AQA Chemistry GCSE

Required Practical 4 - Temperature Changes

Past Exam Questions

Q1. Some students investigated magnesium oxide.

(a) Magnesium oxide has the formula MgO.

(i) Calculate the relative formula mass (M_r) of magnesium oxide.

Relative atomic masses: O = 16; Mg = 24.

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Relative formula mass = ... (2)

(ii) Calculate the percentage by mass of magnesium in magnesium oxide.

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Percentage by mass of magnesium in magnesium oxide = ...% (2)

(iii) Calculate the mass of magnesium needed to make 25 g of magnesium oxide.

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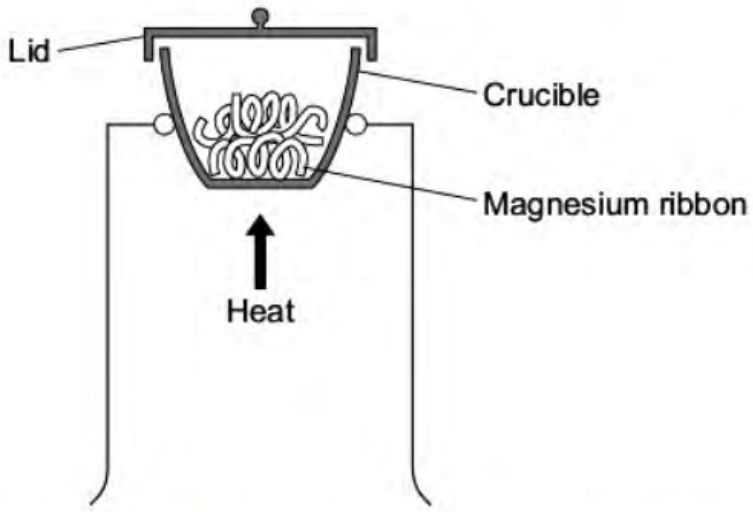
Mass of magnesium = ... g (1)

(b) The students calculated that if they used 0.12 g of magnesium they should make 0.20 g of magnesium oxide. They did this experiment to find out if this was correct.



•The students weighed 0.12 g of magnesium ribbon into a crucible.
•They heated the magnesium ribbon.
•They lifted the lid of the crucible slightly from time to time to allow air into the crucible.
•The students tried to avoid lifting the lid too much in case some of the magnesium oxide escaped.
• When all of the magnesium appeared to have reacted, the students weighed the magnesium oxide produced.

The results of the experiment are shown below.

Mass of magnesium used in grams	0.12
Mass of magnesium oxide produced in grams	0.18

(i) The mass of magnesium oxide produced was lower than the students had calculated. They thought that this was caused by experimental error.
Suggest two experimental errors that the students had made.

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..... (2)

(ii) The students only did the experiment once. Give two reasons why they should have repeated the experiment.

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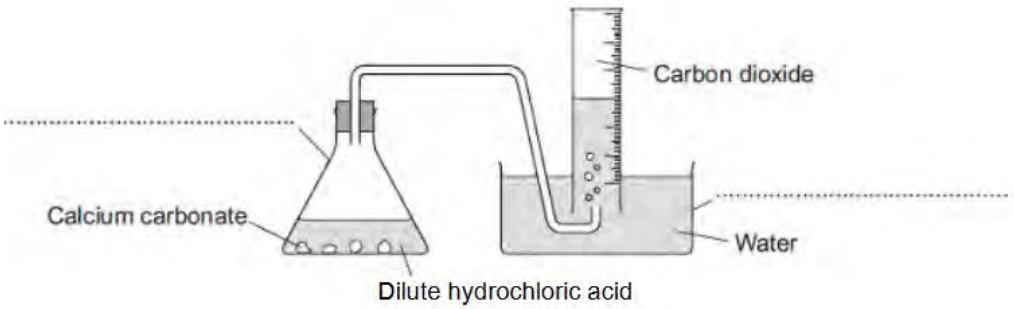
..... (2)

Q2. Some students were investigating the rate at which carbon dioxide gas is produced when metal carbonates react with an acid.

One student reacted 1.00 g of calcium carbonate with 50 cm3 , an excess, of dilute hydrochloric acid. The apparatus used is shown in Diagram 1

Diagram 1



(a) Complete the two labels for the apparatus on the diagram.

(2)

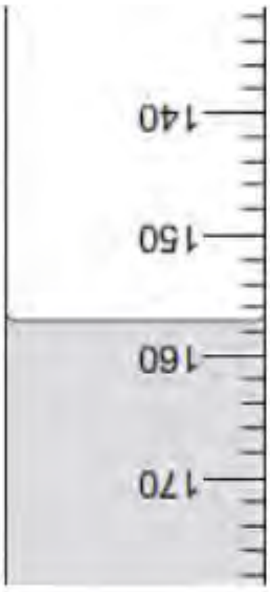
(b) The student measured the volume of gas collected every 30 seconds.
The table shows the student's results.

Time in seconds	Volume of carbon dioxide collected in cm^3
30	104
60	
90	198
120	221
150	232
180	238
210	240
240	240

(i) Diagram 2 shows what the student saw at 60 seconds.

Diagram 2

What is the volume of gas collected?



Volume of gas = ... cm3 (1)

(ii) Why did the volume of gas stop changing after 210 seconds?

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(1)

Q3. Dilute nitric acid reacts with potassium hydroxide solution.
The equation for the reaction is:

$$HNO3 + KOH \rightarrow KNO3 + H2O$$

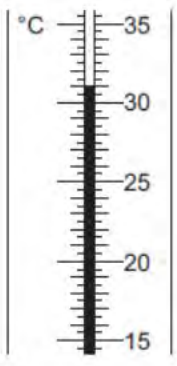
A student investigated the temperature change in this reaction.

This is the method the student used:

Step 1 - Put 25 cm3 of dilute nitric acid in a polystyrene cup.
Step 2 - Use a thermometer to measure the temperature of the dilute nitric acid.
Step 3 - Use a burette to add 4 cm3 of potassium hydroxide solution to the dilute nitric acid and stir the mixture.
Step 4 - Use a thermometer to measure the highest temperature of the mixture.
Step 5 - Repeat steps 3 and 4 until 40 cm3 of potassium hydroxide solution have been added.

The dilute nitric acid and the potassium hydroxide solution were both at room temperature.

(a) Figure 1 shows part of the thermometer after some potassium hydroxide solution had been added to the dilute nitric acid.



What is the temperature shown on the thermometer?

The temperature shown is ..... °C

(1)

(b) Errors are possible in this experiment.

(i) Suggest two causes of random error in the experiment.

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(2)

(ii) Another student used a glass beaker instead of a polystyrene cup.
This caused a systematic error.

Why does using a glass beaker instead of a polystyrene cup cause a systematic error?

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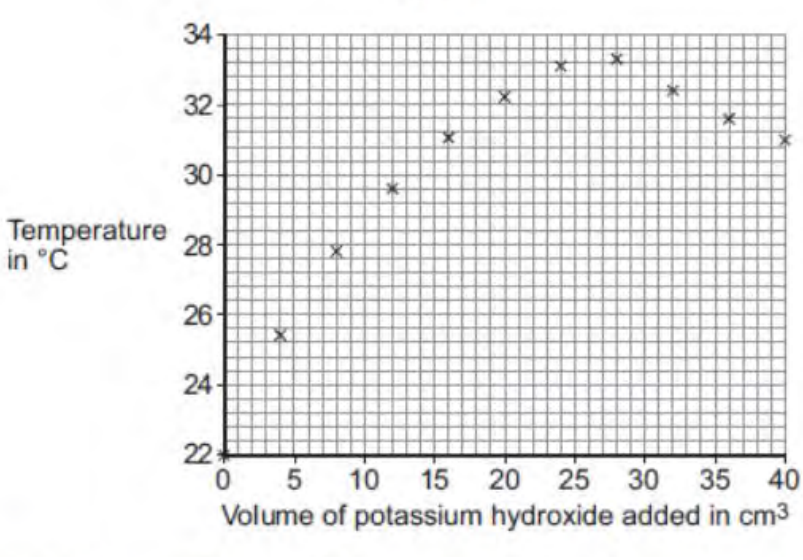
(1)

(c) The results of the student using the polystyrene cup are shown in Figure 2



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(i) How do the results in Figure 2 show that the reaction between dilute nitric acid and potassium hydroxide solution is exothermic?

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(1)

(ii) Explain why the temperature readings decrease between 28 cm3 and 40 cm3 of potassium hydroxide solution added.

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(2)

(iii) It is difficult to use the data in Figure 2 to find the exact volume of potassium hydroxide solution that would give the maximum temperature. Suggest further experimental work that the student should do to make it easier to find the exact volume of potassium hydroxide solution that would give the maximum temperature

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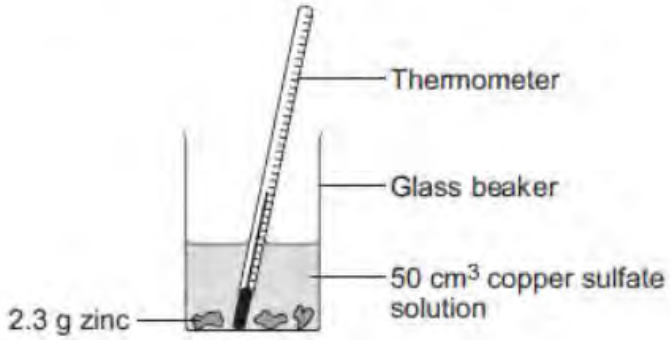
(2)

Q4. A student investigated the temperature change when zinc reacts with copper sulfate solution. The student used a different concentration of copper sulfate solution for each experiment.
The student used the apparatus shown below.



The student:

- Measured 50 cm3 copper sulfate solution into a glass beaker
- Measured the temperature of the copper sulfate solution
- Added 2.3 g zinc
- Measured the highest temperature
- Repeated the experiment using copper sulfate solution with different concentrations.

$$Zn(s) + CuSO_4(aq) \longrightarrow Cu(s) + ZnSO_4(aq)$$

zinc + copper sulfate solution ⟶ copper + zinc sulfate solution

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a) The thermometer reading changes during the reaction.

Give one other change the student could see during the reaction.

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(1)

(b) Suggest one improvement the student could make to the apparatus.

Give a reason why this improves the investigation.

Improvement .....

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Reason .....

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(2)

(c) In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.
The student's results are shown in the table.

Table

Experiment number	Concentration of copper sulfate in moles per dm^3	Increase in temperature in °C
1	0.1	5
2	0.2	10
3	0.3	12
4	0.4	20
5	0.5	25
6	0.6	30
7	0.7	35
8	0.8	35
9	0.9	35
10	1.0	35

Describe and explain the trends shown in the student's results.

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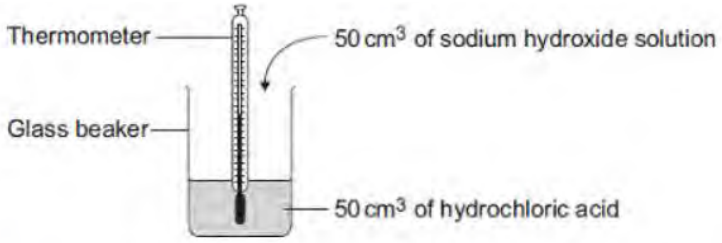
(6)

Q5. Read the information about energy changes and then answer the questions. A student did an experiment to find the energy change when hydrochloric acid reacts with sodium hydroxide.

The equation which represents the reaction is:

$$HCl + NaOH \rightarrow NaCl + H_2O$$

The student used the apparatus shown in the diagram.



The student placed 50 cm3 of hydrochloric acid in a glass beaker and measured the initial temperature.

The student then quickly added 50 cm3 of sodium hydroxide solution and stirred the mixture with the thermometer. The highest temperature was recorded.

The student repeated the experiment, and calculated the temperature change each time.

	Experiment 1	Experiment 2	Experiment 3	Experiment 4
Initial temperature in °C	19.0	22.0	19.2	19.0
Highest temperature in °C	26.2	29.0	26.0	23.5
Temperature change in °C	7.2	7.0	6.8	4.5

(a) The biggest error in this experiment is heat loss.

Suggest how the apparatus could be modified to reduce heat loss.

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(1)

(b) Suggest why it is important to mix the chemicals thoroughly.

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(1)

(c) Which one of these experiments was probably done on a different day to the others?

Give a reason for your answer.

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(1)

(d) Suggest why experiment 4 should not be used to calculate the average temperature change.

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(1)

(e) Calculate the average temperature change from the first three experiments.

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Answer = ... °C

(1)

(f) Use the following equation to calculate the energy change for this reaction.

Energy change in joules = 100 × 4.2 × average temperature change

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Answer = ... J

(1)

(g) Which one of these energy level diagrams represents the energy change for this reaction?

Give a reason for your answer.

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(1)