Rates of Reaction (Specimen)
For moderation in May 20yy or January 20zz

Teachers’ Notes

This ISA relates to Additional Science / Chemistry Unit 2:
C2.4 Rates of Reaction

Topic of investigation
Section C2.4.1 Speeding up or slowing down chemical reactions is important in everyday life and in industry. Changes in temperature, concentration of solution, gas pressure, surface area of solids and the presence of catalysts all affect the rates of reaction

Overview
Candidates should:
• develop hypotheses and plan practical ways to test them
• make risk assessments and manage risks when carrying out practical work
• collect, process, analyse and interpret primary and secondary data, including the use of appropriate technology to draw evidence-based conclusions
• review methodology to assess fitness for purpose, and review predictions in light of outcomes.

Candidates should be told to investigate a factor that affects the rate of chemical reaction.
They will need to produce their own hypothesis and research a plan.

The teacher should describe the context in which the investigation is set.
Candidates need to develop their own hypothesis. They should research two possible methods to investigate it and develop a detailed plan for one of these methods.
Candidates will need to decide which variables need to be controlled in order to investigate the hypothesis and research a method that could be used, with particular reference to hazards and risk assessment.
In Section 1 of the ISA, candidates will be required to provide a full plan of the method that they have chosen to use.
Once the candidates have researched and written up their own plan in the first part of the ISA they should carry out their investigation providing that this is workable, valid, safe and manageable in the laboratory.

Risk Assessment
It is the responsibility of the centre to ensure that a risk assessment is carried out.
Stage 1 – Planning (Limited control)

Teachers should provide the candidates with a Candidate Research Notes Form. In Additional Science and Biology teachers should instruct the candidates to write their hypothesis and the chosen context on their Candidate Research Notes.

Candidates should be given the opportunity to plan an investigation to test their hypothesis. The investigation should be set in a context by the teacher. Examples of suitable contexts could include, the rate that a kitchen work surface cleaner works, or the rate at which antacid tablets work. Whichever context is chosen, the teacher must take care to present it in such a way that it does not limit the candidates’ choice of method for the investigation. Teachers should instruct the candidates to write their hypothesis and the chosen context on their Candidate Research Notes.

Candidates should then independently research an appropriate plan to test the hypothesis and decide for themselves factors such as the range, interval and number of repeat readings that they should take, and the variables that need to be controlled. They should use at least two sources for this research.

They will need to undertake independent research to identify two methods that could be used. During this time they may make up to one A4 side of their own Candidate Research Notes for use during Section 1 and Section 2 of the ISA. The Candidate Research Notes sheet must be used for this purpose.

For their research candidates may use technology such as the internet or CD-ROMs, textbooks or any other appropriate sources of information. Candidates should also research how the results of the investigation might be useful in the specified context.

There is no set time allocation for this research, but it is anticipated that it should take no longer than 3 hours of work. This research may be done in the laboratory or elsewhere.

The teacher should check and sign the Candidate Research Notes before allowing the candidate to use them during the completion of Section 1 of the ISA. These must be checked to ensure they do not include plagiarised text or a pre-prepared draft. The candidate may use these notes while completing Section 1 and Section 2 of the ISA. When the candidate has completed Section 2, the Candidate Research Notes should be stapled to the ISA.

Stage 2 – Reporting on the planning research (High control)

For this stage, candidates must work individually under direct supervision

After the Stage 1 planning session, candidates should be given Section 1 of the ISA and should work on their own, under controlled conditions, to answer it. Candidates should take their Candidate Research Notes into the formal assessment.

Section 1 will require them to:

- state and explain their hypothesis
- consider the variables (independent, dependent and control) that they will need to manage during the investigation
- report on their research into how to test their hypothesis
- write a detailed plan of their chosen method
- write a brief outline of an alternative method and explain why it was not chosen
- identify possible hazards and write down how the risks may be minimised
- draw a blank table suitable for the method they have planned.

Candidates may choose to use technology to draw the table, e.g. a computer spread sheet. This must be done under the direct supervision of the teacher, and may be done at any convenient time between the planning session in Stage 1 and the completion of Section 1 of the ISA.

While answering Section 1 of the ISA, candidates must not be allowed to use notes, textbooks, the Internet or any other source of help apart from their own Candidate Research Notes.
Stage 3 – Practical Work (Limited control)

For this part of the investigation candidates may work individually or in groups.

Candidates may work in groups to carry out their plans, but each candidate must contribute to the collection of data.

Candidates may use appropriate technology during the practical work, e.g. data loggers or sensors.

If the candidate is going to carry out his or her own plan, then the teacher may photocopy the plan from Section 1 of that candidate's ISA. This photocopy may then be given to the candidate to use during the practical session.

If the teacher deems that the plan produced by the candidate is invalid, unworkable, unsafe, unmanageable or for any other reason unsuitable, then the teacher may provide a method.

An example of a suitable method is attached to these notes.

Candidates may use their own blank table for the results providing that this has already been marked by the teacher. Alternatively, the teacher may provide a blank table for the results:

- if the table produced by the candidate is inadequate - in which case the candidate would not be able to score full marks for producing a table
- if the candidate carries out an investigation from a method provided by the teacher, or the teacher prefers that the candidates use a particular format - in which case the candidate would be able to score full marks for producing their own table.

Stage 4 – Processing primary data (High control)

For this part of the investigation candidates must work individually under direct supervision.

Candidates should be given back their table of results, or a table containing the pooled results of the class, and asked to display these on a bar chart or line graph. Candidates must decide for themselves which format is the more appropriate for any particular investigation. Candidates may use appropriate technology to do this, e.g. a graph-drawing program on a computer.

If a candidate chooses to use a computer, this must be done under the direct supervision of the teacher and must be printed straight away.

Candidates should not be allowed to take their results and chart or graph away: the teacher must collect them at the end of the lesson and mark them before Stage 5.

Stage 5 – Analysing results (High control)

For this part of the investigation candidates must work individually under direct supervision.

AQA will provide a Secondary Data Sheet.

The candidates should also be given a table of results from other candidates in the class, or the teacher's results. Candidates should use the results of others to analyse the validity of their results.

Candidates should be given Section 2 of the ISA.

They should also be given:

- their own table of results
- a reminder of the context in which the investigation was set
- their own chart or graph
- the Secondary Data Sheet supplied by AQA
- their own Candidate Research Notes.

The teacher should have recorded the marks for each candidate’s table and graph/chart before these are given back. This will ensure that a candidate cannot gain an unfair advantage by making any alterations to them at this stage.

Any candidate who does not take an active part in the practical work cannot score any marks for Section 2 of the ISA.
Section 2 will require candidates to:

- analyse their own results
- draw a conclusion
- match their achieved results to the hypothesis they investigated
- evaluate the method of collection and the quality of the resulting data
- analyse further secondary data drawn from the same topic area as their original investigation
- relate their findings to the context set in the ISA.
Additional Science / Chemistry Controlled Assessment

CU2.1 Rates of Reaction

This method could be used to investigate the following hypothesis:

‘The rate of a chemical reaction depends on the concentration of the reactants’

You will need to prepare a table for the results.

Equipment

2 moles per dm$^3$ hydrochloric acid solution
18 cm of magnesium ribbon
stopwatch
100 cm$^3$ measuring cylinder
100 cm$^3$ beaker or conical flask
ruler

Method:

1. Cut the piece of magnesium ribbon into six 3cm lengths.
2. Measure 60 cm$^3$ of hydrochloric acid into the flask or beaker using the measuring cylinder.
3. Drop one piece of magnesium ribbon into the flask and start the stopwatch.
4. When all the magnesium ribbon has dissolved stop the stopwatch. Record the time.
5. Rinse the flask.
6. Measure 52 cm$^3$ of hydrochloric acid into the flask or beaker using the measuring cylinder.
   Add 8 cm$^3$ of water.
7. Drop one piece of magnesium ribbon into the flask and start the stopwatch.
8. When all the magnesium ribbon has dissolved stop the stopwatch. Record the time.
9. Rinse the flask.
10. Repeat steps 6-9 with each of the hydrochloric acid and water volumes from the table below.

<table>
<thead>
<tr>
<th>Volume of hydrochloric acid in cm$^3$</th>
<th>Volume of hydrochloric acid in cm$^3$</th>
<th>Volume of water in cm$^3$</th>
<th>Concentration of solution in moles per dm$^3$</th>
</tr>
</thead>
<tbody>
<tr>
<td>60</td>
<td>60</td>
<td>0</td>
<td>2.00</td>
</tr>
<tr>
<td>52</td>
<td>52</td>
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</tr>
<tr>
<td>22</td>
<td>22</td>
<td>38</td>
<td>0.75</td>
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</table>
## ISA Explanation Sheet

This sheet should accompany each ISA

<table>
<thead>
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<th>Centre Number</th>
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<th>8</th>
<th>7</th>
<th>6</th>
<th>5</th>
</tr>
</thead>
<tbody>
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<td>Date Practical Carried Out</td>
<td>10/5/11</td>
<td></td>
<td></td>
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<tr>
<td>ISA Code</td>
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</tr>
<tr>
<td>Name of Teacher</td>
<td>J. Harrison</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ISA Title</td>
<td>Rates of Reaction</td>
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</tbody>
</table>

**Did the candidates use their own plans?**

**YES**

If NO give details of any changes you made for this investigation.

*Candidate 1567 and others used the disappearing cross experiment.*

Any other Information:

Teacher Signature: J. Harrison

Please attach any experimental worksheet or outline used by the candidates to carry out the investigation.
Investigation Title ___Rates of Reaction_________________________________________

ISA number: ___CU2.x_____________________

The only notes the candidate takes into the Controlled Assessment are to be written in the spaces on the back of this sheet.

This sheet should be given to the teacher for checking before it is used in Section 1 of the ISA.

When Section 1 of the ISA has been completed, this sheet should be retained by the teacher for subsequent use with Section 2.

When Section 2 of the ISA has been completed, this sheet should be stapled to it.

Declaration

I confirm that these are the only notes used in the Controlled Assessment.

Teacher signature: J. Harrison

Candidate signature: J. Edwards

Date: ________3/5/11____________________

This form can be downloaded from aqa.org.uk/candidatenotes

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**Hypothesis** The higher the temperature the faster the rate of reaction.

**Research sources**

- The Internet: [http://www.bbc.co.uk/schools/gcsebitesize/science/add_aqa/chemreac/ratesrev1.shtml](http://www.bbc.co.uk/schools/gcsebitesize/science/add_aqa/chemreac/ratesrev1.shtml)
- Higher science for GCSE 2 Mark Levesley

**Method(s)**

- Disappearing cross – sodium thiosulfate and hydrochloric acid
- Use different concentrations of sodium thiosulfate (60% solution of a 40 g/l solution) Measure time taken for cross to disappear
- Or use marble chips and a gas syringe to measure volume of gas produced in fixed time.

**Equipment**

- Measuring cylinders, stopwatch, conical flask, heating equipment, goggles.

**Risk assessment issues**

- Sulfur dioxide produced – wash flask out as soon as possible
- Hydrochloric acid burns – wear safety goggles.

**Context**

- Reaction of cleaners at removing limescale from kettles

**Relating the investigation to the context**

- Need to use hot or it will take too long.
Notice to Candidate. The work you submit for assessment must be your own. If you copy from someone else or allow another candidate to copy from you, or if you cheat in any other way, you may be disqualified.

Candidate Declaration. I have read and understood the Notice to Candidate and can confirm that I have produced the attached work without assistance other than that which is acceptable under the scheme of assessment.

Candidate Signature: J. Edwards
Date: 23/2/11

AQA
General Certificate of Secondary Education
June 20yy and January 20zz
Additional Science / Chemistry (Specimen)
AS4P/CH4P/CU2.x
Controlled Assessment ISA CU2.x Rates of Reaction
Section 1
For moderation in May 20xx or January 20xx
Time allowed: 45 minutes

For this paper you must have:
• your Candidate Research Notes.
• a pencil and a ruler
You may use a calculator.

Instructions
• Use black ink or black ball-point pen.
• Fill in the boxes at the top of this page.
• Answer all questions in the spaces provided.
• Do all rough work in this book.
• Cross through any work you do not want to be marked.

Information
• The marks for questions are shown in brackets.
• The maximum mark for this paper is 20.
• The maximum mark for the Controlled Assessment Unit is 50.
• You are reminded of the need for good English and clear presentation in your answers.

Details of additional assistance (if any). Has the candidate received any help or information from anyone other than the subject teacher(s) in the production of this work? If the answer is yes give the details below or on a separate page.

Yes ☐ No ☑

Teacher Declaration:
I confirm that the candidate’s work was conducted under the conditions laid out by the specification. I have authenticated the candidate’s work and am satisfied that to the best of my knowledge the work produced is solely that of the candidate.

Signature of teacher ..........R. Brown........................................ Date .....4/4/11....................

As part of AQA’s commitment to assist students, AQA may make your CAU available on a strictly anonymous basis to teachers, examining staff and students in paper form or electronically, through the Internet or other means, for the purpose of indicating a typical mark or for other educational purposes. In the unlikely event that your CAU is made available for the purposes stated above, you may object to this at any time and we will remove the work on reasonable notice. If you have any concerns please contact cfg@aqa.org.uk

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1. Write down your hypothesis.

Hypothesis: The higher the temperature, the faster a reaction will take place.

Explain why you made this hypothesis.

Explanation: The hotter something is, the quicker the particles in it move (Kinetic theory). This means the particles will collide more often and have more energy. The reaction happens when particles collide. When you heat something you are giving it more energy. So if you increase the temperature of the reaction, you are increasing the energy and so increasing the rate of the reaction.

(3 marks)

2. Think about the research that you did to find how to test your hypothesis.

Identify two sources that you used for your research.

- Higher science for GCSE 2 Mark Levesley
- http://www.bbc.co.uk/schools/gcsebitesize/science/add_aqa/chemreac/ratesrev1.shtml

Which of these sources was the more useful? Why was this source better than the other source?

The “Higher Science” textbook contained a good explanation of how chemical reactions take place. It also had a good labelled diagram and a detailed method for how to do the experiment.

BiteSize was OK in giving me the theory but it didn’t explain a suitable method.

(3 marks)
In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.

From the research that you have done, describe in detail how you are going to do your investigation.

You should include:

- the equipment that you plan to use
- how you will use the equipment
- the measurements that you are going to make
- how you will make it a fair test
- a risk assessment.

2 measuring cylinders
Sodium thiosulfate solution (60% solution of a 40 g/l solution)
Hydrochloric acid (0.5 M)
Bunsen burner, tripod, gauze, heatproof mat
Conical flask, stopwatch, thermometer, goggles

Continue your answer on the next page
1. Measure out 50 ml of sodium thiosulfate and 10 ml of acid.
2. Heat the sodium thiosulfate standing on gauze on a tripod on a heat proof mat over the Bunsen.

3. When it reaches the right temperature, place on top of cross take temperature and note it, then add acid and time how long it takes for the cross to disappear.

4. Do each temperature (every 10°C) 3 times for accuracy.

Fair test.

Because various other things affect the rate of reaction, I must keep these things constant.

1. The concentration of the sodium thiosulfate affects it because the more molecules there are of sodium thiosulfate, the more often they will collide with each other.

2. The concentration of the hydrochloric acid. This is for the same reason as for the sodium.

3. The volume of the sodium thiosulfate. This is because the more sodium thiosulfate there is, the more often the molecules will collide so the rate of reaction will be quicker.

4. The volume of the hydrochloric acid. This is for the same reasons as for the volume of the sodium thiosulfate.

5. I must use the same beaker because we are measuring the amount of precipitated sulfur. If the bottom of the beaker is larger it will take longer to precipitate enough sulfur to cover the cross.

6. I will use temperatures of 10°C, 20°C, 30°C, 40°C, 50°C, 60°C, 70°C, 80°C, 90°C and 100°C but since it will be difficult to get exact temperatures, I will do as near than possible.

(6 marks)
4 Think about the hazards in your investigation.
Describe one hazard in your investigation and say how you would reduce any risks.

During the reaction sulfur dioxide is given off. This is poisonous and if it is present in large quantities could kill you.

Wear goggles and lab coat,

Be careful to keep acid away from Bunsen! Turn Bunsen down/off in between using it.

Wash out flask immediately after each experiment because of SO₂ given off.

(3 marks)

5 In your research, you will have found other methods that you could have used.
Outline one other method that you could have used and explain why you decided not to use this method.

I could have used marble chips and hydrochloric acid and a gas syringe. I would have connected this to the top of a conical flask and timed how long it took to collect a certain amount of gas.

I didn't do this because the marble chips would have different surface areas and it wouldn't be as accurate.

(3 marks)

6 Make sure that you hand in your Candidate Research notes and your blank table for the results with this paper.

You will be awarded up to two marks for your table.

(2 marks)

<table>
<thead>
<tr>
<th>Temperature of sodium thiosulfate solution in °C</th>
<th>Time taken for cross to disappear in seconds</th>
</tr>
</thead>
</table>

END OF SECTION 1
<table>
<thead>
<tr>
<th>Centre Number</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Surname</td>
<td>Edwards</td>
</tr>
<tr>
<td>Other Names</td>
<td>Jim</td>
</tr>
<tr>
<td>Notice to Candidate. The work you submit for assessment must be your own. If you copy from someone else or allow another candidate to copy from you, or if you cheat in any other way, you may be disqualified.</td>
<td></td>
</tr>
<tr>
<td>Candidate Declaration. I have read and understood the Notice to Candidate and can confirm that I have produced the attached work without assistance other than that which is acceptable under the scheme of assessment.</td>
<td></td>
</tr>
<tr>
<td>Candidate Signature</td>
<td>J. Edwards</td>
</tr>
<tr>
<td>Date</td>
<td>4/2/11</td>
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</table>

**AQA**

General Certificate of Secondary Education
June 20yy and January 20zz

Additional Science / Chemistry (Specimen) AS4P/CH4P/CU2.X
Controlled Assessment ISA CU2.x Rates of reaction
Section 2
For moderation in May 20xx or January 20xx

For this paper you must have:
- results tables and charts or graphs from your investigation
- your Candidate Research Notes
- the Secondary Data Sheet
- a pencil and ruler
You may use a calculator

Time allowed
- 50 minutes

Instructions
Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer all questions in the spaces provided.
- Do not write outside the box around each page or on blank pages.
- Do all rough work in this book. Cross through any work you do not want to be marked.

Information
- The marks for questions are shown in brackets.
- The maximum mark for Section 2 is 30.
- The maximum mark for the Controlled Assessment Unit is 50
- You are reminded of the need for good English and clear presentation in your answers.

Details of additional assistance (if any). Has the candidate received any help or information from anyone other than the subject teacher(s) in the production of this work? If the answer is yes give the details below or on a separate page.

Yes □ No √

Did the candidate take an active part in the practical?

Yes √ No □

Teacher Declaration:
I confirm that the candidate’s work was conducted under the conditions laid out by the specification. I have authenticated the candidate’s work and am satisfied that to the best of my knowledge the work produced is solely that of the candidate.

Signature of teacher ……..R. Brown…………………………... Date ……..4/4/11……………………

As part of AQA’s commitment to assist students, AQA may make your CAU available on a strictly anonymous basis to teachers, examining staff and students in paper form or electronically, through the Internet or other means, for the purpose of indicating a typical mark or for other educational purposes. In the unlikely event that your CAU is made available for the purposes stated above, you may object to this at any time and we will remove the work on reasonable notice. If you have any concerns please contact cfg@aqa.org.uk.

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1 (a) Do your results support the hypothesis you investigated?
You should use any pattern that you can see in your results to support your answer.
You should include examples from your results.

I can see from my graph that although it is true that “the higher the temperature the quicker the rate of reaction”, it is not quite so straightforward as that. At the very high temperatures (between 50 °C and 70°C) the graph flattens out. This may be because of the fact that the hotter it is, the quicker it cools down once it is off the flame so that the higher temperatures cooled down the most whereas the lower temperatures stayed at the same point. .................................................................

(3 marks)

1 (b) Did you get any anomalous results?
Explain your answer.
Your explanation should include examples from your results.

My result of 31 °C was not very good. This may be because it was stood too near to a Bunsen burner so warmed up or may be because we did not measure accurately or just because it is difficult to tell exactly when the cross disappeared. We redid this at 29 °C and got a much more accurate result i.e. 48s rather than 27s. .................................................................

(3 marks)

1 (c) Describe in detail how you could use repeated readings to obtain more accurate results

Instead of doing each temperature 3 times, I did a large number of temperatures. This is because it would have been extremely difficult to reach each temperature exactly the same as it was the first time. But if I had done repeats I would have been able to calculate a mean after getting rid of any anomalous results. .................................................................

(3 marks)
1 (d) Resolution refers to the smallest scale division of a measuring instrument.

What was the resolution of the device that you used to measure the timing of the reaction?

One hundredth of a second on the electronic stopclock..........

Do you think that this resolution was appropriate for this measurement? Explain your answer.

No, I only recorded the time to the nearest whole second. This was because it was impossible to judge when the cross had disappeared to the nearest 1/100 th second..................

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3 marks)

1 (e) Most investigations contain errors or uncertainties.

What do you think was the cause of the largest error or uncertainty in your investigation?

I found that the acid was cooling down the sodium thiosulfate considerably at the higher temperatures. .......

...........................................................................................................................................

Explain what you could do to reduce the size of this error if you were to repeat the investigation.

I could repeat the experiment, heating the acid in a water bath to the required temperature before adding it to the Na₂S₂O₃..........................

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(3 marks)
2 You have been given a Secondary Data Sheet that provides results from similar investigations.

2 (a) Draw a sketch graph of the results in Case Study 1.

The graph should show how time taken for magnesium ribbon to dissolve varies with the concentration of nitric acid.

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(2 marks)
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2 (b) A detergent manufacturer is investigating the concentration of detergent that should be used in the product.

The manufacturer’s hypothesis is:

‘As with all chemical reactions, the rate of cleaning is always directly proportional to the concentration of the detergent in the cleaning solution.’

2 (b)(i) Look at Case Studies 1, 2 and 3.

Explain whether or not the results in Case studies 1, 2 and 3 support this hypothesis.

To gain full marks, your explanation should include appropriate examples from Case Studies 1, 2 and 3.

Case study 1 does because if you double the concentration (e.g. from 0.25 to 0.5 the time taken for the magnesium to dissolve halves). .................................................................................................................................

Case study 2 supports it as well, but there is some variation and the mean has been wrongly calculated for 0.5 mol/dm³. .................................................................................................................................

Case study 3 doesn’t support because they investigated different types of magnesium, not concentration. .........................

(3 marks)
2 (b)(ii) Look at Case Study 4.
To what extent do the results shown support the manufacturer's hypothesis?
Explain your answer.

Graph A shows that as the concentration is increased, the
time for the reaction gets less, but it is not directly
proportional – if it was, the graph would show a curve.
\( \text{e.g. } 0.2 \text{ mol/dm}^3 \text{ takes about 70 sec. but double the} \)
concentration is about 58 sec, not 35 sec.
Also, the rate of the reaction does not necessarily mean
the same as the rate of cleaning.
Graph B doesn't show anything about concentration.

3 How could the results from your investigation be useful in the context you have
researched?
You may use information from your Candidate Research Notes to help you to answer
this question.

Limescale removers for kettles should be used at a high
temperature, otherwise it will take too long. This is why
the instructions say use boiling water.

You should also take care not to breathe in any fumes
from the reaction.

4 Make sure that you hand in your Candidate Research notes, results tables, and chart or
graph with this paper.

You will be awarded up to four marks for your chart or graph.

END OF QUESTIONS
Results tables and graph

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<thead>
<tr>
<th>Temp °C</th>
<th>Time s</th>
</tr>
</thead>
<tbody>
<tr>
<td>14</td>
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<td>6</td>
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</tbody>
</table>
Please mark in red ink. Each part of each question must show some red ink to indicate that it has been seen. Subtotals for each part of each question should be written in the right-hand margin.

Enter the marks for **Section 1** and **Section 2** and the **total mark** on the front cover of the answer booklet for Section 1. Fasten both sections together with the results table(s) and the graphical work and the Candidate Research Notes from Section 1 of the ISA.

The teacher must sign and date the front covers of Section 1 and Section 2 of the ISA.

The papers must be kept in a secure place and must **not** be returned to the candidates.

These Marking Guidelines are necessarily generic. Additional guidance on how to relate these generic Marking Guidelines to particular investigations is given below the generic section.

Read through the whole of the candidate’s answer and use the Marking Guidelines below to arrive at a ‘best-fit’ mark as candidates may meet some criteria but not others in a mark range.

---

### SECTION 1

<table>
<thead>
<tr>
<th>Q. No.</th>
<th>0 marks</th>
<th>1 mark</th>
<th>2 marks</th>
<th>3 marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>No creditworthy response</td>
<td>There is a hypothesis that, by implication, identifies the independent and dependent variables, but there is no explanation.</td>
<td>There is a hypothesis that, by implication, identifies the independent and dependent variables, however, the explanation for this hypothesis is unclear.</td>
<td>There is a hypothesis that, by implication, identifies the independent and dependent variables, The hypothesis is explained clearly</td>
</tr>
</tbody>
</table>

**Additional Guidance**

An example of a hypothesis could be: “I think that if I change the concentration of the solution then the reaction will finish sooner.”

An example of an unclear explanation could be: “I think this because there are more particles available to react.”

An example of a clear explanation could be: this is called the collision theory; anything that increases the number of collisions in a set time will increase the rate of a reaction.
<table>
<thead>
<tr>
<th>Q. No. 2</th>
<th>0 marks</th>
<th>1 mark</th>
<th>2 marks</th>
<th>3 marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>No creditworthy response</td>
<td>Two relevant sources are clearly identified.</td>
<td>Two relevant sources are clearly identified</td>
<td>Two relevant sources are clearly identified</td>
<td></td>
</tr>
<tr>
<td>or one relevant source is identified and the usefulness of the source commented on</td>
<td></td>
<td>The usefulness of one of the sources is commented on.</td>
<td>The usefulness of both sources is explained and a comparison made.</td>
<td></td>
</tr>
</tbody>
</table>

### Additional Guidance

An identified source is referred to by title and author or for websites at least the name of the web site should be quoted.

Any identified source should be capable of being accessed by the moderator.

A clear comment on only one of the sources may be sufficient to gain 3 marks if the answer implies a comment on the other source.

If candidates have taken part in peer discussion as part of their research, simply stating this is not sufficient to qualify for quoting a source. Similarly, reference to their own notes or exercise book alone is insufficient.
## CU2.x Rates of Reaction - Specimen ISA - Marking Guidelines

### SECTION 1

In this question candidates are required to produce extended written material in English, and will be assessed on the quality of their written communication as well as the standard of the scientific response.

Candidates will be required to use good English, organise information clearly and use specialist vocabulary where appropriate.

In order to attain a mark within a certain level, both the science and the Quality of Written Communication must be considered.

Read through the whole of the candidate's answer and use the Marking Guidelines below to arrive at a 'best-fit' mark, as candidates may meet some criteria but not others in a mark range.

<table>
<thead>
<tr>
<th>Q. No.</th>
<th>0 marks</th>
<th>1 or 2 marks</th>
<th>3 or 4 marks</th>
<th>5 or 6 marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>No creditworthy response</td>
<td>Some of the necessary equipment is stated.</td>
<td>Most of the necessary equipment is stated.</td>
<td>Most of the necessary equipment is stated.</td>
</tr>
<tr>
<td></td>
<td>The method described is weak but shows some understanding of the sequence of an investigation</td>
<td>The method described will enable valid results to be collected</td>
<td>The method described will enable valid results to be collected</td>
<td></td>
</tr>
<tr>
<td></td>
<td>The measurements to be made are stated</td>
<td>The measurements to be made are stated and at least one control variable is given</td>
<td>The measurements to be made are stated and the significant control variables are clearly identified, with details of how they will be monitored or controlled.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>The answer is poorly organised, with almost no specialist terms and little or no detail given</td>
<td>The answer has some structure and organisation, use of specialist terms has been attempted but not always correctly, and some detail is given</td>
<td>The answer is coherent and written in an organised, logical sequence, containing a range of relevant specialist terms used correctly</td>
<td></td>
</tr>
<tr>
<td></td>
<td>The spelling, punctuation and grammar is very weak</td>
<td>The answer shows reasonable spelling, punctuation and grammar although there may still be some errors.</td>
<td>The answer shows almost faultless spelling, punctuation and grammar</td>
<td></td>
</tr>
</tbody>
</table>

**Additional Guidance**

*It may be possible to credit a clearly labelled diagram for some of the marks*
CU2.x Rates of Reaction - Specimen ISA - Marking Guidelines

### SECTION 1

<table>
<thead>
<tr>
<th>Q. No. 4</th>
<th>0 marks</th>
<th>1 mark</th>
<th>2 marks</th>
<th>3 marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>No creditworthy response</td>
<td>An appropriate hazard is identified, but the corresponding risk assessment and control measure is weak or absent</td>
<td>Any significant hazards are identified, together with a corresponding control measure but the risk assessment is weak or absent</td>
<td>Any significant hazards are identified, together with an assessment of the associated risks and corresponding control measures</td>
<td></td>
</tr>
</tbody>
</table>

**Additional Guidance**
Typical hazards with associated risk reduction might include: acid is corrosive, there is a risk of it splashing into the eyes, therefore wear safety goggles and plastic gloves.

<table>
<thead>
<tr>
<th>Q. No. 5</th>
<th>0 marks</th>
<th>1 mark</th>
<th>2 marks</th>
<th>3 marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>No creditworthy response</td>
<td>An alternative method is outlined briefly although some of the necessary steps may not be clear</td>
<td>An alternative method is outlined briefly</td>
<td>An alternative method is outlined briefly</td>
<td></td>
</tr>
<tr>
<td>A suggestion is given as to why this alternative method would not have been as good as the one chosen</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Additional Guidance**

<table>
<thead>
<tr>
<th>Q. No. 6</th>
<th>0 marks</th>
<th>1 mark</th>
<th>2 marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>No table or a table with incomplete headings or units for the measured variables. Fewer than half of the required elements are present</td>
<td>A table with incomplete headings or units for the measured variables</td>
<td>Correct headings and units present for all measured variables.</td>
<td></td>
</tr>
</tbody>
</table>

**Additional Guidance**
The table should be able to accommodate all the variables that the candidate is going to measure or record during the investigation. There is no need for the candidate to include columns for repeats, means or derived values.
## SECTION 2

<table>
<thead>
<tr>
<th>Q. No. 1(a)</th>
<th>0 marks</th>
<th>1 mark</th>
<th>2 marks</th>
<th>3 marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>No creditworthy response</td>
<td>A valid statement is made about whether or not the results support the hypothesis</td>
<td>A valid statement is made about whether or not the results support the hypothesis, The answer includes either a reference to a pattern or some examples from the results</td>
<td>A valid statement is made about whether or not the results support the hypothesis, The answer includes a reference to a pattern and some examples from the results</td>
<td></td>
</tr>
</tbody>
</table>

**Additional Guidance**
The candidate’s statement(s) must match the candidate’s own results.

An example of a pattern might be ‘the higher the concentration, the faster the reaction went’.

An example of results quoted in support might be ‘when the concentration was 0.1 M, the magnesium all dissolved in 30 seconds, but when the concentration was 0.2 M, it all went in 15 seconds’
<table>
<thead>
<tr>
<th>Q. No.</th>
<th>0 marks</th>
<th>1 mark</th>
<th>2 marks</th>
<th>3 marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (b)</td>
<td>No creditworthy response</td>
<td>There is a correct statement as to whether or not there are any anomalous results</td>
<td>There is a correct statement as to whether or not there are any anomalous results and a statement or implication that anomalous results are ones that do not fit the pattern.</td>
<td>There is a correct statement as to whether or not there are any anomalous results and a statement or implication that anomalous results are ones that do not fit the pattern. Some examples from the results are given to support this, e.g. by specifying results that are considered to be anomalous or by referring to the fact that, e.g. all results are very close to a line of best fit.</td>
</tr>
<tr>
<td>1 (c)</td>
<td>No creditworthy response</td>
<td>A statement is made that a mean should be calculated</td>
<td>A statement is made that a mean should be calculated by adding the results together and dividing by the number of values</td>
<td>A statement is made that a mean should be calculated by adding the results together and dividing by the number of values. Anomalous results are discarded before calculating a mean or a graph is plotted and a best fit line is drawn ignoring anomalous points</td>
</tr>
</tbody>
</table>

**Additional Guidance**

N.B. the candidate’s response must match the candidate’s own results.

Accept the term ‘average’ as an alternative to ‘mean’.
## SECTION 2

<table>
<thead>
<tr>
<th>Q. No. 1 (d)</th>
<th>0 marks</th>
<th>1 mark</th>
<th>2 marks</th>
<th>3 marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>No creditworthy response</td>
<td>A correct value for the resolution is given or a sensible but incorrect value is given for the resolution with a correct statement appropriate to the resolution they have given</td>
<td>A correct value for the resolution is given and a correct statement as to whether or not the resolution was appropriate is given, but the explanation is not clear.</td>
<td>A correct value for the resolution is given and a correct statement as to whether or not the resolution was appropriate is given and there is a clear explanation.</td>
<td></td>
</tr>
</tbody>
</table>

### Additional Guidance

The resolution will normally be either the smallest scale division or half the smallest scale division. Look at the candidate's table of results in order to confirm the explanation. A clear explanation will convey that the candidate understands the term resolution.

<table>
<thead>
<tr>
<th>Q. No. 1 (e)</th>
<th>0 marks</th>
<th>1 mark</th>
<th>2 marks</th>
<th>3 marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>No creditworthy response</td>
<td>Identifies a suitable error or uncertainty</td>
<td>Identifies a suitable error or uncertainty Suggests a way of reducing the error identified</td>
<td>Identifies a suitable error or uncertainty Suggests a way of reducing the error identified Explains how the way suggested will reduce the error or uncertainty</td>
<td></td>
</tr>
</tbody>
</table>

### Additional Guidance

The most likely sources of error are the dilution of the hydrochloric acid to make the different concentrations, the cutting of the magnesium ribbon or the determination when the ribbon had completely dissolved.
### SECTION 2

<table>
<thead>
<tr>
<th>Q. No. 2 (a)</th>
<th>0 marks</th>
<th>1 mark</th>
<th>2 marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>No creditworthy response</td>
<td>Both axes labelled with the variables (ignore any units given).</td>
<td>Both axes labelled with the variables (ignore any units given). and an appropriate line drawn</td>
<td></td>
</tr>
</tbody>
</table>

**Additional Guidance**
- Accept axes drawn either way round (i.e. it doesn't matter which axis the roughness is on)
- The line should curve from top left to bottom right if drawn conventionally
- No values need to be shown on either axis, and the line may intercept either axis.

<table>
<thead>
<tr>
<th>Q. No. 2 (b)(i)</th>
<th>0 marks</th>
<th>1 mark</th>
<th>2 marks</th>
<th>3 marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>No creditworthy response</td>
<td>A simple correct statement is made about <strong>at least</strong> two of the Case Studies 1, 2 and 3, as to whether or not they support the hypothesis.</td>
<td>Correct statements are made Case Studies 1, 2 and 3, supported by a more detailed explanation of <strong>one</strong> of them.</td>
<td>Correct statements are made Case Studies 1, 2 and 3, supported by a more detailed explanation of <strong>both</strong> Case Studies 2 and 3.</td>
<td></td>
</tr>
</tbody>
</table>

**Additional Guidance**
- An example of a clear statement for Case Study 1 is “increasing the concentration reduces the time taken for the magnesium to dissolve”.
- A more detailed explanation for Case Study 2 could be that “the results support the hypothesis, if the incorrectly calculated mean is corrected”
- A more detailed explanation for Case Study 3 could be “the investigation is not relevant as it deals with particle size, not concentration.”
### Q. No. 2 (b)(ii)

<table>
<thead>
<tr>
<th></th>
<th>0 marks</th>
<th>1 mark</th>
<th>2 marks</th>
<th>3 marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td>There is a simple statement saying whether or not the results in Case Study 4 support the manufacturer’s hypothesis and this is supported by some <strong>qualitative</strong> information quoted.</td>
<td>There is a simple statement saying whether or not the results in Case Study 4 support the manufacturer’s hypothesis and this is supported by some <strong>quantitative</strong> information quoted.</td>
<td>There is a simple statement saying whether or not the results in Case Study 4 support the manufacturer’s hypothesis and this is supported by some <strong>quantitative</strong> information quoted.</td>
<td>There is also a statement that makes clear the limitations of the data in supporting the hypothesis</td>
</tr>
</tbody>
</table>

**Additional Guidance**

There are no marks for simply stating whether or not the results support the hypothesis, the marks are for the explanation.

A simple statement might be that it supports the hypothesis because graph A shows that increasing the concentration removes the ‘standard’ stain in a quicker time.

A more detailed statement might be that whilst increasing the concentration cleans the stain faster shown in Graph A, so too does increasing the temperature shown in Graph B.

Further information about the limitations might include the concentration will be limited by the mass of cleaner that can dissolve in water, or the temperature effect will be limited by the boiling point of water.

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### Q. No. 3

<table>
<thead>
<tr>
<th></th>
<th>0 marks</th>
<th>1 mark</th>
<th>2 marks</th>
<th>3 marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>No creditworthy response</td>
<td>Results from the investigation or an idea from the research has been related to the context.</td>
<td>Results from the investigation or an idea from the research has been related to the context.</td>
<td>Results from the investigation or an idea from the research has been related to the context.</td>
<td>Results from the investigation or an idea from the research has been related to the context.</td>
</tr>
</tbody>
</table>

**Additional Guidance**

An idea from the research could be how manufacturers of floor cleaners should determine the best concentration to use.

A simple explanation could involve relating the concentration to the cost-effectiveness. .

A detailed explanation could be how to determine the best combination of concentration and temperature to use for optimum results.
<table>
<thead>
<tr>
<th>Q. No. 4</th>
<th>Answer</th>
<th>Additional Guidance</th>
<th>Mark</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>X axis: suitable scales chosen and labelled with quantity and units.</td>
<td>Scale should be such that the plots occupy at least one third of each axis. Accept axes reversed. It may not always be necessary to show the origin.</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Y axis: suitable scales chosen and labelled with quantity and units.</td>
<td>Allow one plotting error out of each 5 points/bars plotted.</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Points or bars plotted correctly to within ± 1 mm.</td>
<td>Allow error carried forward from incorrect points. If wrong type of graph / chart, maximum 3 marks.</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Suitable line drawn on graph or bars correctly labelled on bar chart.</td>
<td>If the independent variable is: • categoric, should draw a bar chart • continuous, should draw a best fit line N.B. If no line possible because there is no correlation, candidates should state this on the graph to gain the mark</td>
<td>1</td>
</tr>
</tbody>
</table>