1 A teacher investigates the temperature changes that occur when sodium hydroxide solution is added to dilute hydrochloric acid.

This is the method she uses.

- place some of the acid in a glass beaker and measure its temperature
- add a known volume of sodium hydroxide solution
- stir the mixture and record the highest temperature reached
- repeat the experiment with different volumes of sodium hydroxide solution

(a) State two factors that the teacher must keep constant to make this a valid investigation (a fair test).

(2)

1 .....

2 .....

(b) Explain how the use of a polystyrene cup, in place of a glass beaker, will affect the accuracy of the results.

(2)

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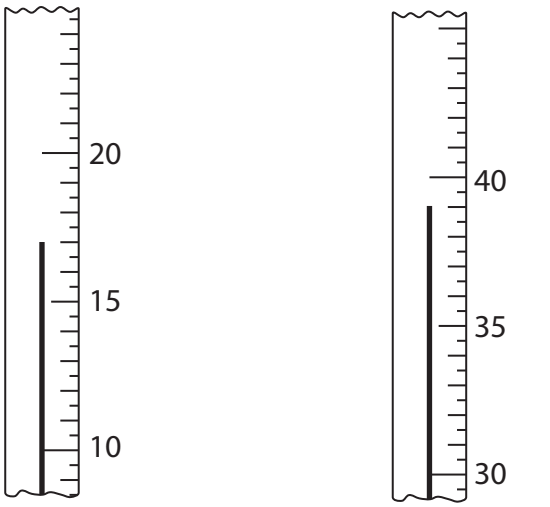
(c) (i) The diagram shows the thermometer readings for one of the experiments.



initial temperature final temperature

Record the temperatures and calculate the temperature change.

(3)

final temperature of mixture	..... °C
initial temperature of acid	..... °C
temperature change	..... °C

(ii) State how the temperature change shows whether the reaction between sodium hydroxide and hydrochloric acid is exothermic or endothermic.

(1)

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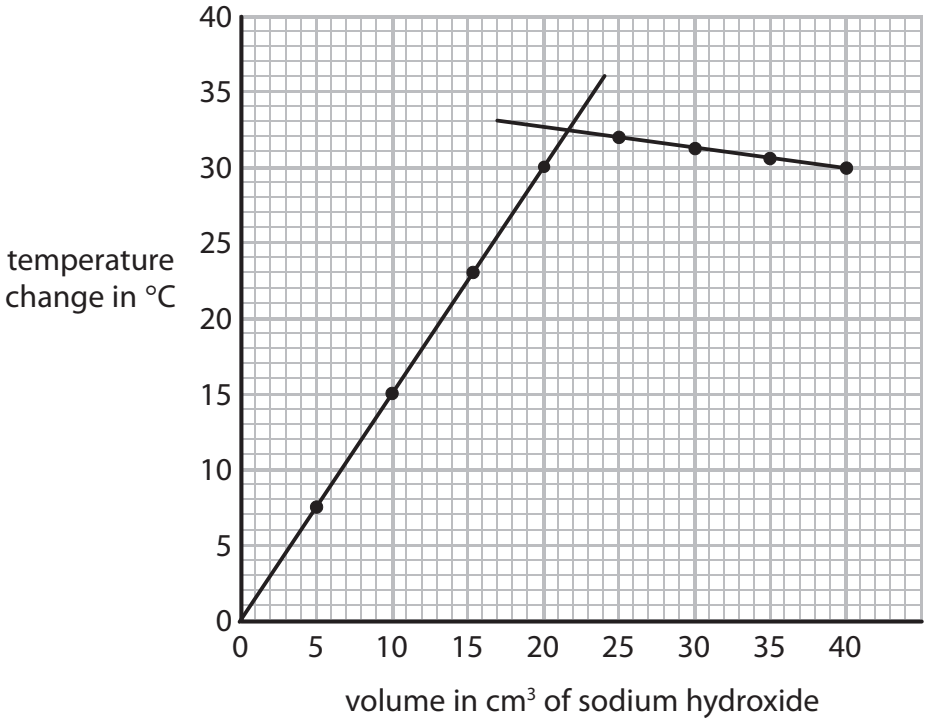
(d) The graph shows the result of the teacher's investigation.



Explain the shape of the graph.

(2)

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(Total for Question 1 = 10 marks)

2 A student investigates the rate of reaction between sodium thiosulfate and hydrochloric acid at 25 °C.

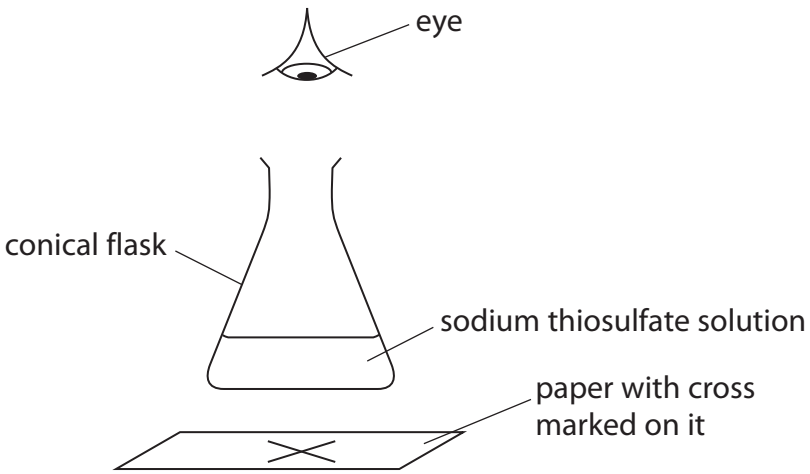
The equation for the reaction is

$$Na_2S_2O_3(aq) + 2HCl(aq) \rightarrow 2NaCl(aq) + H_2O(l) + SO_2(g) + S(s)$$

She uses this method.

- pour 50 cm^3 of sodium thiosulfate solution into a conical flask
- place the conical flask on top of a sheet of paper with a cross drawn on it
- add 10 cm^3 of hydrochloric acid and start the timer
- stop the timer when the cross can no longer be seen and record the time taken

The student repeats the experiment five times with different volumes of sodium thiosulfate solution. She adds water as necessary to keep the total volume of reaction mixture constant.



(a) Why can the student no longer see the cross at the end of each experiment?

(1)

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.....

(b) The student keeps the total volume of the reaction mixture constant in each experiment.

Explain how this makes each experiment a fair test.

(1)

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.....

(c) The table shows the student's results.

Experiment	Volume of $Na_2S_2O_3$ solution in cm^3	Volume of water in cm^3	Time in seconds
1	50	0	5
2	40	10	60
3	30	20	80
4	20	30	130
5	15	35	180
6	10	40	255

Why is it important for the student to add the water before the acid in experiments 2 to 6?

(1)

.....

.....

.....

(d) Sulfur dioxide gas is given off in the reaction.

Suggest a safety precaution that the student should take when doing this experiment.

Explain your answer.

(2)

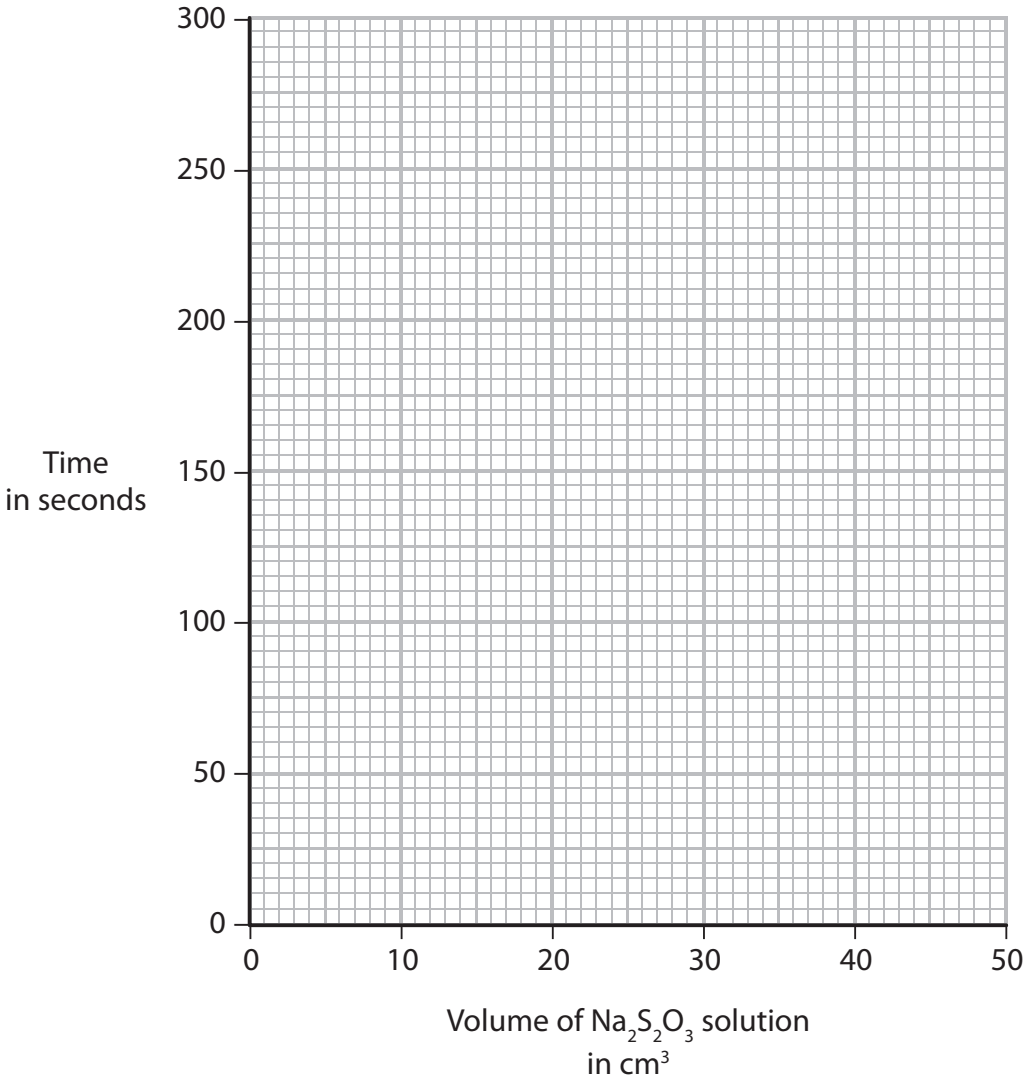
precaution .....

explanation .....

.....

(e) (i) Plot the student's results on the grid and draw a curve of best fit.

(3)



(ii) On the grid, sketch the curve that you would expect if the investigation were repeated at 40 °C.

Assume all other factors remain constant.

(2)

(Total for Question 2 = 10 marks)

3 Solid X contains two cations (positive ions) and one anion (negative ion).

One of the cations is Fe^{3+}

(a) The table describes the tests carried out on an aqueous solution of X and some of the observations made.

Complete the table by giving the missing observation.

(1)

Test	Observation
add sodium hydroxide solution then heat the mixture and test the gas given off with damp red litmus paper	.... litmus paper turns blue
add dilute hydrochloric acid, then add a few drops of barium chloride solution	white precipitate forms

(b) (i) Which cation, other than Fe^{3+}, is present in X?

Explain your answer.

(2)

cation .....

explanation .....

.....

(ii) Identify the anion present in X.

(1)

.....

(c) When zinc is added to a solution containing Fe^{3+} ions, a reaction occurs.

The ionic equation for this reaction is

$$Zn(s) + 2Fe^{3+}(aq) \rightarrow Zn^{2+}(aq) + 2Fe^{2+}(aq)$$

Identify the reducing agent in this reaction and explain your choice.

(2)

reducing agent .....

explanation .....

.....

.....

(Total for Question 3 = 6 marks)

4 A student added some pieces of iron to a boiling tube containing dilute hydrochloric acid. She observed fizzing and the formation of a solution, X.

(a) Identify the gas that causes the fizzing and describe a test for it.

(2)

Gas .....

Test .....

.....

(b) Solution X contains chloride ions.

(i) The student confirmed this by adding some silver nitrate solution. She observed a white precipitate of silver chloride.

Give the formula of the white precipitate, and name the other solution she should have added before the silver nitrate solution.

(2)

Formula of white precipitate .....

Other solution .....

(ii) Complete the word equation for the reaction in this test.

(1)

iron chloride + silver nitrate → silver chloride + ...

(c) Solution X also contains ions of iron. The student thought that these ions had the formula Fe^{2+} or Fe^{3+}.

What reagent should she add to decide whether solution X contains Fe^{2+} or Fe^{3+} ions? State the result of the test in each case.

(3)

Reagent .....

Result with Fe^{2+} ions .....

.....

Result with Fe^{3+} ions .....

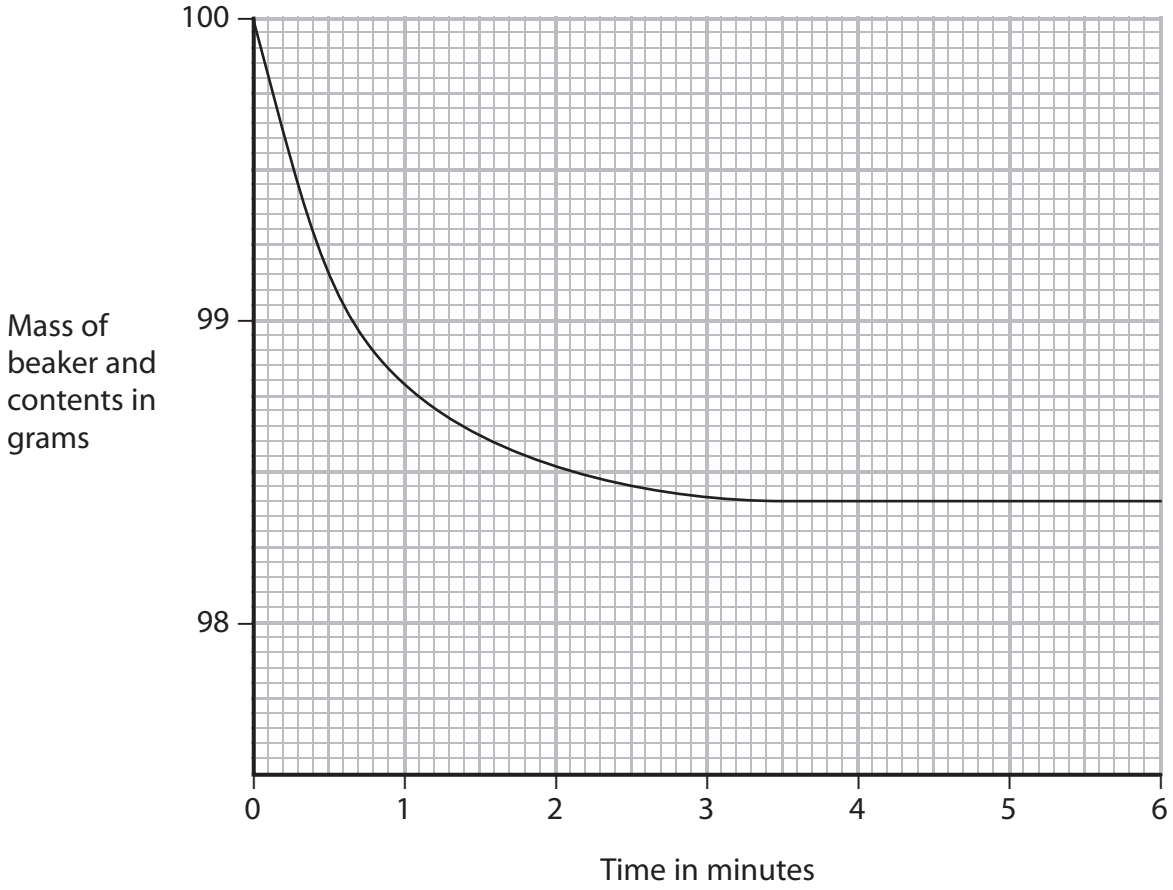
.....

(Total for Question 4 = 8 marks)

5 An excess of dilute hydrochloric acid was added to a lump of calcium carbonate in a beaker.

The mass of the beaker and contents was recorded every 30 seconds.

The graph shows the results.



The equation for the reaction is

$$CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + H_2O(l) + CO_2(g)$$

(a) State **two** observations that can be made when dilute hydrochloric acid is added to calcium carbonate.

(2)

1 .....

2 .....

(b) Give the test for carbon dioxide gas.

(2)

Test .....

Result .....

(c) Describe the relationship between the mass of the beaker and contents, and the time.

(1)

.....

.....

(d) (i) After how many minutes did the reaction stop?

(1)

.....

(ii) State why the reaction eventually stopped.

(1)

.....

.....

(e) Identify the compounds, other than water, present in the solution in the beaker

(i) after two minutes

(1)

.....

(ii) after five minutes

(1)

.....

(f) The experiment was repeated using the same mass of calcium carbonate, but as a powder instead of a single lump.

On the graph, sketch the curve you would expect to obtain from this second experiment.

(2)

(Total for Question 5 = 11 marks)

6 Compound **X** is a blue, crystalline solid. It contains copper(II) ions (Cu^{2+}), sulfate ions (SO_4^{2-}) and water of crystallisation.

(a) A student dissolved some of compound **X** in water and then added aqueous sodium hydroxide solution. She obtained a blue precipitate.

Give the formula of the blue precipitate formed in the reaction.

(1)

.....

(b) Another student tested a solution of compound **X** for sulfate ions using dilute hydrochloric acid, followed by a few drops of barium chloride solution. She obtained a white precipitate.

Why is the dilute hydrochloric acid necessary in this test?

(1)

.....

.....

.....

(c) The empirical formula of compound **X** is $CuSO_9H_{10}$

Write the formula of compound **X** to show its water of crystallisation.

(1)

.....

(d) Compound **X** gives a blue-green colour in a flame test.

Outline how you would carry out a flame test.

(2)

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(Total for Question 6 5 marks)

7 (a) Wine can be made from grapes.

The grapes are crushed to produce an aqueous solution containing glucose. Yeast is then added to this solution.

The solution is kept at a constant temperature for a period of time. The glucose is converted into ethanol.

(i) Name the process in which glucose is converted into ethanol.

(1)

.....

(ii) What is the purpose of the yeast?

(1)

.....

.....

(b) Grape vines can be attacked by a fungus that ruins the grapes. The fungus can be killed using Bordeaux mixture, a solid containing copper(II) sulfate and calcium hydroxide.

(i) State a test to show that Bordeaux mixture contains calcium ions.

(2)

test for calcium ions .....

observation .....

(ii) A sample of Bordeaux mixture is dissolved in water.

Describe separate tests to show that this solution contains copper(II) ions and sulfate ions.

(5)

test for copper(II) ions .....

.....

observation .....

test for sulfate ions.....

.....

observation.....

(c) Ethanol can be manufactured by passing a hot mixture of ethene and steam, at a high pressure, over a catalyst.

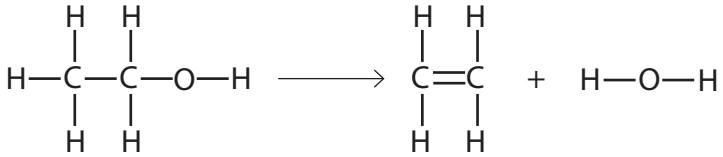
State the pressure used and name the catalyst.

(2)

pressure ..... atm

catalyst .....

(d) The equation for the conversion of ethanol into ethene can be written using displayed formulae.



The table gives some average bond energies.

Bond	Average bond energy in kJ/mol
C—C	348
C=C	612
C—H	412
C—O	360
O—H	463

Use information from the table to calculate the enthalpy change, in kJ/mol, for the conversion of ethanol into ethene.

(4)

enthalpy change = ... kJ/mol

(Total for Question 7 = 15 marks)