I am dedicating this book to my fellow teachers and to my students, which will benefit from any proceeds arrived from this book.

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Introduction

Fellow Educator,

I am a Science Teacher in Columbia County, GA. I have an AA Degree in Business Administration from St. Petersburg Jr. Col., an AS in Graphic Arts from the Air Force, a BS in Elementary Ed from Langston University and am completing an MS in Earth Science through Mississippi State this semester. Science has been my hobby all my life. I’ve been teaching science for 4 years. I’ve participated in AIMS courses, trained at the KS STARBASE, volunteered as a research assistant on the NOAA Research Vessel US Oregon II and conducted training for teachers. I have over 70 credit hours in science on my college transcripts.

My family and I recently moved to GA, where I found myself in need of taking the Praxis II Exam for Middle School Science. I went to the local Borders and Barnes and Noble expecting to pay $20 - $40 for a Praxis II study guide. When I was unable to find a book covering the topics suggested on the ETS web site I set out to create my own study notes. Other teachers at my own school were in the same boat. One teacher shared another book with me, produced by another teacher. I found it valuable but not as complete as my own notes. Recently, I tried to direct another friend of mine to this book and found out it was no longer available through Lulu.com.

It was at this point that I decided to sell my own book. I am not selling this book for personal profit but to fill a need in the educational community. I plan to use any profits from this book to buy equipment such as a laptop computer, robotics equipment, bottle rocket launchers and various other supplies for my classroom.

Whether you came across my book because you didn’t have the time to look up all of the topics on your own or were simply looking for review notes to compare to your own, I hope that I have been able to assist you in your career choice of becoming a teacher. There have been few greater joys in my life than when I decided to change careers and teach. I want to wish you luck and thank you for assisting me in providing additional supplies and equipment for my students.

Best of luck and thank you!

Laurel Burdette

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Middle Grade Science
Study Notes for the Multiple Choice Section

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Chapter I Scientific Methodology, Techniques and History

** I was initially not going to include this portion of the topics in my Study Notes Book. Most of the topics are common sense or items that can not be easily identified within a few lines. These items should come naturally if you have taught or been in a teacher training program.

A. Methodology and Philosophy
B. Mathematics, Measurement, and Data Manipulation
C. Laboratory Procedures and Safety

A. Methodology and Philosophy

- Demonstrate understanding of scientific methods of problem solving
  
  Most states use a form of the 5 Step Scientific Method including the following:

  1. State the problem
  2. Make Observations
  3. Form a Hypothesis
  4. Do the Experiment
  5. Draw a conclusion.

- Distinguish among scientific facts, models, theories and laws
- Use science process skills in experiments and investigations, and to solve problems
- Demonstrate understanding of experimental design
- Demonstrate knowledge of the historical roots of science
  
  Pasteur – discovered microorganisms
  Hook - microscopes
  Mendel – father of genetics, worked with plants
  Darwin – father of Modern Biology
  Newton – basically the father of Physics
  Kepler – dealt with mathematical calculations for determining the distances of celestial bodies

- Demonstrate understanding of the unified, integrative nature of the various disciplines and concepts in science
  
  Biology – study of living organisms
  Physics – study of the forces of nature
  Chemistry – deals with the composition of substances
  Geology – study of the earth’s processes
  Astronomy – study of celestial bodies
  Ecology – the study of organism interactions with their environments
  Oceanography – study of the world’s hydrosphere
B. Mathematics, Measurement, and Data Manipulation
   ● Demonstrate understanding of scientific measurement and notation systems
   ● Demonstrate understanding of processes involved in scientific data collection, manipulation, interpretation, and presentation
     **Know how to read maps, charts and graphs, the majority of my questions form this section were based on interpreting data.
   ● Interpret and draw conclusions from data, including those presented in tables, graphs, maps, and charts
   ● Identify and demonstrate an understanding of sources of error in data that is presented

C. Laboratory Procedures and Safety
   ● Demonstrate understanding of procedures for safe preparation, storage, use, and disposal of laboratory and field materials
   ● Identify laboratory and field equipment appropriate for scientific procedures
   ● Demonstrate knowledge of safety and emergency procedures for the science classroom and laboratory
Chapter 2  Basic Principles

A. Matter and Energy
B. Heat and Thermodynamics
C. Atomic and Nuclear Structure

A. Matter and Energy

● Demonstrate understanding of the structure and properties of matter

Matter is anything that has mass and takes up space as defined in nearly every science book. Matter contains both physical and chemical properties. Chemical properties are when the matter forms another form of matter. The most common example of this is rusting. Physical properties include color, smell, density, buoyancy, boiling, freezing and melting points. If you crumble a piece of paper it has not changed chemically. The traditional 3 states of matter have been replaced with the 4 states of matter, solid, liquid, gas and now plasma. Plasma has more recently been added because it has been created in laboratories more and more and does not fit the typical definitions of the other states of matter.

● Demonstrate understanding of the factors that influence the occurrence and abundance of the elements

There are over 118 elements on the periodic table. An element is a substance that can not be broken down into any other substance. Within the earth’s crust the following are the most abundant elements:

<table>
<thead>
<tr>
<th>Element</th>
<th>Abundance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oxygen</td>
<td>46%</td>
</tr>
<tr>
<td>Silicon</td>
<td>28%</td>
</tr>
<tr>
<td>Aluminum</td>
<td>8%</td>
</tr>
<tr>
<td>Iron</td>
<td>5%</td>
</tr>
<tr>
<td>Calcium</td>
<td>4%</td>
</tr>
<tr>
<td>Sodium</td>
<td>2%</td>
</tr>
<tr>
<td>Magnesium</td>
<td>2%</td>
</tr>
<tr>
<td>Potassium</td>
<td>2%</td>
</tr>
<tr>
<td>Titanium</td>
<td>.5%</td>
</tr>
<tr>
<td>Hydrogen</td>
<td>.14%</td>
</tr>
</tbody>
</table>
Within the Earth’s atmosphere the following are the most abundant elements:

<table>
<thead>
<tr>
<th>Element</th>
<th>Abundance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen</td>
<td>78%</td>
</tr>
<tr>
<td>Oxygen</td>
<td>20%</td>
</tr>
<tr>
<td>Argon</td>
<td>1%</td>
</tr>
<tr>
<td>Carbon Dioxide</td>
<td>.03%</td>
</tr>
</tbody>
</table>

- **Distinguish between physical and chemical changes of matter**
  Chemical changes change the element by exchanging electrons. A new substance is formed and the most common example is rusting.

  Physical changes merely change the appearance of a substance. You can still identify individual elements of the substance or matter.

- **Demonstrate understanding of the conservation of mass/energy**
  The Law of Conservation of Energy states that energy cannot be created or destroyed, but can change its form. The total quantity of matter and energy available in the universe is a fixed amount and never any more or less.

- **Demonstrate understanding of energy transformations**
  **Kinetic Energy** - Kinetic Energy exists whenever an object which has mass is in motion with some velocity. Everything you see moving about has kinetic energy.
  **Potential Energy** - Potential energy is energy due to position or stored energy. Potential energy is also called gravitational potential energy. Pulling back a rubber band has potential energy until it is released.

**B. Heat and Thermodynamics**

- **Distinguish between heat and temperature**
  Heat – the kinetic energy of random molecular motion
  Temperature – the measure of the degree of hot or coldness of an object

- **Demonstrate understanding of measurement, transfer, and effects of thermal energy on matter**
  Measurement of heat is based on several different scales such as Celsius, Fahrenheit, and Kelvin. Kelvin is mostly used in terms of Astronomy, Fahrenheit in the US measurement and Celsius is the metric measurement of temperature and used by most of the world and by the US in Science research.

  Transfer of energy occurs with conduction (one object touching another hot object becomes hot), convection (fluids transfer by the circulation,
such as boiling water) and radiation (doesn’t need a medium, the warmth on your face from the sun).

Thermal Energy on matter warms the matter. Thermal energy causes the atoms to vibrate making the heat of the object rise and essentially raising the temperature.

● Solve quantitative problems dealing with the measurement and transfer of thermal energy

**I had several questions on my examine asking me to convert measurements from Celsius to Fahrenheit and back. If you get confused convert the boiling point of water from C to F and if you match up you know you are using the right formula.

To convert Fahrenheit to Celsius  \( \frac{5}{9} (F^\circ - 32) = \)
To convert Celsius to Fahrenheit \( \frac{9}{5} \times C^\circ + 32 = \)
To convert Celsius to Kelvin \( C^\circ + 273 = \)

● Demonstrate understanding of the First and Second Laws of thermodynamics

I found this interesting way to remember the 3 Laws of Thermodynamics; I wish I could find where I saw it to give credit.

1. You cannot get something for nothing, because matter and energy are conserved. **(You cannot win.)** The amount of heat entered is the same amount of heat/energy that you will get back.
2. You cannot return to the same energy state, because there is always an increase in disorder; entropy always increases. **(You cannot break even).** Heat moves from hot to cold, heat cannot be converted & isolated systems become disordered or have entropy.
3. Absolute zero is unattainable **(You cannot get out of the game).**

**Entropy is the amount of disorder created in a system**
C. Atomic and Nuclear Structure

- Demonstrate understanding of atomic models and their experimental bases

  In 1909 Rutherford was working on perfecting a theory about the structure of atoms. By 1911 he presented his new model which included a nucleus, empty space and electrons. By 1913 a man named Bohr working with Rutherford speculated that electrons moved in distinct paths around the nucleus. He also theorized that electrons could jump from one level to another. Modern Scientists have concluded that electrons do not travel in specific paths.

- Demonstrate understanding of atomic and nuclear structure and forces

  The atomic structure of an element is the amount of protons, neutrons and electrons. Nuclear forces are those forces that combine the nucleuses of atoms or divide the nucleuses into other elements. These processes are called Fusion and Fission respectively.

- Relate electron configuration to the chemical and physical properties of an atom

  Atoms contain protons which are positively charged particles in the nucleus of the atom, neutrons which have no charge inside of the nucleus and then rings of electrons. Each layer of electrons can only hold a specified amount of electrons. The tendency to lose or gain electrons effects the chemical properties of the atoms. The first 4 rings of electrons hold 2, followed by 8, followed by 18 and then 32 electrons. They do not orbit in a flat plain.

- Demonstrate knowledge of characteristics of radioisotopes and radioactivity (for example, half-life)

  Radioisotopes – Isotopes which spontaneously emit radiation, used in medicines

  Radioactivity – The atoms making up matter are generally stable, but some of them are spontaneously transformed by emitting radiations which release energy.

  Isotopes - Atomic nuclei with the same number of protons, but with differing numbers of neutrons

  Half-life - The time period under which one half of the radioactive cores decay is called half-life of the isotope.

- Identify products of nuclear reactions

  A nuclear reactor is like a furnace which produces steam and hot gases. This steam or hot gasses can provide heat directly or drive turbines to generate electricity. Nuclear reactors are used for electric-power generation throughout much of the world as well as for propelling submarines and some surface vehicles. Nuclear reactors produce mass amounts of energy, steam and gases. By products of the reactors need to
be safely disposed. Wastes included used fuel rods, shoe covers and other clothing used by employees and the chemicals used to make uranium.

Nuclear reactions are either fusion or fission. Fusion is when you are fusing 2 elements together and is responsible for the energy that supplies our sun’s energy. Fission is when you break down larger elements into smaller ones and is used for most nuclear energy. High temperatures are required for this type of reaction which is why nuclear power plants are located on bodies of water.
Chapter 3 Physical Sciences

A. Physics
   1. Mechanics
   2. Electricity and magnetism
   3. Waves

B. Chemistry
   1. Periodicity
   2. The Mole and Chemical Bonding
   3. The Kinetic Theory and States of Matter
   4. Chemical Reactions
   5. Solutions and Solubility

A. Physics
1. Mechanics
   ● Demonstrate understanding of (the variables involved in) straight line motion, projectile motion, circular motion, and periodic motion
     - **straight line motion** – when the movement of an object is in a straight line, whether or not acceleration is constant.
     - **circular motion** – continuous acceleration, also called centripetal acceleration
     - **projectile motion** – curved path an object takes. It initially goes straight but as gravity comes into play the object will curve towards the ground
     - **periodic motion** – when an object has constraints on its motion it moves back and forth, such as a pendulum.

   ● Demonstrate understanding of Newton’s laws of motion
     **Law #1** - An object at rest (or in motion) will remain at rest (or in motion) until acted upon by an outside force. Part 2, states that an object moving at a particular velocity will continue at that speed until acted upon by an outside force.
     **Law #2** – The acceleration of an object depends on the mass and amount of force applied.

   ● Distinguish between weight and mass
     Weight – gravitational force on an object
     Mass – amount of matter an object is composed of.

   ● Distinguish among work, energy, and power
     Work- action caused by force acting upon an object
     Energy – ability to do work
     Power – rate at which work is completed
• Demonstrate understanding of friction
  Friction is the opposing force between 2 surfaces. Friction causes objects
  in motion to slow down.

• Demonstrate understanding of simple machines and torque
  Simple machines make doing work easier. There are 6 types of simple
  machines:
    a) Levers – applying force to loads
    b) Inclined plane – requires smaller force
    c) Wedge – output force in greater than input force
    d) Screw
    e) Wheel & Axle
    f) Pulley
  Torque – force that rotates things, such as a wrench

• Demonstrate understanding of linear momentum
  Linear Momentum is defined as the mass of an object times its velocity. It
  is the tendency of an object moving in a certain direction to keep going at
  the same speed in the same direction.

• Demonstrate understanding of the conservation of energy and the
  conservation of linear momentum
  Definition of conservation of momentum - when there is no net external
  force acting on a system of particles the total momentum of the system is
  conserved. Basically no matter what the nature of interaction its total
  momentum will remain the same.
  Conservation of energy - the amount of energy remains constant and
  energy is neither created nor destroyed.

• Demonstrate understanding of angular momentum and torque and
  angular momentum conservation
  Objects moving around a fixing point are considered to have angular
  momentum the smaller the circle the faster the spin. Since torque is the
  turning or rotating of an object this theory pertains to torque as well.

• Demonstrate understanding of the force of gravity
  The attraction of 2 objects based on their masses is gravity. All matter
  has gravitational forces. The more the matter the greater the
  gravitational force.

• Demonstrate understanding of pressure and Pascal’s principle for fluids
  A change is the pressure in a closed fluid will be equally distributed to all
  parts of the fluid. This principle applies to hydraulics.
• Demonstrate understanding of Archimedes’ principle (buoyancy)

The buoyant force of an object in a fluid is an upward force equal to the weight of the volume of fluid it displaces. An object will sink if it weighs more than the water it displaces. It will float if it weighs less than the water it displaces.

• Demonstrate understanding of Bernoulli’s principle for fluids

As the speed of fluid increases, its pressure decreases. This principle allows for airplanes to achieve lift. Air is considered a fluid because it has a high percentage of water vapor.

2. Electricity and Magnetism

• Demonstrate understanding of the repulsion and attraction of electric charges

Opposite charges attract just as in magnets. Same charges repel.

• Demonstrate understanding of the characteristics of current electricity and simple circuits (for example, resistance and Ohm’s law, electromotive force, potential difference, capacitance, current)

Resistance – the opposition to the flow of electric charges
Ohm’s law – the law that states the relationship between current voltage and resistance
Electromotive Force – the difference between the electric potential and actual usage.
Potential difference – the difference in an electrical charge as it moves from one point to another
Capacitance – the number of electrons a capacitor can hold
Current – continuous flow of charge through a circuit caused

• Apply Ohm’s law to series and parallel circuits

Ohm’s Law Parallel Circuits - voltage is constant, while the “current drop” across each parallel leg differs, due to the load of that leg.

(Current) \( \frac{V}{R} = \frac{V}{R_1} + \frac{V}{R_2} + \frac{V}{R_3} \)
(Resistance) \( \frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} \)

Ohm’s Law Series Circuit –
● Compare and contrast series and parallel circuits
  Series Circuit – all parts are connected in a single loop in a closed circuit. When one item is removed from the circuit the entire circuit fails to work. Parallel circuit – different branches connect back to the energy source. Items wired in a parallel circuit are not dependant of the other loads in the circuit.

● Compare and contrast conductors and insulators
  Conductor is a material through which electricity flows easily
  Insulator is a material that does not allow electricity to pass through

● Compare and contrast direct current and alternating current
  Direct Current or DC is typically from batteries and applies a straight flow of current only in one direction from the source of energy. Alternating Current or AC is current that we have in our homes. Current flows or alternates in directional force.
  *Both are a viable energy source but direct current source are usually limited in nature, such as a battery and can run out, whereas AC current can usually supply and endless supply.

● Identify sources of EMF (for example, batteries, photo cells, generators)
  Batteries – come in 2 forms, wet cells and dry cells, both of which utilize chemicals to create and maintain a charge
  Photo Cells – contain silicon atoms, as light shines on the cells, electrons are ejected and sent along the wire connected to the cell. This will occur as long as light shines on the cell.
  Generators – converts kinetic energy into usable electrical energy, typically with a motor (electromagnetic source)

● Demonstrate understanding of magnets, magnetic fields, and magnetic forces
  Magnets have north and south poles, opposite poles attract and like poles repel each other. Magnetic fields are created surrounding electric currents. Magnetic forces can be create electricity such as in a generator.

● Demonstrate understanding of how transformers and motors work
  Step-up Transformers - transformers use by electrical plants that increase the voltage but lower amps to allow for electricity to travel over great distances to end consumers.
  Step-down Transformers – these transformers lower the amount of voltage but increase the amps coming into a home so that it is in a usable form. Typically the transformers on poles behind your houses would be a step down.
  Generators – converts kinetic energy into usable electrical energy, typically with a motor (electromagnetic source)
  Motors – changes electrical energy into kinetic energy.
3. Waves

- Define and use the terms speed, amplitude, wavelength, and frequency
  
  **amplitude** – the height of the wave from its rest position, effects the loudness of a sound wave
  
  **wave speed** – the wavelength x frequency of a wave
  
  **wavelength** – the distance from 2 crests, troughs or other chosen spot on 2 waves
  
  **frequency** – the amount of waves in a given period of time, effects the pitch of a sound wave

- Distinguish between the characteristics of transverse and longitudinal waves
  
  Transverse waves do not require a medium. They travel perpendicular to the source of their energy. The highest part is the crest and the lowest part is the trough. Longitudinal waves require a medium through which to travel. They travel much like a slinky. The area of compaction is called a compression and the area of the wave which is stretched apart is called the rarefaction.

- Demonstrate understanding of reflection, refraction, dispersion, absorption, transmission, scattering, and superposition
  
  **reflection** – the bouncing back of a wave off of a smooth surface can be any type of wave in light an example would be seeing yourself in a mirror
  
  **refraction** – the bending of a wave as it travels from one medium to another
  
  **dispersion** – the spreading out of a wave over a broad area.
  
  **absorption** – when particles through which the wave travels absorb some of the energy of the wave
  
  **transmission** – passing of light through matter
  
  **scattering** – the release of energy that has been absorbed by particles as a wave has passed.
  
  **superposition** – 2 or more waves interact without changing their amplitude

- Demonstrate understanding of diffraction and interference
  
  **diffraction** – when waves bend around or through a barrier. This is the reason we can hear around corners.
  
  **Interference** – when 2 more waves interact with one another. In constructive interference the crests of 2 wave combined to amplify the wave. When the crest of one and the trough of another wave overlap, destructive interference occurs and lowers the amplitude.

- Demonstrate understanding of the Doppler Effect
  
  When wave speeds increase the pitch of a sound wave gets higher. In the Doppler Effect, as a vehicle with a loud siren comes towards a person the
waves are getting to the person increasingly faster. This causes a higher pitch to be heard. Once the vehicle has passed and the waves are reaching the person at a slower rate, the pitch of the sound lowers. Doppler principles are also utilized by weather forecasters to determine the direction of storms.

- **Demonstrate understanding of polarization**
  Polarized light waves only travel in one specific direction. They are great for sunglasses as they can allow you to see fish and other items in the water that would normally be reflected or refracted away from your eyesight.

- **Recognize the characteristics of sound waves (for example, pitch, loudness, speed)**
  - **Pitch** = the frequency of a wave, the higher the higher the pitch
  - **Loudness** = the amount of amplitude, the higher the amplitude the louder the sound
  - **Speed** = combination of the frequency and wavelength of a wave

- **Characterize the electromagnetic spectrum (gamma rays to radio waves)**
  - **Radio Waves** – long wavelengths carry radio and television information for entertainment
  - **Microwaves** – radio waves with the shortest wavelengths, used in microwave ovens and to transmit cellular telephone messages
  - **Infrared Waves** – provides heat energy such as that in your toaster
  - **Visible Light Waves** – the part of the spectrum that you can see
  - **Ultraviolet Waves** – too short to see, but help to produce vitamin D, can cause cancer
  - **X-rays** – pass through the body and are absorbed by dense tissues, will leave an image on the film to determine bone breaks etc.
  - **Gamma Rays** – used to diagnose and treat cancer
Demonstrate understanding of how sound waves are produced by the vibrations of air columns and strings

Sound Quality – the result of several pitches blending together to form music from instruments.
Resonance - when 2 objects vibrate at or near the same frequency, they can cause a second object to vibrate.
Sound waves vibrate the air inside chambers of an instrument when the string is plucked and stroked. The air is amplified by the hollow core of the instrument and resonates outward from the instrument.

Demonstrate understanding of color and the visible spectrum (for example, addition and subtraction, relationship to wave frequency)

When all light waves are combined you will see white light. One way to remember the order of the light spectrum is Roy G. Biv (Red, Orange, Yellow, Green, Blue, Indigo, Violet) Red has the longest wavelength, violet has the shortest frequency.

Demonstrate understanding of geometric optics (mirrors, lenses, prisms, fiber optics) and of polarization

Mirrors – reflection
Lenses – convex, curved outward, makes things look smaller; concave, curved inward, makes things look larger
Prisms – a triangular shaped object that allows light to pass through and be refracted at different lengths to show all of the colors of the spectrum.
Fiber Optics - the use of fibers to transmit light over long distances
Polarization – when light vibrates only in one plane

B. Chemistry

(I checked out a video at our local library on chemistry that did a very good job at re-explaining chemical formulas etc. For me, reading over the material still left me fuzzy as the last chemistry class I had was 1986

1. Periodicity

Demonstrate understanding of the meaning of chemical periodicity

Periodicity is the similarity between the properties of chemical elements that are grouped together on the periodic table. Families are in columns across the table and periods going down the rows of the periodic table. The left hand side of the table contains the metals and the far right side contains the gasses. The atomic weight on the element corresponds with its place on the table. The heavier the element the higher the number and lower on the chart the element will be found
● Demonstrate understanding of periodic trends in chemical and physical properties

The Period Table is an organized chart of the known elements in the world. Elements have common characteristics with others in the same row or column.

Group (Column) 1 = Alkali Metals
Group 2 = Alkali Earth Metals
Group 3 = Group 12 Transition
Group 13 = Boron Family
Group 14 = Carbon Family
Group 15 = Nitrogen Family
Group 16 = Oxygen Family
Group 17 = Halogens (the most reactive non-metals)
Group 18 = Noble Gases

2. The Mole and Chemical Bonding

● Demonstrate understanding of the mole concept and chemical composition

1 mole of molecules has a mass equal to the molecular weight in grams. For example, nitrogen atomic weight is 14.0067, which means that one mole of N is 14.0067 g, 2 moles of N would be 28.2 g and so on.

● Interpret and use chemical formulas

The formulas quickly demonstrate the composite of the formulas in a “short hand” type of representation. Two Examples are below:
C6H12O6 would mean 6 molecules of carbon, 12 of hydrogen and 6 of oxygen and represents glucose.
H2O represents 2 hydrogen and 1 oxygen molecule

- **Demonstrate understanding of the systematic nomenclature of inorganic compounds**
  A naming system for chemicals. For inorganic compounds the positive ion (cation) is always named first and listed first in writing the formula for the compound.

- **Demonstrate understanding of the nomenclature of simple organic compounds**
  For organic compounds 3 things are required to name the compounds, 1) A base indicating the ring of carbon atoms found in the molecular structure 2) A suffix designating other groups that may be present in the compound. 3) Names of substituent groups, other than hydrogen, that complete the molecular structure.

- **Identify the various types of bonds**
  - **Ionic Bonds** – bond between 2 oppositely charged ions
  - **Covalent Bonds** – bond between the shared electrons of an atom and the nuclei of the atoms
  - **Metallic Bonds** – attraction between positive charged metal ion and electrons in a metal
  - **Chemical Bond** – the bonding of 2 atoms
  - **Hydrogen** – water formation, positive ions attracted to other molecules

- **Interpret electron dot and structural formulas**
  Electron Dot Diagrams show the valence electrons of an atom and are useful in demonstrating how bonding might transpire in atoms. Below is a picture of several Dot Diagrams:
3. The Kinetic Theory and States of Matter

- **Demonstrate understanding of kinetic molecular theory**
  
  The Molecular Theory States:
  - Matter is composed of molecules of atoms. The space that the molecules occupy (volume) is derived from the space in between the molecules and not the space the molecules contain themselves.
  - The molecules are in constant motion and each state of matter differs in the speed of that motion. Molecules move fastest in gases, then liquid then solid.

- **Demonstrate understanding of phase changes**
  
  Condensation – from gas to a liquid
  Freezing – from a liquid to a solid
  Evaporation – liquid into a gas at less than a boiling point
  Melting – solid to a liquid
  Vaporization – liquid to gas at boiling point
  Sublimation – solid straight to a gas

- **Demonstrate understanding of the relationships among temperature, pressure, volume, and number of molecules of a gas**
  
  Temperature – as temp increases, the volume of gas will increase and vice versa.
  Pressure – as pressure increases, volume decreases, thinking of it as pushing it down with the increased pressure, as pressure lowers volume increases.
  Volume – increases as pressure decreases
  Number of molecules – the # of molecules remains the same. The amount of space it takes up does not.

- **Demonstrate understanding of the characteristics of crystals**
  
  Crystals are orderly 3 dimensional arrangements of molecules. Rock crystals form from magma, as with all crystals the slower they cool, the larger the crystal. Crystals do not just form in rocks. They can also form in solutions.

4. Chemical Reactions

- **Demonstrate ability to balance chemical equations**

  \[
  \begin{array}{ccc}
  \text{Balancing} & \text{Equations} \\
  ① H_2 + O_2 & \rightarrow & H_2O \\
  ② H_2 + O_2 & \rightarrow & 2H_2O \\
  ③ 2H_2 + O_2 & \rightarrow & 2H_2O \\
  ④ Al + Cl_2 & \rightarrow & AlCl_3 \\
  ⑤ 2Al + 3Cl_2 & \rightarrow & 2AlCl_3 \\
  \text{Balanced Equation} & \rightarrow & \text{CH}_4 + 2O_2 \rightarrow 2H_2O + CO_2
  \end{array}
  \]
• Identify the various types of chemical reactions
   When one or more substance changes to produce a different substance a chemical reaction has taken place. Clues to chemical reactions include, the formation of gas, solid formation, color change, energy change and smell. Rusting is a common example of a chemical change. Another example is the breaking down of foods with enzymes.

• Distinguish between endothermic and exothermic chemical reactions
   Exothermic means “out” or that the energy is released or removed from the chemical reaction.
   Endothermic means “in” or that the energy is absorbed during the reaction.

• Demonstrate understanding of the effects of temperature, pressure, concentration, and the presence of catalysts on chemical reactions
   Temperatures – as increases, increases the rate of reaction
   Concentration – as the concentration increases there is more reactant and the rate of reactions increases.
   Surface area – increased exposed surface area, increases the rate of reaction
   Catalysts – substance that speeds up the reactions
   Inhibitor – a substance that stops the chemical reactions.

• Demonstrate understanding of practical applications of electrochemistry
   The use of chemicals to create electricity such as in the case of wet and dry cell batteries.

5. Solutions and Solubility
• Demonstrate understanding of solution terminology and distinguish among types of solutions
   Solution – a mixture of 2 or more substances. Can be a solid, such as steel, liquid, such as soft drinks or even a gas, such as our air.
   Solute is the lesser substance and the Solvent is the substance with greater quantity.
   Concentration – measure of the amount of solute in a solvent
   Solubility – the amount of solute needed to saturate a solution
   Suspension – particles are throughout the liquid but settle when left alone over time. The particles are large.
   Colloids – dispersed through but not heavy enough particles to settle out. Particles can be seen.

• Demonstrate understanding of various types of solvents and factors affecting the dissolving process
   Solvents include water, which is inorganic and organic solvents including oxygenated (alcohols & ketones), hydrocarbon solvents (aliphates & aromatics) & chlorinated solvents
Demonstrate understanding of the effect of temperature and pressure on the solubility of a solute

There are 3 ways to speed up the solubility of a solute, heating, mixing and crushing the substances. In terms of temperature, in liquids an increase in temperature will increase the solubility. However, in gases as the temperature rises the gas has a lower ability to hold the solute and so it decreases. To increase solubility you must lower the temperature of gases. This is the opposite of liquids.

Demonstrate understanding of the physical and chemical properties of acids, bases, and salts

Acids – increase the # of hydrogen ions. Tastes sour and can change color. They are corrosive. Turns blue litmus paper red

Bases – increases the # of hydroxide ions. Tastes bitter, feels slippery and can change colors. Turns red litmus paper blue.

<table>
<thead>
<tr>
<th>pH Level</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (VERY acidic)</td>
<td>Hydrochloric acid</td>
</tr>
<tr>
<td>2</td>
<td>Lemon juice</td>
</tr>
<tr>
<td>3</td>
<td>Soft Drinks</td>
</tr>
<tr>
<td>4</td>
<td>Tomatoes</td>
</tr>
<tr>
<td>5</td>
<td>Black coffee</td>
</tr>
<tr>
<td>6</td>
<td>Milk</td>
</tr>
<tr>
<td>7 (neutral)</td>
<td>Human saliva &amp; tap water</td>
</tr>
<tr>
<td>8</td>
<td>Sea water</td>
</tr>
<tr>
<td>9</td>
<td>Baking soda</td>
</tr>
<tr>
<td>10</td>
<td>Milk of Magnesia</td>
</tr>
<tr>
<td>11</td>
<td>Detergents</td>
</tr>
<tr>
<td>12</td>
<td>Ammonia</td>
</tr>
<tr>
<td>13</td>
<td>Oven cleaner</td>
</tr>
</tbody>
</table>

(I remember that Acid begins with A and so starts with #1)

Salts - have a positive electrical charge and replace hydrogen ions with metallic ions. In other words a positive ion from a base and negative ion of an acid combine.

Demonstrate knowledge of the meaning of pH and the effects of buffers

Ph is the Potential Hydrogen available in a solution. The above scale shows numbers 1-14 and examples along the scale. 1-6 pH are considered Acidic, 8-14 would be considered Alkaline. A 7 would be a neutral substance. Buffers are substances that resist change in the Ph value.
Chapter 4  Life Science

A. The Cell

- Demonstrate knowledge of the structure and function of organelles, including membranes
  - Membranes allow materials to enter and leave the cells through a process known as osmosis.
  - Organelles float inside the cells in a fluid like substance known as cytoplasm.
  - Nucleus – contains DNA and is the control center of the cell.
  - Chloroplasts – in plant cells, makes food from the energy of the sun.
  - Ribosome – amino acids are hooked together to form proteins.
  - Golgi Complex – moves materials in and out of the cell.
  - Endoplasmic Reticulum (ER) – makes lipids and breaks down substances to be released outside of the cell.
  - Vacuole – stores water and other substances.
  - Mitochondria – makes ATP from broken down food molecules.
  - Lysosomes – digests food particles, wastes and foreign substances.
  - Cell wall – outer layer of Plant cells only.

- Distinguish between prokaryotic and eukaryotic cells

<table>
<thead>
<tr>
<th>Prokaryotic Cells</th>
<th>Eukaryotic Cells (you &amp; I)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No nucleus</td>
<td>Nucleus</td>
</tr>
<tr>
<td>No membranes</td>
<td>Membrane covers organelles</td>
</tr>
<tr>
<td>Circular DNA</td>
<td>Linear DNA</td>
</tr>
<tr>
<td>Bacteria</td>
<td>All other cells</td>
</tr>
</tbody>
</table>

- Demonstrate understanding of the cell cycle and cytokinesis
  - Cell copies the chromosomes and centrioles
  - Mitosis Phase I – centrioles move to opposite sides of cell and chromosomes form rod like structures.
  - Mitosis Phase II – Chromosomes line up along the equator.
  - Mitosis Phase III – Chromatids separate pulling the opposite sides apart.
Mitosis Phase IV – Membrane forms around the two new sets of chromosomes

Cytokinesis – the splitting of the cytoplasm into 2 distinct new cells

- Demonstrate understanding of chemical reactions in respiration and photosynthesis
  
  Respiration and Photosynthesis are basically opposite reactions. In Photosynthesis carbon dioxide and water combine with light to form glucose and oxygen
  
  \[6\text{CO}_2 + 6\text{H}_2\text{O} + \text{light} \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2\]

  Respiration combines glucose and oxygen to form carbon dioxide, water, and energy (ATP)
  
  \[\text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2 \rightarrow 6\text{CO}_2 + 6\text{H}_2\text{O}\]

- Demonstrate understanding of mitosis and meiosis
  
  Mitosis is the division of cells into 2 identical cells and uses 4 stages. Mitosis is the division of sex cells and creates 4 new cells in 8 stages. Each new cell has half the DNA found in the original cell.

B. Genetics

- Demonstrate understanding of DNA replication
  
  DNA has nucleotides, A = Adenine, T=Thymine, G=Guanine and C=Cytosine. A only matches up to T and G only matches up across from C! The DNA strands separate and the cell matches up the corresponding nucleotide to the open end of the DNA strand making an exact copy of the previous strand.

- Demonstrate understanding of the processes involved in protein synthesis
  
  The first step of making a protein is to copy the section of a DNA strand containing a gene. The DNA is then sent to the ribosome where attaches the appropriate amino acid in the right order. Bases of the molecules attach to the DNA strand. Once the amino acids are joined a protein has been created.

- Demonstrate understanding of the causes and results of mutation
  
  When the order of the protein DNA bases is left out, changed or deleted in some way a mutation occurs. As the DNA replicates itself again, the mistake continues on through mitosis and meiosis.

- Demonstrate understanding of some aspects of non-Mendelian inheritance (for example, multiple alleles, multiple genes)

  In humans multiple genes often act together. This is why we have so many different colors of eyes, hair and skin color. Multiple alleles are responsible for humans having multiple blood types.
- Demonstrate understanding of Mendelian inheritance (monohybrid and dihybrid crosses)

<table>
<thead>
<tr>
<th></th>
<th>$R$ (dominant for round seeds)</th>
<th>$r$ (recessive trait for wrinkled seeds)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$Rr$</td>
<td>$Rr$</td>
<td>$Rr$</td>
</tr>
<tr>
<td>$Rr$</td>
<td>$Rr$</td>
<td>$Rr$</td>
</tr>
</tbody>
</table>

All of the above plants would have Round Seeds.

<table>
<thead>
<tr>
<th></th>
<th>$R$ (dominant for round seeds)</th>
<th>$r$ (recessive trait for wrinkled seeds)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$RR$</td>
<td>$RR$</td>
<td>$Rr$</td>
</tr>
<tr>
<td>$Rr$</td>
<td>$Rr$</td>
<td>$rr$</td>
</tr>
</tbody>
</table>

In this case there would be 3 plants with a Phenotype of having round seeds and one would demonstrate wrinkled seeds. Phenotype is the outward appearance of an organism and genotype is the actual genetic disposition of an organism. For example, above, the plant that is $Rr$ would appear to have round seeds but could produce a plant with wrinkled seeds because it has a genotype of $Rr$.

- Demonstrate knowledge of how recombinant DNA is constructed and Identify uses of recombinant DNA (for example, in the production of insulin)

For years humans with diabetes utilizing insulin created by pigs to survive through their disease. More recent advances have enabled scientists to create insulin using recumbent DNA. In this process human genes are placed inside of bacteria causing them to produce human insulin. There was initially much controversy surround the manipulation of human DNA. It is now fairly common.

- Demonstrate understanding of the interaction between heredity and environment

Heredity is the genetic material passed on by the parent to offspring. The environment can have just as severe an impact based on the nutrition and optimal growing conditions. For example, as person can have a gene for a certain disease but with proper medical treatment and diet the person may never develop a full blown case of the disease, however, without proper care the person can develop the disease.
• Identify chromosomal and gene aberrations that lead to common human genetic disorders (for example, Down syndrome)
  
  Down’s Syndrome – can be determined by karyotyping the chromosomes, is caused by an extra 21st chromosomes
  Turner Syndrome – have only one x chromosome
  Klinefelter’s Syndrome – have 2 x and one y chromosomes
  Sickle Cell – 11th pair of chromosomes

C. Evolution

• Identify evidence that supports the theory of evolution
  Evolution is supported by the fossil records, the likeness of many different animals’ skeletons, embryonic structures and genetic similarities. One of the principle theories involves “survival of the fittest” whereby the fit animals will survive leading to improved breeds.

• Demonstrate understanding of the mechanisms of evolution
  Natural Selection occurs in response to the environment. Animals become speciated by Separation, Adaptation and Division. Animals adapt to their environment with their behaviors and reproduction.

• Demonstrate knowledge of isolating mechanisms and speciation
  Isolating mechanisms can create new species of animals. For example in the Grand Canyon squirrels living in the canyon became separated during the creation of the Grand Canyon. This formed 2 separate families. Based upon the food eaten, their abilities to survive predators, the amount of predators, amount of food etc, each group of squirrels adapted new features. Today there are distinctly different squirrels in the Grand Canyon Park.

  A similar event occurred with Finches in the Galapagos Islands. Isolated Finches have developed distinctly different features and can not even interbreed any more.

• Demonstrate understanding of the scientific hypotheses for the origin of life on Earth
  The basic hypothesis for the life on earth involves the Big Bang Theory. Life slowly began after the initial cooling of the earth. Earth formed several billion years ago. The earliest signs of life come from the Paleozoic period and involves mostly fishes, followed by reptiles, plants, birds, dinosaurs, plants, insects, mammals and lastly humans.

D. Diversity of Life

• Demonstrate understanding of the levels of organization and characteristics of life
  In order for something to be considered life it must reproduce and utilize water. There are many definitions. There are consumers, decomposers
and producers within the realm of living organisms. Consumers obtain nutrients from other organisms, producers, make their own food and decomposers feed on dead organisms.

● Identify the elements of the hierarchical classification scheme into kingdom, phylum, class, order, family, genus, and species
  
  Phylums – each Kingdom is divided into several phylums
  Classes – each phylum are divided into classes
  Orders – classes are divided into orders
  Families – orders are divided into families ex, felidae (cats)
  Genus – families are divided into genus
  Species – lowest level of classification
  One way to remember is the mnemonic: King Phillip Came Over From Greece Sloshed!

● Demonstrate knowledge of the characteristics of viruses, bacteria, protists, fungi, plants, and animals
  
  Viruses – microscopic organism that invades cells. It can not live on its own. It needs a host.
  Bacteria – small simple organism, oldest organisms on earth
  Protista – single celled animal with a nucleus, use photosynthesis for energy
  Fungi – obtain food by breaking down food in their surroundings and absorbing nutrients
  Plants – have cell walls, make their own foods and sex cells
  Animals – many cells, sexual reproduction, specialized parts, move and are consumers.

E. Plants

● Demonstrate understanding of the characteristics of vascular and nonvascular plants
  
  Vascular – have a tissue system to supply water and nutrients along the length of the plant.
  Nonvascular – non tubes to distribute water and food, must use diffusion or osmosis for nutrients

● Demonstrate understanding of the structure and function of roots, stems, and leaves
  
  Roots – supports the plant and supplies plant with water and nutrients, they can also store excess food
  Stems – store material, support the body and connect root system to leaves
  Leaves - photosynthesis
● Demonstrate understanding of control mechanisms (for example, hormones, photoperiods, and tropisms)

  hormones – can effect the plant flowering mechanism, growth sexuality
  photoperiods – the requirement of a plant to have a certain length of daylight in order to flower. This can be controlled variable
  tropisms – growth in response to a stimuli

● Demonstrate understanding of water and nutrient uptake and transport systems

  Water is taken in from the root systems and brought up the stems to the leaves where the water is combined with light and carbon dioxide to release oxygen. Stored food in often in the form of a fruit.

● Demonstrate understanding of sexual and asexual reproduction in plants

  In asexual reproduction of plants the stem or root produces the new plant. A strawberry produces by way of runners along the ground.
  During sexual reproduction, flowering plants produces sperms cells and has ovaries. The seeds are fertilized often with the assistance of insects. The ovary then develops into a fruit. The seeds lay dormant inside of the fruit until conditions cause the seed to be released, buried under soil and become a new plant.

F. Animals

● Demonstrate understanding of the anatomy and physiology of structures associated with life functions of organisms in the animal kingdom: digestion; circulation; respiration; excretion; nervous control; musculoskeletal system; immunity; the endocrine system; reproduction and development

  Digestion System – stomach, pancreas, liver, gallbladder, small intestine & large intestine. The stomach starts the digestion of proteins but the small intestine absorbs all other carbohydrates, proteins and lipids. The large intestine only absorbs water
  Circulation System – heart, blood and blood vessels, the job is to provide nutrients to all the cells of the body and remove carbon dioxide that the cells have produced.
  Respiration – lungs, throat and associated pathways to the lungs. The job is to intake and expel gasses for use by the circulatory system
  Excretion – process of removing wastes from the body
  Nervous System – brain nerves and spinal cord, the function is to send and receive messages to the body from the brain
  Musculoskeletal System – muscles and connective tissues
  Immunity System – cells, organs tissues that fight off disease; Phagocytes and Lymphocytes - T cells and B cells
  Endocrine System – glands that control growth, including sexual development and the fluid balance in the body; hormones
  Reproduction System – female = uterus, ovaries, egg cells, fallopian tubes and vagina; male = penis, urethra, epididymis, testis, scrotum, ejaculatory
duct, seminal vesicle, vas deferens and prostate gland. Females are born with all the eggs they will have in their life and contribute only X chromosomes. Males produce sperm at adolescence and contribute both X or Y chromosomes and therefore determine the sex of babies.

**Demonstrate knowledge of homeostasis and how it is maintained**

Homeostasis is a regulating process that keeps a steady balance from disturbing external influences. For example, the human body core temperature is homeostatically maintained to within a degree or 2 of 98.6 despite variations in the temperature of the air surrounding humans. This is done through signals from the brain to sweat, to cool humans, or to constrict blood vessels on the surface, to warm humans, etc.

**Demonstrate knowledge of how animals respond to stimuli**

Animals respond to light, gravity, touch, and various other stimuli in a fashion that would indicate acceptance or dislike to the stimuli. For example, some worms and fish will move toward light. This is an automatic response and conducted with the use of a thinking brain.

G. Ecology

**Demonstrate understanding of population dynamics**

Population dynamics is the number of animals of a particular species in an area. Limiting factors like the availability of food, water, and shelter can impact an area’s ability to sustain plant and animal life. The amount of plants and animals in an area can affect the livelihoods of other populations. If there is a drastic change in one population, it will inevitably change the population of the others. For example, if the population of one particular animal increases, the demand for its food will increase, lowering the availability of the food for both its species and other species.

**Demonstrate knowledge of social behaviors (for example, territoriality, dominance, altruism, threat display)**

- **Territoriality** – a system where animals spread themselves out and claim a territory. Often times the fittest animal picks the best spot for food, water and mating, thereby sending the lesser fit animals to less than optimum conditions.
- **Domiance** – an animal's place within the group is determined by its relationships with other members of the group. Animals challenge each other to determine who is the so-called dominant figure. Once decided, animals respect the dominancy of one animal or challenge it with a fight.
- **Altruism** – when animals help other animals; this goes against Darwin’s theory of the survival of the fittest.
- **Threat display** – used by animals to demonstrate they are willing to fight and often thwart off potential fights.
• Demonstrate understanding of intraspecific competition
  Intraspecific competition is the struggle for limited resources. It is resolved through competition or cooperation. Related to symbiosis.

• Demonstrate understanding of interspecific relationships (for example, commensalism, mutualism, parasitism)
  commensalism – when one organism benefits from the relationship but the other is not affected. Ex. Sharks and remoras.
  mutualism – relationship in which both organisms benefit. Ex. Bacteria in human intestines and humans. Humans provide food to the bacteria. The bacteria provide vitamins to humans.
  parasitism – when one organism benefits and the other is harmed. Ex. Caterpillars and plants.

• Demonstrate understanding of succession
  Succession is the gradual development of a community over time. An example would be beach communities. Over time communities develop from beach sand dunes up to a forest. The primary succession causes fertilized soil to develop and enables the next level or succession of plant life to survive and so on.

• Demonstrate understanding of the concepts of stability of ecosystems and the effects of disturbances
  Ecosystems are a balance of the plants and animals living in them. When one animal starts to reproduce or increase it puts a demand on the food supply. On the opposite end of the spectrum, if one animal is taken away from the ecosystem a negative effect can also occur because that or plant may play a crucial role in controlling another animal’s population. If you take a snake out of an ecosystem, the population of plant eating insects may increase and cause plants to be overwhelmed and die off, causing other animals to die off and so on.

• Demonstrate understanding of energy flow (for example, trophic levels and food webs)

![Food Chain/Trophic Levels Diagram]

Each level requires an increased amount of energy to sustain life. There are producers, consumers and decomposers in food chains. Each level has a common requirement of energy.
● Demonstrate understanding of biogeochemical cycles (for example, nitrogen, carbon, water)

Water cycle – water flows in a continuous cycle of evaporation, precipitation, infiltration, runoff, followed by evaporation etc.
The carbon cycle – carbon is released by animals, combustion and volcanoes and then taken back in by plants and cycled back through Nitrogen Cycle – nitrogen composes 78% of the atmospheric gases. Plants and animals utilize nitrogen and then release it in a similar cycle

Oxygen cycle – oxygen is mainly absorbed and released through water.

● Identify the types and characteristics of biomes

Forests – an area with enough rain to sustain lush foliage

Deciduous – in warmer climates. Leaves fall off of the trees during the winter to conserve water.

Coniferous – in the colder climates. Mostly evergreens that do not lose their leaves during the winter months.

Tropical Rain – warmest climates. These are divided into 3 regions, the canopy, the ground level and the trees. Largest rainfall and warmest average temperatures

Deserts – extreme hot and cold areas with limited resources of water.

Tundra – an area too cold for trees to grow. Ground is often in a frozen state or permafrost

Grasslands – usually between deserts and forests. This area gets enough water to sustain grasses but not trees. Usually a very short rainy season and long droughts.

Highlands – an area above the tree line that can located at any latitude including along the equator. Extremely cold and limited trees.
A. Physical Geology

- Demonstrate understanding of the processes of mineral and rock formation

  Sedimentary rocks form from the weathered remains of all 3 types of rocks that have been lithified.  
  Igneous rocks – form with the crystallization of hot magma from within the earth. The slower the cooling the larger the crystals 
  Metamorphic rocks are formed by heat, pressure and /or chemicals altering existing rock deep within the earth’s crust.

- Demonstrate understanding of the methods used to identify and classify different types of minerals, rocks, and soils

  There are 4000 minerals but only 8 make up 98% of the crust of the earth. Those elements are, O, Si, Al, Fe, Ca, Na, K, Mg. Minerals are classified by their crystal sizes, luster, color, streak, hardness, cleavage and fracture properties. Hardness is based on the Mons Scale, basically if one mineral is capable of scratching another it must be harder. Below is the Mons Scale

<table>
<thead>
<tr>
<th>Hardness</th>
<th>Mineral Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>Diamond</td>
</tr>
<tr>
<td>9</td>
<td>Corundum</td>
</tr>
<tr>
<td>8</td>
<td>Topaz</td>
</tr>
<tr>
<td>7</td>
<td>Quartz</td>
</tr>
<tr>
<td>6</td>
<td>Potassium Feldspar</td>
</tr>
<tr>
<td>5</td>
<td>Apatite</td>
</tr>
<tr>
<td>4</td>
<td>Fluorite</td>
</tr>
<tr>
<td>3</td>
<td>Calcite</td>
</tr>
<tr>
<td>2</td>
<td>Gypsum</td>
</tr>
<tr>
<td>1</td>
<td>Talc</td>
</tr>
</tbody>
</table>

Soils – aridisols (very dry and light in color), mollisols (dark and fertile in grasslands), alfisols (found under forest vegetation from Southern Florida to Minnesota), Ultisols (SE United States, tend to be red and are found where there is lots of water), Spodosols (rich with sand), Entisols (immature sands deposited from wind or water), Inceptisols (found in Tundra environments), Vertisols (heavy clay), Histosols (organic from poor drainage areas), Andisols (volcanic material).
● Demonstrate knowledge of the structure of Earth and the physical characteristics of Earth’s various layers

The layers of the earth are the Inner Core, Outer Core, Mantle, and the Crust
Lithosphere – outer most layer, the land area we see
Biosphere – the life on earth
Atmosphere – the layer of gases surrounding the earth
Hydrosphere – the water portion of the earth of which 3% is fresh water and 97% is salt water. Large portion of the 3% of fresh water is locked up in the glaciers.

● Demonstrate understanding of the internal processes and resulting features of Earth, including folding, faulting, earthquakes, and volcanoes

Movement of the plates causes several different events to occur. Folding is when 2 plates are compressing against one another. The folding causes either an Anticline (the shape of an A) or a Syncline to occur.
Faulting is where 2 plates move past one another. Earthquakes are vibrations of the earth’s crust caused by the rapid release of energy. Volcanoes usually are found along fault lines. They are an area where hot magma is thrown from the center of the earth at intervals.

● Demonstrate understanding of plate tectonic theory and the evidence that supports this theory

Theory – earth’s continents are on large plates that float on the earth’s mantle. They were once all one super continent. There is evidence to support this Continental Drift Theory, such as
a) The fit of the continents, like that of a large puzzle
b) Fossil evidence on different continents aligned with the puzzle
c) Rock types and structure similarities where the continents would have been connected.

● Demonstrate understanding of the hydrologic cycle and the processes by which water moves through the cycle

Water moves through the cycle by the means of:
a) Evaporation – from the oceans and streams
b) Precipitation – over the land
c) Infiltration – water seeping into the lakes and streams through the soil
d) Transpiration – absorbed by plants and later released back into the atmosphere
e) Runoff – from the lakes and streams back into the large oceans and seas
Demonstrate understanding of the processes of weathering, erosion, and deposition

There are 2 types of weathering, mechanical and chemical. Mechanical is caused by frost wedging expansion, thermal expansion and biological activity. Chemical is caused by dissolution, oxidation and hydrolysis. The type of rock, climate and amount of time will affect how fast the weathering can occur.

Erosion is the transportation of material by water, wind and ice. Erosion occurs mainly because of weathering.

Deposition is when water vapor turns into ice without going through the liquid state.

B. Historical Geology

Demonstrate understanding of the principle of uniformitarianism

Uniformitarianism states that physical, chemical and biological properties that exist today also existed in the past, the same principles. It does not mean that things occurred at the same rate as they do today.

Demonstrate understanding of the basics principles of stratigraphy

This is also known as the Laws of Supposition. Basically if you are looking at a side view of layers of rocks the oldest rocks will be on the bottom and the newer rocks will be on the top. Igneous intrusions will be newer than the layers of rocks they cut through as those rocks would have had to have been there before they could seep through.

Distinguish between relative and absolute time

Relative dating is placing rocks and structures in an order of occurrence based on evidence and then extrapolating the dates of existence. Absolute dating is when you know the exact date a formation occurred. For example, the weathering of a tombstone can be considered absolute because you have a date of which the tombstone was placed there.

Recognize the processes involved in the formation of fossils

a) Petrified – animals cavities are filled with minerals and replaced
b) Mold – shell buried in sediment then dissolved away leaves a mold
c) Cast – when the mold is filled with a mineral
d) Carbonization – left behind carbon in the shape of an animal
e) Impressions – prints or shapes left in rocks
f) Amber – some animals such as insects get trapped in a resin like material, leaving complete animals preserved

Demonstrate understanding of the types of information fossils provide

Fossils provide information about the surface of the earth (water or land), the climate of an area and the types of organisms that existed at that time period.
- Demonstrate understanding of the geologic time scale and how it was developed
- Outline the sequence of important events in the Earth’s history

<table>
<thead>
<tr>
<th>Eon</th>
<th>Era</th>
<th>Period</th>
<th>Epoch</th>
<th>Development of Plants &amp; Animals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phanerozoic</td>
<td>Cenozoic</td>
<td>Quarternary &amp; Tertiary</td>
<td>Holocene, Pleistocene, Piocene, Miocene, Oligocene, Eocene, Paleocene</td>
<td>Humans Develop Age of Mammals Extinction of Dinosaurs</td>
</tr>
<tr>
<td></td>
<td></td>
<td>65 m. years ago</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mesozoic</td>
<td></td>
<td>Cretaceous, Jurassic, Triassic</td>
<td>Age of Reptiles</td>
<td>First flowering plants First birds Dinosaurs Develop</td>
</tr>
<tr>
<td></td>
<td></td>
<td>248 m. years ago</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Paleozoic</td>
<td></td>
<td>Permian, Pennsylvanian, Mississippian, Devonian, Silurian, Ordovician, Cambrian</td>
<td>Age of Amphibians</td>
<td>Extinction of trilobites First Reptiles First Insect fossils Fishes dominate Land Plants</td>
</tr>
<tr>
<td></td>
<td></td>
<td>540 m. years ago</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Proterozoic</td>
<td>Precambrian Time = 88% of the geological time scale 4.5 b. years ago</td>
<td>First multicelled organisms First one-celled organisms Origins of Earth</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Archean</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Hadean</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
C. Oceanography

- Demonstrate understanding of the geographic location of oceans and seas
  
  Your best bet is to make sure you know which continents they fall on, in or near by using a map.
  
  4 oceans – Atlantic, Pacific, Indian, Arctic
  
  Top 12 Seas, in order: Coral Sea, Arabian Sea, S. China Sea, Mediterranean Sea, Bering Sea, Bay of Bengal, Sea of Okhotsk, Gulf of Mexico, Gulf of Guinea, Barents Sea, Norwegian Sea, Gulf of Alaska

- Demonstrate understanding of the processes involved in the formation and movement of ocean waves
  
  Ocean waves are movement of energy through a medium. The water does not move but rather orbits in small circles. They are caused by the wind blowing across the ocean surface. There are different types of waves such as Capillary (wind driven), Wind Wave (wind over ocean), Seiche (change in atmospheric pressure, storm surge or tsunami), seismic wave (volcanic eruption of faulting on the seafloor), Tide (gravitational attraction of the rotation of earth)

- Demonstrate understanding of the primary causes and factors that influence tides
  
  Tides are caused by inertia and the gravitational pull of both the moon and the sun on the earth’s surface. This causes the rhythmic rising and falling of the water on the earth’s surface. Most coasts have semidiurnal tides or 2 high and 2 low tides per day. Neap Tides occur are the smallest variations between the high and low tide and occur when the sun earth and moon are at right angles. Spring tides occur when the earth sun and moon are in a straight line and are the largest variations between the high and low tide.

- Demonstrate understanding of the processes that influence the topography and landforms of the ocean floor and shorelines
  
  Sea floor landforms are created in similar ways to continental landforms. Volcanoes deposit lava which is solidified into rock or can create islands and canyons. Sea Floor Spreading can cause mass plains areas. Mountain building such as faulting and folding can cause underwater mountain ranges. Some ocean terms include the:
  
  a) Abyssal plain – an area where sea floor spreading has created flat plains like area under water
  b) Continental shelf – shallow region extending out from the continents
  c) Continental slope – where the shelf meets the deep reaches of the ocean
  d) Ridge – underwater mountain range
  e) Trench – Ocean floor canyon
Demonstrate knowledge of the major surface and deep-water currents in the oceans and the causes of these currents.

Currents are caused by the sinking of colder dense water and the rising of warmer water. The water circulates due to the uneven heating of the earth between the poles and the equator.

<table>
<thead>
<tr>
<th>Temperature</th>
<th>Current</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cold</td>
<td>Antarctic Circumpolar Current</td>
</tr>
<tr>
<td>Cold</td>
<td>Peru Current</td>
</tr>
<tr>
<td>Cold</td>
<td>Benauela Current</td>
</tr>
<tr>
<td>Cold</td>
<td>Labrador Current</td>
</tr>
<tr>
<td>Cold</td>
<td>California Current</td>
</tr>
<tr>
<td>Cold</td>
<td>Alaskan Current</td>
</tr>
<tr>
<td>Cold</td>
<td>Kamchatka Current</td>
</tr>
<tr>
<td>Cold</td>
<td>Canary Current</td>
</tr>
<tr>
<td>Warm</td>
<td>N. Pacific Current</td>
</tr>
<tr>
<td>Warm</td>
<td>Equatorial Counter Current</td>
</tr>
<tr>
<td>Warm</td>
<td>S. Equatorial Current</td>
</tr>
<tr>
<td>Warm</td>
<td>Eastern Australia Current</td>
</tr>
<tr>
<td>Warm</td>
<td>Gulf Stream</td>
</tr>
<tr>
<td>Warm</td>
<td>N. Equatorial Current</td>
</tr>
<tr>
<td>Warm</td>
<td>N. Atlantic Current</td>
</tr>
</tbody>
</table>

Demonstrate understanding of the factors that influence the physical and chemical properties of seawater and nutrient cycles of the ocean

Sea water contains approximately 3.3 – 3.7% by mass of salt. The heat capacity of water decreases with salinity, lowers the freezing point, slows evaporation and changes the osmotic pressure of the water. The salts come from a combination of weathering and out gassing of underwater volcanoes. Scientists track the temperature, salinity and pressure of sea water to determine its density and it’s ability to sustain life.

In the oceans plants utilize the nutrients in the surface layer reached by sunlight. This is where photosynthesis takes place and is in the upper most level of the water column depending on the clarity of the water. Most nutrients are removed from the euphotic zone and transferred to the deeper ocean as dead organisms sink to the ocean floor. In the deeper layers nutrients are brought back into solution. The ocean cannot support productivity except where nutrients are returned to the euphotic zone from below in upwelling regions such as the global currents.
D. Meteorology

- Demonstrate knowledge of the structure of the atmosphere and thermal and chemical properties of atmospheric layers

  Layers of Earth’s Atmosphere:
  
  ![Diagram of atmospheric layers]

  The troposphere is where nearly all weather initiates. The ionosphere is an electrically charged area.

- Demonstrate knowledge of the chemical composition of the atmosphere

<table>
<thead>
<tr>
<th>Element</th>
<th>% of Atmosphere</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen</td>
<td>78%</td>
</tr>
<tr>
<td>Oxygen</td>
<td>21%</td>
</tr>
<tr>
<td>Argon</td>
<td>.9%</td>
</tr>
<tr>
<td>Carbon Dioxide</td>
<td>.03%</td>
</tr>
<tr>
<td>Others</td>
<td>1%</td>
</tr>
</tbody>
</table>

- Demonstrate understanding of the factors influencing seasonal and latitudinal variation of solar radiation

  Tilt of the earth causes the seasons. The angle the sun’s rays strike the earth causes variations. The earth is closer to the sun in January than in July.

- Distinguish among the terms relative humidity, absolute humidity, dew point, and frost point

  - Relative humidity – the amount of water vapor compared to what the body of air could hold
  - Absolute humidity – the amount of water vapor compared to the volume of air
  - Dew point – temperature air is cooled to, to reach saturation point
  - Frost point – temperature in which ice crystals form when temp reaches a dew point below freezing.
- Demonstrate understanding of the causes of global wind belts
  
  * Air pressure causes convection, warm air rises, cools and sinks.

  ![Global pattern of winds]

  - Polar easterlies, Prevailing Westerlies (where the majority of the US lies), the Doldrums/Horse Latitudes (between the westerlies and tradewinds, an area of little wind, called the Horse latitudes because sailors dumped horses overboard when stalled to get their ships moving), the northeastern and southeastern trade winds. Air heats at the equator and sinks at the poles causing convection winds.

- Identify the factors that contribute to small-scale atmospheric circulation
  
  * Specific heat – amount of heat required to raise the temperature. Water has a 3 x’s greater specific heat than land. Land will heat quicker.

- Demonstrate knowledge of various cloud and precipitation types and their formation

  **Precipitation**

  * Sleet – rain freeze when passing through a subfreezing layer of air
  * Freezing Rain – cold air freezes on contact with a frozen surface
  * Hail – lumps of raindrops that have gathered layers from being updrafted back into the clouds
  * Snow – ice crystals that formed in cool temps and pass continually through cool temps until hitting the ground.

  **Clouds**

  * High – Cirrus, Cirrostratus & cirrocumulus
  * Middle Level – altocumulus & altostratus (light rain)
  * Low Level –stratus, stratocumulus, nimbostratus (produces the most precipitation) Cumulus and cumulonimbus (anvil head and tornadoes)
● Characterize major types of air masses in terms of temperature, moisture content, and source areas
  
c\(_{A}\) = continental arctic – cold and dry air from Arctic & Greenland
  
c\(_{P}\) = continental polar – very cold and dry from Canada & Alaska
  
c\(_{T}\) = continental tropical – hot & dry air from the SW US (mostly summer)
  
m\(_{T}\) = maritime tropical – SE US, warm and humid
  
m\(_{P}\) = maritime polar – mildly cool and humid all year long Western USA

● Demonstrate understanding of high- and low-pressure systems
  
  High pressure systems – stable air, associated with clearing air and good weather

  Low pressure – unstable air, associated with bad weather. Tornadoes and Hurricanes have extremely low pressures.

● Demonstrate understanding of the structure and movement of frontal systems (cold, warm, stationary, occluded) and the air circulation around and weather associated with frontal systems
  
cold front – moves cooler air under warm air. Heavy rain usually found ahead of the front

  warm front – warm air moving over colder air, light rain over a large area

  stationary front – several days stalled movement, causes of most flooding rains

  occluded front – two fronts overlapping, cold front conquers a warm front

● Interpret information on weather maps

Isobars – points of equal pressure

Isotherms – connecting points of air temperature
Demonstrate understanding of the analyses needed to perform short-term weather forecasting and recognize some of the methods used to perform long-term weather forecasting

**Short term** - Computer modeling, persistence forecasts, trend forecasting and “Nowcasting” – weather radar & geostaionary satellites

**Long term** - Climatic data & computer modeling; Examine statistical records of past and compare to the visual data of the current weather. Extrapolate potential weather. Nearly all done by computer modeling.

Demonstrate understanding of the regional and local natural factors that affect climate

Temperature & Precipitation are the 2 things that effect the climate of a region.
Temperature is based on latitude, altitude, distance to a body of water and ocean currents.
Precipitation is based on mountains & winds.

Demonstrate understanding of how humans affect and are affected by climate (for example, desertification, greenhouse effect, volcanic ash effect, El Niño)

Desertification – spreading of desert conditions mostly by clear cutting and removal of forests.
Greenhouse – increase in greenhouse gases can potentially cause global warming
Volcanic Ash – blocks sunlight, causing cooler temperatures
El Nino – period of ocean warming that effect eastern tropical pacific (warmer waters in the NE US & West; drought in Indonesia, Australia & Phillippines; suppress hurricanes in the Atlantic)

E. Astronomy

Demonstrate knowledge of the major theories of origin and structure of the universe

**Big Bang Theory** – whereby the entire universe was created when a very condense amount of matter exploded pushing out all matter into space and creating the heavens stars and planets as we known them today. This theory is the most widely accepted in the scientific community. It is supported by evidence that all other galaxies are moving away from us(redshift data). Scientific laws created by Newton, Kepler and others, when applied to the universe fit the visual data we are receiving now. Basically the universe is between 10 to 20 billions years old. This theory often coincides with evolution.

**Creationism** – this theory is held by people of various faiths whereby a powerful being created the heavens, earth and all of its living creatures. Some theologians access that the earth is as young as 10,000 years old. Evidence provided by churches does not often past the test of science but until either case is proven both are viewed as viable theories.
• Define and use large units of distance (for example, astronomical unit, lightyear, parsec)
  
  \[ Au = \text{distance between earth and the sun, approx 150 million km or 93 million miles} \]
  \[ LY = \text{distance it takes light to travel in a year, approx 63000 AU or 9.6 trillion km} \]
  \[ \text{Parsec} = \text{distance from the sun to object with a parallel angle of 1 arc second}. \]

• Demonstrate understanding of the origin and life cycle of stars
  
  As a gas cloud condenses in space a dense body of material develops into a proto star > main sequence star > red giant star > planetary nebula > white dwarf star
  
  Initial energy source of stars is gravitational energy, if the star has enough mass fusion occurs.

• Demonstrate understanding of the major theories involving the origin of the solar system
  
  Our solar system is estimated to be about 5 billions years old. 2 theories, the Evolutionary Theory and the Catastrophe theory explain our solar system. In the catastrophe theory a comet closed very close to the sun and dragged material away from the sun. The evolutionary Theory suggests that we were initially a large globular cloud of gas that was spinning from the “Big Bang”. The spinning brings about conservation of angular momentum and the gas cloud begins to flatten and spin rather fast. As the gases cool, elements form and group together to form planets, asteroids, moons etc.

• Identify the major features and characteristics of the Sun and the source of the Sun’s energy
  
  The sun has 3 main areas:
  
  The photosphere which is the part most likely seen by us on earth. It is approximately 5800 degrees Celsius.
  
  The Chromosphere, which is approximately 10000 degrees Celsius and then the corona, which is only seen during eclipse of the sun, is 1-2 million degrees Celsius.
  
  The sun also consists of solar flares, which have cycles of approximately 11 years and can effect weather on earth; spinicules and solar winds.

  The sun’s energy comes from nuclear fusion in which 4 Hydrogen nuclei are fused to make 1Helium. Hydrostatic Equilibrium also contributes to the sun’s energy. The gravitational pull of material downward is equal to the upward forces cause by the nuclear fusion in the core.
**Identify the components of the solar system and characterize the physical features and movements of the planets, asteroids, comets, and other solar system components**

Planets, comets, asteroids and nearly all celestial objects orbit in elliptical patterns.

*Our Sun, is NOT in a unique place within our galaxy the Milky Way. It is actually located within the disk portion of the galaxy about 1/3 of the way from the outer edge. Most of the celestial bodies we see with the naked eye belong to our galaxy. Our solar system includes Mercury, Venus, Earth, Mars (The Terrestrial Planets) and then (the Jovian Planets) Jupiter, Saturn, Uranus, Neptune & Pluto. There are several known comets along with an asteroid belt between Mars and Jupiter.*

**Demonstrate understanding of the geometry of the Earth-Moon-Sun system and the causes of lunar and solar eclipses**

*Lunar eclipse* when the earth is between the moon and the sun. Seen at night. Does not always happen because the moon orbits at an inclination. *Solar eclipse* is when the moon is between the earth and the sun. This type averages 2 per year but can only be seen in a very small location at one time.

**Demonstrate understanding of the causes of moon phases**

The moon’s phases go as followed:

New> Crescent> Waxing 1st Quarter> Waxing Gibbous> Full Moon> Waning Gibbous> Waning 3rd Quarter> New Moon

**Demonstrate understanding of the causes of Earth’s seasons**

The earth is tilted on its axis at 23.5°. During the summer the northern hemisphere is positioned facing toward the sun. During the winter the southern hemisphere is angled toward the sun. It should be noted that the earth is actually closest in its orbit around the sun during the northern hemisphere’s winter months.

**Demonstrate knowledge of how units of time (for example, year, day, hour) are based on Earth’s motions**

*Year = the amount of time it takes the earth to revolve around the sun.*

*Day = time it takes the earth to make a complete rotation*

*Hour = 15 degrees of longitude on earth*

**Demonstrate understanding of time zones on Earth**

The prime meridian is at 0 degrees longitude. It goes through England. Each line of longitude is equivalent to 15 degrees for a total of 24 lines of
longitude and a 360-degree circumference around the earth. Each line of longitude is equal to one hour. 180 degrees of longitude is the International Date Line. This is the position on earth where our calendars change from one day to the next.

● Demonstrate understanding of geosynchronous orbits and recognize how satellites have contributed to science and technology

Geosynchronous satellites circle the earth once a day. The time it takes to travel around the earth is called it’s period. Geostationary Satellites hover over the equator. They are used for TV broadcasting, cell phones, weather and military.

● Recognize the contributions of manned and unmanned space missions and the present limitations of space exploration

Manned missions are not as cost effective. The limits include time constraints and the ability to supply enough food, oxygen and water for human beings to survive for an extended period of time. It is generally not possible to travel to another solar object in space beyond on moon with a manned mission. Some manned missions include the first trips into space, to the moon, and to the International Space Station. It is generally considered a waste of time and money to continue manned space missions.

Unmanned missions have a much greater potential. They can operate at much longer durations without the need to return to the earth. The equipment can be smaller and much more cost effective. Some examples of recent unmanned missions include the Hubble Space Telescope, The Mars Rovers, Spirit & Opportunity and the Cassini-Huygens Mission which involved studying Saturn and it’s moons.

● Recognize the scientific contributions of remote sensing

Remote sensing is used to view a wide variety of conditions on the earth. They have been used to view the magnetic field, the heat, the atmosphere, “hole in the ozone”, POES & GOES weather satellites etc.
Chapter 6  Science, Technology and Society

*** This particular unit in ever changing. I am supplying general information at the most basic level. But, it is difficult to predict the nature of the questions that could arise from this section.

- Demonstrate understanding of the uses and applications of science and technology in daily life (e.g., production, transmission, and use of energy; production, storage, use, management, and disposal of consumer products; management of natural resources; nutrition and public health issues, agricultural practices, etc.)

  **Production, transmission and use of energy** – currently most people in the US get their electric from energy moguls. There is growing need for alternate production of electricity using renewable resources such as wind, and solar. Also with growing emphasis on the unethical scams conducted by energy moguls people need to focus on conservation and high efficiency appliances.

  **Production, storage, management and disposal of consumer products** – the average person in the United States disposes of 1600 pounds of waste each year! The majority of that waste is in the form of paper which is a recyclable material.

  **Management of natural resources** – natural resources are mostly non-renewable in nature. Governments often regulate the use and destruction of these resources and determine whether the current need surpasses the irrefutable damage caused by the removal of the resources.

  **Nutrition and public health issues** – governments regulate vaccinations to eliminate mass communicable diseases and make recommendations for the overall health and well being of their populations. In the United States that includes truth in labeling, the food pyramid and public education within the school systems. Other issues involve protecting people from Mad Cow disease and various other diseases associated with the public food supply.

  **Agricultural practices** – uses of chemicals as fertilizers and insect control, irradiating meat, genetically engineered produce, soil conservation

- Demonstrate understanding of the social, political, ethical and economic issues arising from the use of certain technologies (e.g., cloning, prolonging life, prenatal testing, etc.) and the impact of science and technology on the environment and human affairs

  **Cloning** – has the potential to supply us with organs for the sick, also has the potential of initially producing severely deformed beings, of which the life and livelihood would be a hot debate. The main issue seems to be religious objection and whether or not humans have the right to play god. The potential for the human population is far less reaching than that of genetic testing which could alter the general populations as people opt for particular traits. However, genetic testing is not banned.
Prolonging life – certainly with the Terri Schaivo case still on people’s minds this is not probably a topic I can do justice on. Economically who is going to pay for the continued care of ailing individuals? Who has the right to decide who can die? This is sure to be a topic in the news for many years to come.

Prenatal testing – there has always been concern that prenatal testing may result in the unnecessary ending of a life that may otherwise be healthy. Again the issues tend to surround a person’s individual moral and religious beliefs.
Chapter 7 Essay Questions

The essay questions come from Physical Sciences (Chemistry/Physics), Life Sciences, and Earth/Space Sciences. I personally found my essay questions came straight from the content areas discussed in Chapter 1-6 of these study notes. I had thoroughly studied the suggested topics and was fairly easily able to answer the questions presented to me at my test session. I did find myself short on time. I did not bring a watch and ended up with just 30 minutes to complete the 3 essays. I would suggest leaving a little more time for the essay portion because it counts for 25% of the score.

Additionally, the questions are reported to assess the following skills:

A. Concepts and Models
(1 QUESTION)
This question assesses one or more of the following competencies:
● Formulate scientific concepts correctly and identify and correct improperly formulated concepts
● Use models (defined as ideas or constructs created as tentative descriptions of structures or processes in nature) to communicate concepts and to explain natural phenomena

B. Data Analysis, Experimental Design, and Investigations
(1 QUESTION)
This question assesses one or more of the following competencies:
● Analyze and interpret data obtained from an experiment or investigation, including graphical data
● Design an experiment or investigation that tests a simple hypothesis
● Describe a laboratory or field demonstration that would illustrate a fundamental scientific concept

C. Systems: Patterns and Processes
(1 QUESTION)
This question assesses the following competency:
● Analyze relationships among the interacting parts of a natural system
● Identify and explain the processes that follow patterns and cycles in natural systems In addition, one of the three questions will contain a component that requires an understanding of the scientific concepts and principles involved in the interrelationships among science, technology, and society.

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Bibliography


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