10 \\
\hline \\
\times & 10 & \times & 10 & \times & 11 & \times & 10 \\
\end{array}
\]

2 Write the answers.

\[
\begin{array}{cccccccc}
22 & 16 & 100 & 30 & 44 & 71 & 500 \\
\times & 100 & \times & 100 & \times & 73 & \times & 100 \\
\hline \\
\times & 100 & \times & 100 & \times & 100 & \times & 100 \\
\end{array}
\]

3 Fill in the rest of this sentence.
When you multiply any number by 100, __________

4 Write the answers

\[
79 \times 1,000 = \underline{} \quad 1,000 \times 20 = \underline{} \quad 500 \times 1,000 = \underline{} \quad
\]

5 The painters are painting one of the walls in the gym. The wall is 10 feet high and 45 feet long. They have already painted 133 square feet. How many square feet do they have left to paint?

a Write the question in your own words.

b Underline the information in the problem that will help you answer the question.
Independent Worksheet 1  More Practice Multiplying by 10, 100 & 100 (cont.)

5c  Circle the operations you will need to solve this problem:
addition (+)  subtraction (−)  multiplication (×)  division (÷)

d  Solve problem 5 in the space below. Show all your work.

Write your answer here. Include the units. ________________________

CHALLENGE

6  The painters are going to paint the hallway wall. The wall is 10 feet high and 80 feet long. It takes one gallon of paint to cover 200 square feet. A gallon of paint costs $26.25. How much will it cost to paint the wall?

a  Write the question in your own words.

b  Underline the information in the problem that will help you answer the question.

c  Circle the operations you will need to solve this problem:
addition (+)  subtraction (−)  multiplication (×)  division (÷)

d  Solve this problem in the space below. Show all your work.

Write your answer here. Include the units. ________________________
**Set A5 ★ Activity 3**

**ACTIVITY**

**Multiplying Single Digits by Multiples of Ten**

**Overview**
Students make sketches to investigate and make generalizations about multiplying single digits by multiples of ten. Then they complete two related worksheets independently.

**Skills & Concepts**
- multiply by 10, 100, and 1000
- compare the values represented by digits in whole numbers using place value

**You’ll need**
- Explore Six (page A5.26, run 1 copy on a transparency and a class set on paper)
- Explore More (page A5.27, run a class set)
- Multiplication Practice (page A5.28, run a class set)
- overhead pens in black and red
- red, blue, and regular pencils for students

**Instructions for Multiplying Single Digits by Multiples of Ten**
1. Give students each a copy of Explore Six, and display the transparency at the overhead. Review the instructions and examine the example at the top of the sheet with the class. Do problem a. together. Use your red overhead pen to label the dimensions of the rectangle, and have students use their red pencils to do so on their own sheets. Work with student input to determine the area of the rectangle and write a matching multiplication equation.

---

**Explore Six**

1. Label the dimensions and area of the rectangle on each grid. Write a multiplication equation to match.

   **example:**
   
   ![Rectangle](image)

2. Use the information above to help solve these equations.

   $6 \times 50 = \_\_\_\_$  $6 \times 60 = \_\_\_\_$  $6 \times 70 = \_\_\_\_$

   $6 \times 80 = \_\_\_\_$  $6 \times 90 = \_\_\_\_$  $6 \times 100 = \_\_\_\_$

---

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Activity 3  Multiplying Single Digits by Multiples of Ten (cont.)

2. When students understand what to do, have them work on the sheet independently. Give assistance as needed. Encourage them to share and compare their answers with neighbors as they finish.

3. When most students have finished the sheet, reconvene the class. Ask children to pair-share any mathematical observations they can make about the worksheet. Here are some questions you might pose to spark their thinking:
   - Did you notice any patterns in your answers?
   - Did the sheet seem easy or challenging?
   - What was easy (or challenging) for you about these problems?

4. Call on volunteers to share their observations with the class. Chances are, some of your students will note the relationship between the basic facts for 6 and multiplying 6 by multiples of 10. If this does not emerge during the discussion, write the combinations shown below on the board as students watch.

   \[
   \begin{array}{cc}
   6 \times 1 &= 6 & 6 \times 10 &= 60 \\
   6 \times 2 &= 12 & 6 \times 20 &= 120 \\
   6 \times 3 &= 18 & 6 \times 30 &= 180 \\
   6 \times 4 &= 24 & 6 \times 40 &= 240
   \end{array}
   \]

Then have them list the rest of the combinations in the series, through 6 × 10 and 6 × 100, as you record at the board. Here are some additional questions to pose:
   - What do you notice about these pairs of combinations?
   - Why does this pattern work the way it does?
   - What happens to the value of each of the digits in the basic fact products when 6 is multiplied by a multiple of 10? Why?
   - Would this pattern work with a different single-digit number? Why or why not?

5. Give students each a copy of Explore More. This sheet asks them to further explore the relationship between basic facts and multiplying by multiples of 10 by choosing a single-digit number between 4 and 9 (other than 6) to investigate. Review the instructions on the sheet with the class. Clarify and model as needed. Ask students to draw the missing dimension for each rectangle in red, and the rectangle on each grid in blue.

6. When students understand what to do, let them go to work. Give assistance as needed, and encourage children to share their discoveries with one another as they work. As they finish, have students start working on the Multiplication Practice sheet. Unfinished work can be sent home to be completed or assigned as seatwork at another time.
**Activity 3  Multiplying Single Digits by Multiples of Ten (cont.)**

**Explore More**

1. Choose a number between 4 and 9 (not 6) to multiply by 10 and multiples of 10. Draw the missing dimension and fill in the rectangle on each grid. Label the dimensions and the area of each rectangle. Write a multiplication equation to match.

![Grids and rectangles](image)

2. Use the information above to help complete these equations. Put the number you chose in the blank to the left side of the equation.

   \[
   \begin{align*}
   &\_ \times 50 = \_ \\
   &\_ \times 80 = \_ \\
   &\_ \times 90 = \_ \\
   &\_ \times 100 = \_
   \end{align*}
   \]

**Multiplication Practice**

1. Solve these problems in your head. Write the answers.

   \[
   \begin{array}{cccccccc}
   10 & 20 & 30 & 40 & 50 & 60 & 70 \\
   \times & 3 & \times & 3 & \times & 3 & \times & 3 \\
   \_ & 80 & 90 & 100 & 1,000 & 10,000 & 100,000 \\
   \times & 3 & \times & 3 & \times & 3 & \times & 3
   \end{array}
   \]

2. Explain how you figured out the answers to the problems above.

3. Solve these problems in your head. Write the answers.

   \[
   \begin{array}{cccccccc}
   10 & 20 & 30 & 40 & 50 & 60 & 70 \\
   \times & 4 & \times & 5 & \times & 5 & \times & 5 \\
   \_ & 80 & 90 & 100 & 1,000 & 60 & 70 & 80 \\
   \times & 4 & \times & 5 & \times & 8 & \times & 2 & \times & 5
   \end{array}
   \]

   ![Challenges](image)

**INDEPENDENT WORKSHEET**

Use Set A5 Independent Worksheet 2 to provide students with more practice multiplying single digit numbers by multiples of 10.
Explore Six

1 Label the dimensions and area of the rectangle on each grid. Write a multiplication equation to match.

**Example**

\[
\begin{array}{c}
6 \\
10
\end{array}
\]

\[
6 \times 10 = 60
\]

\[
6 \times 60 = \quad \quad \quad 6 \times 70 = \quad \quad \quad 6 \times 80 = \quad \quad \quad 6 \times 90 = \quad \quad \quad 6 \times 100 = \quad \quad \quad
\]

2 Use the information above to help solve these equations.

\[
6 \times 50 = \quad \quad \quad 6 \times 60 = \quad \quad \quad 6 \times 70 = \quad \quad \quad
\]

\[
6 \times 80 = \quad \quad \quad 6 \times 90 = \quad \quad \quad 6 \times 100 = \quad \quad \quad
\]
Explore More

1. Choose a number between 4 and 9 (not 6) to multiply by 10 and multiples of 10. Draw the missing dimension and fill in the rectangle on each grid. Label the dimensions and the area of each rectangle. Write a multiplication equation to match.

2. Use the information above to help complete these equations. Put the number you chose in the blank to the left side of the equation.

\[
\begin{align*}
\_ \times 50 &= \_ \\
\_ \times 60 &= \_ \\
\_ \times 70 &= \_ \\
\_ \times 80 &= \_ \\
\_ \times 90 &= \_ \\
\_ \times 100 &= \_
\end{align*}
\]
Multiplication Practice

1 Solve these problems in your head. Write the answers.

<p>| | | | | | | |</p>
<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>20</td>
<td>30</td>
<td>40</td>
<td>50</td>
<td>60</td>
<td>70</td>
</tr>
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<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

80  90  100 1,000 10,000 100,000

2 Explain how you figured out the answers to the problems above.

3 Solve these problems in your head. Write the answers.

<p>| | | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>20</td>
<td>30</td>
<td>40</td>
<td>50</td>
<td>60</td>
<td>70</td>
</tr>
<tr>
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<tr>
<td></td>
<td></td>
<td></td>
<td>4</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

80  90  100 1,000 60 70 80

400 300 500 600 200 700 800

900 400 800 600 700 800 800

<p>| | | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>9</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

9  12  9  12  11  8  12

CHALLENGE
Set A5 ★ Independent Worksheet 2

INDEPENDENT WORKSHEET

More Tens, Hundreds & Thousands

1 Solve these problems in your head. Write the answers.

\[
\begin{array}{cccccccc}
100 & 200 & 300 & 400 & 500 & 600 & 700 \\
\times 9 & \times 9 & \times 9 & \times 9 & \times 9 & \times 9 & \times 9 & \times 9 \\
\hline
\end{array}
\]

\[
\begin{array}{cccccccc}
800 & 900 & 2,000 & 3,000 & 4,000 & 5,000 & 6,000 \\
\times 9 & \times 9 & \times 9 & \times 9 & \times 9 & \times 9 & \times 9 & \times 9 \\
\hline
\end{array}
\]

2 Solve these problems in your head. Write the answers.

\[
\begin{array}{cccccccc}
90 & 80 & 70 & 60 & 50 & 40 & 30 \\
\times 5 & \times 6 & \times 8 & \times 3 & \times 6 & \times 9 & \times 4 \\
\hline
\end{array}
\]

\[
\begin{array}{cccccccc}
900 & 800 & 700 & 600 & 500 & 400 & 300 \\
\times 9 & \times 8 & \times 7 & \times 6 & \times 5 & \times 4 & \times 3 \\
\hline
\end{array}
\]

3 Write the answers to these problems.

\[
\begin{array}{llll}
200 \times 10 = \_ & 400 \times 100 = \_ & 30 \times 1,000 = \_ \\
200 \times 20 = \_ & 400 \times 200 = \_ & 30 \times 2,000 = \_ \\
200 \times 30 = \_ & 400 \times 300 = \_ & 30 \times 3,000 = \_ \\
\end{array}
\]

(Continued on back.)
Circle one of the expressions below. Write a story problem to match. Solve your own problem.

400 × 40  1,000 × 18  300 × 30  2,000 × 24
Set A5 ★ Activity 4

Single-Digit Multiplication with Pictures & Numbers

Overview
Students use the area model to picture and solve 1-digit by 2-digit multiplication problems. In this activity, the focus is on transitioning to using numbers only, connecting them to the area model as needed to support students’ work.

Skills & Concepts
★ multiply two-digit by one-digit numbers
★ estimate products to approximate solutions and determine reasonableness of answers
★ solve single- and multi-step word problems involving multi-digit multiplication and verify the solutions

You’ll need
★ Multiplication Story Problems (page A5.32, run one copy on a transparency)
★ Single-Digit Multiplication (pages A5.33 and A5.34, run a class set)
★ overhead pens
★ a piece of paper to mask portions of the overhead

Instructions for Single-Digit Multiplication with Pictures & Numbers
1. Place the top section of Multiplication Story Problems on display at the overhead. Keep the other two problems covered for now. Read the problem with the class. Work with students’ input to record a matching multiplication expression in vertical form. Ask them to pair-share estimates. Then call on volunteers to share their estimates with the class and explain their reasoning.

Students It’s going to be more than 160 square feet because 10 × 8 is 80, and 80 + 80 is 160. I said maybe about 180 because 8 × 25 is 200. 8 × 20 is 160, so this will be more.

2. Demonstrate how to make a very quick sketch to show 8 × 23 either on the whiteboard or the overhead. First sketch the dimensions, then the total array, and then add a line to show how the array can be divided into two partial products by place value (a step-by-step example is shown on the next page).
Activity 4  Single-Digit Multiplication with Pictures & Numbers (cont.)

3. After you’ve sketched the array, give students each a copy of the Single-Digit Multiplication worksheet. Ask them to record $8 \times 23$ as the first problem at the top of the sheet and make a quick sketch similar to yours. Then ask everyone to find the total product by filling in and adding together the two partial products. Have them compare their results with a neighbor as they finish, and then reconvene the class.

4. Ask students to share their partial products while you record them in numerical form beside the array. Focus students’ attention on the magnitude of the final answer by starting with the numbers in the tens place, as shown below.

5. Repeat Steps 1–4 with the other two problems at the overhead. Ask students to use your method of recording and computing for Problems 2 and 3. (A filled in copy of the overhead is shown below for your reference.) Then give students the second page of Single-Digit Multiplication (or have them turn their sheets over if you ran the pages back-to-back), and work the rest of the problems independently. Give help as needed, or meet with a small group to provide extra support.
**Activity 4  Single-Digit Multiplication with Pictures & Numbers (cont.)**

Use sketches and numbers to solve each of these story problems with your class.

1

2

3

4 Use a sketch and numbers to solve the problems below. Follow the example.

<table>
<thead>
<tr>
<th>Sketch</th>
<th>Numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Sketch" /></td>
<td>28 × 4 &lt;br&gt; 4 × 20 = 80 &lt;br&gt; 4 × 8 = 32 &lt;br&gt; <strong>112</strong></td>
</tr>
</tbody>
</table>

a 36 <br> 5 × 30 = <br> 5 × 6 = <br> **112**

b 24 <br> 7 × 20 = <br> 7 × 4 = <br> **112**

c 45 <br> 9 × 40 = <br> 9 × 5 = <br> **112**

5 Use numbers to solve these problems.

<table>
<thead>
<tr>
<th>a</th>
<th>b</th>
<th>c</th>
<th>d</th>
</tr>
</thead>
<tbody>
<tr>
<td>52 × 6</td>
<td>37 × 7</td>
<td>65 × 4</td>
<td>325 × 7</td>
</tr>
<tr>
<td>6 × 50 = &lt;br&gt; 6 × 2 = +</td>
<td>7 × 30 = &lt;br&gt; 7 × 7 = +</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**INDEPENDENT WORKSHEET**

Use Set A5 Independent Worksheet 3 to provide students with more practice finding and adding partial products to multiply double-digit by single-digit numbers.
### Multiplication Story Problems

1. The kids in Mr. Gill’s class are going to paint a mural in the hallway by the office. The wall is 8 feet high and 23 feet long. How many square feet is the wall they’re going to paint?

2. The fourth graders are doing a show for their families. They set up 6 rows of chairs. They put 26 chairs in each row. How many chairs did they use altogether?

3. There is a big party at the park. There are 7 tables with balloons for the kids. Each table has 34 balloons. How many balloons in all?
Use sketches and numbers to solve each of these story problems with your class.

1

2

3
4 Use a sketch and numbers to solve the problems below. Follow the example.

<table>
<thead>
<tr>
<th>Sketch</th>
<th>Numbers</th>
</tr>
</thead>
</table>
| **example** | 28 \(\times\) 4  
 4 \(\times\) 20 = 80  
 4 \(\times\) 8 = 32  
 80 + 32 = 112 |
| **a** | 36 \(\times\) 5  
 5 \(\times\) 30 =  
 5 \(\times\) 6 = +  |
| **b** | 24 \(\times\) 7  
 7 \(\times\) 20 =  
 7 \(\times\) 4 = +  |
| **c** | 45 \(\times\) 9  
 9 \(\times\) 40 =  
 9 \(\times\) 5 = +  |

5 Use numbers to solve these problems.

<table>
<thead>
<tr>
<th>a</th>
<th>b</th>
<th>c</th>
<th>d</th>
</tr>
</thead>
</table>
| 52 \(\times\) 6  
 6 \(\times\) 50 =  
 6 \(\times\) 2 = +  | 37 \(\times\) 7  
 7 \(\times\) 30 =  
 7 \(\times\) 7 = +  | 65 \(\times\) 4  
 7 \(\times\) 7 = +  | 325 \(\times\) 7  
 208 \(\times\) 4  
 7 \(\times\) 7 = +  |
Set A5 ★ Independent Worksheet 3

Double-Digit by Single-Digit Multiplication

1 Use a sketch and numbers to solve the problems below. Follow the example.

<table>
<thead>
<tr>
<th>Sketch</th>
<th>Numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>example</td>
<td>$24 \times 7$</td>
</tr>
<tr>
<td></td>
<td>$7 \times 20 = 140$</td>
</tr>
<tr>
<td></td>
<td>$7 \times 4 = + 28$</td>
</tr>
<tr>
<td></td>
<td>$\underline{168}$</td>
</tr>
<tr>
<td>a</td>
<td>$27 \times 5$</td>
</tr>
<tr>
<td></td>
<td>$5 \times 20 = \underline{100}$</td>
</tr>
<tr>
<td></td>
<td>$5 \times 7 = + 35$</td>
</tr>
<tr>
<td></td>
<td>\underline{\hspace{2cm}}</td>
</tr>
<tr>
<td>b</td>
<td>$23 \times 9$</td>
</tr>
<tr>
<td></td>
<td>$9 \times 20 = \underline{180}$</td>
</tr>
<tr>
<td></td>
<td>$9 \times 3 = + 27$</td>
</tr>
<tr>
<td></td>
<td>\underline{\hspace{2cm}}</td>
</tr>
<tr>
<td>c</td>
<td>$35 \times 8$</td>
</tr>
<tr>
<td></td>
<td>$8 \times 30 = \underline{240}$</td>
</tr>
<tr>
<td></td>
<td>$8 \times 5 = + 40$</td>
</tr>
<tr>
<td></td>
<td>\underline{\hspace{2cm}}</td>
</tr>
</tbody>
</table>

2 Use numbers to solve these problems.

| a   | $43 \times 6$ |
|     | $6 \times 40 = \underline{240}$ |
|     | $6 \times 3 = + 18$ |
| b   | $68 \times 6$ |
|     | $6 \times 60 = \underline{360}$ |
|     | $6 \times 8 = + 48$ |
| c   | $65 \times 4$ |
| d   | $83 \times 4$ |

(Continued on back.)
3 There is an area on our playground for kids to ride their bikes. It is 9 feet wide and 26 feet long. How many square feet is the bike area?

a Write the question in your own words.

b Underline the information in the problem that will help you answer the question.

c Solve this problem in the space below. Show all your work.

d Write your answer here. Include the units. ________________________

CHALLENGE

4 A professional basketball court is 94' long and 50' wide. A highschool basketball court is 84' long and 50' wide. How many more square feet is a professional basketball court than a highschool basketball court?

a Write the question in your own words.

b Underline the information in the problem that will help you answer the question.

c Circle the operations you will need to solve this problem:
addition (+) subtraction (−) multiplication (×) division (÷)

d Solve this problem in the space below. Show all your work.

e Write your answer here. Include the units. ________________________
Set A5 ★ Activity 5

Introducing the Standard Multiplication Algorithm

Overview
Students use the standard algorithm to multiply two- and three-digit by one-digit numbers.

Skills & Concepts
★ multiply 2- and 3-digit by 1-digit numbers using the standard multiplication algorithm
★ estimate products to approximate solutions and determine reasonableness of answers

You’ll need
★ Roll Your Own Multiplication Problems (page A5.38, run a class set)
★ dice numbered 1–6 (class set)
★ dice numbered 4–9 (class set)
★ several blank transparencies
★ overhead pens
★ Student Math Journals or 1 piece of lined or grid paper per student

Instructions for Introducing the Standard Multiplication Algorithm

1. Write $8 \times 28$ on the board or overhead. Ask students to first pair-share estimates and then call on volunteers to share their thinking with the class.

   Students  It’s kind of like 8 times 30. That would be 240 because 8 × 3 is 24.
   We said 10 times 28 is 280, so it’s going to be less than that.
   Eight times 20 is 160, but then you have to add on the $8 \times 8$.
   It’s going to be more than 200 for sure.

2. Next, ask students to find the product using the computing method they practiced during the previous activity. Encourage them to make sketches to support their thinking if that's helpful to them. Then ask a volunteer to make a labeled sketch that shows the partial products, and another volunteer to record the computations at the board.

   \[
   \begin{array}{c}
   \phantom{8}28 \\
   \times \phantom{2}8 \\
   \hline
   160 \\
   64 \\
   \hline
   224
   \end{array}
   \]

3. Explain that many people use a method for solving problems like these that features some interesting shortcuts. Before calculators were invented, this method helped people solve large multiplication problems. Then demonstrate the standard algorithm at the overhead or board. Talk your way through each step as you do it. Ask students to watch and listen closely to see if they can make sense of what you’re doing based on all the experiences they’ve had with multiplication.
**Teacher**  This method starts with the ones instead of the tens. So first I multiply 8 × 8. That’s 64. I write the 4 in the ones place and move the 6 tens from 64 over to the tens place. Then I multiply 8 times 20. That’s 160. If I add the 60 I carried over to the tens place, it’s 220, and 220 plus 4 is 224.

\[
\begin{array}{c}
8 \\
\times 8 \\
\hline
224
\end{array}
\]

4. When you have finished the demonstration, ask students to explain how this method works. Can they see any connection between the algorithm and the area model? Does the strategy make sense to them?

**Students**  My mom showed me how to do it that way last year.
I don’t get where the little 6 at the top came from.
It’s like carrying when you add.
I like that way of doing it. It seems faster and easier.
Why do they start with the ones instead of the tens? I like the other way better.

Ask your students to connect the algorithm you’ve modeled to the array. Where do they see 224 in the array?

**Students**  I don’t see 224 in the array at all.
But that’s what you get if you add 160 and 64 together because 160 and 60 makes 220, and then 4 more is 224, right?
It’s kind of like you just do everything at the same time instead of doing it in two steps.

5. Now give students a chance to try the standard algorithm for themselves. Write 6 × 26 on the whiteboard and ask students to copy the problem into their journals and jot an estimate to the side. Then work with class input to solve it together, using the standard algorithm. Work the following four problems together in a similar fashion.

- 36 × 4
- 48 × 5
- 144 × 6
- 345 × 5

6. Provide students with more practice using the standard algorithm. Depending on the needs and strengths of your class, you may want to have some students solve additional problems with you, while others work independently on the Roll Your Own Multiplication sheet. Students who are very comfortable with the algorithm can be assigned to solve the challenge problem at the bottom of the sheet.
Activity 5  Introducing the Standard Multiplication Algorithm (cont.)

Roll Your Own Multiplication Problems

1. For problems e–g below:
   - Choose a die numbered 1–6 or 4–9.
   - Roll it as many times as you need to fill in each of the boxes below. You can write each number you roll in any box on the sheet, but once all the boxes are filled, you can’t change them.
   - Use the method you just learned in class to solve your problems.
   - When you’re finished, trade papers with a classmate and have him or her check your answers.

a

b

c

d

e

f

g

CHALLENGE

5. Use each of these digits just one time: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9. Write them in the spaces below to make each problem correct.

a

b

c

d

Note  If some of your students are confused by the standard algorithm, you may want to share the strategy shown below, in which the partial products are added, but computation starts with the ones instead of the tens. This strategy may help ease some students’ transition into the standard algorithm.

\[
\begin{align*}
247 
\times 4 &= 47 \\
4 \times 7 &= 28 \\
4 \times 40 &= 160 \\
\hline
188 \\
\end{align*}
\]

INDEPENDENT WORKSHEET

Use Set A5 Independent Worksheet 4 to provide students with more practice using the standard algorithm for multiplication for 2-digit by 1-digit multiplication.
Roll Your Own Multiplication Problems

1. For problems e–g below:
   - Choose a die numbered 1–6 or 4–9.
   - Roll it as many times as you need to fill in each of the boxes below. You can write each number you roll in any box on the sheet, but once all the boxes are filled, you can't change them.
   - Use the method you just learned in class to solve your problems.
   - When you're finished, trade papers with a classmate and have him or her check your answers.

   a
   \[
   \begin{array}{c}
   \boxed{\phantom{0}} \\
   \boxed{\phantom{0}} \\
   \times \\
   \boxed{\phantom{0}} \\
   \boxed{\phantom{0}}
   \end{array}
   \]
   b
   \[
   \begin{array}{c}
   \boxed{\phantom{0}} \\
   \boxed{\phantom{0}} \\
   \times \\
   \boxed{\phantom{0}} \\
   \boxed{\phantom{0}}
   \end{array}
   \]
   c
   \[
   \begin{array}{c}
   \boxed{\phantom{0}} \\
   \boxed{\phantom{0}} \\
   \times \\
   \boxed{\phantom{0}} \\
   \boxed{\phantom{0}}
   \end{array}
   \]
   d
   \[
   \begin{array}{c}
   \boxed{\phantom{0}} \\
   \boxed{\phantom{0}} \\
   \times \\
   \boxed{\phantom{0}} \\
   \boxed{\phantom{0}}
   \end{array}
   \]
   e
   \[
   \begin{array}{c}
   \boxed{\phantom{0}} \\
   \boxed{\phantom{0}} \\
   \times \\
   \boxed{\phantom{0}} \\
   \boxed{\phantom{0}}
   \end{array}
   \]
   f
   \[
   \begin{array}{c}
   \boxed{\phantom{0}} \\
   \boxed{\phantom{0}} \\
   \times \\
   \boxed{\phantom{0}} \\
   \boxed{\phantom{0}}
   \end{array}
   \]
   g
   \[
   \begin{array}{c}
   \boxed{\phantom{0}} \\
   \boxed{\phantom{0}} \\
   \times \\
   \boxed{\phantom{0}} \\
   \boxed{\phantom{0}}
   \end{array}
   \]

4. CHALLENGE

5. Use each of these digits just one time: 0 1 2 3 4 5 6 7 8 9
Write them in the spaces below to make each problem correct.

   a
   \[
   \begin{array}{c}
   \boxed{6} \\
   \boxed{6} \\
   \times \\
   \boxed{3} \\
   \boxed{3} \\
   \boxed{6}
   \end{array}
   \]
   b
   \[
   \begin{array}{c}
   \boxed{4} \\
   \boxed{4} \\
   \times \\
   \boxed{3} \\
   \boxed{1}
   \end{array}
   \]
   c
   \[
   \begin{array}{c}
   \boxed{4} \\
   \boxed{4} \\
   \times \\
   \boxed{4} \\
   \boxed{5}
   \end{array}
   \]
   d
   \[
   \begin{array}{c}
   \boxed{8} \\
   \boxed{2} \\
   \times \\
   \boxed{3} \\
   \boxed{2}
   \end{array}
   \]
Set A5 ★ Independent Worksheet 4

Using the Standard Algorithm for Two-Digit by One-Digit Multiplication

Maddie and her mom got 6 boxes of treats for their dogs. There are 34 treats in each box. How many treats did they get for their dogs?

To solve this problem, multiply $6 \times 34$. Here are two different methods:

- You can make a sketch and list the partial products. Then you can add them.

\[
\begin{array}{c}
30 \\
4 \\
\hline
6 \\
\end{array}
\]

\[
\begin{array}{c}
180 \\
24 \\
\hline
204 \\
\end{array}
\]

- You can also multiply by using the standard algorithm. If you use this method, you don’t have to list the partial products.

\[
\begin{array}{c}
2 \\
34 \\
\times 6 \\
\hline
204 \\
\end{array}
\]

Multiply the ones, $6 \times 4 = 24$ ones.

Since 24 is 2 tens plus 4 ones, write the 4 in the ones place and write the 2 tens above the 3 in the tens place.

Multiply the tens, $6 \times 3 = 18$ tens.

Add the 2 tens you carried over to the 18 tens. Write 20 tens in the tens and hundreds place.

1 Use the standard algorithm to solve the problems below.

\[
\begin{array}{ccccccc}
23 & & 35 & & 29 & & 44 & & 67 & & 19 \\
\times & 4 & & \times 7 & & \times 3 & & \times 4 & & \times 2 & & \times 8 \\
\hline & & & & & & & & & & \\
\times & 4 & & \times 3 & & \times 6 & & \times 4 & & \times 7 & & \times 5 \\
\end{array}
\]
Set A5 Activity 6

Think before You Multiply

Overview
In this activity, students consider the following questions: Is it always most efficient and effective to use the standard algorithm for multi-digit multiplication? What kinds of combinations are best solved with the algorithm? What kinds of combinations might be better solved using other methods?

Skills & Concepts
★ multiply 2- and 3-digit by 1-digit numbers using the standard multiplication algorithm
★ estimate products to approximate solutions and determine reasonableness of answers
★ identify strategies that can be used to solve a problem, select and use one or more appropriate strategies to solve the problem, and justify the selection
★ explain why a specific problem-solving strategy was used to determine a solution

Instructions for Think before You Multiply
1. Tell students in a minute, you’re going to show them a multiplication problem at the overhead, and ask them to solve it mentally. Let them know that they can use any method that makes sense to them. Then display the first problem on the overhead, keeping the rest covered for now. Ask students to think privately about the problem and raise their hand when they have the answer.

2. When most of the students have raised their hands, call on several to share their solutions and explain their methods to the class. Record each method at the overhead as students share, and label the methods with input from the class.

Danny First I tried doing it the way where you multiply 2 × 8 first, but I couldn’t keep the numbers in my head. Then I saw 48 is really close to 50, so I went 50 + 50 is 100, and take away 4 is 96.
Activity 6  Think before You Multiply (cont.)

*Rosa* I thought it was pretty easy to start with the ones. I went 2 × 8 is 16, put down the 6 and carry the 10. Then 2 × 40 is 80 plus 10 more is 90, so it’s 96 in all.

*Jamal* I just doubled 48. It’s 96 because 40 and 40 is 80, then 8 and 8 is 16, and 80 plus 16 is 96.

*Tran* I did it kind of that way with multiplying. I said 2 × 40 is 80 and 2 × 8 is 16. 80 + 16 is 96.

3. Repeat Steps 1 and 2 with the next two problems on the overhead (23 × 4 and 99 × 5). Encourage students to debate and discuss the methods they’re choosing. Some may feel that the standard algorithm or finding and adding partial products is easiest, while others find a basic facts strategy or the use of landmark numbers such as 25, 50, or 100 is more efficient.

*Students* It’s too hard to keep the numbers in your head with the regular way. On 99 × 5, you can just go 100 × 5 and take away 5. That’s the easiest!
Same with 4 × 23. That’s just like 4 × 25, and then take 8 away.
I like using tens and ones on that one. Just go 4 × 20 is 80, and 4 × 3 is 12, so you get 92.
I think when you’re doing multiplication in your head, the regular way is hard because you have to remember what number you put in the ones place, and what you put over in the tens place.

4. Show the fourth problem, 125 × 4, and ask students if they can solve it in their heads. Some may say they can’t because the numbers are too big. Give them a minute to think about it. Chances are, at least a few will use a basic facts strategy such as double-doubles or landmark numbers. If not, volunteer one of these strategies yourself. Then work with student input to solve the problem using the standard algorithm and then partial products. Which of these methods seems easiest and most efficient? Why?

5. Show the last problem, 469 × 5, on the overhead, and ask students if they can work it in their heads. Why or why not? Many students will probably agree that it’s too big to tackle mentally. Ask them to pair-share estimates, and then work the problem twice in their journals, once using the standard algorithm and once by finding and adding the partial products. Have them share and compare their work with the people sitting next to them to be sure they have the correct answers. Then talk with the group about both methods. Which seemed easier? Which seemed most efficient? Why?
6. Work with the class to make some generalizations about the different multiplication methods they’ve used to solve the problems on the overhead. Is the standard algorithm always the quickest and easiest? What about finding and adding partial products? When does it work best to use a basic facts strategy or a landmark number? Record some of their thoughts on a piece of chart paper.

Which Multiplication Methods Work Best?
- If you’re multiplying numbers like 4 × 38 in your head, it’s easy to do the tens and then the ones and add them.
- You should use landmark numbers when you can. Like if you’re doing 6 × 199, just think about 6 × 200, and take 6 away.
- If you’re multiplying a big number, like 5 × 469, the regular way is good. But you have to remember to carry the tens and hundreds, and add them in.
- If you find partial products for 5 × 469, it’s 2000 + 300 + 45. There’s more to write, but you can see all the numbers.

7. Hand out a copy of Multiplication Methods to each student and give children the rest of the math period to work the problems. If some students still need support in solving multi-digit multiplication problems, you may want to meet with a small group while the rest of the class works independently.

<table>
<thead>
<tr>
<th>Standard Algorithm</th>
<th>Partial Products</th>
<th>Landmark Numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 × 100 = 400</td>
<td></td>
<td>199 is almost like 200</td>
</tr>
<tr>
<td>4 × 90 = 360</td>
<td></td>
<td>4 × 200 = 800</td>
</tr>
<tr>
<td>4 × 9 = 36</td>
<td></td>
<td>800 – 4 = 796</td>
</tr>
<tr>
<td>400 + 360 + 36 = 796</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. Use the standard algorithm to solve each problem below. Then solve it a different way. Label your method. Circle the method that seemed quicker and easier.

Standard Algorithm | A Different Way

| a | 37 × 4 |
| b | 63 × 7 |
| c | 299 × 6 |
| d | 749 × 7 |

2. Fill in the bubble to show the best estimate for each problem.

3. Circle the method that seems to help most for estimating.

Standard Algorithm | Partial Products

4. The fourth and fifth graders at King School went to the museum yesterday in 7 buses. There were 65 students on each bus. How many students were there in all? Show your work.

Use Set A5 Independent Worksheet 5 to provide students with additional opportunities to select and use different multiplication methods.
Think Before You Multiply

1

\[
\begin{array}{c}
48 \\
\times 2 \\
\hline
\end{array}
\]

2

\[
\begin{array}{c}
23 \\
\times 4 \\
\hline
\end{array}
\]

3

\[
\begin{array}{c}
99 \\
\times 5 \\
\hline
\end{array}
\]

4

\[
\begin{array}{c}
125 \\
\times 4 \\
\hline
\end{array}
\]

5

\[
\begin{array}{c}
469 \\
\times 5 \\
\hline
\end{array}
\]
Here are three different ways to solve $4 \times 199$.

<table>
<thead>
<tr>
<th>Standard Algorithm</th>
<th>Partial Products</th>
<th>Landmark Numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 3 199</td>
<td>4 $\times$ 100 = 400</td>
<td>199 is almost like 200</td>
</tr>
<tr>
<td>$\times$ 4</td>
<td>4 $\times$ 90 = 360</td>
<td>4 $\times$ 200 = 800</td>
</tr>
<tr>
<td>796</td>
<td>4 $\times$ 9 = 36</td>
<td>800 $-$ 4 = 796</td>
</tr>
<tr>
<td></td>
<td>400 + 360 + 36 = 796</td>
<td></td>
</tr>
</tbody>
</table>

1 Use the standard algorithm to solve each problem below. Then solve it a different way. Label your method. Circle the method that seemed quicker and easier.

<table>
<thead>
<tr>
<th>Standard Algorithm</th>
<th>A Different Way</th>
</tr>
</thead>
<tbody>
<tr>
<td>a 37 $\times$ 4</td>
<td></td>
</tr>
<tr>
<td>b 63 $\times$ 7</td>
<td></td>
</tr>
<tr>
<td>c 299 $\times$ 6</td>
<td></td>
</tr>
<tr>
<td>d 749 $\times$ 7</td>
<td></td>
</tr>
</tbody>
</table>
2 Fill in the bubble to show the best estimate for each problem.

<table>
<thead>
<tr>
<th>a</th>
<th>43</th>
<th></th>
<th>b</th>
<th>226</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>x</td>
<td>7</td>
<td></td>
<td>x</td>
<td>4</td>
<td></td>
</tr>
</tbody>
</table>

- a  200  250  300  350
- b  700  800  900  1,000

C Circle the method that seems to help most for estimating.

- Standard Algorithm
- Partial Products

3 The fourth and fifth graders at King School went to the museum yesterday in 7 buses. There were 65 students on each bus. How many students were there in all? Show your work.

4 The big building downtown has 27 floors. There are 8 offices on each floor. Each office has 8 computers. How many computers are there in all? Show your work.
Set A5 ★ Independent Worksheet 5

Choose Your Strategy

Here are three different ways to solve $4 \times 29$.

<table>
<thead>
<tr>
<th>Standard Algorithm</th>
<th>Partial Products</th>
<th>Landmark Numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>$3$</td>
<td>$4 \times 20 = 80$</td>
<td>$29$ is almost like $30$.</td>
</tr>
<tr>
<td>$29$</td>
<td>$4 \times 9 = 36$</td>
<td>$4 \times 30 = 120$</td>
</tr>
<tr>
<td>$\times 4$</td>
<td>$80 + 36 = 116$</td>
<td>$120 - 4 = 116$</td>
</tr>
<tr>
<td>$116$</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1 Use the standard algorithm to solve each problem below. Then solve it a different way. Label your method. Circle the method that seemed quicker and easier.

<table>
<thead>
<tr>
<th>Standard Algorithm</th>
<th>A Different Way</th>
</tr>
</thead>
<tbody>
<tr>
<td>$a$</td>
<td></td>
</tr>
<tr>
<td>$39$</td>
<td></td>
</tr>
<tr>
<td>$\times 6$</td>
<td></td>
</tr>
<tr>
<td>$b$</td>
<td></td>
</tr>
<tr>
<td>$51$</td>
<td></td>
</tr>
<tr>
<td>$\times 7$</td>
<td></td>
</tr>
<tr>
<td>$c$</td>
<td></td>
</tr>
<tr>
<td>$65$</td>
<td></td>
</tr>
<tr>
<td>$\times 7$</td>
<td></td>
</tr>
<tr>
<td>$d$</td>
<td></td>
</tr>
<tr>
<td>$199$</td>
<td></td>
</tr>
<tr>
<td>$\times 8$</td>
<td></td>
</tr>
</tbody>
</table>

(Continued on back.)
2 Fill in the bubble to show the best estimate for each problem. Explain your choice.

<p>| | | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>51</td>
<td>×</td>
<td>8</td>
<td></td>
<td>350</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>400</td>
<td>450</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>500</td>
<td></td>
</tr>
<tr>
<td>b</td>
<td>326</td>
<td>×</td>
<td>3</td>
<td></td>
<td>700</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
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<td></td>
<td></td>
<td>800</td>
<td>900</td>
</tr>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1,000</td>
<td></td>
</tr>
</tbody>
</table>

C Circle the method that seems to help most for estimating.

- Standard Algorithm
- Partial Products
- Landmark Numbers

3 Sam, Sarah, Deena, and TJ each have 37 marbles. How many marbles do they have in all? Show your work.

4 The kids at the high school are having a car wash. They charge $6.00 to wash a car. If they wash 28 cars a day for 4 days, how much money will they make? Show your work.
Set A5 ★ Activity 7

Splat!

Overview
Students are asked to make some generalizations about multiplying two multiples of 10. Then they play a new game to practice multiplying combinations such as 20 × 30, 40 × 50, and so on, first as a whole class, and then in pairs.

Skills & Concepts
★ represent multiplication of two-digit by two-digit numbers
★ multiply by 10 and multiples of 10
★ compare the values represented by digits in whole numbers using place value

You’ll need
★ Splat! Hundreds Grid (page A5.50, run one copy on a transparency and a half-class set on paper)
★ Introducing the Game of Splat! (page A5.51, run one copy on a transparency)
★ Splat! Spinner (page A5.52, run a half-class set)
★ Splat! Record Sheet (page A5.53, run a half-class set)
★ overhead pens
★ 2 overhead triangle pattern blocks or overhead base 10 units
★ half class set of transparent spinner overlays
★ game markers (1 per student)
★ 5 1/2" × 8 1/2" colored copy paper, 1 piece for each student plus a few extra

About the Game
In the game of Splat, players take turns spinning a spinner numbered 10, 20, 30, 40, 50, and 60 twice and multiplying the 2 numbers spun. Each player gets 4 turns per round and adds the results to get a total for the round. If a player spins a 10, she scores 0 for that turn. If she spins two 10s in a single turn, she scores 0 for the entire round. After they have played several rounds, players compute and compare their game totals.

Instructions for Splat!
1. Ask students to pair up. Give each pair one copy of the Splat! Hundreds Grid to share, and place the transparency on display at the overhead.

Without giving them any instruction other than to pay attention to the key at the top of the page, ask students to determine the area of the entire grid. Have them pair-share their ideas for a minute, and then ask volunteers to share their thinking at the overhead.

Students
We said the whole grid is a 6-by-6 square, and the area is 36.
We thought the area was 36 because 6 × 6 is 36, and then you just add a zero.
We looked at the key and said okay, the grid is a 60-by-60 square because each of those lines is like a skinny base 10 strip.
We said the same thing, and then we figured out that the area must be 36 hundred because each of the small squares is worth 100.
That’s the same as 3,600, right?
Activity 7 Splat! (cont.)

Work with student input to record a multiplication sentence at the whiteboard to match the dimensions and area of the grid \((60 \times 60 = 3,600)\).

2. Now use two half-sheets of copy paper to mask the overhead grid until only a 20-by-20 square remains in the top corner, as shown below.

Have student pairs work together, each using their half sheet of paper, to do the same on the Hundreds Grid they're sharing. What is the area of the region that's showing? Ask a student volunteer to record a multiplication sentence to match the dimensions and area of the region \((20 \times 20 = 400)\) on the whiteboard.
3. Then write $30 \times 30$ on the board and ask students to move their paper masks until the dimensions you've identified are showing on their grid. What is the area of this region? Record the answer as students share it. Repeat this exercise with $40 \times 50$, $30 \times 40$, $50 \times 50$, and $50 \times 60$.

4. Ask students to explain what happens when two multiples of 10, such as the examples listed on the board, are multiplied. Some students will probably respond with the idea that you simply multiply the digits at the front of each number and then “add on” 2 more zeros at the end. Press the class to think a little more deeply about the question using the visual model provided by the grid to support them in doing so.

   **Students** $3 \times 3$ is 9, right? What’s weird is that 30 is only 10 times bigger than 3, but 900 is 100 times bigger than 9.
   
   But each one of the squares in the grid is 100 instead of 1, so the area of a 30-by-30 is 900.
   
   10 times 30 is 300, so 30 times 30 is 3 times more than that. $3 \times 300$ is 900.
   
   All the answers on the board are 100 times bigger than they would be if the numbers were in 1s instead of 10s. Like $4 \times 5$ is 20, so $40 \times 50$ is 2,000.
   
   Just pretend like you’re multiplying like $3 \times 3$ or $4 \times 5$, and then make the answer 100 times bigger.

5. Place the game introduction overhead on display and explain that you’re going to play a new game with the class. Ask student pairs to keep their Hundreds Grid and half-sheets of copy paper in front of them. Then set the transparent spinner overlay on top of the spinner and spin twice. Use a triangle from your set of overhead pattern blocks to mark the results of both spins at the top of the transparency. (Students will use game markers when they play the game independently, but since those markers won't fit on the transparency, you'll have to use overhead pattern block triangles instead.) Give student pairs a moment to multiply the two numbers you spun, using their Hundreds Grid and half-sheets of paper for support if needed, or computing the answer mentally. Then record the answer in your Round 1, Turn 1 box.
Activity 7  Splat! (cont.)

6. Continue until you’ve taken 4 turns. Then work with class input to add the numbers and record your total for the round. If you spin a 10 on one of your turns, you score 0 for that turn. If you spin two 10s on one of your turns, you record an “S” for Splat! in that box. You lose the rest of your turns for the round, and you score 0 for the entire round, no matter how many points you got in previous turns. You have to take all 4 turns unless you get wiped out by a Splat! first.

Teacher  Whew! That was a close one! I was worried that I’d spin another 10 on that last turn and lose all my points for the round. Okay, I’m up by 4,600 points. Your turn!

7. Ask student volunteers to spin and record for the class on the lower part of the overhead. As they take 4 turns, encourage all your students to do as much of the computation as they can mentally, continuing to use their Hundreds Grid for visual support as needed.

8. After students have completed their first round, play your second round. Then have volunteers spin and record a second round for the class. When you and the class have both completed 2 rounds, ask students to find the game total for each team and determine the difference between the 2 scores. Finally, show the class how to record the results for each team at the overhead.
9. When the game is finished, give students time to play it again in partners. Each student pair will need:
- one copy of the Splat! Spinner
- one Splat! Record Sheet
- 2 game markers
- one spinner overlay

Both partners will record their turns on the same sheet, just as in the demonstration game. Their version of the record sheet has room to play 5 rounds, however, so they may need extra time to complete the game during another math period.

Extensions
- Meet with small groups of students who need additional support in multiplying multiples of 10 to play a small-group version of Splat. Model and share your own thinking, and encourage students to help one another as you play.
- Run extra copies of the Splat! Record Sheet and have students revisit the game during Work Places. If you run more copies of the spinner and have students use a pencil and paper clip for a spinner arrow, you can also assign the game as homework.
Splat! Hundreds Grid

Key

10 10 100
## Introducing Splat!

### First Spin

<table>
<thead>
<tr>
<th></th>
<th>10*</th>
<th>20</th>
<th>30</th>
<th>40</th>
<th>50</th>
<th>60</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Second Spin</strong></td>
<td>10*</td>
<td>20</td>
<td>30</td>
<td>40</td>
<td>50</td>
<td>60</td>
</tr>
</tbody>
</table>

*If you spin a 10, you score 0 for that turn.

If you spin two 10s in a single turn, that’s a Splat! and you score 0 for the round.

### Teacher

<table>
<thead>
<tr>
<th>Round</th>
<th>Turn 1</th>
<th>Turn 2</th>
<th>Turn 3</th>
<th>Turn 4</th>
<th>Round Total</th>
<th>Scratch Paper</th>
</tr>
</thead>
<tbody>
<tr>
<td>Round 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Round 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

I won/lost by ________ points.

### Class

<table>
<thead>
<tr>
<th>Round</th>
<th>Turn 1</th>
<th>Turn 2</th>
<th>Turn 3</th>
<th>Turn 4</th>
<th>Round Total</th>
<th>Scratch Paper</th>
</tr>
</thead>
<tbody>
<tr>
<td>Round 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Round 2</td>
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<td></td>
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<td></td>
</tr>
</tbody>
</table>

We won/lost by ________ points.
### Splat! Spinner

A hexagonal spinner with numbers 10, 20, 30, 40, 50, and 60. Each number can be repeated.

#### First Spin

<p>| | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>10*</td>
<td>20</td>
<td>30</td>
<td>40</td>
<td>50</td>
<td>60</td>
</tr>
</tbody>
</table>

#### Second Spin

<p>| | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>10*</td>
<td>20</td>
<td>30</td>
<td>40</td>
<td>50</td>
<td>60</td>
</tr>
</tbody>
</table>
Splat! Record Sheet

**Player 1**

<table>
<thead>
<tr>
<th></th>
<th>Turn 1</th>
<th>Turn 2</th>
<th>Turn 3</th>
<th>Turn 4</th>
<th>Round Total</th>
<th>Scratch Paper</th>
</tr>
</thead>
<tbody>
<tr>
<td>Round 1</td>
<td></td>
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<tr>
<td>Round 2</td>
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<tr>
<td>Round 3</td>
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<tr>
<td>Round 4</td>
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<td></td>
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<tr>
<td>Round 5</td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

Game Total

I won/lost by ________ points.

**Player 2**

<table>
<thead>
<tr>
<th></th>
<th>Turn 1</th>
<th>Turn 2</th>
<th>Turn 3</th>
<th>Turn 4</th>
<th>Round Total</th>
<th>Scratch Paper</th>
</tr>
</thead>
<tbody>
<tr>
<td>Round 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Round 2</td>
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<tr>
<td>Round 3</td>
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<td></td>
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<tr>
<td>Round 4</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Round 5</td>
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<td></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

Game Total

I won/lost by ________ points.
Set A5 ★ Activity 8

Sketching Arrays & Partial Products

Overview
The teacher introduces a technique for drawing quick sketches of 2-digit by 2-digit multiplication combinations. Students then practice the sketching technique and use it to solve a variety of multiplication problems.

Skills & Concepts
★ represent multiplication of two-digit by two-digit numbers
★ multiply two-digit by two-digit numbers
★ estimate products to approximate solutions and determine reasonableness of answers

You'll need
★ The Ladybugs' Park (page A5.58, run one copy on a transparency)
★ Multiplication Sketches (pages A5.59 and A5.60, run a class set)
★ overhead pens
★ a piece of paper to mask portions of the overhead

Instructions for Sketching Arrays & Partial Products
1. Place the top section of The Ladybugs' Park on display at the overhead. Read the problem with the class. Ask students to estimate the area of the sandbox, and call on volunteers to share their thinking with the class.

2. As students watch, sketch a frame for 12 × 18 at the overhead. Then fill in the array as shown at the top of the next page. Let students know that you are drawing lines based on the place values in the dimensions (between the 10 and the 8 in 18, and the 10 and the 2 in 12).

3. After you have drawn in the lines, ask the students to help you fill in the area of each part of the array. Prompt their thinking, if necessary, by labeling the tens and ones on the frame.

Students
I think about 210 square centimeters because 10 × 18 is 180, and then 2 × 18 is 36.
I said 200 because 12 × 18 is kind of like 10 × 20, and that's 200.
4. After you’ve labeled all 4 parts of the array, remind students that each part is called a partial product, and that the sum of the partial products is the total product of 12 × 18. Then ask students to find the sum of the partial products mentally. Record their thinking as an equation beside the array. Also record a multiplication equation to show the dimensions and total area together.

5. Repeat Steps 1–4 with the second problem on the overhead.

6. Now give students each a copy of the Multiplication Sketches worksheets. Ask them to complete the first problem on their own or in pairs. Circulate as they work, and then reconvene the class to discuss their thinking when most are finished. Walk through the problems step by step as a whole group, starting with a sketch of the array on the whiteboard that replicates the picture on the first worksheet and finishing with an addition and a multiplication equation to express the total area.
Activity 8 Sketching Arrays & Partial Products (cont.)

7. When students understand what to do, have them complete the rest of the first sheet and all of the second independently. Provide assistance as needed. Encourage students to share and compare their answers as they finish the assignment.

INDEPENDENT WORKSHEET

Use Set A5 Independent Worksheet 6 to provide students with more practice multiplying multiples of 10 by multiples of 10.
The Ladybugs’ Park

1. The ladybugs over in Leafington are building a park for their children. They are planning to make a sandbox that is 12 centimeters wide and 18 centimeters long. How many square centimeters will their sandbox be?

2. There is a patch of dirt near the sandbox that measures 24 by 29 centimeters. The ladybugs want to divide it into different sections as shown below. Use a multiplication equation to label each section. Then find the total area of the 24 by 29 cm patch.
1a Mrs. Hill's pre-school classroom is 16 feet wide and 28 feet long. She is planning to divide it into 4 sections. Here is her plan. Use a multiplication equation to label the area of each section. (in square feet)

28´

28´

16´

Rug

Tables

Art Area

Library Corner

b What is the total area of the 16-by-28-foot classroom? Show your work.

2 Write the answers.

\[
\begin{array}{ccccccc}
20 & 30 & 50 & 40 & 10 & 60 & 30 \\
\times 30 & \times 40 & \times 30 & \times 20 & \times 90 & \times 30 & \times 30 \\
\end{array}
\]
3 Sketch an array for each of the frames below. Label each part with a multiplication equation to show its area. Then find the total area of the array.

\[ \begin{array}{c}
\text{a} \\
\hline
13 \quad 26 \\
\hline
\text{total area} = \underline{\quad} \\
\end{array} \]

\[ \begin{array}{c}
\text{b} \\
\hline
14 \quad 15 \\
\hline
\text{total area} = \underline{\quad} \\
\end{array} \]

\[ \begin{array}{c}
\text{c} \\
\hline
17 \quad 23 \\
\hline
\text{total area} = \underline{\quad} \\
\end{array} \]

4 Write the answers.

\[
\begin{array}{cccccccc}
20 & 20 & 40 & 40 & 50 & 50 & 70 & 70 \\
\times 9 & \times 8 & \times 7 & \times 4 & \times 8 & \times 5 & \times 8 & \times 8 \\
\end{array}
\]
Set A5 ★ Independent Worksheet 6

**Multiplying Multiples of Ten & More**

1 Write the answers.

<table>
<thead>
<tr>
<th></th>
<th>20</th>
<th>30</th>
<th>40</th>
<th>50</th>
<th>60</th>
<th>70</th>
<th>80</th>
</tr>
</thead>
<tbody>
<tr>
<td>×</td>
<td>20</td>
<td>30</td>
<td>40</td>
<td>50</td>
<td>60</td>
<td>70</td>
<td>80</td>
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<td></td>
<td>20</td>
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<td>20</td>
<td>40</td>
<td>70</td>
<td>90</td>
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<tr>
<td>×</td>
<td>40</td>
<td>50</td>
<td>50</td>
<td>60</td>
<td>90</td>
<td>80</td>
<td>80</td>
</tr>
</tbody>
</table>

2 Multiply each number in the top row by the number at the left. The first one is done for you as an example.

<table>
<thead>
<tr>
<th>×</th>
<th>2</th>
<th>4</th>
<th>8</th>
<th>3</th>
<th>6</th>
<th>12</th>
<th>5</th>
<th>10</th>
<th>7</th>
<th>9</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>40</td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>×</th>
<th>2</th>
<th>4</th>
<th>8</th>
<th>3</th>
<th>6</th>
<th>12</th>
<th>5</th>
<th>10</th>
<th>7</th>
<th>9</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>×</th>
<th>2</th>
<th>4</th>
<th>8</th>
<th>3</th>
<th>6</th>
<th>12</th>
<th>5</th>
<th>10</th>
<th>7</th>
<th>9</th>
</tr>
</thead>
<tbody>
<tr>
<td>24</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3 Katy says you can use the answers in the first 2 rows of Problem 2 to help figure out the answers in the third row. Do you agree with her? Why or why not?
Set A5 ★ Activity 9

Double-Digit Multiplication with Pictures & Numbers

Overview
Students use the area model to picture and solve 2-digit by 2-digit multiplication problems. In this activity, the focus is on transitioning to using numbers only, connecting them to the area model as needed to support students’ work.

Skills & Concepts
★ represent multiplication of two-digit by two-digit numbers
★ multiply two-digit by two-digit numbers
★ estimate products to approximate solutions and determine reasonableness of answers
★ solve single- and multi-step word problems involving multi-digit multiplication and verify the solutions

You’ll need
★ Double-Digit Multiplication (pages A5.64 and A5.65, run a class set)
★ overhead pens
★ Student Math Journals or 1 piece of lined or grid paper per student

Instructions for Double-Digit Multiplication with Pictures & Numbers
1. Write $23 \times 35$ in vertical format on the whiteboard or the overhead.

2. Now make a quick sketch to match the expression. First sketch the dimensions, then the total array, and then add two lines to show how the array can be divided into four partial products by place value.

Have students each write a story problem to match the expression in their journals, along with an estimate of the answer. When they've had a few minutes to work, ask them to pair-share their story problems and estimates. Then call on several volunteers to share their story problems with the class, and several others to share and justify their estimates.
Activity 9  Double-Digit Multiplication with Pictures & Numbers (cont.)

3. After you’ve sketched the array, give students each a copy of the Double-Digit Multiplication worksheets. Ask them to make a similar quick sketch on the first sheet, which includes $23 \times 35$ as the example problem. Then ask everyone to find the total product by filling in and adding together the four partial products.

4. After they have had a few minutes to work, ask students to compare their results with a neighbor. Then reconvene the class. Ask students to share their partial products one at a time, while you record them in numerical form beside the array. Each time, use a short line segment to show which two numbers are being multiplied, as shown below. If you work from top left to top right, and then lower left to lower right, you can keep students’ attention on the magnitude of the final answer.

   **Teacher**  Okay, what was the product for this part of the array?

   **Briana**  It’s 20 times 30. That’s 600.

   **Teacher**  I’ll write that over here like this. I am drawing a line from the 2 down below to the 3 up top to show that we have multiplied 20 times 30. What does this tell us right away, before we go any further, about how big our final answer will be?

   **James**  It’s going to be more than 600. There’s still more to go.

5. Continue in this manner until students have reported the total product. Each time you add a partial product, draw a line from a digit in the bottom number to a digit in the top number to show which numbers were multiplied. In the end, the recording will look like this:
Activity 9  Double-Digit Multiplication with Pictures & Numbers (cont.)

6. Leave the example on the overhead or whiteboard and give students the rest of the period to work on the Double-Digit Multiplication sheets, using this method of recording and computing. Let them know that they don't have to draw the lines between the numbers they're multiplying if they don't want to. However, the lines can help them keep track of which numbers they have already multiplied, especially if they choose to drop the sketches, which is also an option. Circulate as they're working, and encourage students who seem confused to continue sketching before they compute. You may also want to meet with a small group to provide extra support if necessary.

INDEPENDENT WORKSHEET

Use Set A5 Independent Worksheet 7 to provide students with more practice multiplying double-digit numbers by finding and adding 4 partial products.
1 Find the product of each pair of numbers below. Make a labeled sketch to help, or just use numbers. Show all of your work.

**Example**

\[
\begin{array}{c}
35 \\
\times 23 \\
\end{array}
\]

**a**

\[
\begin{array}{c}
24 \\
\times 18 \\
\end{array}
\]

**b**

\[
\begin{array}{c}
27 \\
\times 25 \\
\end{array}
\]

**c**

\[
\begin{array}{c}
36 \\
\times 13 \\
\end{array}
\]

**d**

\[
\begin{array}{c}
46 \\
\times 36 \\
\end{array}
\]
Double-Digit Multiplication  page 2 of 2

2  Solve the story problems below. Make a labeled sketch to help, or just use numbers. Show all of your work.

a  Jon works at T-Shirts R Us. Yesterday, he unpacked 28 boxes of new shirts. Each box had 24 shirts in it. How many shirts did he unpack?

b  Jon made 23 stacks of long-sleeved t-shirts. He put 17 shirts in each stack. How many shirts did he stack in all?

CHALLENGE

C  Then Jon made 24 stacks of short-sleeved t-shirts. He put 16 shirts in each stack. The store he works for had to pay $4.99 for each shirt. How much did they have to pay for all the shirts Jon stacked?
Set A5 ★ Independent Worksheet 7

### Using Four Partial Products to Multiply Two-Digit Numbers

1. Multiply to get four partial products and add them up.

<table>
<thead>
<tr>
<th>Example</th>
<th>a</th>
<th>b</th>
</tr>
</thead>
</table>
| \[\begin{array}{c}
0 & 29 \\
\times & 25 \\
\hline
 & 400 \\
& 180 \\
& 100 \\
& 45 \\
\hline
 & 725 \\
\end{array}\] | \[\begin{array}{c}
37 \\
\times & 24 \\
\hline \\
\end{array}\] | \[\begin{array}{c}
26 \\
\times & 32 \\
\hline \\
\end{array}\] |

<table>
<thead>
<tr>
<th>c</th>
<th>d</th>
<th>e</th>
</tr>
</thead>
</table>
| 45 | \[\begin{array}{c}
24 \\
\times & 18 \\
\hline \\
\end{array}\] | \[\begin{array}{c}
76 \\
\times & 15 \\
\hline \\
\end{array}\] |

<table>
<thead>
<tr>
<th>f</th>
<th>g</th>
<th>h</th>
</tr>
</thead>
</table>
| 33 | \[\begin{array}{c}
53 \\
\times & 39 \\
\hline \\
\end{array}\] | \[\begin{array}{c}
34 \\
\times & 73 \\
\hline \\
\end{array}\] |
**Set A5 ★ Activity 10**

**Multiplication Menus**

**Overview**
A “multiplication menu” is a set of related multiplication facts that revolves around a single multiplicand. Menus are introduced in this activity to help students think flexibly and easily about double-digit multiplication.

**Skills & Concepts**
- multiply by 10 and multiples of 10
- mentally multiply 2-digit numbers by numbers through 10 and by multiples of 10
- apply the distributive property to calculations with whole numbers

**You’ll need**
- A Multiplication Menu (page A5.70, run one copy on a transparency)
- Multiplication Menus (pages A5.71 and A5.72, run a class set)
- overhead pen
- a piece of paper to mask portions of the overhead
- calculators available
- Student Math Journals or 1 piece of lined or grid paper per student

**Instructions for Multiplication Menus**
1. Ask students to find the next available page in their journal. Explain that you’re going to do some mental math together, and ask them to write the letters a–i down the left side of the page, leaving a line between each letter.

2. Show just the first multiplication problem at the top of the transparency on display. Have students copy the problem, 1 × 14, and write the answer. Show the next 2 problems one at a time and repeat the process with each. Although the focus is on mental strategies, let students know they can make little “arithmetic notes” off to one side of their journal page to track their thinking. (Some students may recognize, for instance, 2 × 14 is 14 doubled but still need to record 14 + 14 to get the answer.)

Then call on volunteers to share their solutions and strategies for Problems a–c as you fill in the answers at the overhead.

3. Next, show Problem d, 20 × 14. Have students copy this combination into their journals and record the answer, using information from the first three combinations, mental strategies, and such “arithmetic notes” as they need to track their own thinking. Ask them to pair-share their solutions and strategies and then call on volunteers to share their thinking with the class.
Students  I said 20 × 14 is 280 because it’s just double 140.
If you know that 10 × 14 is 140, you can add 140 and 140 to get 280.
At first I thought it was 168, because I added the answer for 2 × 14 and the answer for 10 × 14, but
then I realized it would have to be 10 × 14 plus 10 × 14.
I said it was 280 because 2 × 14 is 28, and 20 × 14 is ten times more than that.

4. Record the answer, 280, at the overhead. Work through Problems e–h in a similar fashion, stopping
after each one to have students share their thinking as you record the answer. In each case, encourage
students to use the information that’s already available to them to solve the problem.

Teacher  Who’d like to share their solution and strategy for solving 5 × 14?

Students  I took the answer for 3 × 14 and added on two more 14s. First I got up to 56, and then 70.
I did kind of the same thing, but I added the answers for 2 × 14 and 3 × 14 to get 5 × 14.
I said 5 × 14 must be like half of 10 × 14. 10 × 14 is 140; cut it in half and you get 70.
I just went 5 × 10 is 50 and 5 × 4 is 20, so the answer must be 70.

5. After the class has completed Problems a–h, display the prompt and the last combination at the bot-
tom of the overhead.

Ask students, working individually or in pairs, to use the information provided by the previous com-
binations to solve the problem, and to write a brief explanation of how they got the answer in their
journals. Students who finish well ahead of their classmates may be invited to find a few more related
products, such as 8 × 14, 14 × 14, 25 × 14, and so on. After they’ve had a few minutes to work, ask a
couple of volunteers to share how they found the answer to 23 × 14 with the class. As they do so, re-
cord their strategies on the overhead.
Set A5 Number and Operations: Multi-Digit Multiplication

Activity 10 Multiplication Menus (cont.)

Use the information above to find these products using mental strategies.

\[ 3 \times 14 = 42 \]
\[ 5 \times 14 = 70 \]
\[ 30 \times 14 = 420 \]
\[ 15 \times 14 = 210 \]

Find the product shown below. Explain how you got your answer:

\[ 23 \times 14 = \]
\[ \begin{array}{c}
20 \times 14 + 280 \\
3 \times 14 + 42 \\
23 \times 14 = 322 \\
3 \times 14 + 42 \\
322
\end{array} \]

6. Give students each a copy of the Multiplication Menus sheets. Review the instructions with the class and then give them the remainder of the session to work the problems on the two sheets.

6a. Take each page of Multiplication Menus and have the students complete the problems on it.

7. Use Set A5 Independent Worksheet 8 to give students more practice with multiplication menus.
A Multiplication Menu

a 1 × 14 = ________

b 2 × 14 = ________

c 10 × 14 = ________

d 20 × 14 = ________

Use the information above to find these products using mental strategies.

e 3 × 14 = ________

f 5 × 14 = ________

g 30 × 14 = ________

h 15 × 14 = ________

Find the product shown below. Explain how you got your answer.

i 23 × 14 = ________
Multiplication Menus  page 1 of 2

1a  Find the product on the left side of the page. Then use the information to find the products on the right side of the page.

1 × 13 = ________  
3 × 13 = ________  
2 × 13 = ________  
5 × 13 = ________  
10 × 13 = ________  
30 × 13 = ________  
20 × 13 = ________  
15 × 13 = ________

b  Find the product shown below. Explain how you got your answer.

23 × 13 = ________

2a  Find the product on the left side of the page. Then use the information to find the products on the right side of the page.

1 × 22 = ________  
3 × 22 = ________  
2 × 22 = ________  
5 × 22 = ________  
10 × 22 = ________  
30 × 22 = ________  
20 × 22 = ________  
15 × 22 = ________

b  Find the product shown below. Explain how you got your answer.

25 × 22 = ________
Multiplication Menus  page 2 of 2

3a Find the product on the left side of the page. Then use the information to find the products on the right side of the page.

\[
\begin{align*}
1 \times 34 &= \underline{} & 3 \times 34 &= \underline{} \\
2 \times 34 &= \underline{} & 5 \times 34 &= \underline{} \\
10 \times 34 &= \underline{} & 30 \times 34 &= \underline{} \\
20 \times 34 &= \underline{} & 15 \times 34 &= \underline{}
\end{align*}
\]

b Find the product shown below. Explain how you got your answer.

\[
40 \times 34 = \underline{}
\]

4a Make up your own multiplication menu. You can choose any 2, 3, or 4-digit number that doesn't end in a zero to be your multiplier.

\[
\begin{align*}
1 \times \underline{} &= \underline{} & 3 \times \underline{} &= \underline{} \\
2 \times \underline{} &= \underline{} & 5 \times \underline{} &= \underline{} \\
10 \times \underline{} &= \underline{} & 30 \times \underline{} &= \underline{} \\
20 \times \underline{} &= \underline{} & 15 \times \underline{} &= \underline{}
\end{align*}
\]

b Now write one more combination using your multiplier that can be solved using the information on your menu. Find the answer and explain how you got it.

\[
\underline{} \times \underline{} = \underline{}
\]
More Multiplication Menus

1a Fill in the blanks on the left side of the page. Then use the information to fill in the blanks on the right side of the page.

1 × 23 = ________
2 × 23 = ________
10 × 23 = ________
20 × 23 = ________
3 × 23 = ________
5 × 23 = ________
30 × 23 = ________
15 × 23 = ________

b Find the product shown below. Explain how you got your answer.

25 × 23 = ________

2a Fill in the blanks on the left side of the page. Then use the information to fill in the blanks on the right side of the page.

1 × 35 = ________
2 × 35 = ________
10 × 35 = ________
20 × 35 = ________
3 × 35 = ________
5 × 35 = ________
30 × 35 = ________
15 × 35 = ________

b Find the product shown below. Explain how you got your answer.

36 × 35 = ________

(Continued on back.)
Independent Worksheet 8  More Multiplication Menus (cont.)

3a Fill in the blanks on the left side of the page. Then use the information to fill in the blanks on the right side of the page.

1 × 45 = □□□□□□□□  
3 × 45 = □□□□□□□□  
2 × 45 = □□□□□□□□  
5 × 45 = □□□□□□□□  
10 × 45 = □□□□□□□□  
30 × 45 = □□□□□□□□  
20 × 45 = □□□□□□□□  
15 × 45 = □□□□□□□□

b Find the product shown below. Explain how you got your answer.

19 × 45 = □□□□□□□□

4a Make up your own multiplication menu. You can choose any 2, 3, or 4-digit number that doesn't end in a zero to be your multiplier.

1 × □□□□ = □□□□□□□□  
3 × □□□□ = □□□□□□□□  
2 × □□□□ = □□□□□□□□  
5 × □□□□ = □□□□□□□□  
10 × □□□□ = □□□□□□□□  
30 × □□□□ = □□□□□□□□  
20 × □□□□ = □□□□□□□□  
15 × □□□□ = □□□□□□□□

b Now make up one more combination using your multiplier that can be solved using the information on your menu. Find the answer and explain how you got the answer.

□□□□ × □□□□□□□□ = □□□□□□□□
Set A5 ★ Activity 11

Introducing a Two-Part Area Model

Overview
Students review some of their current strategies for double-digit multiplication and then explore a variation of the area model in which the rectangular array is divided into 2 instead of 4 parts.

Skills & Concepts
★ represent multiplication of 2-digit by 2-digit numbers
★ mentally multiply 2-digit numbers by numbers through 10 and by multiples of 10
★ estimate products to approximate solutions and determine reasonableness of answers
★ explain why a specific problem-solving strategy was used to determine a solution

You’ll need
★ Multiplication Strategies (page A5.77, run one copy on a transparency)
★ Two-Part Multiplication (page A5.78, run one copy on a transparency)
★ Two-Part Multiplication (pages A5.79 and A5.80, run a class set)
★ copy paper, one sheet per student
★ overhead pens
★ a piece of paper to mask portions of the overhead

Instructions for Introducing a Two-Part Area Model
1. Give each student a piece of copy paper and write the following multiplication problem on the whiteboard.

   \[
   \begin{array}{c}
   \text{25} \\
   \times \text{23}
   \end{array}
   \]

   Ask students to jot an estimate of the answer on their paper and explain their thinking to the person sitting next to them.

2. Next ask students to solve the problem, but leave the choice of a strategy up to them. As they finish, have them pair-share their answers and strategies. Then place the top portion of the Multiplication Strategies overhead on display. Ask students to examine the four different responses and locate the one most similar to their own. Then call on a different volunteer to explain each strategy to the class.
Mr. Ozuna asked his 4th graders to solve $23 \times 25$. Here are the answers from four of his students. How do they compare with yours?

<table>
<thead>
<tr>
<th>Name</th>
<th>Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jon</td>
<td>$400 + 60 + 15 = 575$</td>
</tr>
<tr>
<td>Josie</td>
<td>$20 \times 25 = 500$  $3 \times 25 = 75$  $500 + 75 = 575$</td>
</tr>
<tr>
<td>Nick</td>
<td>$20 \times 25 = 500$  $3 \times 25 = 75$  $500 + 75 = 575$</td>
</tr>
<tr>
<td>Kamela</td>
<td>$20 \times 25 = 500$  $3 \times 25 = 75$  $500 + 75 = 575$</td>
</tr>
</tbody>
</table>

3. Ask students to compare and contrast these four strategies. How are the strategies alike and how are they different? Does one seem to have any advantage over the others? Why or why not? Which might your students choose if they had to do the problem in their head instead of on paper?

Students

Kamela’s way is really fast, but it’s a little confusing. I don’t quite get how to do that one.

I do! I think it’s the easiest.

I like Josie’s way because you can see all the steps.

I still like drawing a picture like Jon did. It just seems easier to see what’s going on.

Nick’s way is really fast too. I think it would be the easiest one to do in your head.

I can make a sketch in my head and just see what the answer would be.

4. Now reveal the middle portion of the overhead. Ask students to examine the sketch quietly for a moment and then invite them to share their observations first in pairs and then with the class.

Students

It’s the area model, but it’s different.

It’s like Jon’s way up there, except there are 2 parts instead of 4.

I think that’s a pretty easy way to do it. The top part would be $20 \times 25$, and that’s 500.

Hey, this is kind of like Nick’s way, because it’ll be 500 for the top part and 75 for the bottom part.

5. After students have shared their observations, work with input from the class to label the lower region with a multiplication equation. Then transfer the information to the expression at the right of the sketch, looping the numbers as shown on the top of the next page to emphasize the fact you’ve multiplied 25 by the number of ones in 23. Repeat the process with the top region, again looping the numbers to emphasize the fact that you’ve multiplied 25 by the number of tens in 23.
Activity 11: Introducing a Two-Part Area Model (cont.)

6. Now reveal the problem at the bottom of the overhead, 22 × 24. Work with input from the class to fill in the frame with a rectangle, divide the rectangle into two parts, write a multiplication equation to show the area of each part, and transfer the information to the expression at the right of the sketch.

7. Give students each a copy of the Two-Part Multiplication sheets.

Set A5 Number and Operations: Multi-Digit Multiplication

NAME DATE

Two-Part Multiplication page 1 of 2

1 For problems a–f:
• label the frame to show the 2 numbers that are being multiplied.
• sketch in the rectangle and divide it into 2 parts.
• label each of the parts with a multiplication equation.
• add the partial products to get the answer.

   a. 
   b. 
   c. 
   d. 
   e. 
   f. 

Two-Part Multiplication page 2 of 2

2 For problems a–f:
• multiply the top number by the ones and then by the tens.
• add the partial products to get the answer.

   a. 
   b. 
   c. 
   d. 
   e. 
   f. 

example

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Activity 11  Introducing a Two-Part Area Model (cont.)

Use the top part of the corresponding overhead to review the instructions for page 1. Work through Problem 1a and, if necessary, Problem 1b, with the class. Many students find it helpful to break the side dimension on each rectangle into tens and ones, so you may want to model this and encourage them to do so.

8. Use the lower part of the overhead to review the instructions for the second sheet. Here, students are asked to work with numbers alone, multiplying first by the 1s in the multiplier, then by the 10s, and finally adding the two partial products to get the answer. Work through Problems 2a and 2b together at the overhead, and then give students the remainder of the session to complete the assignment.
**Multiplication Strategies**

Mr. Ozuna asked his 4th graders to solve $23 \times 25$. Here are the answers from four of his students. How do they compare with yours?

<table>
<thead>
<tr>
<th></th>
<th>Jon</th>
<th>Josie</th>
<th>Nick</th>
<th>Kamela</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>20(\times)5 (=) 100</td>
<td>25 (\times) 25 (=) 500</td>
<td>20 (\times) 25 (=) 500</td>
<td>25 (\times) 25 (=) 500</td>
</tr>
<tr>
<td></td>
<td>20(\times)5 (=) 100</td>
<td>3 (\times) 25 (=) 75</td>
<td>3 (\times) 25 (=) 75</td>
<td>3 (\times) 25 (=) 75</td>
</tr>
<tr>
<td></td>
<td>60 (\times) 23 (=) 15</td>
<td>25 (\times) 23 (=) 20</td>
<td>25 (\times) 23 (=) 20</td>
<td>25 (\times) 23 (=) 20</td>
</tr>
<tr>
<td></td>
<td>+ 400 (\times) 400 (=) 400</td>
<td>+ 15 (\times) 400 (=) 15</td>
<td>+ 15 (\times) 400 (=) 15</td>
<td>+ 15 (\times) 400 (=) 15</td>
</tr>
<tr>
<td></td>
<td>100 (\times) 100 (=) 100</td>
<td>100 (\times) 100 (=) 100</td>
<td>100 (\times) 100 (=) 100</td>
<td>100 (\times) 100 (=) 100</td>
</tr>
<tr>
<td></td>
<td>+ 60 (\times) 60 (=) 60</td>
<td>+ 60 (\times) 60 (=) 60</td>
<td>+ 60 (\times) 60 (=) 60</td>
<td>+ 60 (\times) 60 (=) 60</td>
</tr>
<tr>
<td></td>
<td>+ 15 (\times) 15 (=) 15</td>
<td>+ 15 (\times) 15 (=) 15</td>
<td>+ 15 (\times) 15 (=) 15</td>
<td>+ 15 (\times) 15 (=) 15</td>
</tr>
<tr>
<td></td>
<td>575 (\times) 575 (=) 575</td>
<td>575 (\times) 575 (=) 575</td>
<td>575 (\times) 575 (=) 575</td>
<td>575 (\times) 575 (=) 575</td>
</tr>
</tbody>
</table>

**Diagram 1**

$23 \times 25 = 575$

**Diagram 2**

$22 \times 24 = 528$
Two-Part Multiplication

1 For problems a–f:
• label the frame to show the 2 numbers that are being multiplied.
• sketch in the rectangle and divide it into 2 parts.
• label each of the parts with a multiplication equation.
• add the partial products to get the answer.

\[
\begin{array}{c}
\begin{array}{c}
21 \\
\times 15
\end{array}
\end{array}
\]

\[
\begin{array}{c}
\begin{array}{c}
14 \\
\times 16
\end{array}
\end{array}
\]

2 For problems a–f:
• multiply the top number by the ones and then by the tens.
• add the partial products to get the answer.

\[
\begin{array}{c}
\begin{array}{c}
24 \\
\times 12
\end{array}
\end{array}
\]

\[
\begin{array}{c}
\begin{array}{c}
2 \times 24 = 48 \\
10 \times 24 = 240
\end{array}
\end{array}
\]

\[
\begin{array}{c}
\begin{array}{c}
288
\end{array}
\end{array}
\]

\[
\begin{array}{c}
\begin{array}{c}
23 \\
\times 13
\end{array}
\end{array}
\]

\[
\begin{array}{c}
\begin{array}{c}
25 \\
\times 22
\end{array}
\end{array}
\]
1 For problems a–f:
• label the frame to show the 2 numbers that are being multiplied.
• sketch in the rectangle and divide it into 2 parts.
• label each of the parts with a multiplication equation.
• add the partial products to get the answer.

\[
\begin{align*}
\text{a} & \quad 21 \times 15 \\
\text{b} & \quad 14 \times 16 \\
\text{c} & \quad 22 \times 12 \\
\text{d} & \quad 17 \times 13 \\
\text{e} & \quad 23 \times 23 \\
\text{f} & \quad 24 \times 14 \\
\end{align*}
\]
Two-Part Multiplication page 2 of 2

2 For problems a–f:
- multiply the top number by the ones and then by the tens.
- add the partial products to get the answer.

\[
\begin{align*}
\text{example} & \quad 24 \\
& \times 12 \\
2 \times 24 &= 48 \\
10 \times 24 &= 240 \\
& = 288
\end{align*}
\]

\[
\begin{align*}
a & \quad \begin{array}{c}
23 \\
\times 13 \\
\hline
\end{array} \\
b & \quad \begin{array}{c}
25 \\
\times 22 \\
\hline
\end{array} \\
c & \quad \begin{array}{c}
25 \\
\times 26 \\
\hline
\end{array} \\
d & \quad \begin{array}{c}
33 \\
\times 22 \\
\hline
\end{array} \\
e & \quad \begin{array}{c}
36 \\
\times 12 \\
\hline
\end{array} \\
f & \quad \begin{array}{c}
42 \\
\times 24 \\
\hline
\end{array}
\end{align*}
\]
ACTIVITY

Reviewing & Evaluating Multiplication Methods

Overview
Students review some of the multi-digit multiplication methods they have explored and think critically about which strategies are most effective when. Then they work independently on a set of problems and discuss their solutions, as well as the strategies they selected.

Skills & Concepts
★ multiply 2- and 3-digit by 2-digit numbers using the standard multiplication algorithm
★ solve single- and multi-step word problems involving multi-digit multiplication and verify the solutions
★ identify strategies that can be used to solve a problem, select and use one or more appropriate strategies to solve the problem, and justify the selection
★ explain why a specific problem-solving strategy was used to determine a solution

You’ll need
★ Reviewing Multiplication Methods (page A5.91, run one copy on a transparency and a class set on paper)
★ Evaluating Multiplication Methods (pages A5.92 and A5.93, run a class set)
★ overhead pens

Instructions for Reviewing & Evaluating Multiplication Methods
1. Give students each a copy of Reviewing Multiplication Methods, and display a copy of the sheet at the overhead.
2. On this sheet, students will find five of the multiplication methods they’ve explored over the past few weeks. Give them a minute to examine the sheet quietly and star the methods they find easiest and most effective right now. Ask them to share and explain their choices in pairs, and then invite volunteers to share with the class.

Students
I put a star by Method A because it's easy, like with 4 × 124, you can just do doubles and then double it again.
I still like the 4-part way because it’s easy for me to do the multiplication in my head and then add up the numbers.
I really like that 2-part way—it's faster than the other one.
I think the regular way on E is the best because it works with big numbers.
But with numbers like 299, you don’t even need to do hardly any work. Just think it's like 3 × 300, and then subtract 3.
### Activity 13  Reviewing & Evaluating Multiplication Methods (cont.)

3. Then work with class input to complete the examples at the overhead as students do so on their copies of the sheet.

**Teacher**  Let’s complete the example for Method A together. It says $4 \times 124$ and tells us to double it and then double it again. What do we need to write on the sheet to show this?

**Justin**  You could just write $124 + 124$, or $124 \times 2$ and do it in your head. Then just double that to get the answer.

**Teacher**  What if the problem had been $3 \times 124$ or $5 \times 124$ instead of $4 \times 124$? Would our basic fact strategies still work? Talk with the person sitting next to you—what do you think?

**Students**  If it was $3 \times 124$, you could just double it and add another $124$. For $5 \times 124$, you could just multiply by 10 and cut the answer in half, just like if you were doing $5 \times 9$ or $5 \times 12$. 

---

**Method A**  Use basic fact strategies.

**Example**  $4 \times 124$  Double it and then double it again.

Teacher  Double it and then double it again.

Justin  $124 + 124$, or $124 \times 2$ and do it in your head. Then just double that to get the answer.

Teacher  What if the problem had been $3 \times 124$ or $5 \times 124$ instead of $4 \times 124$? Would our basic fact strategies still work? Talk with the person sitting next to you—what do you think?

Students  If it was $3 \times 124$, you could just double it and add another $124$. For $5 \times 124$, you could just multiply by 10 and cut the answer in half, just like if you were doing $5 \times 9$ or $5 \times 12$. 

---

**Method B**  Multiply to get 4 partial products and add them up.

**Example**  $27 \times 34$

Teacher  Double it and then double it again.

Justin  $124 + 124$, or $124 \times 2$ and do it in your head. Then just double that to get the answer.

Teacher  What if the problem had been $3 \times 124$ or $5 \times 124$ instead of $4 \times 124$? Would our basic fact strategies still work? Talk with the person sitting next to you—what do you think?

Students  If it was $3 \times 124$, you could just double it and add another $124$. For $5 \times 124$, you could just multiply by 10 and cut the answer in half, just like if you were doing $5 \times 9$ or $5 \times 12$. 

---

**Method C**  Multiply by the 10's and then by the 1's. Add the partial products.

**Example**  $16 \times 25$

Teacher  Double it and then double it again.

Justin  $124 + 124$, or $124 \times 2$ and do it in your head. Then just double that to get the answer.

Teacher  What if the problem had been $3 \times 124$ or $5 \times 124$ instead of $4 \times 124$? Would our basic fact strategies still work? Talk with the person sitting next to you—what do you think?

Students  If it was $3 \times 124$, you could just double it and add another $124$. For $5 \times 124$, you could just multiply by 10 and cut the answer in half, just like if you were doing $5 \times 9$ or $5 \times 12$. 

---

**Method D**  Use landmark numbers.

**Example**  $3 \times 299$

Teacher  Double it and then double it again.

Justin  $124 + 124$, or $124 \times 2$ and do it in your head. Then just double that to get the answer.

Teacher  What if the problem had been $3 \times 124$ or $5 \times 124$ instead of $4 \times 124$? Would our basic fact strategies still work? Talk with the person sitting next to you—what do you think?

Students  If it was $3 \times 124$, you could just double it and add another $124$. For $5 \times 124$, you could just multiply by 10 and cut the answer in half, just like if you were doing $5 \times 9$ or $5 \times 12$. 

---

**Method E**  Use the standard algorithm.

**Example**  $46 \times 73$

Teacher  Double it and then double it again.

Justin  $124 + 124$, or $124 \times 2$ and do it in your head. Then just double that to get the answer.

Teacher  What if the problem had been $3 \times 124$ or $5 \times 124$ instead of $4 \times 124$? Would our basic fact strategies still work? Talk with the person sitting next to you—what do you think?

Students  If it was $3 \times 124$, you could just double it and add another $124$. For $5 \times 124$, you could just multiply by 10 and cut the answer in half, just like if you were doing $5 \times 9$ or $5 \times 12$. 

---

**Method F**  Use the standard algorithm.

**Example**  $46 \times 73$
**Activity 13** Reviewing & Evaluating Multiplication Methods (cont.)

**Teacher** So if you're multiplying a number—even a big number—by a single digit, you might remember back to some of the basic fact strategies you already know. Let's look at Method B, the 4-part model. What do we have to do to use this method?

**Students** We have to look at the 4 little lines and do those multiplication problems. Like on the first one, it's $20 \times 30$. That's 600. And the next one is $20 \times 4$, and that's 80.

**Teacher** Let's write each step down on our papers. I'll do that up here, and you work on your sheets.

4. Complete the rest of the examples on the sheet together in a similar fashion, reviewing and discussing each strategy as you enter the needed information at the overhead and students do so on their worksheets.

5. Leave the overhead on display, and give students each a copy of the Evaluating Multiplication Methods sheets. Review the instructions at the top of the first page, and explain to students that for each problem, they’ll need to choose the multiplication method that seems best to them, and then use that method to solve the problem. Decisions will vary from one student to the next, and that's okay. If a few students raise the point that there are multiplication methods other than the ones shown on the overhead, acknowledge the fact, but ask them to make their selections from Methods A–E for this assignment.
Activity 13  Reviewing & Evaluating Multiplication Methods (cont.)

6. Once students understand what to do, give them time to complete the sheets. When most have finished the assignment, ask them to meet in pairs to share and compare their answers, as well as the methods they chose. If their answers don't match, ask them to re-examine the problem and see if they can resolve the difference.

7. Reconvene the class toward the end of the period. Work with student input to record each multiplication problem at the whiteboard along with the answer.

\[
\begin{align*}
158 \times 8 & = 1,264 \\
40 \times 16 & = 640 \\
175 \times 26 & = 4,550 \\
45 \times 49 & = 2,205
\end{align*}
\]

Then ask volunteers to share the methods they chose to help solve each problem and explain their choices to the class. During the discussion, elicit these ideas:

- There are a variety of ways to solve multi-digit multiplication problems; it's not necessary to use the same method every time. What's important is to choose the method that is most efficient and effective.

- The method you choose to solve a particular problem depends on the numbers themselves. Here are some examples:
  - Use a basic fact strategy if the multiplier is a single digit.
  - Use a 2-part method when it's relatively easy to compute each partial product mentally (i.e., 16 \times 40).
  - Use a 4-part method or the standard algorithm when the numbers are not as "friendly" (i.e., 49 \times 45).
  - Use the standard algorithm when you're multiplying 3 digits by 2 digits.
**Reviewing Multiplication Methods**

Read and review these multiplication methods with your class. Then complete the example in each strategy box, A–E.

<table>
<thead>
<tr>
<th>Method A</th>
<th>Use basic fact strategies.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>example</strong></td>
<td>$4 \times 124$</td>
</tr>
<tr>
<td></td>
<td>Double it and then double it again.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Method B</th>
<th>Multiply to get 4 partial products and add them up.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>example</strong></td>
<td>$27 \times 34$</td>
</tr>
<tr>
<td></td>
<td>$34$</td>
</tr>
<tr>
<td></td>
<td>$\times 27$</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Method C</th>
<th>Multiply by the 10s and then by the 1s. Add the partial products.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>example</strong></td>
<td>$16 \times 25$</td>
</tr>
<tr>
<td></td>
<td>$25$</td>
</tr>
<tr>
<td></td>
<td>$\times 16$</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Method D</th>
<th>Use landmark numbers.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>example</strong></td>
<td>$3 \times 299$</td>
</tr>
<tr>
<td></td>
<td>$299$</td>
</tr>
<tr>
<td></td>
<td>$\times 3$</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Method E</th>
<th>Use the standard algorithm.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>example</strong></td>
<td>$46 \times 73$</td>
</tr>
<tr>
<td></td>
<td>$73$</td>
</tr>
<tr>
<td></td>
<td>$\times 46$</td>
</tr>
</tbody>
</table>
Evaluating Multiplication Methods  page 1 of 2

For each problem on this page and the next,
• write the letter of the method you think will work best.
• use the method to solve the problem. Show all your work.

1. People need to drink about 8 cups of water each day. Zoo elephants need to drink about 158 quarts of water each day. How many cups of water are there in 158 quarts of water? (Remember that there are 4 cups in a quart.)

I think Method _____ will work best for this problem.

2. So far, the elephant keeper has brought in 40 gallons of water for the elephants. How many cups of water are there in 40 gallons? (Remember that there are 16 cups in a gallon.)

I think Method _____ will work best for this problem.
3  Zoo elephants eat about 175 pounds of food a day. Most of their food is hay, but they also eat fruits and vegetables. How many pounds of food would it take to feed 26 elephants for one day?
I think Method ____ will work best for this problem.

4  Each elephant at our zoo gets about 45 pounds of vegetables a day. How many pounds of vegetables does it take to feed one elephant for 49 days (7 weeks)?
I think Method ____ will work best for this problem.

5  An elephant can spend up to 18 hours a day eating. How many hours would that total in one year? About how many months' worth of time is that?
Set A5 ★ Independent Worksheet 9

Pine Cones & School Supplies

The scouts made bags of pine cones to sell at the crafts fair. They made 24 bags. Each bag had 36 pine cones in it. How many pine cones did they use in all?

To solve this problem, multiply 24 × 36.

One way to do this is to multiply to find 4 partial products and then add them up.

Another way is to use the standard algorithm.

<table>
<thead>
<tr>
<th>Partial Products</th>
<th>Standard Algorithm</th>
</tr>
</thead>
<tbody>
<tr>
<td>36 × 24</td>
<td>18 × 36</td>
</tr>
<tr>
<td>20 × 30 = 600</td>
<td>× 24</td>
</tr>
<tr>
<td>20 × 6 = 120</td>
<td>144</td>
</tr>
<tr>
<td>4 × 30 = 120</td>
<td>+ 720</td>
</tr>
<tr>
<td>4 × 6 = + 24</td>
<td>864  pine cones</td>
</tr>
</tbody>
</table>

864 pine cones

Some people call the standard algorithm a short-cut because you don't have to write as much.

1 Use the standard algorithm to solve the problems below. Show your work.

Example

\[
\begin{align*}
18 \\
\times 23
\end{align*}
\]

\[
\begin{align*}
32 \\
\times 27
\end{align*}
\]

\[
\begin{align*}
45 \\
\times 23
\end{align*}
\]

\[
\begin{align*}
53 \\
\times 26
\end{align*}
\]

\[
\begin{align*}
18 \\
\times 19
\end{align*}
\]

\[
\begin{align*}
84 \\
+ 560
\end{align*}
\]

\[
\begin{align*}
644 \\
37 \\
\times 26
\end{align*}
\]

\[
\begin{align*}
41 \\
\times 22
\end{align*}
\]

\[
\begin{align*}
47 \\
\times 39
\end{align*}
\]

\[
\begin{align*}
66 \\
\times 25
\end{align*}
\]

\[
\begin{align*}
83 \\
\times 24
\end{align*}
\]

(Continued on back.)
Independent Worksheet 9  Pine Cones & School Supplies (cont.)

2 Use the standard algorithm to solve the multiplication problems below. Show your work.

a Mr. Wu got 35 boxes of crayons for his fourth graders. Every box had 24 crayons in it. How many crayons in all?

b Ms. Penny got 18 packs of felt markers for her fifth graders. Each pack had 36 markers in it. How many markers in all?

C The office got 15 cartons of envelopes. Each carton had 12 boxes of envelopes in it. Each box had 54 envelopes in it. How many envelopes did they get in all?
Multi-Digit Multiplication Post-Assessment

Overview
The pre-assessment given in Activity 1 is re-administered in somewhat different form during this activity. Students’ work on the post-assessment will provide information about what they have learned, as well as the areas in which they need continued support.

Skills & Concepts
- multiply by 10, 100, and 1000
- multiply one- and two-digit numbers by numbers through 10 and by multiples of 10
- multiply up to 3-digit by 1- and 2-digit numbers accurately using the standard algorithm
- estimate products to approximate solutions and determine reasonableness of answers
- solve single- and multi-step word problems involving multi-digit multiplication

You’ll need
- Multi-Digit Multiplication Post-Assessment (pages A5.100–A5.103, run a class set)
- Multi-Digit Multiplication Post-Assessment Class Checklist (page A5.104, run 1 or 2 copies)
- Multi-Digit Multiplication Pre- & Post-Assessment Scoring & Comparisons (optional, pages A5.11 and A5.12, run a class set)
- Student Reflection Sheet: Multiplication (see note)
- Base 10 Grid Paper (page A5.13, run as needed)

Note
If you had students fill out the Student Reflection Sheet (pages A5.14–A5.16) after the Multi-Digit Multiplication Pre-Assessment, plan to have them fill it out again when you return their scored post-assessments.

Instructions for Multi-Digit Multiplication Post-Assessment
1. Give each student a copy of the 4-page post-assessment and then read and review the tasks with the class. Have students write their names on their papers and circle each “doing” word as you read through the items together. Remind students that they’ll need to check off each checkpoint as they complete the items.

2. Before they start to work, be sure students understand that they only need to circle and solve one combination in problems 2, 3, and 7. Take a minute, if necessary, to review the standard multiplication algorithm, because students are specifically asked to use that method to solve problems 2, 3, and 7. In problems 2 and 3, they’re also asked to use a second method. You might take a minute to review some of the methods they’ve explored over the past few weeks: sketches on base 10 grid paper, freehand 4-part and 2-part area models, finding and adding 4 or 2 partial products, and so on. Tell students that you’ll place a stack of base ten grid paper near each table or cluster of desks if they want to use it for any of the problems other than problem 7.

3. Remind students that you are available to re-read any of the directions or problems for them while they work. Advise them to complete the items they find easiest and most familiar first, even if that means skipping around a bit, and then return to the questions they find more challenging and writing “I don’t know yet” if necessary.
4. If you plan to score this assessment as suggested in “Looking at Student Work” below, let students know that you will be scoring their papers. In many of the problems, they will be given a point for the answer and a point for showing their work. In problems 2 and 3, they will get a point for using the standard algorithm to solve the combination they’ve selected, and another point for solving it using a different method. In problems 4 and 8, they need to estimate answers and explain their estimates; points will be given for the estimate and the explanation. While it may seem that this will create more test anxiety, we find that it is very helpful to students when we share our expectations before they start.

5. Give students the rest of the period to complete the assessment. Make sure your students understand what they are expected to do when they complete the assessment and where you want them to place their finished papers.

**LOOKING AT STUDENT WORK**

Below you’ll find an item-by-item answer key and scoring suggestions for this post-assessment. We generally use the percentage of points earned to determine whether a student is working at an advanced, proficient, basic, or novice level with regard to the material on the assessment. You may need to adjust the scoring system for this assessment to ensure that it reflects the expectations for fourth-graders in your district.

<table>
<thead>
<tr>
<th>POINTS SCORED</th>
<th>PERCENTAGE OF TOTAL</th>
<th>LEVEL</th>
</tr>
</thead>
</table>
| 29 – 32 points      | 90 – 100 %          | Advanced  
(Working above grade level) |
| 24 – 28 points      | 75 – 89%            | Proficient  
(Working at grade level) |
| 17 – 23 points      | 53 – 74%            | Basic  
(Working toward grade level) |
| 16 points or fewer  | 50% or lower        | novice  
(Working below grade level) |

In addition to scoring these post-assessments, you may find it helpful to compare them to students’ pre-assessments. Although some students may not score particularly well on the post-assessment, you may find that they have actually made quite a bit of progress based on what they were able to do at the beginning of this collection of activities.
### Problem 1

**PROBLEM 1**

1. There are 24 crayons in a box. There are 8 boxes of crayons in a jumbo pack. Mrs. Perez bought 4 jumbo packs of crayons for her class. How many crayons did she get in all?

   **A5.97**

   **SCORING: 3 POINTS POSSIBLE**

   - 1 point for a strategy that indicates the student understands this is a 2-step problem requiring two different calculations or sets of calculations
   - 1 point for work that uses any combination of labeled sketches, numbers, and/or words to demonstrate how the solution was found
   - 1 point for the correct answer, 768

   **Comments**

   It is possible for a student to score 2 points on this problem, even if she doesn’t get the correct answer. One of the goals of multi-digit multiplication activities was to help students develop skills at solving multi-step problems. Even if the student makes errors in her calculations, using a strategy that reflects good understanding of the problem can be awarded 2 points.

```
<table>
<thead>
<tr>
<th>Number of Jumbo Packs</th>
<th>Number of Boxes per Pack</th>
<th>Total crayons</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>8</td>
<td>32</td>
</tr>
<tr>
<td>1296</td>
<td></td>
<td>768</td>
</tr>
<tr>
<td>768</td>
<td></td>
<td>768</td>
</tr>
</tbody>
</table>
```

### Problem 2

**PROBLEM 2**

2. Choose one of the problems below and circle it.

   $24 \times 8$
   $32 \times 8$
   $42 \times 7$
   $99 \times 5$

   **SCORING: 3 POINTS POSSIBLE**

   - 1 point for using the standard algorithm to get the correct answer
   - 1 point for using any other method to get the correct answer (see Comments)
   - 1 point for any reasonable response to the question about which method was easier and faster

   **Answers to the 4 problems**

   - $6 \times 24 = 144$
   - $8 \times 32 = 256$
   - $7 \times 42 = 294$
   - $5 \times 99 = 495$

   **Comments**

   Possible strategies include a labeled sketch on base 10 grid paper, a freehand sketch of the area model divided into 4 or 2 parts, finding and adding 4 or 2 partial products, a basic facts strategy such as double-double-doubles, or repeated addition. Students who are still using repeated addition and are not yet using the standard algorithm for 1-by 2-digit multiplication accurately will need extra support to develop proficiency with this skill. (See Grade 4 Support Activity 22, Spin & Multiply. You’ll find this activity at the back of the Grade 4 Number Corner Blacklines.)

### Problem 3

**PROBLEM 3**

3. Choose one of the problems below and circle it.

   $25 \times 33$
   $25 \times 35$
   $43 \times 31$
   $51 \times 32$

   **SCORING: 2 POINTS POSSIBLE**

   - 1 point for using the standard algorithm to get the correct answer
   - 1 point for using any other method to get the correct answer (see Comments)

   **Answers to the 4 problems**

   - $18 \times 25 = 450$
   - $23 \times 33 = 759$
   - $23 \times 43 = 989$
   - $32 \times 51 = 1,632$

   **Comments**

   Possible methods include a labeled sketch on base 10 grid paper, a freehand sketch of the area model divided into 4 or 2 parts, finding and adding 4 or 2 partial products, or repeated addition. Students who are still using repeated addition and are not yet using the standard algorithm for 2-by 2-digit multiplication accurately will need extra support to develop proficiency with this skill. (See Grade 5 Support Activities 31, Spin & Multiply Big Time, and 36, Multiplication Tic-Tac-Toe. You’ll find these activities at the back of the Grade 5 Number Corner Blacklines.)
### Problem 4

Fill in the bubble to show the best estimate for each problem. Explain your choice.

- **a**
  - Responses will vary. Sample: $4 \times 200$
  - Why? Is 800. Then 48 is almost like 50, and $4 \times 50$ is 200. 800 + 200 is 1,000 so that's what I picked.

- **b**
  - Responses will vary. Sample: $20 \times 25$
  - Why? Is 500. Then $5 \times 25$ is 125. 500 + 125 is 625 so 600 is the closest.

**Scoring:** 4 points possible
- 1 point for selecting the closest estimate to each problem (1,000 and 600)
- 1 point for each reasonable explanation of the selected estimate (see Comments)

**Comments**
If a student hasn't chosen the closest estimate, but has given an explanation that demonstrates good number sense, consider awarding 1 point for the item.

### Problem 5

Write the answer to each problem.

- **5 a**
  - $45 \times 10 = 450$
  - $45 \times 15 = 675$
  - $45 \times 20 = 900$
  - $45 \times 30 = 1,350$
  - $45 \times 50 = 2,250$
  - $45 \times 100 = 4,500$
  - $45 \times 1,000 = 45,000$

**Scoring:** 6 points possible
- 1 point for each correct answer

**Comments**
Because they should be able to do these problems mentally, students are not required to show their work. Don't penalize them, however, if they've used the standard algorithm or some other method to get the answers.

### Problem 6

Write the answer to each problem.

- **6 a**
  - $40 \times 2 = 80$
  - $40 \times 4 = 160$
  - $40 \times 30 = 1,200$
  - $40 \times 50 = 2,000$
  - $40 \times 100 = 4,000$
  - $40 \times 300 = 12,000$

**Scoring:** 6 points possible
- 1 point for each correct answer

**Comments**
Because they should be able to do these problems mentally, students are not required to show their work. Don't penalize them, however, if they've used the standard algorithm or some other method to get the answers. Of greater concern are those students who are trying to manipulate the numbers without adequate understanding. Such students may give an answer of 150 for $30 \times 50$ or 400 for $50 \times 80$ because they have latched onto the idea of multiplying the digits in the tens place as if they were ones (i.e., $5 \times 8 = 40$), but aren't sure how many zeros to add. You might ask these students to continue using Base Ten Grid Paper or even base ten pieces to solve such problems so that they can develop a greater understanding of the place value concepts at work.
**Activity 14 Multi-Digit Multiplication Post-Assessment (cont.)**

**PROBLEM 7**

Choose one of the multiplication problems below and circle it. Pick the one that seems best for you — not too hard and not too easy.

<p>| | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>112</td>
<td>× 24</td>
<td>125</td>
<td>× 17</td>
<td>332</td>
</tr>
</tbody>
</table>

- Use the standard algorithm to find the answer to the problem you circled. Be sure to show all of your work.

  - Responses will vary.
  - Sample for 332 × 26:
    - Answer: 8,632

- Write a story problem to match the multiplication problem you just solved.

  - Responses will vary. Sample: The school cafeteria got 26 packs of napkins. There are 332 napkins in each pack. How many napkins in all?

**SCORING: 3 POINTS POSSIBLE**

- 1 point for using the standard algorithm to get the correct answer
- 2 points for a multiplication story problem that matches the selected combinations (A story problem that involves repeated addition rather than multiplication may be awarded 1 point.)

**Answers to the 6 problems:**

- 24 × 112 = 2,688
- 17 × 125 = 2,125
- 26 × 332 = 8,632
- 25 × 254 = 6,350
- 37 × 382 = 14,134
- 48 × 569 = 27,312

**Comments**

Students’ story problems will give you some indication of how well they understand the operation of multiplication. Even if they’re able to go through the mechanics of the standard algorithm, students who write story problems that involve addition rather than multiplication may still be using additive rather than multiplicative reasoning when they think about multiplication.

**PROBLEM 8**

- We can hear someone out mowing the lawn in front of our school. The lawn is 24 feet wide and 49 feet long. How many square feet of grass do they have to mow?

  - Write an expression to match this problem.
  - Andy says the answer is going to be about 800. Do you agree with Andy? Why or why not?
  - Use any method except repeated addition to solve the problem. Show all of your work.

  - Responses will vary. Sample: No because 49 is really close to 50. 20 × 50 would be 1,000 so I think Andy’s estimate is too low.

**SCORING: 5 POINTS POSSIBLE**

- 1 point for the correct expression: 24 × 49 or 49 × 24
- 1 point for the correct response to part b: No or I disagree
- 1 point for a reasonable explanation of why Andy’s estimate is too low (see Comments)
- 1 point for a method other than repeated addition
- 1 point for the correct answer, 1,176

**Comments**

If a student agrees with Andy that 800 is a reasonable estimate, and gives an explanation that reflects good number sense, you might consider awarding a point for the explanation. Possible methods for solving the problem include a labeled sketch on base 10 grid paper, a freehand sketch of the area model divided into 4 or 2 parts, finding and adding 4 or 2 partial products, or the standard algorithm. Repeated addition is not acceptable.

---

**Note:** In order to help students develop fluency with the skills taught during this activity set, you’ll want to provide more practice over the coming months. Independent Worksheets 1–9 that follow this activity are provided for this purpose. Additional multi-digit multiplication exercises and problems can be found on The Math Learning Center website: www.mathlearningcenter.org.
1 There are 24 crayons in a box. There are 8 boxes of crayons in a jumbo pack. Mrs. Perez bought 4 jumbo packs of crayons for her class. How many crayons did she get in all?

a Solve the story problem above. Show your work with labeled sketches, numbers, and/or words.

b Mrs. Perez got ________ crayons in all.

2 Choose one of the problems below and circle it.

\[
\begin{array}{cccc}
24 & 32 & 42 & 99 \\
\times 6 & \times 8 & \times 7 & \times 5 \\
\end{array}
\]

a Use the standard algorithm to solve the problem you circled. Show all your work in the box below.

b Use a different method to solve the problem you circled. Show all your work in the box below.

c Which method was easier and faster for you? Why?
Multi-Digit Multiplication Post-Assessment

3. Choose one of the problems below and circle it.

\[
\begin{array}{cccc}
25 & 33 & 43 & 51 \\
\times 18 & \times 23 & \times 23 & \times 32 \\
\hline
\end{array}
\]

- \textbf{a} Use the standard algorithm to solve the problem you circled. Show all your work in the box below.

- \textbf{b} Use a different method to solve the problem you circled. Show all your work in the box below.

4. Fill in the bubble to show the best estimate for each problem. Explain your choice.

\[
\begin{array}{ccc}
248 \\
\times 4 & 800 & 900 \\
& 1,000 & 1,200 \\
\hline
\end{array}
\]

\textbf{a} Why?

\[
\begin{array}{ccc}
25 \\
\times 25 & 400 & 500 \\
& 600 & 700 \\
\hline
\end{array}
\]

\textbf{b} Why?

5. Write the answer to each problem.

\[
\begin{array}{ccccccc}
45 & 10 & 29 & 100 & 1,000 & 60 \\
\times 10 & \times 50 & \times 100 & \times 60 & \times 18 & \times 1,000 \\
\hline
\end{array}
\]
Multi-Digit Multiplication Post-Assessment  page 3 of 4

6  ____ Write the answer to each problem.

\[
\begin{align*}
40 & \times 2 \\
60 & \times 4 \\
50 & \times 30 \\
80 & \times 50 \\
21 & \times 30 \\
32 & \times 30 \\
\end{align*}
\]

7  Choose one of the multiplication problems below and circle it. Pick the one that seems best for you - not too hard and not too easy.

\[
\begin{align*}
112 & \times 24 \\
125 & \times 17 \\
332 & \times 26 \\
254 & \times 25 \\
382 & \times 37 \\
569 & \times 48 \\
\end{align*}
\]

a  ____ Use the standard algorithm to find the answer to the problem you circled. Be sure to show all of your work.

b  ____ Write a story problem to match the multiplication problem you just solved.
8 We can hear someone out mowing the lawn in front of our school. The lawn is 24 feet wide and 49 feet long. How many square feet of grass do they have to mow?

a ____ Write an expression to match this problem.

b Andy says the answer is going to be about 800. Do you agree with Andy? Why or why not?

c ____ Use any method except repeated addition to solve the problem. Show all of your work.
### Multi-Digit Multiplication Post-Assessments Class Checklist

| Student name | 1a Uses any combination of labeled sketches, numbers, and words to solve the problem; indicates understanding that 2 steps are necessary | 2a Uses the standard algorithm for 2-digit by 1-digit multiplication | 2b Uses a different method for 2-digit by 1-digit multiplication | 2c Gives a reasonable explanation about which strategy was easier | 3a Uses the standard algorithm for 2-digit by 2-digit multiplication | 3b Uses a different method for 2-digit by 2-digit multiplication | 4a Chooses the best estimate for 4 × 248 (1,000), and justifies estimate | 4b Chooses the best estimate for 25 × 25 (600), and justifies estimate | 5 Multiplies 2-digit numbers by 10, 100, and 1,000 | 6 Multiplies 1- and 2-digit numbers by multiples of 10 | 7a Uses the standard algorithm for 3-digit by 2-digit multiplication | 7b Writes a story problem to match the multiplication problem from 7a | 8a Records a correct expression | 8b Disagrees with Andy’s estimate and justifies response | 8c Uses a method other than repeated addition to multiply 24 × 79 | 8d Gives correct answer, 1176 | **Total score / Level of proficiency** |
|--------------|----------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------|-------------------------------------------------|-------------------------------------------------|-------------------------------------------------|-------------------------------------------------|-------------------------------------------------|-------------------------------------------------|-------------------------------------------------|-------------------------------------------------|-------------------------------------------------|-------------------------------------------------|-------------------------------------------------|-------------------------------------------------|-------------------------------------------------|-------------------------------------------------|-------------------------------------------------|-------------------------------------------------|
|              | 2*                                                                                                                             | 1                                                                | 1                                               | 1                                               | 1                                               | 1                                               | 2                                               | 2                                               | 6                                               | 6                                               | 1                                               | 2                                               | 1                                               | 2                                               | 1                                               | 1                                               | 32                                              |

* The total possible number of points for each problem is shown.  ** A Advanced (working above grade level) 29–32 points (90–100% correct)  P Proficient (working at grade level) 24–28 points (75–89% correct)  B Basic (working toward grade level) 17–23 points (53–74% correct)  N Novice (working below grade level) 16 points or fewer (64% or less correct)
Activity 1

Bowling for Equations

Overview
The teacher introduces Roll-a-Fact, a game that provides opportunities to write and solve equations, as well as contexts for learning about the conventions of order of operations. To play the game, teams take turns to roll three dice (numbered 1 – 6) and make as many numbers from 1 to 10 as possible by adding, subtracting, multiplying, or dividing the numbers showing on the dice.

Skills & Concepts
★ write and solve equations with (=) to show equivalence
★ model, explain, and solve open number sentences involving addition, subtraction, multiplication, and division
★ use the order of operations to evaluate, simplify, and compare mathematical expressions involving the four operations, parentheses, and the symbols <, >, and =

You’ll need
★ The Roll-A-Fact Game (page B1.5, run one copy on a transparency)
★ 3 dice (numbered 1 – 6) for each group of 4 students
★ Student Math Journals or notebook paper
★ helper jar containing a popsicle stick for each child with his/her name on it
★ a timer

Advance Preparation Draw 10 circles on the board and number them from 1–10 as shown below.

Instructions for Bowling for Equations
1. Ask students if any of them have ever gone bowling. If so, what do they know about the game? After a few volunteers have shared, explain that in bowling, the objective is to knock down 10 pins with one or two rolls of a bowling ball. If you knock down all 10 pins with one roll, it's called a strike. If you knock them all down with two rolls, it's called a spare.

2. Now explain that you are going to play a new game called Roll-a-Fact today. This game is similar to bowling, except instead of rolling a ball, the class will roll 3 dice and knock down numbered pins by adding, subtracting, multiplying or dividing the numbers rolled to make 1 through 10. Each number rolled must be used exactly once on one side of an equation.

3. Work through an example together so students understand how to play the game. Draw their attention to the “bowling pins” you have drawn on the board. Rather than rolling the dice, ask students to pretend that the numbers that came up were 3, 4, and 6. Write these numbers on the board. Then work with input from the class to knock over the 7 pin by devising an equation that uses 3, 4, and 6 to make 7. Accept ideas for knocking over other pins as well during this initial discussion.
Bowling for Equations (cont.)

Teacher  Let's see if we can knock over the 7 pin in our bowling alley up here on the board. How can we use the 3, 4 and 6 to make 7? We can add, subtract, multiply or divide the numbers, but we have to use all 3 of them, and the answer has to be 7.

Maria  3 + 4 makes 7.

Teacher  That's true, but we have to use all 3 numbers. Raise your hand when you have an idea.

Donald  You could do 4 – 3 = 7 – 6. That works, because it's 1 = 1.

Teacher  Yep, but you have to combine all three of the numbers to make 7.

Students  Oh, I see a way! You can get 7 if you add 6 plus 4 and then take away 3. I have another idea. You could go 4 × 6 and then divide by 3. No wait, that's 8.

4. Record students' ideas on the board, and cross out each pin they knock down. Reinforce the meaning of the equals sign by writing the pin number on the right or the left side of each equation. If a student announces she has found a way to make 7, place the 7 on the left-hand side of the equation (e.g., 7 = 6 + 4 – 3). If another shares that 4 + 3 – 6 is 1, place the 1 on the right-hand side of the equation.

5. After you have recorded 3 or 4 equations, ask students to work on their own in their math journal or on a piece of notebook paper to see if they can devise a way to knock over any of the other pins. Although the roll 3, 4, 6 isn't a strike, it is possible to make 1, 2, 3, 5, 6, and 8 with these three numbers. Chances are, ideas for 1, 2, 3, and 8 will emerge first. If no one volunteers ways to knock over any of the other pins, let students know that it is possible to knock over 5 and 6. Can they figure out how? Let them wrestle with the problem for another minute or so, and then continue the discussion. Both numbers will provide an opportunity to open a discussion about the use of parentheses in writing equations. Students may come up with the equation 6 – 4 + 3 as a way to make 5, for instance, but what about 6 – (4 – 3)?

Teacher  Did anyone come up with a way to make 5? What about 6?

Students  I found a way to make 5, if you go 6 – 4 + 3, because 6 – 4 is 2 and then add 3. And for 6, you can go 3 × 4 – 6, because 3 × 4 is 12, and you get 6 if you take 6 away.

Teacher  Let's write your equations up here. Did anyone find a different way to make 5 or 6? No? I have an idea I'd like to share for 5. I'll write it up here on the board: 5 = 6 – (4 – 3).

Students  I respectfully disagree, Mrs. Dietz. I think 6 – 4 – 3 is impossible. 6 – 4 is 2, and you can't take 3 away from 2.

You can if you use negative numbers! 6 – 4 – 3 is negative 1!

But there's something with those parenthesis marks. Why did you put them there, Mrs. D?

Teacher  Those parentheses are a way to signal that you need to do that operation first. What happens if you do 4 – 3 first, and then subtract that answer from 6?

Students  4 – 3 is 1, and 6 – 1 is 5.

Oh yeah, it does work.

Hey, that gives me a new idea for 6. You can go 6 ÷ 4 – 3, but you have to put parentheses around the 4 – 3.
6. Record any additional ideas that have come out of the discussion. When there is general agreement that only pins 1, 2, 3, 5, 6, and 8 can be knocked down with a roll of 3, 4, 6, remind students that they can still get a spare if they can knock down the rest of the pins with a second roll. Ask them to pretend that the second roll was 3, 3, and 4. Write these numbers on the board, and give students a minute to work. Record their ideas on the board.

7. Now display the Roll-A-Fact Game sheet and review the rules at the top together. Explain that you will play as Team 1, while the students work together as Team 2. Let them know that after both teams have rolled, you will set the timer for 3 minutes. When it rings, you and the students will take turns writing equations on the game sheet. Tell them that you will choose names out of the helper jar to share, so everyone will need to be prepared. Give them a choice of working alone or in pairs, and ask them to record their work in their journal or on the backside of the paper they have been using.

8. Roll the dice and record your numbers on the game sheet. Call on a student to do the same for the class. Set your timer for 3 minutes and go to work as students do the same. When the timer sounds, record one of your equations and cross out the pin you just knocked down. Then pull a name from the helper jar and ask the student to come up, record an equation for the class, and cross out the corresponding pin. Take turns back and forth. When you enter your equations, reinforce the fact that we generally work from left to right, but we can use parentheses to show that we need to do something else first.
**Bowling for Equations** (cont.)

**PJ** How come you used parentheses on that last equation, Mrs. Dietz? I don't think you need them there.

**Teacher** That's a good question, PJ. It doesn't seem like I'd need them because 4 - 3 is 1, and 1 × 2 is 2. We'll talk more about this tomorrow, but here's the deal. Even though we usually work equations from left to right, mathematicians have agreed to always do the multiplication or division first. Let me write the equation without any parentheses: 4 - 3 × 2. If I did the multiplication first, what would I get for an answer?

**Students** 3 × 2 is 6.
Then it would be 4 – 6. That's impossible.
No it isn't! It's negative 2, but there's no bowling pin for that one!

**Teacher** So with this equation, I need to use parentheses to show that I need to subtract first and then multiply.

9. Continue until neither team has any more equations to share. If one or both teams got a strike, you'll have a winner or a tie. If neither team got a strike, roll the dice again, and have a student do so for the class. Then repeat step 7 to see if either can get a spare. If neither team gets a spare, the team that knocked down the most pins wins.

**Extensions**

- Have students play a doubles version of Roll-a-Fact, 2 students against 2 students. Place the game sheet on display so they can see the rules, and have students draw the pins in their journal or on a piece of notebook paper. Each group of 4 will also need 3 dice numbered 1-6.
- Once students are familiar with the game, encourage them to develop variations. What happens if you use 2 dice numbered 1-6 and 1 die numbered 4-9? What happens if all 3 dice are numbered 4-9? The numbers on the pins can be changed as well, and even the number of pins themselves. What about Super Roll-a-Fact, with 15 pins numbered 1-15 and 3 or 4 dice? What about letting some of the pins be negative (e.g., -4, -3, -2, -1, 0, 1, 2, 3, 4, 5)? These are only some of the many possible variations students might explore.
- Roll-a-Fact provides a good context for investigating probability and combinatorics. For instance, given 3 dice numbered 1-6, how many different rolls are there? Which of these rolls produce a strike with a set of pins numbered 1-10? What is the probability of rolling a strike? What is the worst possible roll? Is there more than one “worst roll”? Any of these questions might lead to a full-fledged investigation by an interested individual or group. Results and new discoveries could then be shared with the rest of the class, or written up for inclusion on a class or school web site.
- NCTM’s Illuminations web site features an online game called Krypto that is very similar to Roll-a-Fact. To access Krypto, go to http://illuminations.nctm.org/ and click into the Activities section, where you can find the game quickly by typing the name into the Advanced Options search field. You might share this link with interested students and their families.
Roll-A-Fact

Game Rules:
• Roll 3 dice numbered 1–6. Record the numbers you get.
• Add, subtract, multiply, or divide the 3 numbers to make as many numbers from 1–10 as possible.
• You must use all 3 numbers exactly once on one side of each equation.
• Strike beats a spare. If neither team gets a strike or a spare, the team that knocks down the most pins wins.

Team 1
1st Roll: __, __, ___
2nd Roll: __, __, ___

Team 2
1st Roll: __, __, ___
2nd Roll: __, __, ___
Variables & Expressions

Overview
This activity provides a formal introduction to variables and expressions. Students learn that an expression is a very short way to describe an amount. Expressions can be a number, a variable, or a combination of numbers, variables and/or operations. Students work together as a group, and then individually, to write and evaluate expressions about simple situations.

Skills & Concepts
★ model, explain, and evaluate expressions involving addition, subtraction, multiplication, and division
★ use the order of operations to evaluate, simplify, and compare mathematical expressions involving the four operations, parentheses, and the symbols <, >, and =
★ recognize that a symbol represents the same number throughout an equation or expression (e.g., ∆ + ∆ = 8; thus, ∆ = 4)
★ use real-world situations involving multiplication or division to represent number sentences
★ use number sense, properties of multiplication, and the relationship between multiplication and division to find values for the unknowns that make the number sentences true

Instructions for Variables & Expressions
1. Let students know that they are going to do some work with expressions and variables today. Write the word expression on the board. Read it with the class and ask if anyone has heard or read the word before. If so, do they know its meaning? We often use the word expression in connection with feelings. We might give our mother a flower as an expression of love; we might show a surprised expression when we receive a gift, or an angry expression when something makes us mad. Just as a facial expression can be a very short way to show a complex emotion, a mathematical expression is a very short way to show an amount.

You’ll need
★ Variables & Expressions (page B1.17, run one copy on a transparency)
★ More Variables & Expressions (pages B1.18 & B1.19, run a class set)
★ a piece of paper to mask portions of the display master
★ Student Math Journals or notebook paper
★ overhead base ten pieces
★ 3 bags of base ten units, 40 in each bag
★ access to dice numbered 1–6
2. Illustrate this idea by placing a collection of base ten pieces on display: 3 strips and 6 units. Ask students to describe what they see. Record each expression as it is volunteered.

Teacher Please raise your hand if you have a way to describe this collection of base ten pieces. I’ll write your ideas up here on the board.

Students It’s 36.
It’s 3 tens and 6 ones, or you could go 30 + 6
You could write 3 × 10 + 6.

Teacher Okay, any other ideas? What are some other ways to describe this collection?

Students You could do 10 + 10 + 10 + 6.
I know! It’s 36 so you could say 6 × 6.
72 – 36 would work too.

3. Let students know that each of the descriptions they have offered is a mathematical expression—a very short way to describe an amount. Now hold up one of the bags of base ten units, but do not tell students how many are in the bag. What expression might they use to describe the quantity in the bag?

Students But we don’t know how many are in there!
There’s no way we can tell about how many if we don’t know the number.
Let’s count them!

Teacher When we don’t know what the number is, we can use a letter to represent the quantity instead. How about if we use the letter b to stand for the bag of units?

4. Hold up the quantities of base ten pieces listed below and work with students to devise an expression for each. Record the expressions on the board.

- 1 bag of base ten units and 3 extra units
- 2 bags of base ten units (assure students that each bag contains exactly the same number of units)
- 3 bags of base ten units and 5 extra units

<table>
<thead>
<tr>
<th>Expression</th>
<th>Bag of units</th>
</tr>
</thead>
<tbody>
<tr>
<td>36</td>
<td>b</td>
</tr>
<tr>
<td>3 x 10 + 6</td>
<td>b + 3</td>
</tr>
<tr>
<td>30 + 6</td>
<td>2 x b or 2b</td>
</tr>
<tr>
<td>10 x 10 + 10 + 6</td>
<td>3b + 5</td>
</tr>
<tr>
<td>6 x 6</td>
<td>5 x b</td>
</tr>
<tr>
<td>72 – 36</td>
<td>2b</td>
</tr>
</tbody>
</table>

An expression is a very short way to describe an amount.
5. Ask students to get out their math journals or notebook paper as you place Variables & Expressions on display with just the top section showing. Reveal the text one line or section at a time as you read and discuss it with the class.

Variables & Expressions

In mathematics, an expression names an amount.

- Sometimes, an expression is a number, like 14.
- Sometimes, an expression is a variable, like \( x \) or \( y \) or \( \text{c} \).
- Sometimes an expression includes numbers, operations, and/or variables.

**example** James got a small bag of fish crackers in his lunch today. He gave 6 of the crackers to his friend. We can use the expression \( c - 6 \) to show how many crackers James had left. (We use the letter \( c \) to stand for the number of crackers because we don’t know how many crackers are in the bag.)

1. Write an expression to represent each of these situations:

<table>
<thead>
<tr>
<th>Situation</th>
<th>Expression</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Ashley had a full bag of fish crackers. Her sister gave her 3 more fish crackers.</td>
<td>( c + 3 )</td>
</tr>
<tr>
<td>b. Jason had a full bag of fish crackers. He gave 4 of them to his little brother.</td>
<td>( c - 4 )</td>
</tr>
<tr>
<td>c. There are 5 little bags of fish crackers in the cupboard. Each bag has exactly the same number of crackers.</td>
<td>( 5c )</td>
</tr>
<tr>
<td>d. Haley got a little bag of fish crackers in her lunchbox. She poured out the crackers and divided them evenly with her friend.</td>
<td>( c/2 )</td>
</tr>
</tbody>
</table>

2. There are exactly 42 fish crackers in every bag. Use that information to evaluate each expression above and find the answer.

**example** James had \( c - 6 \) crackers. Now we know \( c = 42 \), so we can write:

\[
42 - 6 = 36\text{ crackers, James had 36 crackers left.}
\]

Have students record a response in their journal to each problem as it is displayed. Then call on volunteers to share and explain their thinking.

**Teacher** Who would like to share the expression they wrote for our first situation. Jeffrey?

**Jeffrey** The girl has 1 bag of crackers and 3 more, so I wrote \( c + 3 \) for that one.

6. When you have worked through the sheet together, give students each a copy of More Variables & Expressions. Review both sheets with the class. When students understand what to do, have them go to work individually or in pairs. Circulate to provide help as needed, or pull a small group to provide extra support.
### Variables & Expressions (cont.)

**Set B1 Algebra: Equations & Operations Blackline Run a class set**

**NAME**

**DATE**

**More Variables & Expressions page 1 of 2**

1. One of the prizes kids can win at the school carnival is a bag of stickers. Each bag has exactly the same number of stickers. Draw a line from each of the situations to the matching expression.

**Situation**

Alicia won a bag of stickers. Her friend gave Alicia 6 more stickers.

- **Expression**
  - $4 \times b$ or $4b$

Corey won 4 bags of stickers.

- **Expression**
  - $2b + 12$

Neena won a bag of stickers. There was a hole in the bag and she lost 9 of the stickers.

- **Expression**
  - $b - 9$

Andre won a bag of stickers. When he got home, he divided the bag of stickers evenly among his 3 cousins.

- **Expression**
  - $\frac{b}{3}$

Raven won 2 bags of stickers. Her friend gave her 12 more stickers.

- **Expression**
  - $b + 3$

2. There are exactly 27 stickers in every bag. Use that information to evaluate each expression above and find the answer.

**Example**

- Alicia had $b + 6$ stickers. Now we know $b = 27$, so we can write

  $27 + 6 = 33$ stickers. Alicia had 33 stickers in all.

3. Tyrone won 3 bags of stickers. He lost 15 of the stickers on the way home. Which expression shows how many stickers Tyrone had when he got home?

- **Expression**
  - $3b + 15$
  - $3b$
  - $3b - 15$
  - $b - 15$

4. Evaluate the expression you just chose. Exactly how many stickers did Tyrone have when he got home? Show your work.

5. To evaluate an expression, you have to replace the variable with a number so you can find the answer. Evaluate each of the expressions below.

<table>
<thead>
<tr>
<th>Expression</th>
<th>Evaluate if $x = 12$</th>
<th>Evaluate if $x = 60$</th>
<th>Evaluate if $x = 100$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$x + 5$</td>
<td>$12 + 5 = 17$</td>
<td>$60 + 5 = 65$</td>
<td>$100 + 5 = 105$</td>
</tr>
<tr>
<td>$x - 8$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$x + 3$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$3x + 5$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$(x + 2) + 4$</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

6. Write a situation to match each of the expressions below. The variable $b$ stands for bag, but you can choose whatever you want to put in the bag.

<table>
<thead>
<tr>
<th>Expression</th>
<th>Situation</th>
</tr>
</thead>
<tbody>
<tr>
<td>$b - 3$</td>
<td>I got a bag of carrots. I gave 3 of the carrots to my friend, Max.</td>
</tr>
<tr>
<td>$25 + b$</td>
<td></td>
</tr>
<tr>
<td>$2b$</td>
<td></td>
</tr>
<tr>
<td>$b - 2$</td>
<td></td>
</tr>
<tr>
<td>$b + 43$</td>
<td></td>
</tr>
</tbody>
</table>

**CHALLENGE**

- $3b - 10$
- $(6b + 2) + 4$
- $(14b + 3) - 12$

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**More Variables & Expressions page 2 of 2**

7. As students finish the assignment, ask them to check their work with at least one other person in class. Challenge them to resolve any differences in their answers by talking with each other and consulting a third student if necessary.

8. Ask students who finish and check their work before the end of the period to continue or start a new game of Roll-a-Fact in their math journals or on a piece of notebook paper. You might also check the extension ideas on page B1.4 and B1.9 for more activity options to offer early finishers.

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**INDEPENDENT WORKSHEET**

Use Set B1 Independent Worksheet 2 to provide students with more practice writing and evaluating expressions.
Variables & Expressions

In mathematics, an **expression** names an amount.
- Sometimes, an expression is a number, like 14.
- Sometimes, an expression is a variable, like \( n \) or \( x \) or \( 5 \).
- Sometimes an expression includes numbers, operations, and/or variables.

**example**  James got a small bag of fish crackers in his lunch today. He gave 6 of the crackers to his friend. We can use the expression

\[ c - 6 \]

to show how many crackers James had left. (We use the letter \( c \) to stand for the number of crackers because we don't know how many crackers are in the bag.)

1 Write an expression to represent each of these situations:

<table>
<thead>
<tr>
<th>Situation</th>
<th>Expression</th>
</tr>
</thead>
<tbody>
<tr>
<td>a  Ashley had a full bag of fish crackers. Her sister gave her 3 more fish crackers.</td>
<td></td>
</tr>
<tr>
<td>b  Jason had a full bag of fish crackers. He gave 4 of them to his little brother.</td>
<td></td>
</tr>
<tr>
<td>c  There are 5 little bags of fish crackers in the cupboard. Each bag has exactly the same number of crackers.</td>
<td></td>
</tr>
<tr>
<td>d  Haley got a little bag of fish crackers in her lunchbox. She poured out the crackers and divided them evenly with her friend.</td>
<td></td>
</tr>
</tbody>
</table>

2 There are exactly 42 fish crackers in every bag. Use that information to evaluate each expression above and find the answer.

**example**  James had \( c - 6 \) crackers. Now we know \( c = 42 \), so we can write:

\[ 42 - 6 = 36 \text{ crackers}, \text{James had 36 crackers left.} \]
More Variables & Expressions page 1 of 2

1 One of the prizes kids can win at the school carnival is a bag of stickers. Each bag has exactly the same number of stickers. Draw a line from each of the situations to the matching expression.

<table>
<thead>
<tr>
<th>Situation</th>
<th>Expression</th>
</tr>
</thead>
<tbody>
<tr>
<td>ex Alicia won a bag of stickers. Her friend gave Alicia 6 more stickers.</td>
<td>$4 \times b$ or $4b$</td>
</tr>
<tr>
<td>a Corey won 4 bags of stickers.</td>
<td>$b + 6$</td>
</tr>
<tr>
<td>b Neena won a bag of stickers. There was a hole in the bag and she lost 9 of the stickers.</td>
<td>$2b + 12$</td>
</tr>
<tr>
<td>c Andre won a bag of stickers. When he got home, he divided the bag of stickers evenly among his 3 cousins.</td>
<td>$b - 9$</td>
</tr>
<tr>
<td>d Raven won 2 bags of stickers. Her friend gave her 12 more stickers.</td>
<td>$b \div 3$</td>
</tr>
</tbody>
</table>

2 There are exactly 27 stickers in every bag. Use that information to evaluate each expression above and find the answer.

example Alicia had $b + 6$ stickers. Now we know $b = 27$, so we can write $27 + 6 = 33$ stickers. Alicia had 33 stickers in all.

| a | Corey won ____ stickers in all. |
| b | Neena had ____ stickers left. |
| c | Each of Andre's cousins got ____ stickers. |
| d | Raven had ____ stickers in all. |

3 Tyrone won 3 bags of stickers. He lost 15 of the stickers on the way home. Which expression shows how many stickers Tyrone had when he got home?

- $3b + 15$
- $3b$
- $3b - 15$
- $b - 15$

4 Evaluate the expression you just chose. Exactly how many stickers did Tyron have when he got home? Show your work.
More Variables & Expressions page 2 of 2

5 To evaluate an expression, you have to replace the variable with a number so you can find the answer. Evaluate each of the expressions below.

<table>
<thead>
<tr>
<th>Expression</th>
<th>Evaluate if $x = 12$</th>
<th>Evaluate if $x = 60$</th>
<th>Evaluate if $x = 120$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$ex \ x + 5$</td>
<td>$12 + 5 = 17$</td>
<td>$60 + 5 = 65$</td>
<td>$120 + 5 = 125$</td>
</tr>
<tr>
<td>$a \ 4x$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$b \ x - 8$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$c \ x ÷ 3$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$d \ 3x + 5$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$e \ (x ÷ 2) + 4$</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

6 Write a situation to match each of the expressions below. The variable $b$ stands for bag, but you can choose whatever you want to put in the bag.

<table>
<thead>
<tr>
<th>Expression</th>
<th>Situation</th>
</tr>
</thead>
<tbody>
<tr>
<td>$ex \ b - 3$</td>
<td>I got a bag of carrots. I gave 3 of the carrots to my friend, Max.</td>
</tr>
<tr>
<td>$a \ 25 + b$</td>
<td></td>
</tr>
<tr>
<td>$b \ 2b$</td>
<td></td>
</tr>
<tr>
<td>$c \ b ÷ 2$</td>
<td></td>
</tr>
<tr>
<td>$d \ b + 43$</td>
<td></td>
</tr>
</tbody>
</table>

CHALLENGE

<table>
<thead>
<tr>
<th>Expression</th>
<th>Situation</th>
</tr>
</thead>
<tbody>
<tr>
<td>$e \ 3b - 10$</td>
<td></td>
</tr>
<tr>
<td>$f \ (6b ÷ 2) + 4$</td>
<td></td>
</tr>
<tr>
<td>$g \ (18b ÷ 3) - 12$</td>
<td></td>
</tr>
</tbody>
</table>
Set B1 ★ Independent Worksheet 2

**Expressions, Variables & Situations**

1. To evaluate an expression, you have to replace the variable with a number so you can find the answer. Evaluate each of the expressions below.

<table>
<thead>
<tr>
<th>Expression</th>
<th>Evaluate if ( x = 8 )</th>
<th>Evaluate if ( x = 24 )</th>
<th>Evaluate if ( x = 400 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( 3x )</td>
<td>( 3 \times 8 = 24 )</td>
<td>( 3 \times 24 = 72 )</td>
<td>( 3 \times 400 = 1200 )</td>
</tr>
<tr>
<td>( 4x )</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( x - 8 )</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( x ÷ 4 )</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( 2x + 5 )</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( (x ÷ 2) + 29 )</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2. Mr. Brown got 3 boxes of envelopes. He gave 4 of the envelopes to his son. Which expression shows how many envelopes Mr. Brown has left?

- \( 3b \times 4 \)
- \( 3b + 4 \)
- \( 3b ÷ 4 \)
- \( 3b - 4 \)

3. Eloise and Dylan are picking cherries. So far, they have picked 5 boxes of cherries, and Dylan has 2 more cherries in his hand. Which expression shows how many cherries Eloise and Dylan have picked?

- \( 2b + 5 \)
- \( 5b + 2 \)
- \( 2 \times 5b \)
- \( 7b \)

4. Write a situation to match each of the expressions below. The variable \( b \) stands for box, but you can choose whatever you want to put in the box.

<table>
<thead>
<tr>
<th>Expression</th>
<th>Situation</th>
</tr>
</thead>
<tbody>
<tr>
<td>( b ÷ 2 )</td>
<td>Kara got a box of jellybeans. She divided the jellybeans evenly with her sister.</td>
</tr>
<tr>
<td>( 19 + b )</td>
<td></td>
</tr>
<tr>
<td>( 2b )</td>
<td></td>
</tr>
<tr>
<td>( b + 12 )</td>
<td></td>
</tr>
</tbody>
</table>
Set B1 ★ Activity 4

Writing & Solving Equations

Overview
Students determine whether pairs of expressions are equal. Then they practice solving equations and writing and solving equations to go with story situations. Finally, they play a new game in which they solve a series of equations.

Skills & Concepts
- write and solve equations with (=) to show equivalence
- use real-world situations involving multiplication or division to represent number sentences
- use number sense, properties of multiplication, and the relationship between multiplication and division to find values for the unknowns that make the number sentences true
- model, explain, and evaluate expressions involving addition, subtraction, multiplication, and division
- use the order of operations to evaluate, simplify, and compare mathematical expressions involving the four operations, parentheses, and the symbols <, >, and =
- recognize that a symbol represents the same number throughout an equation or expression (e.g., \( \Delta + \Delta = 8 \); thus, \( \Delta = 4 \))

You’ll need
- Writing & Solving Equations (page B1.26, run one copy on a transparency)
- Algebra Puzzles, Games 1 & 2 (pages B1.27 & B1.28, see Advance Preparation)
- Algebra Puzzles Record Sheet (page B1.29, run a class set)
- overhead spinner overlay
- red and blue overhead pens
- 3” × 3” sticky notes (see Advance Preparation)
- blue and red colored pencils for each student
- a piece of paper to mask portions of the display master
- Student Math Journals or notebook paper

Advance Preparation Run 1 copy each of pages B1.27 and B1.28 on a transparency. Cover each puzzle on both sheets with a sticky note trimmed to 3” × 1” so students will be able to focus more effectively on each set as it is presented. Do not cover the row of shapes at the bottom of each puzzle.

Instructions for Writing & Solving Equations
1. Let students know that they will be writing and solving equations today, as well as learning to play a new game. Ask them to get out their math journals or a piece of notebook paper as you place Writing and Solving Equations on display with all but the top section covered.
2. Read the text at the top of the sheet with the class, and have them copy the first equation. Explain that there are two expressions, one on either side of the equals sign. What are they? Are they actually equal?

**Students** The first expression is 2 + 5, but there's only a 7 on the other side.
But remember? An expression can be just a number, so the 7 is the other expression.
2 + 5 definitely equals 7.

3. Repeat this process with each of the other equations at the top of the sheet. As students copy each, ask them to circle the two expressions and determine whether or not they are equal. The third equation will present an opportunity to discuss order of operations and to introduce the inequality sign.

**Students** On that third one, I don't think it's equal on both sides.
Yes it is! 1 + 6 is 7, then multiply 7 × 5, and you get 35.
But remember? You have to do multiplication and division first, so it's really 6 × 5 is 30, then add 1.
The real answer is 31, not 35.
We could put parentheses around the 1 + 6. Then it would be right.

**Teacher** If we leave the two expressions exactly the way they are now, are they equal?

**Jasmin** No! You have to follow the rules, so the answer is 31, not 35.

**Teacher** Mathematicians actually have a symbol to show that two expressions are not equal. It is called an inequality sign, and it looks like this: ≠.

**DJ** Cool! It's just an equals sign with a slash through it!

4. Reveal the next section of the display master. Read it with the class, and then ask the students to copy and solve each of the three equations.

To solve an equation, find the value of the variable that will make both expressions equal.

1. Solve each of the equations below:
   4 + r = 14  \( r = \) _____  How did you solve it?
   125 ÷ m = 5  \( m = \) _____  How did you solve it?
   2 × s = 600  \( s = \) _____  How did you solve it?
5. As they finish, have students share their work with the people sitting nearest them. Then call on volunteers to share and explain their answers.

**Students**  
I got 10 for the first one, because I know that 4 + 10 is 14.  
That next one was hard, but then I thought, okay 5 × 20 is 100, so it must be more than that. I tried 25 and it worked.  
I counted by 5s on that one. I got 25, but it took a long time.  
I thought about quarters, like 4 quarters makes a dollar and 1 more would be a dollar and 25 cents. The last one was simple because 6 × 100 makes 600.

6. Now display the problems at the bottom of the sheet, one by one. Work with input from the class to write an equation for each situation. Ask students to record the equation, solve it, and share their thinking before you move to the next problem.

![Equation Examples](image)

7. Transition to the next activity by displaying the top portion of Algebra Puzzles, Game 1 while students put away their journals. Have a helper pass out a copy of the Algebra Puzzles Record Sheet during this time. Review the instructions on the game sheet and decide which team, you or the students, will be blue and which red.

8. Remove the sticky note from the first puzzle. Have students fill in the missing values on their record sheets for Puzzle One: 15, 30, 3, and 200. Then solve the first puzzle as a class, recording on your display master as students do the same on their own record sheets. The solution to each equation will provide the information necessary to solve the next equation. Note with students that the values of the circle and the square have to remain the same throughout Puzzle 1.
Students  We know the circle is 15, and the square is 5.
Oh, I get it! 15 + 5 is 20. Then what times 20 makes 200?
It’s 10! The square has to be 10!

9. When all the equations in Puzzle 1 are solved, and the value of each shape has been recorded in the box below the puzzle, set the spinner overlay on top of the spinner. Make a spin for yourself and invite a student to do the same for the class. (If the class spins the same shape as you did, have them spin again until they land on a different shape.) Use your colored pens to circle the shape spun by each team at the bottom of the Puzzle 1 box as students do the same on their own record sheets. Each team scores the number of points equal to the value of their shape.

10. Repeat steps 8 and 9 for each of the other three puzzles. As you play, reinforce the idea that although the values of the shapes change from one puzzle to the next, they have to remain the same throughout any particular puzzle. Record the value of each shape as it’s determined, both inside the shape itself and in the box at the bottom of the puzzle. By the third or fourth puzzle, students may be ready to work in pairs to solve for all three shapes, sharing their solutions and strategies with the class when they are finished.

11. When all four puzzles have been solved, have students add up the points for each team and record the totals on the game sheet. The team with the highest score wins. Here are the solutions to each of the puzzles for your reference:

Algebra Puzzles, Game 1 Solutions
- Puzzle 1: Circle = 15, Square = 10, Pentagon = 5
- Puzzle 2: Circle = 6, Square = 20, Pentagon = 7
- Puzzle 3: Circle = 5, Square = 25, Pentagon = 4
- Puzzle 4: Circle = 35, Square = 7, Pentagon = 4

Extensions
- When time allows, play the second Algebra Puzzles game with your class. Here are the solutions to each of the puzzles in the second game for your reference:
Algebra Puzzles, Game 2 Solutions

- Puzzle 1: Circle = 12, Square = 27, Pentagon = 10
- Puzzle 2: Circle = 7, Square = 4, Pentagon = 30
- Puzzle 3: Circle = 40, Square = 8, Pentagon = 7
- Puzzle 4: Circle = 4, Square = 18, Pentagon = 2

- Invite interested students to make their own algebra puzzles for classmates to solve.

INDEPENDENT WORKSHEET

Use Set B1 Independent Worksheet 3 to provide students with more practice writing and solving equations.
Writing & Solving Equations

An equation is a mathematical sentence we use to show that two expressions are equal. Look at the examples below. For each equation, identify the two expressions, and decide whether or not they are equal. Remember to use order of operations.

**examples**

\[ 2 + 5 = 7 \]
\[ 3 \times 6 = 29 - 11 \]
\[ 1 + 6 \times 5 = 35 \]
\[ 40 = 3 \times 15 - 5 \]

To solve an equation, find the value of the variable that will make both expressions equal.

1 Solve each of the equations below:

\[ 4 + r = 14 \quad r = \underline{\quad} \] How did you solve it?

\[ 125 \div m = 5 \quad m = \underline{\quad} \] How did you solve it?

\[ z \times 6 = 600 \quad z = \underline{\quad} \] How did you solve it?

To write an equation, think about which two amounts are equal, and write an expression for each amount.

**example** Jake had 34 marbles. He gave some to his brother. Now Jake has 18 marbles. How many marbles did Jake give to his brother?

\[ 34 - m = 18 \]

2 Write and solve an equation for each of the word problems below:

a Amber had 64 beads. She bought some more beads. Now she has 102 beads. How many beads did Amber buy?

b Mr. Smith had 100 pencils. He divided the pencils evenly among all of his students. Each student got 4 pencils. How many students are there in Mr. Smith's class?

c T-shirts are on sale at the mall for $12 each. Jasmin and her mom got shirts for the whole family. Their total was $120. How many shirts did they buy?
Algebra Puzzles, Game 1

Game Rules

1. Copy the numbers in the puzzle onto your own record sheet. Then work together to solve the puzzle and record the value of each shape below the puzzle box.

2. Each team spins for a shape. (Spin again if both teams get the same shape.)

3. Circle the shape at the bottom of the Puzzle 1 box with your team’s color. Your team scores the value of the shape you spun.

4. Repeat steps 1–3 for all four puzzles. Both teams add up their points. The team with the highest score wins.

<table>
<thead>
<tr>
<th>Red Team</th>
<th>Blue Team</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 ○ + 15 = 30</td>
<td>2 4 × ○ = 24</td>
</tr>
<tr>
<td>○ ÷ □ = 3</td>
<td>○ + □ = 26</td>
</tr>
<tr>
<td>(○ + □) × □ = 200</td>
<td>(□ − ○) ÷ □ = 2</td>
</tr>
<tr>
<td>○ = ___ □ = ___ □ = ___</td>
<td>○ = ___ □ = ___ □ = ___</td>
</tr>
<tr>
<td>3 ○ × □ = 15</td>
<td>4 100 − ○ = 65</td>
</tr>
<tr>
<td>□ ÷ ○ = 5</td>
<td>○ ÷ □ = 5</td>
</tr>
<tr>
<td>○ + □ × □ = 105</td>
<td>(○ − □) ÷ □ = 7</td>
</tr>
<tr>
<td>○ = ___ □ = ___ □ = ___</td>
<td>○ = ___ □ = ___ □ = ___</td>
</tr>
</tbody>
</table>

Red Team Total Score _______________ Blue Team Total Score _______________
Algebra Puzzles, Game 2

Game Rules

1. Copy the numbers in the puzzle onto your own record sheet. Then work together to solve the puzzle and record the value of each shape below the puzzle box.

2. Each team spins for a shape. (Spin again if both teams get the same shape)

3. Circle the shape at the bottom of the Puzzle 1 box with your team's color. Your team scores the value of the shape you spun.

4. Repeat steps 1–3 for all four puzzles. Both teams add up their points. The team with the highest score wins.

<table>
<thead>
<tr>
<th>Red Team</th>
<th>Blue Team</th>
</tr>
</thead>
</table>
| 1 〇 + 15 = 27  
(□ - □) × 3 = 45  
□ × 〇 + □ = 147 | 2 14 ÷ 〇 = 2  
〇 × 3 + □ = 25  
□ ÷ (〇 - □) = 10 |
| 〇 =____  □ = ____  □ =____ | 〇 =____  □ = ____  □ =____ |
| 3 〇 - 15 = 25  
〇 ÷ □ = 5  
□ × □ - 〇 = 16 | 4 28 ÷ 〇 = 7  
□ ÷ (〇 + 2) = 3  
(□ + □) ÷ 〇 = 5 |
| 〇 =____  □ = ____  □ =____ | 〇 =____  □ = ____  □ =____ |

Red Team Total Score _____________  
Blue Team Total Score _____________
# Algebra Puzzles Record Sheet

**Game 1**

<table>
<thead>
<tr>
<th>Red Team</th>
<th>Blue Team</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td><strong>1</strong></td>
<td><strong>2</strong></td>
</tr>
<tr>
<td>○ + _____ = _____</td>
<td>_____ × ○ = _____</td>
</tr>
<tr>
<td>○ ÷ __________ = _____</td>
<td>○ ÷ __________ = _____</td>
</tr>
<tr>
<td>(○ + ○) × □ = _____</td>
<td>(□ - □) ÷ ○ = _____</td>
</tr>
<tr>
<td>○ = _____</td>
<td>○ = _____</td>
</tr>
<tr>
<td>□ = _____</td>
<td>□ = _____</td>
</tr>
<tr>
<td>□ = _____</td>
<td>□ = _____</td>
</tr>
</tbody>
</table>

**Game 2**

<table>
<thead>
<tr>
<th>Red Team</th>
<th>Blue Team</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td><strong>1</strong></td>
<td><strong>2</strong></td>
</tr>
<tr>
<td>○ + _____ = _____</td>
<td>_____ ÷ ○ = _____</td>
</tr>
<tr>
<td>(□ - ○) × _____ = _____</td>
<td>○ ÷ __________ = _____</td>
</tr>
<tr>
<td>□ × ○ + □ = _____</td>
<td>(□ - □) ÷ ○ = _____</td>
</tr>
<tr>
<td>○ = _____</td>
<td>○ = _____</td>
</tr>
<tr>
<td>□ = _____</td>
<td>□ = _____</td>
</tr>
<tr>
<td>□ = _____</td>
<td>□ = _____</td>
</tr>
</tbody>
</table>

Red Team Total Score _____________ Blue Team Total Score _____________
Set A10: Numbers & Operations: Multiplying Whole Numbers by Fractions
Activity 1: Multiplying Fractions on the Geoboard ........................................ A10. 1
Ind. Worksheet 1: Pizza Party Planning ..................................................... A10. 17
Activity 2: Quick Sketches & Fraction Arrays ......................................... A10. 9
Ind. Worksheet 2: Brownie Dessert ......................................................... A10. 19
Activity 3: Fraction Word Problems & Arrays ........................................ A10. 13
Ind. Worksheet 3: Multiplying Fractions with Arrays ............................. A10. 21
Ind. Worksheet 4: Company’s Coming! .................................................. A10. 23

Set E2: Data Analysis: Line Plots
Activity 1: Tile Toss Distances ................................................................. E2.1
Activity 2: Endurance Run Results ......................................................... E2.13
Ind. Worksheet 1: Tile Toss Outcomes ................................................... E2.27
Activity 3: Water Consumption ............................................................. E2.19
Ind. Worksheet 2: Rope Climb Results .................................................. E2.29
Set A10 ★ Activity 1

Multiplying Fractions on the Geoboard

Overview
Students re-examine problems from Bridges Unit 6: Session 3, and consider how the relationship between areas on a geoboard might be represented using multiplication. Students then consider additional models on the geoboard in which fractions are multiplied by a whole number.

Skills & Concepts
★ Write an equation showing a fraction $\frac{a}{b}$ as the sum of a number of the unit fraction $\frac{1}{b}$ (CCSS 4.NF.3)
★ Express a fraction as the sum of other fractions with the same denominator in more than one way (CCSS 4.NF.3b)
★ Demonstrate an understanding that a fraction $\frac{a}{b}$ is a multiple of the unit fraction $\frac{1}{b}$ (CCSS 4.NF.4a)
★ Write an equation showing that a fraction $\frac{a}{b}$ is the product of $a \times \frac{1}{b}$ (CCSS 4.NF.4a)
★ Use an area model to multiply a fraction by a whole number (CCSS 4.NF.4b)
★ Explore fraction relationships and operations using a visual model
★ Find equivalent fractions

You'll need
★ Fractions on a Geoboard: Multiplying Fractions, pages A10.5–A10.7 (run a class set.)
★ Geoboards and geobands or Geoboard App (online or iPad) for display
★ Geoboards and geobands for students, optional
★ Paper/pen for use on the display
★ Colored pencils, optional

Note: When you represent the symbolic form for a fraction, please use a horizontal bar.

Instructions for Multiplying Fractions on the Geoboard
1. Distribute copies of Fractions on a Geoboard: Multiplying Fractions and display the top portion. Give students time to build all the regions on their geoboards.

2. Write $C + C = B$ on the whiteboard. Have student pairs discuss if the equation is true. Ask for a volunteer to share. Then ask student pairs to consider using multiplication to show the relationship between regions B and C.
3. After students have had a chance to share observations with a partner, ask for volunteers to share with the class.

   **Teacher** Jesse, where do you see multiplication in the relationship between C and B?

   **Jesse** Well, if two Cs equal B, that’s like saying that $2 \times C = B$.

   **Lauren** And since C is $\frac{1}{8}$, you could write $2 \times \frac{1}{8} = \frac{1}{4}$.

   **Max** I see it as $\frac{1}{4} = 2 \times \frac{1}{8}$

4. Complete information in the first row as students write on their own sheets.

   ![Fraction on a Geoboard]

   **NAME DATE**

   **Set A10 Number & Operations: Multiplying Whole Numbers by Fractions**

   **Blackline Run a class set Fractions on a Geoboard**

   Multiplying Fractions

   In the illustration below, the whole geoboard has an area of 1.

   ![Visual Model]

   Look at the visual models below and think about what you notice about the relationships between the regions on the geoboard. How could you express your observations using multiplication? Explain your thinking in words and record your observations in a multiplication equation.

<table>
<thead>
<tr>
<th>Visual Model</th>
<th>Explanation</th>
<th>Multiplication Equation</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>There are 2 C’s in Part B</td>
<td>$2 \times \frac{1}{8} = \frac{1}{4}$</td>
</tr>
</tbody>
</table>

5. Look at the next visual model. With student input, review ways that the relationship between D and A could be represented with addition. Compile a list of equivalent equations on the board.

   ![Addition on a Geoboard]

   **Teacher** Does anyone know another way we could write $\frac{8}{16}$?

   **Mia** One half. You can see it on the geoboard. 8 is half of 16.
6. Ask students to help you write an explanation such as “There are 8 D’s in section A.” By writing the explanation, students will begin to more explicitly see fraction equations as a sum of the number of a unit fraction.

7. Then ask each student to record one way that relationship between D and A could be expressed using multiplication. Share with partners. Then ask for volunteers to share the multiplication equation.

   **Marin** If $\frac{1}{16} + \frac{1}{16} + \frac{1}{16} + \frac{1}{16} + \frac{1}{16} + \frac{1}{16} + \frac{1}{16} + \frac{1}{16} = \frac{8}{16}$, it’d be a lot easier to write $8 \times \frac{1}{16} = \frac{8}{16}$.

   **Josh** Mine was like Marin’s. But I said that $8 \times \frac{1}{16} = \frac{1}{2}$. 8 is half of 16, like Mia said.

   **Marin** $\frac{8}{16}$ and $\frac{1}{2}$ are the same thing.

   **Cybil** How can $8 \times \frac{1}{16}$ be $\frac{1}{2}$?

   **Teacher** Josh, could you show us on the geoboard?

   **Josh** Sure. Look at the 8 D’s that are shaded in. That makes 8 sixteenths. But the entire part that’s shaded in shows $\frac{1}{2}$ of the whole geoboard. So 8 sixteenths is $\frac{1}{2}$. Or $8 \times \frac{1}{16} = \frac{1}{2}$.

8. Continue having students look at parts in relationship to the entire area of the geoboard. Ask them to write explanations and multiplication equations to represent the shaded portion of the geoboard.

9. As students feel comfortable, encourage them to continue the problems on their own. If they finish the models you’ve created, ask them to solve for an unknown on the challenge problems provided. Reserve time at the end of the session for volunteers to prove their thinking.
Activity 1  Multiplying Fractions on the Geoboard cont.

See Pizza Party Planning on pages A10.17 and A10.18 for more practice with multiplying fractions by a whole number in the context of word problems.
**Fractions on a Geoboard  Multiplying Fractions**

In the illustration below, the whole geoboard has an area of 1.

1. Look at the visual models below and think about what you notice about the relationships between the regions on the geoboard. How could you express your observations using multiplication? Explain your thinking in words and record your observations in a multiplication equation.

<table>
<thead>
<tr>
<th>Visual Model</th>
<th>Explanation</th>
<th>Multiplication Equation</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="a.png" alt="Image" /></td>
<td><img src="a.png" alt="Image" /></td>
<td><img src="a.png" alt="Image" /></td>
</tr>
<tr>
<td><img src="b.png" alt="Image" /></td>
<td><img src="b.png" alt="Image" /></td>
<td><img src="b.png" alt="Image" /></td>
</tr>
<tr>
<td><img src="c.png" alt="Image" /></td>
<td><img src="c.png" alt="Image" /></td>
<td><img src="c.png" alt="Image" /></td>
</tr>
</tbody>
</table>

(continued on next page)
### Fractions on a Geoboard  Multiplying Fractions cont.

<table>
<thead>
<tr>
<th>Visual Model</th>
<th>Explanation</th>
<th>Multiplication Equation</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="d" alt="Diagram" /></td>
<td></td>
<td></td>
</tr>
<tr>
<td><img src="e" alt="Diagram" /></td>
<td></td>
<td></td>
</tr>
<tr>
<td><img src="f" alt="Diagram" /></td>
<td></td>
<td></td>
</tr>
<tr>
<td><img src="g" alt="Diagram" /></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(continued on next page)
### Fractions on a Geoboard

#### Multiplying Fractions cont.

2. Create a sketch that could be used to solve the following unknowns:

<table>
<thead>
<tr>
<th>Problem</th>
<th>Labeled Sketch</th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>a</strong> 3 × ______ = ( \frac{3}{4} )</td>
<td>[Sketch]</td>
<td>[Answer]</td>
</tr>
<tr>
<td><strong>b</strong> 5 × ______ = ( \frac{5}{18} )</td>
<td>[Sketch]</td>
<td>[Answer]</td>
</tr>
<tr>
<td><strong>c</strong> 7 × ______ = ( \frac{7}{8} )</td>
<td>[Sketch]</td>
<td>[Answer]</td>
</tr>
<tr>
<td><strong>d</strong> 2 × ______ = ( \frac{1}{4} )</td>
<td>[Sketch]</td>
<td>[Answer]</td>
</tr>
</tbody>
</table>
Pizza Party Planning

A fourth grade class won a pizza party for contributing the most paper in the recycling contest at school. Medium pizzas were cut into 8 slices and large pizzas were cut into 12 slices.

1 Mariah ate 2 slices of a large pizza. What fraction of the pizza did she eat? Draw a sketch to show your thinking.

2 Carlos said that Mariah ate $\frac{1}{6}$ of a pizza. Explain why you agree or disagree.

3 Mariah's table group seats four students. Each student ate 2 slices of a large pizza. Write a multiplication equation that shows what fraction of a pizza was eaten.
4 Tony ate 3 slices of a medium pizza and his friend Conner ate 4 slices of the same pizza.

a Write two equivalent fractions to tell how much pizza Conner ate.

b Write an equation to show what fraction of the pizza they ate together.

5 Lionel's table group drank $1 \frac{1}{2}$ liters of juice with their pizza. How many milliliters did they drink?
Quick Sketches & Fraction Arrays

Overview
The teacher models how to sketch an array for $\frac{1}{4} \times 3$. Together as a class, students use this quick-sketch method to find the product of $\frac{2}{3} \times 5$. Then, students work independently on 3 more combinations.

Skills & Concepts
★ Write an equation showing a fraction $\frac{a}{b}$ as the sum of a number of the unit fraction $\frac{1}{b}$ (CCSS 4.NF.3)
★ Express a fraction as the sum of other fractions with the same denominator in more than one way (CCSS 4.NF.3b)
★ Write an equation to show a fraction as the sum of other fractions with the same denominator (CCSS 4.NF.3b)
★ Add fractions with like denominators
★ Demonstrate an understanding that a fraction $\frac{a}{b}$ is a multiple of the unit fraction $\frac{1}{b}$ (CCSS 4.NF.4a)
★ Write an equation showing that a fraction $\frac{a}{b}$ is the product of $a \times \frac{1}{b}$ (CCSS 4.NF.4a)
★ Multiply a fraction by a whole number (CCSS 4.NF.4b)

You'll Need
★ Paper for sketching

Note When you represent the symbolic form for a fraction, please use a horizontal bar.

Instructions for Quick Sketches & Fraction Arrays
1. Ask students to imagine the outline of a $\frac{1}{4} \times 3$ array. Following a moment of private think-time, ask a couple of students to describe what they see in their mind’s eye.

   Teacher Yesterday we made rectangular regions on a geoboard to multiply fractions. I wonder if we could make a quick sketch to multiply fractions if we didn’t have a geoboard with us? What would a $\frac{1}{4} \times 3$ array look like? We’ll share after some think-time.

   Devon I see a rectangle with a tiny piece on the side and then a long piece across the top.

   Misty Me, too. The little piece on the side is $\frac{1}{4}$. In my mind I saw the piece on top divided into 3 sections.

   Teacher Let’s draw this model. I’ll make an array just like we did for multiplying 2-digit numbers.

2. Draw a rectangle using the closest whole numbers, $1 \times 3$. Ask students how this could help you to make a $\frac{1}{4} \times 3$ array. With student guidance, split the array into fractional subsections and label the dimensions.

   Teacher When I begin thinking about my rectangle, I’m going to use the closest whole numbers. So if the problem is $\frac{1}{4} \times 3$, I’m going to make a $1 \times 3$ rectangle.
Teacher  Turn to your partner and discuss how I could use this array to help me find \( \frac{1}{4} \times 3 \). Who would like to volunteer an idea?

Jodi  You can just cut the rectangle into fourths.

Teacher  Can you show me what you mean?

Jodi  Sure. (Points on grid.) You can just draw a line to divide the length of your rectangle in half. That shows the two halves or \( \frac{1}{2} \) of 3. Then split each half to make fourths.

Teacher  I'm going to add the lines that Jodi mentioned to our grid. In my drawing, where do you see \( \frac{1}{4} \times 3 \)? Take a moment to tell your partner where you see the \( \frac{1}{4} \times 3 \) array. Who would like to share?

Megan  I see it across the top row. The top row just shows \( \frac{1}{4} \), so you could write \( \frac{1}{4} \) next to the top row.

Teacher  I'm going to erase the 1, label our array with \( \frac{1}{4} \), and shade in the top of my drawing to show the problem we're discussing.

3. Have students pair-share how they see the area pieces to determine the product of \( \frac{1}{4} \times 3 \). Is it the same as \( 3 \times \frac{1}{4} \)? Can they prove it?

Students may notice that they can multiply straight across. Record their thoughts.

Joe  I know you can put any number over 1 and it's still the same number. 3 over 1, that's like just 3. So I put 3 over 1 and multiplied straight across. \( \frac{3}{1} \times \frac{1}{4} = \frac{3}{4} \).

Liz  Hey, that's cool. I wonder if it works every time?

David  You don't even need the 1 under the 3. You can just look at \( 3 \times \frac{1}{4} \) and in your head go \( (3 \times \frac{1}{4}) \).

4. Write another multiplication combination on the board, \( \frac{2}{3} \times 5 \), and repeat the process. This time, begin by having students make and share estimates, first in pairs and then as a class.

Joy  I think the answer is going to be more than one. Like somewhere between 2 \( \frac{1}{2} \) and 4. \( \frac{1}{2} \) of 5 would be 2 \( \frac{1}{2} \) and I know \( \frac{2}{3} \) of 5 is more than that.
5. Ask students to determine the closest whole numbers for $\frac{2}{3}$ and 5. Have students draw a $1 \times 5$ rectangle, divide it into 3 fractional parts, label the drawing, and shade in the area. If students find $\frac{2}{3}$ confusing, you may want to first label each row with $\frac{1}{3}$ or thirds, then erase and label the top two rows with $\frac{2}{3}$.

![Diagram of a 1 x 5 rectangle divided into 3 parts and shaded]

6. Again, have students pair-share to determine the area of $\frac{2}{3} \times 5$. Then work with student input to label the sub-regions, recording the product and one or more equations to show how students figured it out.

- Students may look for groups of fractions that equal 1:

![Diagram showing $\frac{2}{3} \times 5$ with labeled sub-regions and equations]

$$\frac{1}{3} + \frac{2}{3} + \frac{2}{3} + \frac{1}{3} = 3 \frac{1}{3}$$

$$1 + 1 + 1 + \frac{1}{3} = 3 \frac{1}{3}$$

- Students may observe that each column shows $\frac{2}{3}$ of 1 whole:

![Diagram showing $\frac{2}{3} \times 5$ with labeled columns and equations]

$$\frac{1}{3} \times 5 = \frac{5}{3}$$

$$\frac{1}{3} + \frac{2}{3} + \frac{2}{3} + \frac{2}{3} = \frac{10}{3}$$

- They may also notice that $\frac{2}{3} \times 5$ is the same as $\frac{1}{3} \times 10$.

![Diagram showing $\frac{2}{3} \times 5$ with labeled sub-regions and equations]

$$\frac{1}{3} \times 5 = (2 \times 5) \times \frac{1}{3}$$

or

$$10 \times \frac{1}{3}$$

- Or $5 \times \frac{2}{3}$ could be understood as 5 times 2 groups of $\frac{1}{3}$.

$$n \times (\frac{a}{b}) = \frac{(n \times a)}{b}$$

- In this case, $5 \times \frac{2}{3} = \frac{(5 \times 2)}{3}$

7. If students need additional modeling, do another problem together: $4 \times \frac{1}{3}$.

Additional Resource
INDEPENDENT WORKSHEET

See Brownie Dessert on pages A10.19 and A10.20 for more practice with equivalent fractions and word problems.
Brownie Dessert

A fourth grade class earned a brownie dessert party for the highest attendance in one grading period. Smaller pans of brownies were cut into 9 pieces and large pans were cut into 16 pieces.

1 Tori ate 2 pieces of brownie from the smaller pan. What fraction of the brownie did she eat? Draw a sketch to show your thinking.

2 Jorge ate one piece more than Tori. Write two equivalent fractions to show how much Jorge ate.

3 Ford’s table group seats five students. Each student ate 2 pieces from the large brownie pan. Write an equation that shows what fraction of the large brownie pan was eaten.

4 April ate 1 piece from the large pan and her friend Karissa ate 4 slices from the same pan.

a Write two fractions to tell how much of the large brownie pan Karissa ate.

(continued on next page)
b What fraction of the large brownie pan did they eat together?

Frederick had 2 of the brownies from the large pan. His brother said that he ate $\frac{1}{8}$ of the pan of brownies. Explain why you agree or disagree.

In a 12-egg carton, $\frac{1}{6}$ equals 2 eggs. Use the grids below to help you imagine and draw cartons where:

a $\frac{1}{6}$ is 3 eggs

b $\frac{5}{6}$ is 25 eggs

c How did you decide on the sizes of the cartons for a and b?
Set A10 ★ Activity 3

ACTIVITY 3

Fraction Word Problems & Arrays

Overview
Today’s session extends work using array models to multiply a whole number by a fraction. Students sketch, discuss, and solve four story problems.

Skills & Concepts:
★ Write an equation showing a fraction $\frac{a}{b}$ as the sum of a number of the unit fraction $\frac{1}{b}$ (CCSS 4.NF.3)
★ Write an equation to show a fraction as the sum of other fractions with the same denominator (CCSS 4.NF.3b)
★ Add fractions with like denominators
★ Demonstrate an understanding that a fraction $\frac{a}{b}$ is a multiple of the unit fraction $\frac{1}{b}$ (CCSS 4.NF.4a)
★ Write an equation showing that a fraction $\frac{a}{b}$ is the product of $a \times \frac{1}{b}$ (CCSS 4.NF.4a)
★ Multiply a fraction by a whole number (CCSS 4.NF.4b)
★ Solve word problems in which fractions are multiplied by a whole number
★ Use a visual fraction area model to understand multiplication of fractions by a whole number

You’ll need:
★ pens and paper to record on the display
★ Pencil/paper for each student
★ Story Problems: Multiplying Fractions page A10.16, run a class set plus one for display

Note: When you represent the symbolic form for a fraction, please use a horizontal bar.

Instructions for Fraction Word Problems & Arrays
1. Give each student a copy of Story Problems: Multiplying Fractions while you display the same Teacher Master. Read the first problem together, taking time to discuss and record students’ thoughts about what the problem is asking them to do. Pair-share estimates and then ask volunteers to explain their reasoning with the class. Encourage students to consider benchmark fractions.

---

<table>
<thead>
<tr>
<th>Problem</th>
<th>Estimate</th>
<th>Array and Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 The principal hands out ice cream bars and popsicles at field day. The first class finished two bags of ice cream bars. Only $\frac{1}{4}$ of that amount of ice cream bars were needed for the second class. How much ice cream did the second class eat?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Teacher When you estimate, sometimes it’s helpful to think about benchmarks or numbers that are easy to imagine. In this problem I’m wondering if the answer will be closer to zero, one half, or one whole?

Scott It must be close to zero. \( \frac{1}{4} \) of 2 bags has to be a really small number.

Jacque It’s small, but I don’t think it’s that small. \( \frac{1}{4} \) of 1 bag is \( \frac{1}{4} \). So \( \frac{1}{4} \) of 2 bags has to be more. My estimate would be closer to one half.

2. Next, work with the class to sketch an array to represent the problem \( \frac{1}{4} \times 2 \). Ask students to determine the closest whole numbers. Have them draw a \( 1 \times 2 \) rectangle, and coach you to divide it into 4 fractional parts, as they sketch the same model. Label the drawing, and shade in the area.

3. After students have had a chance to sketch the array, work with the class to connect to the original problem. What do the two dimensions represent? What does the area represent? Then ask students to find the area of the array they’ve drawn. Have students pair-share their thoughts before a volunteer shares with the entire class. Record multiplication equations to match student strategies.

Elsie I saw 2 groups of \( \frac{1}{4} \). So I just added \( \frac{1}{4} \) and \( \frac{1}{4} \). That’s \( \frac{2}{4} \).

Jeb I did the same thing. But I said it equals \( \frac{1}{2} \). Because \( \frac{2}{4} \) and \( \frac{1}{2} \) are equivalent.

Sarah I just multiplied. I know that you can put any number over a 1 and it’s still the same number. So I said \( \frac{2}{1} \times \frac{1}{4} \) and just multiplied them across. That’s \( \frac{2}{4} \).

- How are we seeing the area of this rectangle?
  - \( \frac{1}{4} + \frac{1}{4} = \frac{2}{4} \)
  - \( \frac{1}{4} + \frac{1}{4} = \frac{1}{2} \)
  - \( \frac{1}{2} \times 14 = \frac{2}{4} \)

4. With student input, label the area of each rectangle.
Activity 3  Fraction Word Problems & Arrays cont.

5. Repeat this process with the three other problems on the projector as students complete the problems on their own sheets.

INDEPENDENT WORKSHEET

See Multiplying Fractions with Arrays on page A10.21 for more practice with estimating and sketching arrays for multiplying fractions by a whole number.
## Story Problems  Multiplying Fractions

Estimate then draw an array to show your work.

<table>
<thead>
<tr>
<th>Problem</th>
<th>Estimate</th>
<th>Array and Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 The principal hands out ice cream bars and popsicles at field day. The first class finished two bags of ice cream bars. Only $\frac{1}{4}$ of that amount of ice cream bars were needed for the second class. How much ice cream did the second class eat?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 I have 6 dogs. This week each dog gets $\frac{1}{8}$ of a bag of dog treats. How much of the bag is eaten?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 The cookie recipe calls for $\frac{1}{3}$ cup of sugar. I need to make a double batch of cookies. How much sugar do I need?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 If everyone wants a $\frac{1}{4}$ pound hamburger, and we have six people in our family, how many pounds of hamburger do we need?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Multiplying Fractions with Arrays

1. Sketch each array below. Then write a multiplication equation to show how you found the product.

<table>
<thead>
<tr>
<th>Sketch This Array</th>
<th>Equation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>a</strong> $\frac{3}{8} \times 3$</td>
<td></td>
</tr>
<tr>
<td><strong>b</strong> $\frac{2}{6} \times 2$</td>
<td></td>
</tr>
<tr>
<td><strong>c</strong> $\frac{1}{7} \times 5$</td>
<td></td>
</tr>
<tr>
<td><strong>d</strong> $\frac{1}{5} \times 10$</td>
<td></td>
</tr>
</tbody>
</table>

2. Write a story problem to match one of the combinations above.
1 Jamie has three people in her family. For three people, they make a recipe for Cranberry Sauce that calls for the following ingredients:
- 1 (12 ounce) bag of fresh cranberries
- $\frac{3}{4}$ cup orange juice
- $\frac{2}{3}$ cup brown sugar
- $\frac{1}{4}$ cup white sugar

Jamie's grandparents are joining them for dinner. Double Jamie's recipe for Cranberry Sauce. Show your work and the new ingredient list below.

Jamie's aunt, uncle and cousin are now coming for dinner as well. Triple the original recipe. Show your work and the new ingredient list below.
Jamie also needs to plan for the meal. The following portions are for one person. To serve 8, how much of each food is needed? Write an equation to show your thinking.

Note: remember to label the units in your equation.

<table>
<thead>
<tr>
<th>Food</th>
<th>1 Serving</th>
<th>Show Your Work and Write an Equation for 8 Servings</th>
</tr>
</thead>
<tbody>
<tr>
<td>a Vegetables</td>
<td>$\frac{1}{2}$ cup</td>
<td></td>
</tr>
<tr>
<td>b Turkey</td>
<td>3 ounces</td>
<td></td>
</tr>
<tr>
<td>c Gravy</td>
<td>$\frac{1}{4}$ cup</td>
<td></td>
</tr>
<tr>
<td>d Potatoes</td>
<td>$\frac{1}{2}$ cup</td>
<td></td>
</tr>
<tr>
<td>e Stuffing</td>
<td>$\frac{1}{3}$ cup</td>
<td></td>
</tr>
<tr>
<td>f Green Salad</td>
<td>$\frac{3}{4}$ cup</td>
<td></td>
</tr>
<tr>
<td>g Cranberry Sauce</td>
<td>$\frac{1}{4}$ cup</td>
<td></td>
</tr>
<tr>
<td>h Apple Pie</td>
<td>$\frac{1}{8}$ pie</td>
<td></td>
</tr>
</tbody>
</table>
Set E2 ★ Activity 1

Tile Toss Distances

Overview
This is the first day of a three-part Fitness Challenge. Today, students create a line plot from Tile Toss data. Then, they toss tiles onto a stationary target to demonstrate their hand-eye coordination and gather measurement data, to the nearest quarter of an inch. They use the measurement data to construct their own line plots and analyze their results. Finally, they practice their new learning with line plot data.

Skills & Concepts
★ Use the four operations to solve word problems involving distances, including problems involving simple fractions, and problems that require expressing measurements given in a larger unit in terms of a smaller unit.
★ Make a line plot to display a data set of measurements in fractions of a unit (½, ¼, ⅛)
★ Solve problems involving addition and subtraction of fractions by using information presented in line plots.
★ Add and subtract mixed numbers with like denominators, e.g., by replacing each mixed number with an equivalent fraction, and/or by using properties of operations and the relationship between addition and subtraction

You’ll need
★ Fitness Challenge (pages E2.4, 1 copy for display)
★ Target (page E2.5, run a quarter class set and cut apart.)
★ Tile Toss Distances (page E2.6, run 1 copy for display)
★ Your Tile Toss Distances Record Sheet, pages E2.7 and E2.8 run a class set, plus 1 copy for display
★ Tile Challenge Results (E2.9 and E2.10, run a class set plus 1 copy for display)
★ Student Journals or Journal Grid Page (page E2.11, run as needed, optional)
★ colored tile (2 per student)
★ masking tape for a starting line
★ measuring tapes, yard sticks, or rulers (about a fourth of a class set)

Note: Save the Fitness Challenge master for use in Activity 2

Instructions for Tile Toss Distances
1. Open today’s lesson by displaying the Fitness Challenge master. Read the context for the next three sessions as a class. Activate students’ prior knowledge of fitness challenges by asking the following questions: What does it mean to be fit? What is a challenge? What type of fitness challenges do you participate in at our school? What else do you know about fitness challenges?

2. Display the Tile Toss Distances overhead revealing only the top portion. Read the introduction and invite students to think about what they notice about the results.

   Teacher What do the numbers used in the picture represent?
   Lilly The numbers show how far away the tiles are from the target?
   Teacher How could we organize this data?
   John We could use tallies to represent each toss.
Activity 1  Tile Toss Distances (cont.)

Derrick  I agree with John, I notice that if we place the distances in order from least to greatest they
would go from 0 feet to 1 1/2 feet. We are only missing the 1 1/4 foot distance. I think we should use a t-
chart with tallies to represent this data.

Teacher  Tallies and t-chart would work. Sometimes mathematicians display numeric data with line plots.

Shawna  Would a line plot tell us the distances and how many tiles were within that distance?

3. Ask students to get their journals ready for working with Tile Toss Distances. Remind the class that
today they will be recording their values not in inches, but in fractions of a foot. Your students may
want to create a table with equivalent fractions of a foot.

<table>
<thead>
<tr>
<th>foot</th>
<th>inches</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/4 foot</td>
<td>3 inches</td>
</tr>
<tr>
<td>1/2 foot</td>
<td>6 inches</td>
</tr>
<tr>
<td>3/4 foot</td>
<td>9 inches</td>
</tr>
<tr>
<td>1 foot</td>
<td>12 inches</td>
</tr>
</tbody>
</table>

4. Reveal the next portion of the teacher master, dealing with the scale for the line plot. Encourage stu-
dents to consider the least and greatest data points before plotting the scale. Invite a student to come up
and mark the least and greatest data points on the number line and label the points. Then ask students
to pair-share what the scale might be- how does each interval increase? For this example, the data is
rounded to the nearest 1/4 of a foot. Once the range, from 0–1 1/2 feet, has been established, label the line
plot while students do the same in their journals.

Teacher  Should we be marking and labeling of a foot for this data set even though we have no data
for this point?

Sammy  I think we should use it to keep the spacing the same, even if we don’t have a measurement
that goes there.

Teacher  What kind of title could we give to this line plot?

Julie  How about “Tile Toss” for the title?

1 Determine a scale for the line plot by first identifying the range. What’s the
closest and farthest distance? Now, divide the line into equal parts that will ac-
commodate the scale. Create a line plot that has a proper title (including units),
the axis labeled correctly, and the data plotted accurately.

Title  The Toss

<table>
<thead>
<tr>
<th>X</th>
<th>X</th>
<th>X</th>
<th>X</th>
<th>X</th>
<th>X</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Distance</th>
<th>(in feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 1/4</td>
<td></td>
</tr>
</tbody>
</table>

2 What is the difference from the closest tile to the target and the furthest?

3 If you were to line up all of the tile distances, what would the total length be?
5. Have students check each other’s work before you move on to the last two questions. Students should have a title, labels, and the tile toss data recorded. Identify the greatest and least distance in the toss, to determine the difference and answer question 3. Then create equivalent fractions with a denominator of 4, to add each of the distances, to find the total distance in the toss event.

6. Now, students will be participating in the tile toss challenge! Group your class, with about 4–6 students in each group and let them know they will each toss two tiles towards a stationary target. Pass out copies of Your Tile Toss Record Sheet while students tape down the paper target to the floor, and measure a starting line distance from 1 yard away. Brief the students on the rules:
   - students must stand behind the starting line, and not lean over the line, when they make an underhanded toss,
   - every student takes two turns towards the target,
   - no “redo’s” are allowed unless authorized by the teacher.

7. When groups of students have finished tossing their tile, ask them to measure the distances from the target and record their work on the student page. All measurements should be rounded to the nearest $\frac{1}{4}$ of a foot and represented as a fraction. Encourage group members to work collaboratively to answer the questions on the page, including the difference and total length of the tosses. Monitor their work as needed, encouraging students to work precisely and critique the reasoning of others.

8. When most of the groups are finished, gather students and invite them to share their results. During your discussion, focus on the scale of students used for their line plots, the range between the maximum and minimum toss, and their computation, including the concept of mixed numbers and equivalent fractions.

9. Pass out the Tile Challenge Results student page and review the tasks together. This task asks students to work to the nearest $\frac{1}{8}$ of a foot. Give students the option of working on this page independently, in pairs, or with their groups. You may want to choose a few students to work with you, based on their needs.

INDEPENDENT WORKSHEET

Use Set E2 Independent Worksheet 1, Tile Toss Outcomes (page E2.27) for additional practice with line plots.
Fitness Challenge

Your school is participating in a fitness challenge. This test is usually given twice a year, once in the fall and then again in the spring. The challenge is comprised of 2 events: Tile Toss, and Endurance Run

Tile Toss

This activity measures hand-eye coordination. The athlete stands behind the starting line and tosses a tile onto a stationary target. The goal is to land on the outside ring of the target. All tossing is done underhanded. The floor surface will matter. A carpeted floor will provide more friction and slow the tile down; while a tiled floor will allow the tile to bounce and/or slide. Each student is given the opportunity to toss two tiles.

Endurance Run

This activity measures heart/lung endurance. To run the farthest distance, a runner needs to learn proper pacing. Pacing is the average speed you should run to be able to run your best or fastest time.
Target
Tile Toss Distances

Here are the results of 4 students participating in the tile toss challenge. The measurements have been rounded to the nearest of a $\frac{1}{4}$ foot.

1. Determine a scale for the line plot by first identifying the range. What's the closest and farthest distance? Now, divide the line into equal parts that will accommodate the scale. Create a line plot that has a proper title (including units), the axis labeled correctly, and the data plotted accurately.

   Title ________________________________

   _______ _______ _______ _______ _______ _______ _______

   _______________________________(in ________)

2. What is the difference from the closest tile to the target and the furthest?

3. If you were to line up all of the tile distances, what would the total length be?
Your Tile Toss Distances Record Sheet

Each group member will toss 2 tiles towards the target. The goal is to land within or on the target ring. Any tile that lands partially on the ring counts as a hit and should receive a score of 0 feet from the target.

1 Measure the tiles that land outside of the target to the nearest of a foot. Record your group data in the table below.

<table>
<thead>
<tr>
<th>Student Name</th>
<th>Toss Number</th>
<th>Distance from the Target (in fractions/feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Toss # 1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Toss # 2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Toss # 1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Toss # 2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Toss # 1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Toss # 2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Toss # 1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Toss # 2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Toss # 1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Toss # 2</td>
<td></td>
</tr>
</tbody>
</table>

2 What was the tile distance in feet, closest to the target? ____________

3 What was the tile distance in feet, furthest from the target? ____________

4 What is the difference from the closest and furthest distance? Show your work.

The distance is ____________ (Continued on next page.)
Set E2 Data Analysis: Line Plots Blackline  Run a class set.

**Your Tile Toss Distances (cont.)**

5. Determine a scale for the line plot. Then divide the line into equal parts that would support that scale. (Reminder the line plot needs to include the least and greatest data points).

   Title ________________________________________________________________

   __ __ __ __ __ __ __ __ __ __ __ __

___________________________________________________________________

   ________________________________________________________________ (in ____________)

6. Plot the results of the tile toss, placing an X over the correct label for each measurement collected. If a number is repeated, place one X over the other in a vertical column.

7. Record a title for the line plot and include a unit of measurement.

8. Now use your data to answer the following questions:

   a. How many tiles landed on and/or less than $\frac{1}{2}$ of a foot from the target? _______

   b. How many tiles landed further than $\frac{1}{2}$ of a foot from the target? _______

   c. How many tiles are represented in the line plot? _______

   d. What is the combined distance of the group’s tile toss results? Label the unit and show your work.

   The total distance is __________________
Tile Challenge Results

This class participated in the tile toss challenge and measured to the closest $\frac{1}{8}$ of a foot. Complete the missing data and use the line plot below to answer the following questions.

Tile Challenge Results

<table>
<thead>
<tr>
<th>1/8</th>
<th>2/8</th>
<th>3/8</th>
<th></th>
<th>6/8</th>
<th>7/8</th>
<th>8/8</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>___</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

____________________________________________________(in feet)

1. How many tiles are represented on this line plot? _______________

2. How many tiles landed on the target? _______________

3. Did more tiles land on $\frac{7}{8}$ of a foot or $\frac{6}{8}$ of a foot? _______________

4. What is the difference between the furthest and closest tiles to the target? Show your work.

The difference is _______________

(Continued on next page.)
Tile Challenge Results (cont.)

5. What is the total distance of all the tiles added together? Show your work.

The total distance is _______________

CHALLENGE

6. When you place the distances in order from least to greatest, which distance is the middle distance (median) attained by this class? Explain how you know.
Journal Page Grid
Endurance Run Results

Overview
Today, students use color tiles to represent a scale of one-half and one-quarter of a mile. They make a line plot, solve problems involving addition and subtraction of fractions, and add and subtract mixed numbers with like denominators.

Skills & Concepts
★ Use the four operations to solve word problems involving distances, including problems involving simple fractions, and problems that require expressing measurements given in a larger unit in terms of a smaller unit.
★ Make a line plot to display a data set of measurements in fractions of a unit (1⁄4, 1⁄8, 1⁄8)
★ Solve problems involving addition and subtraction of fractions by using information presented in line plots.
★ Add and subtract mixed numbers with like denominators, e.g., by replacing each mixed number with an equivalent fraction, and/or by using properties of operations and the relationship between addition and subtraction

You’ll need
★ Fitness Challenge (page E2.4, saved from Activity 1)
★ Endurance Run Results (page E2.16, run a class set plus 1 copy for display.)
★ More Endurance Run Results (pages E.2.17 and E2.18, run a class set plus 1 copy for display.)
★ color tiles (class set)

Instructions for Endurance Run Results
1. Post the Endurance Run portion of the Fitness Challenge master from Activity 1 and review the description of this event. Let students know that today they will analyze the results of two different classes’ results.

2. Display only the data at the top of the Endurance Run Results master. Ask students to use tile to represent each 1⁄4 of a mile the students completed. For example, if the distance was 3⁄4 of a mile, the students would make a column of 3 tiles. Have students work in groups to represent all 8 of the distances, using this scale (1 tile = 1⁄8 mile) to construct their model. Encourage students to discuss and demonstrate their understanding of fractions in their group. Work through any misconceptions as a class.
3. With the models in front of them, ask students to take turns answering the questions on the display master. Determine the mixed number equal to 7/4. Then instruct the students to devise a method to find the total combined lengths of all the distances. Solicit several strategies for finding the total distance, including a solution that uses an equation.

**Teacher** Which group of students would like to share how they found the total distance this first class ran?

**Sally** Our group decided to line up all the tiles in one long line and then add up the total number to find the total distance of 46 tiles.

**John** I agree that the total is 46 tiles but each of those tiles are worth 1/4 of a mile. The denominator should be 4 and the numerator is 46 for an answer of 46/4 miles.

**Lilly** Our group took John's work one step farther and found that \(46/4 = 11 \frac{1}{2}\) miles.

**Teacher** What would an equation for this problem look like?

**Lilly** We found that we put the tile fraction groups in order from least to greatest and grouped like fractions using parentheses on a scratch piece of paper. So we wrote:

\[
\left(\frac{3}{4} + \frac{3}{4} + \frac{3}{4}\right) + \left(\frac{4}{4} + \frac{4}{4} + \frac{4}{4}\right) + \frac{7}{4} + \frac{8}{4} = \\
\frac{46}{4} = 11 \frac{1}{2}
\]

4. Next display the line plot portion of the master. Ask students to turn to their neighbor and brainstorm a possible title. With student help, record the title and work together to label the x-axis. Finally, determine an appropriate scale and have student help you plot the data points on the line plot.

5. Pass out copies of, the More Endurance Run Results blacklines, and give students a bit of time to share what they notice about the data set. Did this class do better than the previous one at this event? How can they be sure?

6. Invite students to create a model with color tiles to represent each student's results, where each tile is worth 1/2 of a mile. Have students sequence their tile arrangements from least to greatest. Have students work together to fill in the missing numbers and label the line plot on their record sheet.
7. Answer questions two and three as a class and then invite students to record an equation to match the model for question three. Review that in adding or subtracting fractions, a common denominator is useful.

8. Give students an opportunity to work with their neighbors to construct a model and/or equation to show how they would efficiently add the total distances ran by this class. If some groups complete the work quickly, you may want to invite them to take on the challenge problems while they wait for the rest of the class to finish. As students are working, look for a variety of strategies to share with the class.

9. When a majority of students are done, begin the presentations, inviting students to ask questions and compare different explanations. Ask, what is the same or different about the work?

10. If there is time, invite the students who completed the challenge questions to share their solution strategies.
Endurance Run Results

The P.E. teacher recorded the first class’ results in a fraction of a mile. The data below shows how far each of the students ran in 20 minutes.

\[
\begin{array}{ccccccccccc}
\frac{3}{4} & \frac{7}{4} & \frac{4}{4} & \frac{5}{4} & \frac{3}{4} & \frac{4}{4} & \frac{8}{4} & \frac{5}{4} & \frac{3}{4} & \frac{4}{4} \\
\end{array}
\]

1. What is the shortest distance a student ran? ______________

2. What is the longest distance a student ran? ______________

3. What mixed number is the same as \( \frac{7}{4} \) of a mile? ______________

4. What is the total distance these students were able to run in 20 minutes? Show your work.

Students ran __________ miles.

5. Use the data above to create a line plot that has a proper title (including units), the axis labeled correctly, and the data points plotted accurately.

Title ____________________________________________________________

___  ___  ___  ___  ___  ___  ___  ___  ___  ___

________________________________________ (in ________)

© The Math Learning Center
More Endurance Run Results

The P.E. teacher collected data from a second class in the endurance run.

1. Complete the missing labels on the line plot, provide a title, and label the measurement units.

Title: ________________________________

<p>| | | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td></td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2</td>
</tr>
</tbody>
</table>

_____________________________ (in ________)

Use the data above to answer the following questions.

2. How many students ran \( \frac{1}{2} \) of a mile? _____________

3. Which distance did more students complete \( \frac{3}{2} \) or \( \frac{1}{2} \) of a mile? _____________

4. What is the difference between the furthest and least distance run? Show your work.

The difference is _____________

(Continued on next page.)
5 What is the total number of miles run by the second class? Show your work.

The total is _____________

6 The P.E. teacher and the Principal wrote what they thought was the total distance run by this class. Explain why or why not you think each statement makes sense mathematically.

a P.E. Teacher I think $2 \frac{1}{2}$ miles is an outlier and I am going to ignore that number. Therefore, the numbers go from $\frac{1}{2}$ to $1 \frac{1}{2}$ and so I found the answer

$$\frac{1}{2} + \frac{1}{2} + \frac{1}{2} + \frac{2}{2} + \frac{2}{2} + \frac{3}{2} + \frac{3}{2} = \frac{17}{2} = 8 \frac{1}{2} \text{ miles}$$

Agree or Disagree? ___________________________
Why?

b Principal I calculated the following way to find the total distance.

$$\frac{1}{2} + \frac{1}{2} + \frac{1}{2} + \frac{2}{2} + \frac{2}{2} + \frac{3}{2} + \frac{5}{2} = \frac{21}{2} = 10 \frac{1}{2} \text{ miles}$$

Agree or Disagree? ___________________________
Why?

7 Convert each quarter mile into yards and feet.

<table>
<thead>
<tr>
<th>Miles</th>
<th>$\frac{1}{4}$</th>
<th>$\frac{2}{4} = \frac{1}{2}$</th>
<th>$\frac{3}{4}$</th>
<th>$\frac{4}{4} = 1$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yards</td>
<td>440</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Feet</td>
<td></td>
<td></td>
<td></td>
<td>5,280</td>
</tr>
</tbody>
</table>
Tile Toss Outcomes

Another class participated in the tile toss challenge and had the following outcomes.

1  \( \frac{3}{4} \)  \( \frac{1}{4} \)  \( \frac{1}{4} \)  \( \frac{3}{4} \)  \( \frac{1}{4} \)  \( \frac{1}{2} \)  \( \frac{1}{4} \)  \( \frac{3}{4} \)  \( \frac{1}{4} \)  

1. Use the data above to complete the line plot, including a title and unit of measure.

   Title ________________________________________________________________

   0  \( \frac{1}{4} \)  \( \frac{1}{2} \)  \( \frac{3}{4} \)  1  \( \frac{1}{4} \)  \( \frac{1}{2} \)  \( 1 \frac{3}{4} \)  2

   ___________________________________ (in _________)

2. Answer the following questions.
   
   a. How many tiles were tossed in this group? ______________________  
   
   b. How many tiles landed of a foot away from the target? ________________  

(Continued on next page.)
Tile Toss Outcomes (cont.)

C  Did more tiles land less than 1 foot away or more than 1 foot away from the target?  
How do you know?

D  What is the difference between the closest tile to the target and the furthest?  
Show your work.

The difference is ____________________
Set E2 ★ Activity 3

Water Consumption

Overview
This is the final day of the Fitness Challenge lesson sequence. Today, students use capacity units (cups, pints and quarts), to create a line plot. They also add and subtract fractions and mixed numbers with like denominators.

Skills & Concepts
★ Know relative sizes of measurement units within one system of units. Record measurement equivalents in a table.
★ Use the four operations to solve word problems involving distances, including problems involving simple fractions, and problems that require expressing measurements given in a larger unit in terms of a smaller unit.
★ Make a line plot to display a data set of measurements in fractions of a unit (1⁄2, 1⁄4, 1⁄8)
★ Solve problems involving addition and subtraction of fractions by using information presented in line plots.
★ Add and subtract mixed numbers with like denominators, by replacing each mixed number with an equivalent fraction, and/or by using properties of operations and the relationship between addition and subtraction
★ Solve word problems involving addition of fractions referring to the same whole and having like denominators, using visual fraction models and equations to represent the problem.

You’ll need
★ Water Consumption (page E2.22, 1 copy for display)
★ Water Consumption Outcome Record Sheet (pages E2.24 and E2.25, run a class set, plus 1 for display)
★ a 1-gallon container, two 1-quart containers, two 1-pint containers, and a 1-cup container (see Advance Preparation)

Advance Preparation
Access the quart and cup containers from the Number Corner materials, and pint and gallon containers from home.

Instructions for Water Consumption
1. Display the top portion of the Water Consumption master and have a student read the introductory paragraph. Ask student pairs to share what information is given in the problem. Students will likely notice the fractions have common denominators and the values are written as improper fractions.
2. Use the data to construct a line plot together. Ask students to consider how they would partition the line, give them time to pair-share and then share as a class.

*Teacher* How are we going to divide this horizontal axis up?

*Debra* We could divide into 4 equal parts because that’s the denominator.

*Kale* But we have to include $\frac{1}{4}$ to $\frac{3}{4}$ because that’s the least and the most.

*Ellery* I always start with marking the whole values of 0 and 1.

*Bryer* This problem has more than one whole, though. Shouldn’t we divide the line into 2 whole equal parts, like Kale suggested, and then label 2 as $\frac{7}{4}$ is close to $6\frac{1}{4}$.

*Ellery* Right, this number line, I mean line plot, should go from 0–2. Then I can divide my sections into 4 equal parts.

3. Ask several students to help you plot the values on the line plot while the rest of the class works to add up the total amount of water consumed by this class. Discuss a possible label for this line plot, including units. Then ask for several students to show how they figured out the total. Some students may begin to use parentheses to separate like values or grouping the numerators in efficient ways.

$$(3 \times \frac{3}{4}) + (2 \times \frac{1}{4}) + \frac{1}{4} + \frac{3}{4} + \frac{3}{4} + \frac{1}{4}$$

$$= 2 \frac{1}{4} + \frac{1}{4} + \frac{3}{4} + \frac{3}{4}$$

$$\frac{40}{4} = 10 \text{ pints of water}$$
**Activity 3  Water Consumption (cont.)**

**Student** “I like to make ten, so I found all the ways I could add up the numerators to make ten…and this time it added up perfectly!”

\[
\left(\frac{4}{10} + \frac{2}{10}\right) + \left(\frac{4}{10} + \frac{6}{10}\right) + \left(\frac{4}{10} + \frac{5}{10}\right) \text{ that equals } 10, 20, 30, 40, \text{ 4} \frac{4}{10} \text{ths.}
\]

4. Record the total in pints and then ask students to turn and talk to a neighbor on how they would convert pints to cups. Choose a few students to share their thinking and record the answer for question three. Ask students to identify the most and least water consumed, and determine the difference, \(\frac{7}{4} - \frac{9}{4} = \frac{7}{4}\).

5. Pass out copies of Water Consumption Outcomes. Read the top half of the directions as a class. Have students turn to a partner and restate what they are being asked to do. Use the capacity containers to complete the equivalence table together and determine the total water consumption in quarts.

6. For question 3 solicit several student solutions for adding up the fractions of a quart.

**Bryer** I lined up the fractions from the least to the greatest, and then added it up.

\[
\frac{1}{4} + \frac{1}{4} + \frac{2}{4} + \frac{1}{4} + \frac{3}{4} + \frac{4}{4} + 1\frac{1}{4} + 1\frac{2}{4} + 1\frac{2}{4} = 3\frac{20}{4}
\]

**Debra** I agree with you Bryer, but I reduced \(\frac{20}{4} = 5\) quarts. I divided 20 by 4. That gave me 5 quarts. I add 3 plus 5 quarts to get 8 quarts.

**Sammy** Our group had done something similar but instead we left all the fractions as fourths and came up with:

\[
\frac{1}{4} + \frac{1}{4} + \frac{2}{4} + \frac{2}{4} + \frac{3}{4} + \frac{4}{4} + \frac{5}{4} + \frac{6}{4} = \frac{32}{4} = 8 \text{ quarts}
\]

7. Once students determine the total number of quarts of water, have them share their thinking for converting 8 quarts to pint units—8 quarts = ? pints?

---

**INDEPENDENT WORKSHEET**

Assign Set E2 Independent Worksheet 2, Rope Climb Results (page E2.29) for more practice with line plots.
Water Consumption

Every student was given a water bottle before they participated in the run. Each water bottle contained 1 pint of water. Students were encouraged to refill their water bottles anytime. The results below show how much water the first class drank.

\[
\begin{align*}
7 & \quad 4 \\
1 & \quad 4 \\
7 & \quad 4 \\
3 & \quad 4 \\
7 & \quad 4 \\
0 & \quad 4 \\
2 & \quad 4 \\
6 & \quad 4 \\
4 & \quad 4 \\
3 & \quad 4
\end{align*}
\]

1. Use the data to create a line plot that has a proper title (including units), the axis labeled correctly, and the data plotted accurately.

   Title________________________________________

   ____________________________________________

   __ __ __ __ __ __ __ __ __ __

   ____________________________________________ (in ________)  

2. What is the total amount of water drank by the first class in pints? Show your work.

   The class drank ___________ pints

   (Continued on next page.)
3  What is the total amount of water drunk by the first class in cups? Show your work.

The class drank _________ cups

4  The most and the least
   a  What is the most water a student drank? _________
   b  What is the least? _________
   c  What is the difference? _________
Water Consumption Outcomes

The second class received 1 quart water bottles for the run.

1. The results below show how much water the second class drank. Complete the missing labels and label the line plot and units.

Title ________________________________

<table>
<thead>
<tr>
<th>Quart</th>
<th>1/4</th>
<th>2/4 = 1/2</th>
<th>3/4</th>
<th>4/4 = 1</th>
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<tbody>
<tr>
<td>Pints</td>
<td>1</td>
<td>1 1/2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cups</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(Continued on next page.)
4. What is the total amount of water drunk by the second class in quarts? Show your work.

The class drank ____________ quarts

5. What is the total amount of water drunk by the second class in pints? Show your work.

The class drank ____________ pints
Set E2  ★  Independent Worksheet 2

Rope Climb Results

Your P.E. teacher has challenged your class to a rope climb! There are 8 blue pieces of tape equally spaced, and wrapped around the rope to mark off the distances. The following results represent the goal levels that were touched by your class.

1 8 0 8 1 8 4 8 2 8 3 8 8 8 4 8 6 8 7 8

1 Use the data to create a line plot that has a proper title and the axis labeled correctly. Plot the data accurately.

Title ________________________________

______________________________ (in ________)

___ ___ ___ ___ ___ ___ ___ ___

2 How many students stopped at the goal line \( \frac{3}{8} \)? __________

3 At which goal level(s) did the most students stop? __________

4 How many students touched or even passed \( \frac{3}{8} \) of the rope? __________

5 What was the total distance combined for climbing the rope? __________
GRADE 4 – UNIT 7

CCSS SUPPLEMENT ACTIVITIES & INDEPENDENT WORKSHEETS

No Supplements Used
No Supplements Used
Bridges Grade 4 Correlations to Common Core State Standards

Common Core State Standards for Mathematics, Grade 4

In Grade 4, instructional time should focus on three critical areas: (1) developing understanding and fluency with multi-digit multiplication, and developing understanding of dividing to find quotients involving multi-digit dividends; (2) developing an understanding of fraction equivalence, addition and subtraction of fractions with like denominators, and multiplication of fractions by whole numbers; (3) understanding that geometric figures can be analyzed and classified based on their properties, such as having parallel sides, perpendicular sides, particular angle measures, and symmetry.

(1) Students generalize their understanding of place value to 1,000,000, understanding the relative sizes of numbers in each place. They apply their understanding of models for multiplication (equal-sized groups, arrays, area models), place value, and properties of operations, in particular the distributive property, as they develop, discuss, and use efficient, accurate, and generalizable methods to compute products of multi-digit whole numbers. Depending on the numbers and the context, they select and accurately apply appropriate methods to estimate or mentally calculate products. They develop fluency with efficient procedures for multiplying whole numbers; understand and explain why the procedures work based on place value and properties of operations; and use them to solve problems. Students apply their understanding of models for division, place value, properties of operations, and the relationship of division to multiplication as they develop, discuss, and use efficient, accurate, and generalizable procedures to find quotients involving multi-digit dividends. They select and accurately apply appropriate methods to estimate and mentally calculate quotients, and interpret remainders based upon the context.

(2) Students develop understanding of fraction equivalence and operations with fractions. They recognize that two different fractions can be equal (e.g., \(\frac{15}{9} = \frac{5}{3}\)), and they develop methods for generating and recognizing equivalent fractions. Students extend previous understandings about how fractions are built from unit fractions, composing fractions from unit fractions, decomposing fractions into unit fractions, and using the meaning of fractions and the meaning of multiplication to multiply a fraction by a whole number.

(3) Students describe, analyze, compare, and classify two-dimensional shapes. Through building, drawing, and analyzing two-dimensional shapes, students deepen their understanding of properties of two-dimensional objects and the use of them to solve problems involving symmetry.

*Taken from the Common Core State Standards for Mathematics 2010, page 27.*
<table>
<thead>
<tr>
<th>Standard</th>
<th>Bridges</th>
<th>Number Corner</th>
<th>Bridges Supplement</th>
<th>Assessments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. Interpret a multiplication equation as a comparison, e.g., interpret 35 = 5 \times 7 as a statement that 35 is 5 times as many as 7 and 7 times as many as 5. Represent verbal statements of multiplicative comparisons as multiplication equations.</strong></td>
<td></td>
<td></td>
<td>Set B2 Algebra: Multiplication Comparisons &amp; Equations, Activity 1 &amp; Ind. Worksheets 1, 2</td>
<td></td>
</tr>
<tr>
<td><strong>2. Multiply or divide to solve word problems involving multiplicative comparison, e.g., by using drawings and equations with a symbol for the unknown number to represent the problem, distinguishing multiplicative comparison from additive comparison.</strong></td>
<td></td>
<td></td>
<td>Set B2 Algebra: Multiplication Comparisons &amp; Equations, Activity 1 &amp; Ind. Worksheets 1, 2</td>
<td></td>
</tr>
</tbody>
</table>

*Note: For online CCSS assessment resources go to: [http://bridges1.mathlearningcenter.org/CCSS](http://bridges1.mathlearningcenter.org/CCSS)*
### OPERATIONS AND ALGEBRAIC THINKING 4.OA

<table>
<thead>
<tr>
<th>Standard</th>
<th>Bridges</th>
<th>Number Corner</th>
<th>Bridges Supplement</th>
<th>Assessments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gain familiarity with factors and multiples.</strong></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>4. Find all factor pairs for a whole number in the range 1-100. Recognize that a whole number is a multiple of each of its factors. Determine whether a given whole number in the range 1-100 is a multiple of a given one-digit number. Determine whether a given whole number in the range 1-100 is prime or composite.</td>
<td>Unit 1, Sessions 11, 12</td>
<td>Sep. Number Line</td>
<td>Set A6 Number &amp; Operations: Fractions, Mixed Numbers &amp; Decimals, Activity 2</td>
<td>Informal Bridges Practice Book, pp 105, 107, 109</td>
</tr>
<tr>
<td></td>
<td>Home Connections 5, 6, 25</td>
<td>Oct. Number Line</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Nov. Number Line</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Jan. Number Line</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Feb. Number Line</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mar. Number Line</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Generate and analyze patterns.</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Generate a number or shape pattern that follows a given rule. Identify apparent features of the pattern that were not explicit in the rule itself. For example, given the rule “Add 3” and the starting number 1, generate terms in the resulting sequence and observe that the terms appear to alternate between odd and even numbers. Explain informally why the numbers will continue to alternate in this way.</td>
<td>Unit 2, Sessions 1, 2, 4</td>
<td>Sep. Calendar Grid</td>
<td>Bridges Practice Book, pp 122, 125, 126, 129</td>
<td>Informal Unit 7, Session 13 (Work Sample)</td>
</tr>
<tr>
<td></td>
<td>Unit 7, Sessions 1–3, 5–9, 13</td>
<td>Sep. Number Line</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Work Place 7B</td>
<td>Oct. Calendar Grid</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Home Connections 19, 50, 54</td>
<td>Oct. Number Line</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Nov. Number Line</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Jan. Calendar Grid</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Feb. Calendar Grid</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Feb. Number Line</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### NUMBER AND OPERATIONS IN BASE TEN 4.NBT

<table>
<thead>
<tr>
<th>Standard</th>
<th>Bridges</th>
<th>Number Corner</th>
<th>Bridges Supplement</th>
<th>Assessments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Generalize place value understanding for multi-digit whole numbers.</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Recognize that in a multi-digit whole number, a digit in one place represents ten times what it represents in the place to its right. For example, recognize that 700 ÷ 70 = 10 by applying concepts of place value and division.</td>
<td>Unit 2, Sessions 1, 2, 4</td>
<td>Sep. Calendar Grid</td>
<td>Set A3 Number &amp; Operations: Place Value to Millions, Activities 1–3 &amp; Ind. Worksheets 1–3</td>
<td>Formal Bridges, Vol. 1, pp 54–57 (Individual Interview)</td>
</tr>
<tr>
<td></td>
<td>Home Connection 13</td>
<td>Sep. Problem Solving</td>
<td>Set A5 Number &amp; Operations: Multi-Digit Multiplication, Activities 2, 3, 7, 10 &amp; Ind. Worksheets 1, 2</td>
<td>Set A5 Number &amp; Operations: Multi-Digit Multiplication, Activities 1, 14</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Oct. Calendar Grid</td>
<td>Bridges Practice Book, pp 25, 37, 61, 75</td>
<td></td>
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*Note: For online CCSS assessment resources go to: [http://bridges1.mathlearningcenter.org/CCSS](http://bridges1.mathlearningcenter.org/CCSS)*
### NUMBER AND OPERATIONS IN BASE TEN 4.NBT

<table>
<thead>
<tr>
<th>Standard</th>
<th>Bridges</th>
<th>Number Corner</th>
<th>Bridges Supplement</th>
<th>Assessments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Generalize place value understanding for multi-digit whole numbers.</strong></td>
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<tr>
<td>2. Read and write multi-digit whole numbers using base-ten numerals, number names, and expanded form. Compare two multi-digit numbers based on meanings of the digits in each place, using &gt;, =, and &lt; symbols to record the results of comparisons. (Grade 4 expectations in this domain are limited to whole numbers less than or equal to 1,000,000.)</td>
<td>Unit 2, Session 4</td>
<td>Sep. Calendar Grid</td>
<td>Set A3 Number &amp; Operations: Place Value to Millions, Activities 1–3 &amp; Ind. Worksheets 1–3</td>
<td>Formal Bridges, Vol. 1, pp 54–57 (Individual Interview) Number Corner, Checkup 1, 4 (* See Gr 4 Revised Number Corner Quarterly Assessments online)</td>
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<td></td>
<td>Sep. Problem Solving</td>
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<td>Sep. Number Line</td>
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<td>Nov. Number Line</td>
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<td>Dec. Number Line</td>
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<td>Jan. Number Line</td>
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<td>Mar. Number Line</td>
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<tr>
<td>3. Use place value understanding to round multi-digit whole numbers to any place.</td>
<td></td>
<td>Nov. Number Line</td>
<td>Set A4 Number &amp; Operations: Estimating to Multiply &amp; Divide, Independent Worksheets 1–3</td>
<td>Formal Number Corner, Checkup 2 (* See Gr 4 Revised Number Corner Quarterly Assessments online)</td>
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<tr>
<td></td>
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<td>Dec. Number Line</td>
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<tr>
<td></td>
<td></td>
<td>Jan. Number Line</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Use place value understanding and properties of operations to perform multi-digit arithmetic.</strong></td>
<td></td>
<td>Oct. Problem Solving</td>
<td>Bridges Practice Book, pp 1–5, 7, 8, 9, 12, 17, 37</td>
<td>Formal Number Corner, (Baseline &amp; Checkups 1, 2, 4) (* See Gr 4 Revised Number Corner Quarterly Assessments online)</td>
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<tr>
<td></td>
<td></td>
<td>May Calendar Collector</td>
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<tr>
<td>5. Multiply a whole number of up to four digits by a one-digit whole number, and multiply two two-digit numbers, using strategies based on place value and the properties of operations. Illustrate and explain the calculation by using equations, rectangular arrays, and/or area models.</td>
<td>Unit 1, Sessions 8, 10, 13–17 Unit 2, Sessions 6–16, 19, 20 Home Connections 13, 14, 15, 18</td>
<td>Nov. Problem Solving</td>
<td>Set A4 Number &amp; Operations: Estimating to Multiply &amp; Divide, Independent Worksheets 1–3</td>
<td>Informal Unit 2, Sessions 14, 19 (Work Samples)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Dec. Computational Fluency</td>
<td>Set A5 Number &amp; Operations: Mult-Digit Multiplication, Activities 2–11, 13 &amp; Ind. Worksheets 1–9</td>
<td></td>
</tr>
</tbody>
</table>

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**NUMBER AND OPERATIONS IN BASE TEN 4.NBT**

<table>
<thead>
<tr>
<th>Standard</th>
<th>Bridges</th>
<th>Number Corner</th>
<th>Bridges Supplement</th>
<th>Assessments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use place value understanding and properties of operations to perform multi-digit arithmetic.</td>
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<tr>
<td>6. Find whole-number quotients and remainders with up to four-digit dividends and one-digit divisors, using strategies based on place value, the properties of operations, and/or the relationship between multiplication and division. Illustrate and explain the calculation by using equations, rectangular arrays, and/or area models.</td>
<td>Unit 1, Sessions 9, 10</td>
<td>Nov. Problem Solving</td>
<td>Set A4 Number &amp; Operations: Estimating to Multiply &amp; Divide, Independent Worksheets 1–3</td>
<td>Informal: Unit 3, Sessions 13, 17 (Work Samples)</td>
</tr>
<tr>
<td></td>
<td>Unit 3, Session 12–19</td>
<td>Jan. Problem Solving</td>
<td></td>
<td>Formal: Unit 1, pp 54–57 (Ind. Interview)</td>
</tr>
<tr>
<td></td>
<td>Unit 8, Sessions 14, 17, 18</td>
<td>Jan. Computational Fluency</td>
<td>Bridges Practice Book, pp 81, 82, 85, 87, 93, 136</td>
<td>Bridges, Vol. 2, pp 286–292, 386–394 (Unit 3 Pre- and Post-Assessments)</td>
</tr>
<tr>
<td></td>
<td>Home Connection 26</td>
<td>Feb. Problem Solving</td>
<td>Number Corner, Baseline &amp; Checkups 2–4 (* See Gr 4 Revised Number Corner Quarterly Assessments online)</td>
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<tr>
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<td>Mar. Problem Solving</td>
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<td>Mar. Computational Fluency</td>
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<td>Apr. Problem Solving</td>
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<td>Apr. Computational Fluency</td>
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**NUMBER AND OPERATIONS—FRACTIONS 4.NF**

<table>
<thead>
<tr>
<th>Standard</th>
<th>Bridges</th>
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<th>Bridges Supplement</th>
<th>Assessments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extend understanding of fraction equivalence and ordering. (Note: Grade 4 expectations in this domain are limited to fractions with denominators 2, 3, 4, 5, 6, 8, 10, 12 &amp; 100.)</td>
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<tr>
<td>1. Explain why a fraction a/b is equivalent to a fraction (n x a)/(n x b) by using visual fraction models, with attention to how the number and size of the parts differ even though the two fractions themselves are the same size. Use this principle to recognize and generate equivalent fractions.</td>
<td>Unit 3, Sessions 3, 5–9, 11</td>
<td>Oct Calendar Collector</td>
<td>Set A6 Number &amp; Operations: Fractions &amp; Mixed Numbers, Activities 1, 2</td>
<td>Formal: Bridges, Vol. 2, pp 286–292, 386–394 (Unit 3 Pre- and Post-Assessments)</td>
</tr>
<tr>
<td></td>
<td>Unit 6, Sessions 2, 3, 13</td>
<td>Dec Calendar Collector</td>
<td>Bridges Practice Book, pp 41, 42, 45, 47, 59, 101, 105, 107, 109, 111, 113, 115, 117, 119, 137</td>
<td>Number Corner, Baseline &amp; Checkup 3 (* See Gr 4 Revised Number Corner Quarterly Assessments online)</td>
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<td></td>
<td>Home Connections 21, 22</td>
<td>Mar. Calendar Grid</td>
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<td>Apr. Calendar Collector</td>
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<tr>
<td>2. Compare two fractions with different numerators and different denominators, e.g., by creating common denominators or numerators, or by comparing to a benchmark fraction such as 1/2. Recognize that comparisons are valid only when the two fractions refer to the same whole. Record the results of comparisons with symbols &gt;, =, or &lt;, and justify the conclusions, e.g., by using a visual fraction model.</td>
<td>Unit 3, Session 3</td>
<td>Mar. Calendar Grid</td>
<td>Set A6 Number &amp; Operations: Fractions &amp; Mixed Numbers, Activity 2</td>
<td>Formal: Bridges, Vol. 2, pp 286–292, 386–394 (Unit 3 Pre- and Post-Assessments)</td>
</tr>
<tr>
<td></td>
<td>Unit 6, Sessions 2, 3, 10, 11</td>
<td>Mar. Calendar Collector</td>
<td>Bridges Practice Book, pp 42–44, 46, 47, 57, 67, 102, 103, 109, 117</td>
<td>Number Corner, Checkup 4 (* See Gr 4 Revised Number Corner Quarterly Assessments online)</td>
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<tr>
<td></td>
<td>Home Connections 21, 22, 43</td>
<td>Apr. Calendar Collector</td>
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<td>May Number Line</td>
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### Bridges Grade 4 Correlations to Common Core State Standards (cont.)

#### NUMBER AND OPERATIONS—FRACTIONS 4.NF

<table>
<thead>
<tr>
<th>Standard</th>
<th>Bridges</th>
<th>Number Corner</th>
<th>Bridges Supplement</th>
<th>Assessments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Build fractions from unit fractions by applying and extending previous understandings of operations on whole numbers.</td>
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<tr>
<td>3. Understand a fraction $a/b$ with $a &gt; 1$ as a sum of fractions $1/b$.</td>
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</tr>
<tr>
<td>a. Understand addition and subtraction of fractions as joining and separating parts referring to the same whole.</td>
<td>Unit 1, Session 4 Unit 3, Sessions 3, 8 Unit 6, Sessions 2, 3, 13</td>
<td>Sep. Calendar Collector Oct. Calendar Collector Nov. Calendar Collector Dec. Calendar Collector Apr. Calendar Collector</td>
<td>Set A6 Number &amp; Operations: Fractions &amp; Mixed Numbers, Activities 1, 2 Set A9 Number &amp; Operations: Adding &amp; Subtracting Fractions, Activity 1 &amp; Ind. Worksheets 1, 2</td>
<td>Informal Set A9 Number &amp; Operations: Adding &amp; Subtracting Fractions, Ind. Worksheet 2</td>
</tr>
<tr>
<td>b. Decompose a fraction into a sum of fractions with the same denominator in more than one way, recording each decomposition by an equation. Justify decompositions, e.g., by using a visual fraction model. Examples: $3/8 = 1/8 + 1/8 + 1/8$; $3/8 = 1/8 + 2/8$; $21/8 = 1 + 1 + 1/8 = 8/8 + 8/8 + 1/8$.</td>
<td></td>
<td></td>
<td>Set A9 Number &amp; Operations: Adding &amp; Subtracting Fractions, Activity 1 Set A10 Number &amp; Operations: Multiplying Whole Numbers by Fractions, Activities 1–3 &amp; Ind. Worksheets 1–4</td>
<td>Informal Set A9 Number &amp; Operations: Adding &amp; Subtracting Fractions, Ind. Worksheet 2</td>
</tr>
<tr>
<td>c. Add and subtract mixed numbers with like denominators, e.g., by replacing each mixed number with an equivalent fraction, and/or by using properties of operations and the relationship between addition and subtraction.</td>
<td>Unit 3, Session 3</td>
<td>Mar. Problem Solving Apr. Calendar Collector</td>
<td>Set A9 Number &amp; Operations: Adding &amp; Subtracting Fractions, Activity 1 &amp; Ind. Worksheets 1–3</td>
<td>Informal Set A9 Number &amp; Operations: Adding &amp; Subtracting Fractions, Ind. Worksheet 2</td>
</tr>
<tr>
<td>d. Solve word problems involving addition and subtraction of fractions referring to the same whole and having like denominators, e.g., by using visual fraction models and equations to represent the problem.</td>
<td>Unit 1, Session 4</td>
<td>Sep. Calendar Collector Oct. Calendar Collector Nov. Calendar Collector Dec. Calendar Collector</td>
<td>Set A6 Number &amp; Operations: Fractions &amp; Mixed Numbers, Activity 1 Set A9 Number &amp; Operations: Adding &amp; Subtracting Fractions, Activity 1 &amp; Ind. Worksheets 1–3</td>
<td>Informal Set A9 Number &amp; Operations: Adding &amp; Subtracting Fractions, Ind. Worksheet 2</td>
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**Bridges Grade 4 Correlations to Common Core State Standards**

**NUMBER AND OPERATIONS—FRACTIONS 4.NF**

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<tbody>
<tr>
<td>Build fractions from unit fractions by applying and extending previous understandings of operations on whole numbers.</td>
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</tbody>
</table>

4. Apply and extend previous understandings of multiplication to multiply a fraction by a whole number.

| a. Understand a fraction \(\frac{4}{5}\) as a multiple of \(\frac{1}{5}\). For example, use a visual fraction model to represent \(\frac{4}{5}\) as the product \(5 \times \left(\frac{1}{5}\right)\), recording the conclusion by the equation \(\frac{4}{5} = 5 \times \left(\frac{1}{5}\right)\). | Unit 6, Sessions 2, 3, 13 | Set A10 Number & Operations: Multiplying Whole Numbers by Fractions, Activities 1–3 & Ind. Worksheets 1–4 | Informal | Set A10 Number & Operations: Multiplying Whole Numbers by Fractions, Ind. Worksheet 4 |
| b. Understand a multiple of \(\frac{4}{5}\) as a multiple of \(\frac{1}{5}\), and use this understanding to multiply a fraction by a whole number. For example, use a visual fraction model to express \(3 \times \left(\frac{4}{5}\right)\) as \(6 \times \left(\frac{1}{5}\right)\), recognizing this product as \(\frac{12}{5}\). (In general, \(n \times \left(\frac{4}{5}\right) = \frac{12}{5}\)). | Unit 6, Sessions 2, 3, 13 | Set A10 Number & Operations: Multiplying Whole Numbers by Fractions, Activities 1–3 & Ind. Worksheets 1–4 | Informal | Set A10 Number & Operations: Multiplying Whole Numbers by Fractions, Ind. Worksheet 4 |
| c. Solve word problems involving multiplication of a fraction by a whole number, e.g., by using visual fraction models and equations to represent the problem. For example, if each person will eat \(\frac{3}{4}\) of a pound of roast beef, and there are 5 people, how many pounds of roast beef will be needed? Between what two whole numbers does your answer lie? | | | Informal | Set A10 Number & Operations: Multiplying Whole Numbers by Fractions, Activities 1–3 & Ind. Worksheets 1–4 |

Understand decimal notation for fractions, and compare decimal fractions.

| 5. Express a fraction with denominator 10 as an equivalent fraction with denominator 100, and use this technique to add two fractions with respective denominators 10 and 100. For example, express \(\frac{3}{10}\) as \(\frac{30}{100}\), and add \(\frac{3}{10} + \frac{4}{100} = \frac{34}{100}\). | Unit 6, Sessions 9, 10, 12, 13, 16, 17, 20 Work Place 6D Unit 8, Session 13 Home Connection 46 | Mar. Number Line Apr. Number Line May Number Line | Formal | Bridges, Vol. 3, pp 653–657, 759–764 (Unit 6 Pre- and Post-Assessment) Number Corner, Baseline & Checkup 2 (* See Gr 4 Revised Number Corner Quarterly Assessments online) |

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### Bridges Grade 4 Correlations to Common Core State Standards (cont.)

#### NUMBER AND OPERATIONS—FRACTIONS 4.NF

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<tr>
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<th>Bridges</th>
<th>Number Corner</th>
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<tbody>
<tr>
<td>Understand decimal notation for fractions, and compare decimal fractions.</td>
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<tr>
<td>6. Use decimal notation for fractions with denominators 10 or 100. For example, rewrite 0.62 as 62/100; describe a length as 0.62 meters; locate 0.62 on a number line diagram.</td>
<td>Unit 6, Sessions 9, 10, 12–14, 18, 19 Work Places 6B, 6C Home Connection 46</td>
<td>Dec. Calendar Collector Apr. Number Line</td>
<td>Bridges Practice Book, pp 111, 115, 119, 137</td>
<td>Formal Bridges, Vol. 3, pp 653–657, 759–764 (Unit 6 Pre- and Post-Assessment) Number Corner, Checkup 4 (* See Gr 4 Revised Number Corner Quarterly Assessments online)</td>
</tr>
<tr>
<td>7. Compare two decimals to hundredths by reasoning about their size. Recognize that comparisons are valid only when two decimals refer to the same whole. Record the results of comparisons with the symbols &gt;, =, or &lt;, and justify the conclusions, e.g., by using a visual model. (Grade 4 expectations in this domain are limited to fractions with denominators 2, 3, 4, 5, 6, 8, 10, 12, and 100.)</td>
<td>Unit 6, Sessions 10, 11, 18, 20 Work Places 6A, 6D Home Connections 47, 48</td>
<td>Dec. Calendar Collector Mar. Number Line Apr. Number Line</td>
<td>Bridges Practice Book, pp 111, 113, 115, 117, 119, 137</td>
<td>Informal Unit 6, Session 10 (Work Sample) Formal Bridges, Vol. 3, pp 653–657, 759–764 (Unit 6 Pre- and Post-Assessment) Number Corner, Checkup 4 (* See Gr 4 Revised Number Corner Quarterly Assessments online)</td>
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#### MEASUREMENT AND DATA 4.MD

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<tr>
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</thead>
<tbody>
<tr>
<td>Solve problems involving measurement and conversion of measurements from a larger unit to a smaller unit.</td>
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</tr>
<tr>
<td>1. Know relative sizes of measurement units within one system of units including km, m, cm; kg, g; lb, oz.; l, ml; hr, min, sec. Within a single system of measurement, express measurements in a larger unit in terms of a smaller unit. Record measurement equivalents in a two-column table. For example: Know that 1 ft is 12 times as long as 1 in. Express the length of a 4 ft snake as 48 in. Generate a conversion table for feet and inches listing the number pairs (1, 12), (2, 24), (3, 36), ….</td>
<td>Unit 2, Sessions 3–5 Unit 3, Session 3 Work Place 3B Home Connections 20, 25, 44</td>
<td>Sep. Calendar Collector Oct. Calendar Collector Nov. Calendar Collector Number Corner Student Book, pp 4, 20</td>
<td>Set D1 Measurement: Weight &amp; Mass, Activities 4, 5 Set D3 Measurement: Capacity in Metric Units, Activities 1.2 &amp; Ind. Worksheet 1 Set D10 Measurement: Conversions, Activity 1 &amp; Ind. Worksheets 1, 2 Bridges Practice Book, pp 10, 28, 48, 49, 55, 56, 62, 78, 104, 106, 110, 127</td>
<td>Informal Set D10 Measurement: Conversion, Ind. Worksheets 1, 2 Formal Number Corner, Checkups 1, 2 (* See Gr 4 Revised Number Corner Quarterly Assessments online)</td>
</tr>
</tbody>
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<tbody>
<tr>
<td>Solve problems involving measurement and conversion of measurements from a larger unit to a smaller unit.</td>
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<tr>
<td>2. Use the four operations to solve word problems involving distances, intervals of time, liquid volumes, masses of objects, and money, including problems involving simple fractions or decimals, and problems that require expressing measurements given in a larger unit in terms of a smaller unit. Represent measurement quantities using diagrams such as number line diagrams that feature a measurement scale.</td>
<td>Unit 2, Sessions 12–14 Unit 3, Session 9 Unit 6, Sessions 12, 14, 15 Work Place 6B Home Connections 15, 18, 23, 44</td>
<td>Sep. Calendar Collector Oct. Calendar Collector Nov. Calendar Collector Dec. Calendar Collector Jan. Calendar Grid Jan. Problem Solving Mar. Problem Solving May Calendar Grid May Calendar Collector May Problem Solving Number Corner Student Book, p 21</td>
<td>Set A5 Number &amp; Operations: Multi-Digit Multiplication, Activity 13 Set D1 Measurement: Weight &amp; Mass, Activities 4, 5 Set D3 Measurement: Capacity in Metric Units, Activities 1, 2 &amp; Ind. Worksheet 1 Bridges Practice Book, pp 6, 7, 10, 12, 16, 18, 24, 26–28, 30–32, 34, 36, 38, 40, 48, 50, 56, 58, 62, 70, 72, 78, 88, 91, 93, 96, 99, 100, 103, 106, 108–110, 114, 116, 120, 127, 140</td>
<td>Formal Bridges, Vol. 3, pp 653–657, 759–764 (Unit 6 Pre- and Post-Assessment) Number Corner, Baseline &amp; Checkup 2 (* See Gr 4 Revised Number Corner Quarterly Assessments online)</td>
</tr>
<tr>
<td>3. Apply the area and perimeter formulas for rectangles in real world and mathematical problems. For example, find the width of a rectangular room given the area of the flooring and the length, by viewing the area formula as a multiplication equation with an unknown factor.</td>
<td>Unit 1, Sessions 18–20 Unit 2, Sessions 3, 4 Unit 4, Session 10 Work Place 4B Unit 6, Sessions 1, 4 Home Connections 10, 19</td>
<td>Jan. Problem Solving Apr. Calendar Grid Apr. Problem Solving</td>
<td>Set A5 Number &amp; Operations: Multi-Digit Multiplication, Activities 4, 8 &amp; Ind. Worksheets 1, 3, Set D6 Measurement: Area &amp; Perimeter, Activities 1–4 &amp; Ind. Worksheets 1, 2 Set D9 Measurement: Area of Polygons, Activity 1 &amp; Ind. Worksheets 1, 2 Bridges Practice Book, pp 19, 20, 21, 22, 64, 80, 88, 98, 99, 116, 121, 122, 130, 138, 139, 140</td>
<td>Formal Bridges, Vol. 1, pp 49–53 and 125–134 (Unit 1 Pre- and Post-Assmts) Set A5 Number &amp; Operations: Multi-Digit Multiplication, Act. 14 Number Corner, Checkups 2, 3 (* See Gr 4 Revised Number Corner Quarterly Assessments online)</td>
</tr>
<tr>
<td>Represent and interpret data.</td>
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<tr>
<td>4. Make a line plot to display a data set of measurements in fractions of a unit (1/2, 1/4, 1/8). Solve problems involving addition and subtraction of fractions by using information presented in line plots. For example, from a line plot find and interpret the difference in length between the longest and shortest specimens in an insect collection.</td>
<td></td>
<td></td>
<td>Set E2 Data Analysis: Line Plots, Activities 1–3 &amp; Ind. Worksheets 1, 2</td>
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<tbody>
<tr>
<td>Geometric measurement: understand concepts of angle and measure angles.</td>
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<tr>
<td>5. Recognize angles as geometric shapes that are formed wherever two rays share a common endpoint, and understand concepts of angle measurement:</td>
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<td>a. An angle is measured with reference to a circle with its center at the common endpoint of the rays, by considering the fraction of the circular arc between the points where the two rays intersect the circle. An angle that turns through $\frac{1}{360}$ of a circle is called a “one-degree angle,” and can be used to measure angles.</td>
<td>Grade 4, Unit 4, Session 1</td>
<td></td>
<td>Set C3 Geometry: Circles &amp; Angles, Activities 1, 2, 4, 5 &amp; Ind. Worksheet 6</td>
<td>Informal Set C3 Geometry: Circles &amp; Angles, Ind. Worksheet 6</td>
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<tr>
<td>b. An angle that turns through $n$ one-degree angles is said to have an angle measure of $n$ degrees.</td>
<td>Grade 4, Unit 4, Session 1</td>
<td></td>
<td>Set C3 Geometry: Circles &amp; Angles, Activities 1, 2, 4, 5 &amp; Ind. Worksheet 6</td>
<td>Informal Set C3 Geometry: Circles &amp; Angles, Ind. Worksheet 6</td>
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<td>6. Measure angles in whole-number degrees using a protractor. Sketch angles of specified measure.</td>
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<td>Set C3 Geometry: Circles &amp; Angles, Activities 1, 2, 4, 5 &amp; Ind. Worksheet 6</td>
<td>Informal Set C3 Geometry: Circles &amp; Angles, Ind. Worksheet 6</td>
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<td>7. Recognize angle measure as additive. When an angle is decomposed into non-overlapping parts, the angle measure of the whole is the sum of the angle measures of the parts. Solve addition and subtraction problems to find unknown angles on a diagram in real world and mathematical problems, e.g., by using an equation with a symbol for the unknown angle measure.</td>
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<td>Set C3 Geometry: Circles &amp; Angles, Activities 1, 2, 4, 5 &amp; Ind. Worksheet 6</td>
<td>Informal Set C3 Geometry: Circles &amp; Angles, Ind. Worksheet 6</td>
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*Note: For online CCSS assessment resources go to: [http://bridges1.mathlearningcenter.org/CCSS](http://bridges1.mathlearningcenter.org/CCSS)*
### Bridges Grade 4 Correlations to Common Core State Standards

#### GEOMETRY 4.G

<table>
<thead>
<tr>
<th>Standard</th>
<th>Bridges</th>
<th>Number Corner</th>
<th>Bridges Supplement</th>
<th>Assessments</th>
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<tbody>
<tr>
<td><strong>Draw and identify lines and angles, and classify shapes by properties of their lines and angles.</strong></td>
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<tr>
<td>1. Draw points, lines, line segments, rays, angles (right, acute, obtuse), and perpendicular and parallel lines. Identify these in two-dimensional figures.</td>
<td>Unit 1, Sessions 2, 3&lt;br&gt;Unit 4, Sessions 1, 2, 4, 5&lt;br&gt;Home Connection 29</td>
<td></td>
<td>Set C1 Geometry: Parallel, Perpendicular &amp; Intersecting, Activity 1 &amp; Ind. Worksheets 1, 2&lt;br&gt;Set C3 Geometry: Circles &amp; Angles, Activities 1, 2 &amp; Ind. Worksheets 1, 2</td>
<td><strong>Formal</strong>&lt;br&gt;Bridges, Vol. 1, pp 24–27 and 125–134 (Unit 1 Pre- and Post-Assmt)&lt;br&gt;Bridges, Vol. 2, pp 423–426, 517–525 (Unit 4 Pre- and Post-Assessments)</td>
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<td>2. Classify two-dimensional figures based on the presence or absence of parallel or perpendicular lines, or the presence or absence of angles of a specified size. Recognize right triangles as a category, and identify right triangles.</td>
<td>Unit 1, Sessions 2, 3&lt;br&gt;Unit 4, Sessions 4, 10, 11</td>
<td></td>
<td>Set C3 Geometry: Circles &amp; Angles, Activity 1 &amp; Ind. Worksheets 1, 2</td>
<td><strong>Formal</strong>&lt;br&gt;Bridges, Vol. 1, pp 24–27, 125–134 (Unit 1 Pre- and Post-Assessments)&lt;br&gt;Bridges, Vol. 2, pp 423–426, 517–525 (Unit 4 Pre- and Post-Assessments)</td>
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<td>3. Recognize a line of symmetry for a two-dimensional figure as a line across the figure such that the figure can be folded along the line into matching parts. Identify line-symmetric figures and draw lines of symmetry.</td>
<td>Unit 1, Sessions 2, 3&lt;br&gt;Unit 3, Session 1&lt;br&gt;Unit 4, Sessions 2, 5, 9&lt;br&gt;Home Connections 31, 35</td>
<td></td>
<td></td>
<td><strong>Formal</strong>&lt;br&gt;Bridges, Vol. 1, pp 24–27, 125–134 (Unit 1 Pre- and Post-Assessments)&lt;br&gt;Bridges, Vol. 2, pp 423–426, 517–525 (Unit 4 Pre- and Post-Assessments)</td>
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