PEARSON EDEXCEL IGCSE CHEMISTRY · 4CH1

CHEMISTRY



EXAM QUESTION PACK

SECTION 2: INORGANIC CHEMISTRY (PACK 5)

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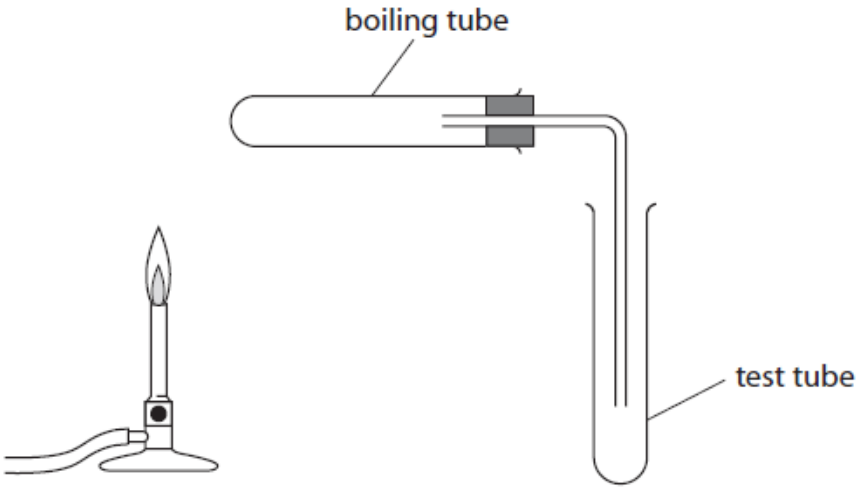
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Q1.

This question is about metal carbonates.

When heated, some metal carbonates decompose to form a metal oxide and carbon dioxide gas.

(a) A student is given three solid metal carbonates, a timer, some limewater and this apparatus.



Describe a method the student can use to find out which metal carbonate decomposes fastest when heated.

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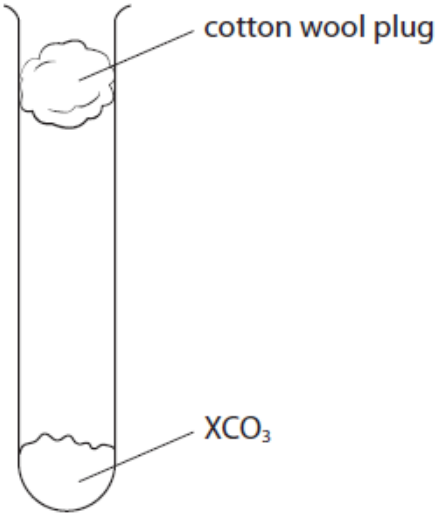
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(b) A student is given a solid metal carbonate with the formula XCO_3

X represents the symbol of a Group 2 metal.

A student uses this apparatus to heat a sample of XCO_3 until it all decomposes.



The equation for the decomposition of XCO_3 is

$$XCO_3 \rightarrow XO + CO_2$$

The student records the mass of XCO^3 and the mass of carbon dioxide that escapes through the cotton wool plug.

These are the student's results.

mass of XCO_3 = 7.40 g

mass of CO_2 = 2.20 g

(i) Give a reason why the student uses a cotton wool plug.

(1)

.....

.....

(ii) Calculate the amount, in mol, of carbon dioxide produced.

[for carbon dioxide M_r = 44]

(1)

amount of carbon dioxide = ... mol

(iii) Use the equation to determine the amount, in mol, of XCO_3 that decomposed.

(1)

amount of XCO_3 = ... mol

(iv) Use the mass of XCO_3 and your answer to (b)(iii) to calculate the relative formula mass (M_r) of XCO_3

(2)

M_r of XCO_3 = ...

(v) Use your answer to (b)(iv) and the Periodic Table on page 2 to determine the identity of the Group 2 metal X.

Show your working.

(2)

identity of X = ...

(Total for question = 11 marks)

Q2.

This is a question about metals and their compounds.

(a) State one property of metals.

(1)

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(b) Mercury is the only metal that is liquid at room temperature.

Describe the difference in the movement of particles in liquid mercury and in a solid metal.

(2)

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(c) Magnesium is a metal that burns in air.

(i) State one observation made during the combustion of magnesium metal.

(1)

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(ii) State one chemical property of the product of combustion that can be used to classify magnesium as a metal.

(1)

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(d) In the absence of air, magnesium reacts with sulfur to form the ionic compound magnesium sulfide, MgS

(i) Give a reason why the reaction needs to be done in the absence of air.

(1)

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(ii) Describe, in terms of electrons, the formation of the ions in magnesium sulfide.

Give the charges on the ions.

(3)

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(iii) Explain why magnesium sulfide has a very high melting point.

(3)

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(iv) Magnesium sulfide reacts with hydrochloric acid to form magnesium chloride and hydrogen sulfide gas, H_2S

Give the chemical equation for this reaction.

(2)

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(Total for question = 14 marks)

Q3.

This question is about salts.

(a) Soluble salts can be prepared by the reaction between a metal oxide and an acid.

The equation for this type of reaction is

metal oxide + acid → salt + water

(i) State the name given to this type of reaction.

(1)

.....

(ii) State, in terms of protons, what happens in this reaction.

(1)

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(b) (i) A student is given 50 cm^3 of dilute sulfuric acid and a bottle of solid copper(II) carbonate.

Describe the method that the student should use to prepare a saturated solution of copper(II) sulfate.

In your answer, refer to the pieces of apparatus that the student should use.

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(ii) The student produces dry crystals of hydrated copper(II) sulfate from the saturated solution.

He calculates that 6.40 g of dry crystals should be formed.

The mass of dry crystals he actually obtains is 1.80 g less than he calculated.

Calculate the student's percentage yield.

Give your answer to one decimal place.

(3)

percentage yield = ... %

(c) (i) Gypsum is hydrated calcium sulfate.

A sample of gypsum contains 79% of calcium sulfate by mass.

Calculate the value of x in $CaSO_4.xH_2O$

[M_r of $CaSO_4$ = 136 M_r of H_2O = 18]

(3)

x = ...

(ii) Describe a test for calcium ions in the sample of gypsum.

(2)

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(Total for question = 15 marks)

Q4.

This question is about metals in Group 1 of the Periodic Table.

When these metals are added to water, they form hydrogen gas and an alkaline solution.

(a) A teacher adds a small piece of lithium to a trough of water to form a solution.

She dips a piece of platinum wire into the solution. She then places the wire into a hot Bunsen flame and the flame changes colour.

(i) State the new colour of the flame.

(1)

.....

(ii) Give the formula of the ion responsible for the new colour.

(1)

.....

(iii) The teacher adds a few drops of litmus indicator to the solution.

Explain the colour of the litmus indicator after it is added to the solution.

(2)

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(b) The teacher adds a small piece of sodium to a second trough of water.

The sodium floats and moves around the surface of the water as it reacts.

(i) Give two other observations that are made as sodium reacts with water.

(2)

1 .....

.....

2 .....

.....

(ii) Complete the chemical equation for the reaction of sodium with water.

(1)

..... Na + ... H_2O → ..... NaOH + ... H_2

(c) The teacher adds a small piece of potassium to a third trough of water.

(i) Give one observation that is different when using potassium instead of sodium.

(1)

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.....

(ii) Give a possible pH value for the solution that forms when potassium reacts with water.

(1)

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(d) Explain why the reaction of rubidium with water is more vigorous than the reaction of potassium with water.

(2)

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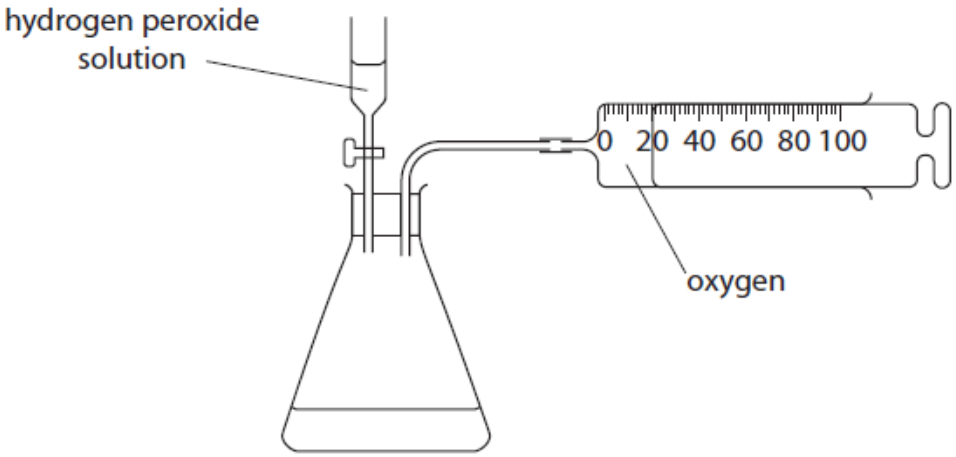
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(Total for question = 11 marks)

Q5.

A student uses this apparatus to investigate the rate of oxygen production by the decomposition of hydrogen peroxide solution, H_2O_2



(a) Give a test to show that the gas collected is oxygen.

(1)

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(b) This experiment is repeated with 1 g of a solid catalyst in the conical flask.

The rate of reaction is greater in this experiment.

Describe how the student can show that the solid is a catalyst and not a reactant.

(3)

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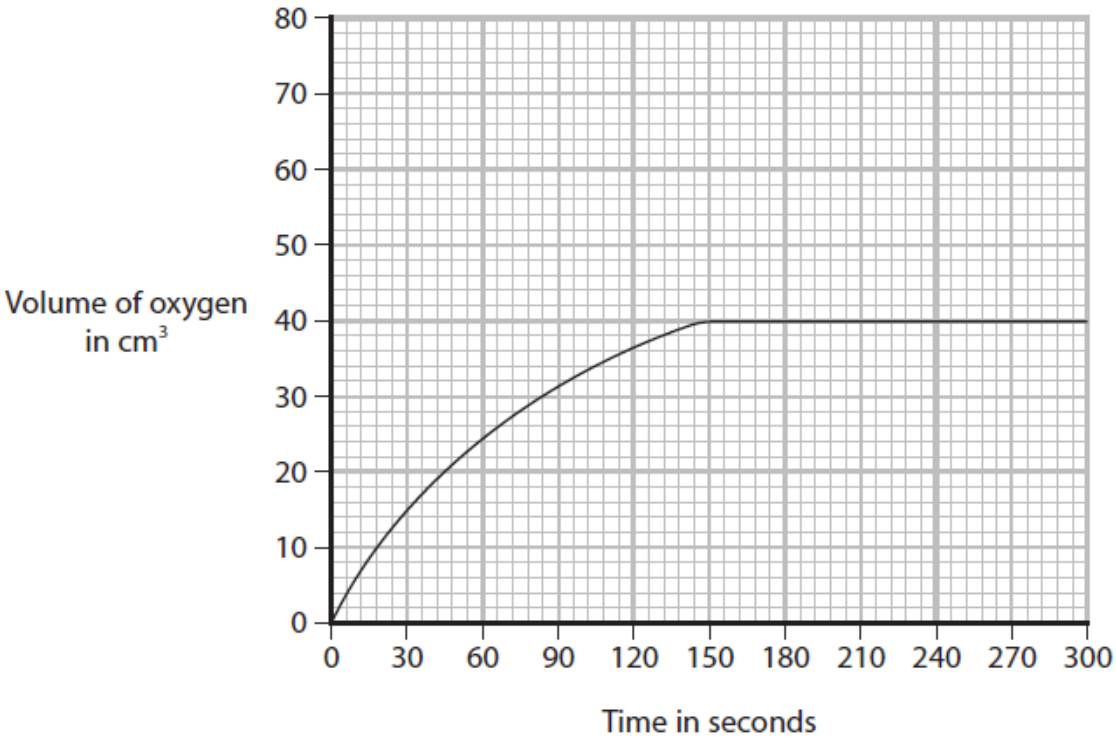
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(c) The graph shows the volume of oxygen collected at 20 °C.



The experiment is done at 40 °C using the same volume and the same concentration of hydrogen peroxide solution.

On the grid, sketch the curve you would expect to obtain.

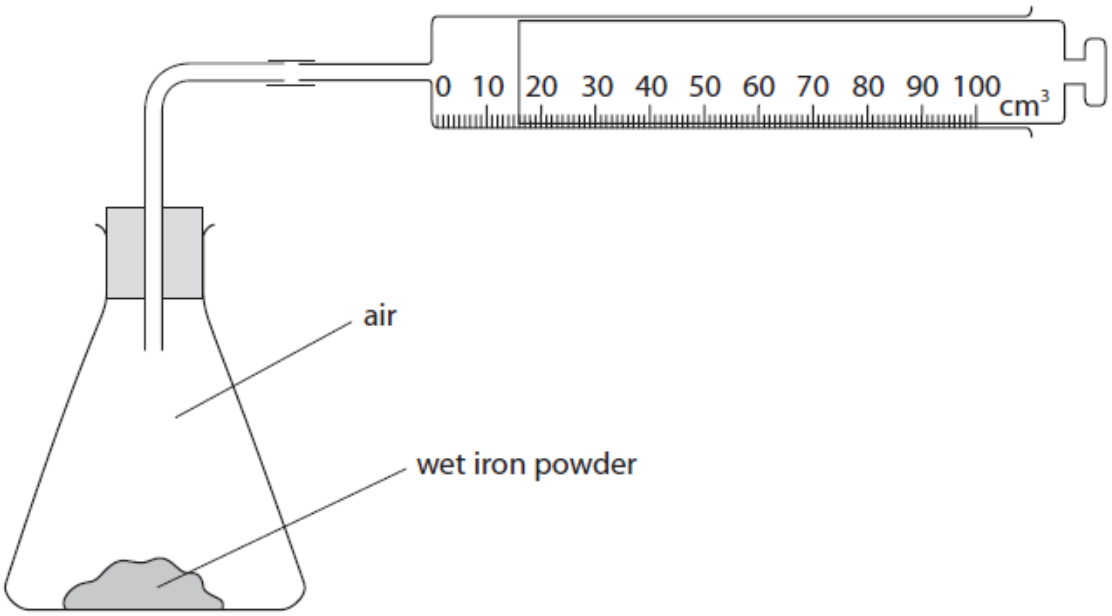
(2)

(Total for question = 6 marks)

Q6.

A student uses the reaction between iron and oxygen to find the percentage of oxygen in air.

The diagram shows the apparatus the student uses.



(a) (i) State why the iron powder needs to be wet.

(1)

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.....

(ii) State the colour of the compound formed in the reaction between iron and oxygen.

(1)

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(iii) Give the formula of the compound formed.

(1)

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(iv) Explain the advantage of using iron powder rather than pieces of iron.

(2)

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(b) The syringe in the diagram shows the reading at the end of the experiment.

Complete table 1 to show the readings on the syringe.

Give both values to the nearest 1 cm^3.

(2)

syringe reading at start	
syringe reading at end	
change in volume in cm^3	65

Table 1

(c) The student repeats the experiment and obtains a different set of results.

Table 2 shows these results.

volume of air in conical flask and glass tube in cm^3	260
syringe reading at start	90
syringe reading at end	22

Table 2

Use the results from table 2 to calculate the percentage by volume of oxygen in the air.

(3)

percentage by volume of oxygen in air = ... %

(Total for question = 10 marks)

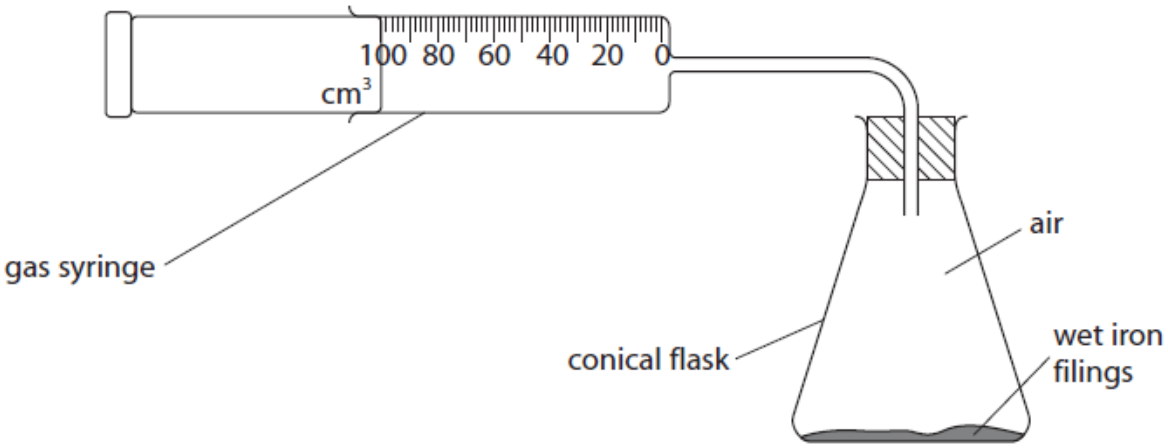
Q7.

This question is about rusting.

(a) When iron rusts, it reacts with oxygen in the air.

A student uses the rusting of iron to find the percentage of oxygen in a sample of air.

The diagram shows the apparatus.



These are the student's results.

volume of air in conical flask and connecting tube = 265 cm^3

volume of air in gas syringe at start = 100 cm^3

volume of air in gas syringe at end = 25 cm^3

Calculate the percentage of oxygen in the sample of air using the student's results.

(3)

percentage of oxygen = ... %

(b) (i) Cars are painted to prevent the iron in car bodies from rusting.

Explain how painting prevents the iron in car bodies from rusting.

(2)

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(ii) Some car manufacturers use paint containing tiny particles of zinc.

Explain how particles of zinc prevent iron in car bodies from rusting even when this paint is scratched.

(2)

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(Total for question = 7 marks)

Q8.

This question is about elements in Group 7 of the Periodic Table and their compounds.

(a) (i) Give the name of this group of elements.

(1)

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(ii) State the colour of chlorine gas.

(1)

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(iii) Give a test for chlorine gas.

(2)

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(b) Give a test to show that a solution contains iodide ions.

(3)

test .....

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.....

.....

result .....

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(c) A student compares the reactivity of the elements bromine, chlorine and iodine.

He mixes these pairs of solutions and observes the reactions that occur.

- chlorine solution and potassium bromide solution
- bromine solution and potassium iodide solution

Explain how the reactions can be used to show the order of reactivity of the three elements.

Include the colour change that the student would observe in each reaction.

(6)

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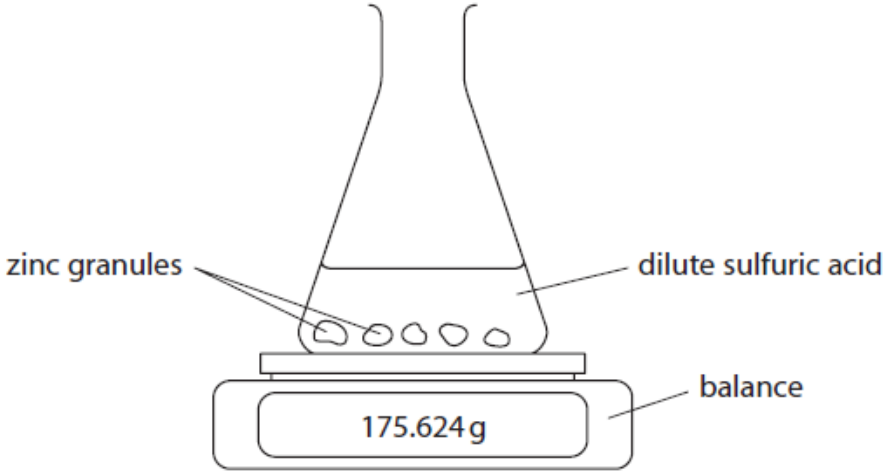
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(Total for question = 13 marks)

Q9.

A student uses this apparatus in an experiment to study the rate of the reaction between zinc and dilute sulfuric acid.



This is the student's method.

- add a few zinc granules to a conical flask on a balance
- of dilute sulfuric acid to the flask, start a timer and immediately record the mass of the flask and contents
- record the mass of the flask and contents every minute until the mass remains constant

The mass of the flask and contents decreases because hydrogen gas is produced and leaves the flask.

The student uses the mass readings to calculate the total mass of hydrogen produced.

(1)

$$Zn\ (.....) + H_2SO_4\ (.....) \rightarrow ZnSO_4\ (.....) + H_2\ (.....)$$

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

Time in minutes	Total mass of hydrogen produced in mg
0	0
1	80
2	110
3	130
4	148
5	162
6	165
7	184
8	192
9	198
10	204
11	209
12	214
13	218
14	220
15	220

(i) Plot the student's results. The first three have been done for you.

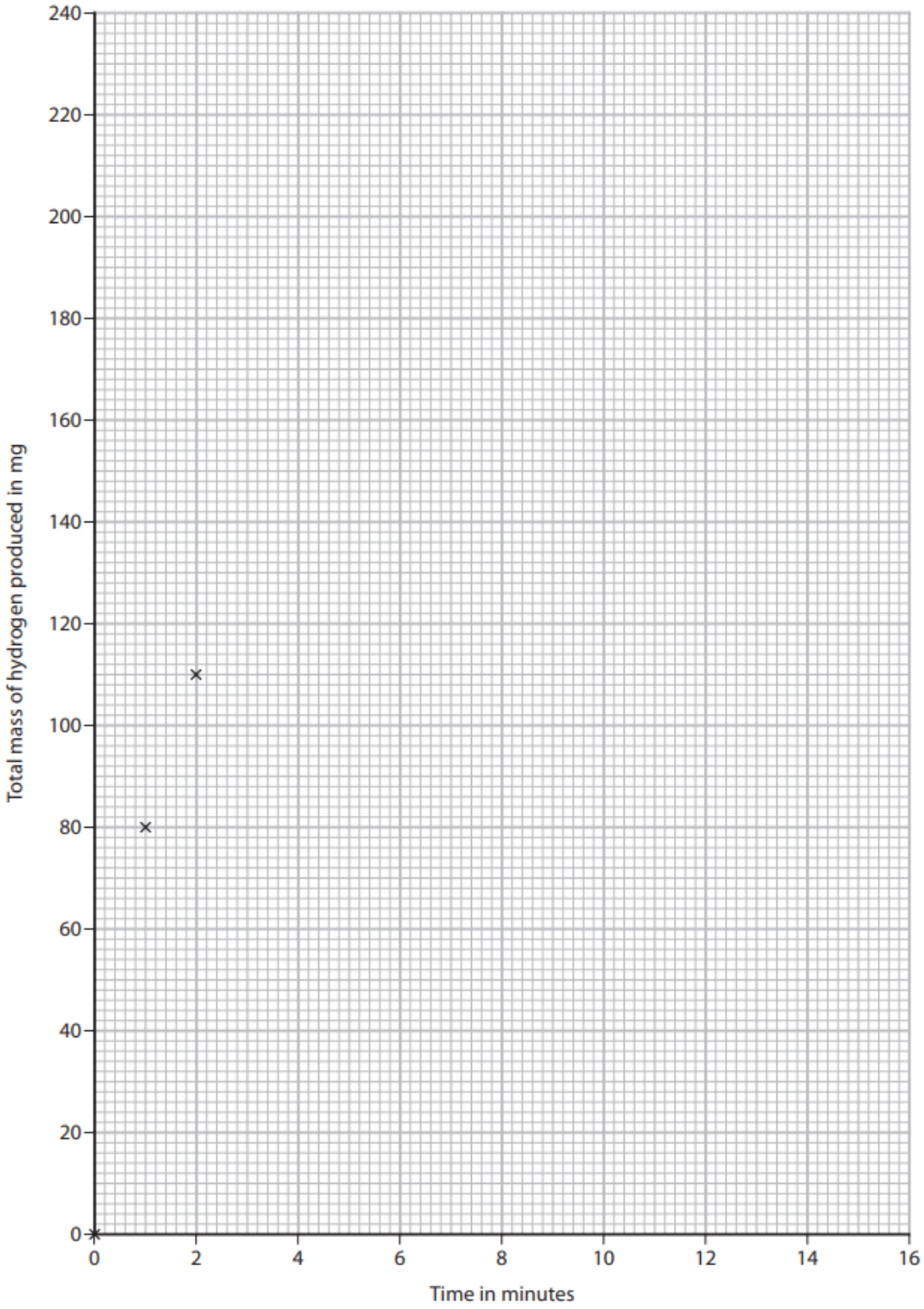
(1)

(ii) Draw a circle around the anomalous result.

(1)

(iii) Draw a curve of best fit.

(1)



(iv) Give a possible reason for the anomalous result.

(1)

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(v) Determine a more likely value for this result.

(1)

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(c) (i) Explain how the shape of the curve shows how the rate of the reaction changes as time increases.

(2)

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(ii) At the end of the experiment there is no zinc left in the flask.

Give a conclusion the student could make from this observation.

(1)

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(d) The student does another experiment using

- the same amount of similarly sized magnesium granules instead of zinc
- the same volume of sulfuric acid, but of a lower concentration

Explain why it is difficult to predict how the rate of reaction in this experiment compares with the rate of reaction in the first experiment.

(3)

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(e) Explain, in terms of particle collision theory, how increasing the temperature affects the rate of a reaction.

(3)

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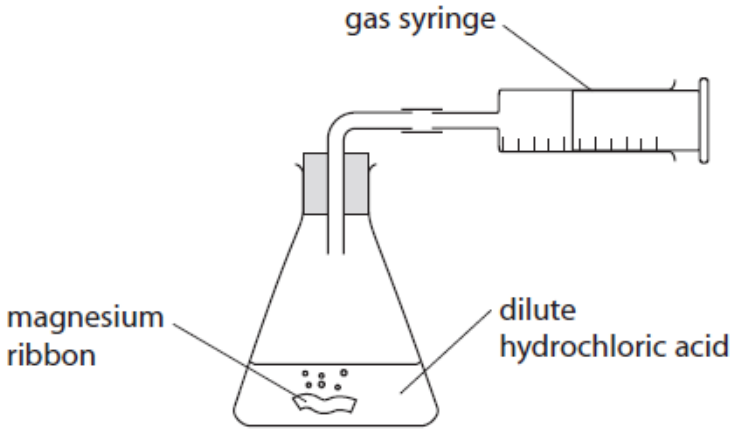
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(Total for question = 15 marks)

Q10.

A student uses this apparatus to investigate the reaction between magnesium and dilute hydrochloric acid.



(a) The word equation for the reaction is

magnesium + hydrochloric acid → magnesium chloride + hydrogen

(i) Complete the chemical equation for this reaction.

(1)

Mg + 2HCl → ..... + ...
...

(ii) Give the test for hydrogen.

(1)

.....

.....

(iii) The student uses 0.090 g of magnesium and 0.025 mol of hydrochloric acid.

Show by calculation that the hydrochloric acid is in excess.

(2)

(b) The student measures the volume of hydrogen collected at regular intervals until the reaction stops.

The table shows the student's results.

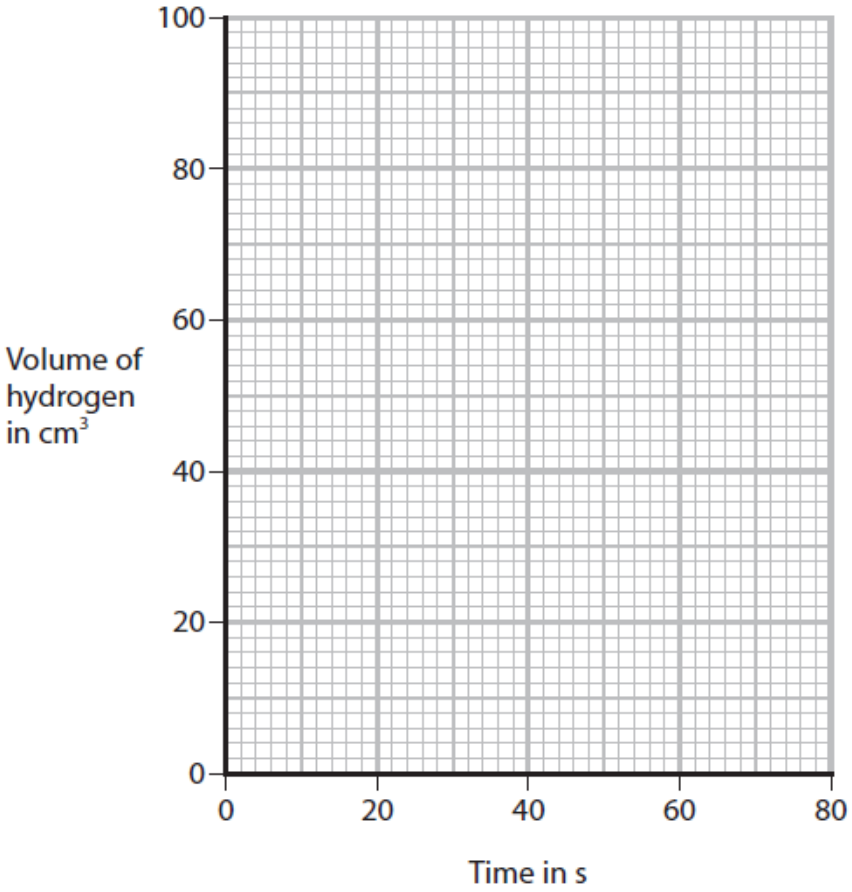
Time in s	0	15	30	45	60	75
Volume of hydrogen in cm^3	0	40	68	80	88	88

(i) Plot the student's results.

(1)

(ii) Draw a curve of best fit.

(1)



(iii) Determine the volume of hydrogen collected in the first 10 seconds.

Show on the graph how you obtained your answer.

(2)

volume of hydrogen = ... cm^3

(iv) Explain why the rate of reaction is greatest at the start of the reaction.

(2)

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(c) The student repeats the experiment at a temperature 5 °C higher than the original temperature.

All other conditions are kept the same.

(i) On the grid, draw the curve you would expect the student to obtain.

(2)

(ii) Explain, in terms of particle collision theory, how increasing the temperature affects the rate of reaction.

(3)

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(Total for question = 15 marks)

Q11.

Zinc reacts with dilute hydrochloric acid to form hydrogen.

(a) (i) Give a chemical equation for this reaction.

(2)

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(ii) Give a test for hydrogen gas.

(1)

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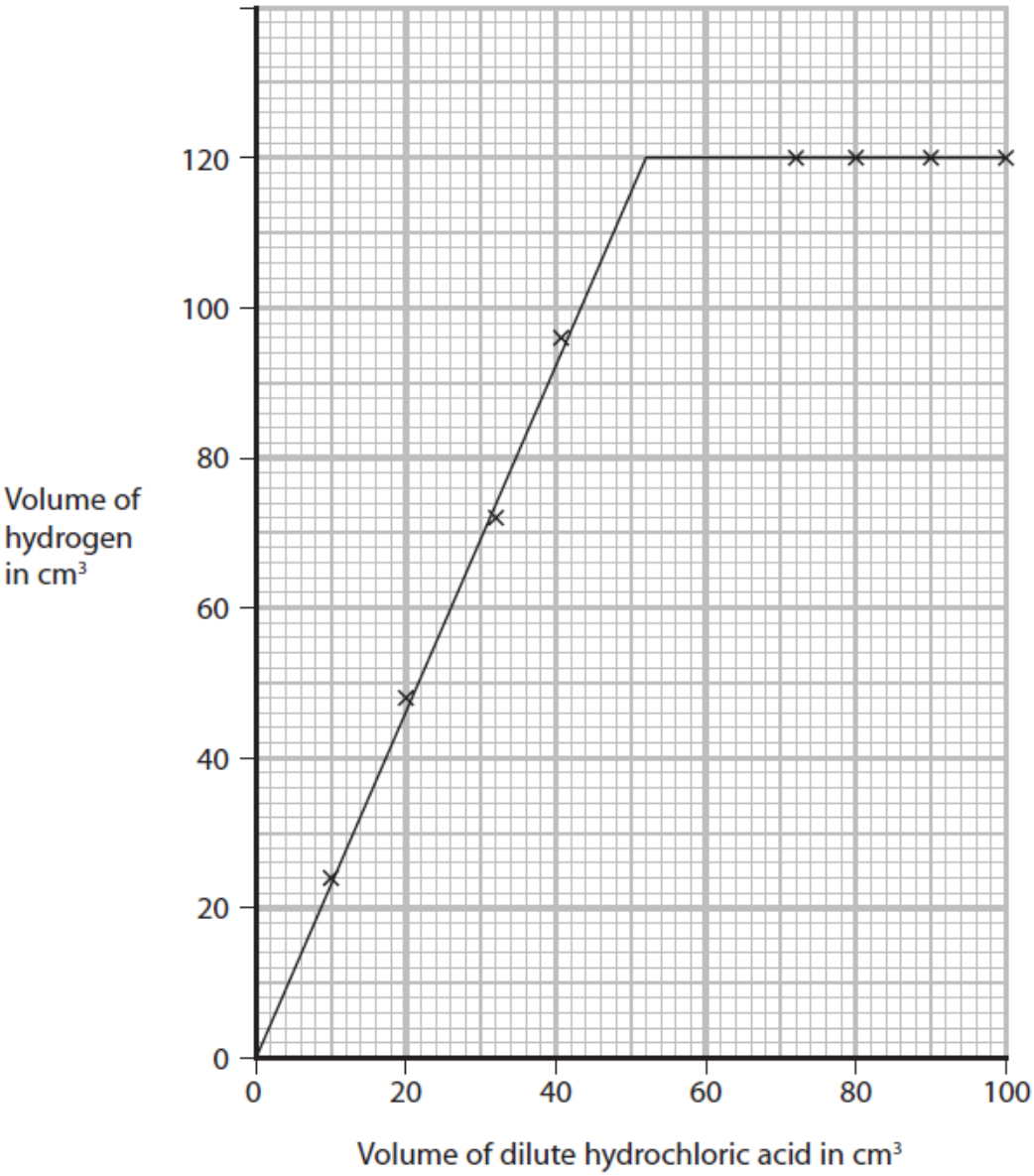
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(b) A student investigates the reaction between pieces of zinc and dilute hydrochloric acid.

In each experiment, he uses the same mass of zinc but a different volume of the acid.

He collects the hydrogen and measures its volume in each experiment.

The graph shows the student's results.



(i) Use the graph to find the minimum volume of acid needed to react with all of the zinc.

(1)

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(ii) The student repeats the investigation, using hydrochloric acid of double the original concentration.

Determine the volume of hydrogen that would be collected using 15 cm^3 of this acid.

Show your working on the graph.

(2)

volume = ... cm^3

(c) Explain how increasing the concentration of the hydrochloric acid affects the rate of reaction.

(3)

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(d) The rate of reaction could also be affected by changing the temperature of the hydrochloric acid, or by using a catalyst.

Explain one other way in which the rate of reaction between zinc and hydrochloric acid can be affected.

(3)

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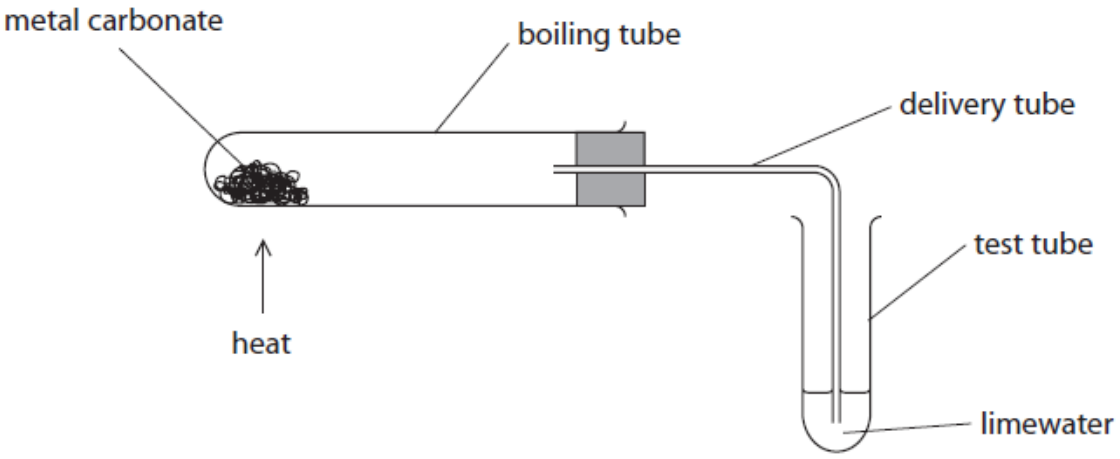
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(Total for question = 12 marks)

Q12.

A student uses this apparatus to investigate the effect of heat on different solid metal carbonates.



This is the student's method.

- use a spatula to put some metal carbonate in the boiling tube
- fit the delivery tube into position
- pour some limewater into the test tube
- start a timer and immediately begin to heat the metal carbonate
- record the time when a change first occurs in the limewater

The student repeats the method using different metal carbonates.

When a metal carbonate is heated a reaction sometimes occurs.

The equation for the reaction is

metal carbonate → metal oxide + carbon dioxide

(a) State the name given to this type of reaction.

(1)

.....

(b) State two variables that the student should control in this investigation.

(2)

1 .....

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2 .....

.....

(c) Suggest why bubbles appear in the limewater immediately after heating has started but before there is any change to
the metal carbonate.

(1)

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(d) Explain the purpose of limewater in this investigation.

(2)

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(e) The table shows some of the results for the student's investigation.

Metal carbonate	Colour change of solid	Time taken for any change in limewater
calcium carbonate	remains white	90 seconds
sodium carbonate	remains white	no change
copper(II) carbonate		50 seconds

(i) State the colour change that occurs for copper(II) carbonate.

(2)

from ..... to .....

(ii) Give a chemical equation for this reaction of copper(II) carbonate.

(1)

.....

(f) (i) There is a relationship between the position of a metal in the reactivity series and how easily the
metal carbonate reacts when heated.

Use the student's results and your own knowledge to deduce this relationship.

(2)

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(ii) State how you should extend the investigation to see if your deduction is correct.

(1)

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(Total for question = 12 marks)

Q13.

(a) A piece of magnesium ribbon is ignited and placed in a gas jar of oxygen.

The equation for the reaction is

$$2Mg + O_2 \rightarrow 2MgO$$

(i) Give two observations that would be made in this reaction.

(2)

1 .....

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2 .....

.....

(ii) State why this is an oxidation reaction.

(1)

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(b) A second piece of magnesium ribbon is ignited and placed in a gas jar of carbon dioxide.

A very exothermic reaction occurs, forming magnesium oxide and carbon.

(i) State what is meant by the term **exothermic**.

(1)

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(ii) Give the chemical equation for this reaction.

(1)

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(iii) A fire starts in a warehouse where magnesium is stored.

Suggest why it would **not** be suitable to use a carbon dioxide fire extinguisher to put out this fire.

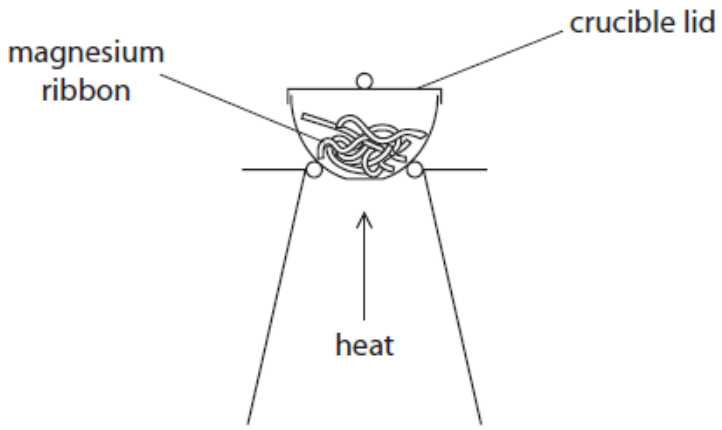
(1)

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(c) A student uses this apparatus to find the mass of magnesium oxide that forms when a known mass of magnesium
is heated.



This is his method.

- find the mass of the crucible and lid
- place some magnesium ribbon in the crucible
- find the mass of the crucible, lid and magnesium
- heat the crucible with the lid on for a few minutes
- find the mass of the crucible, lid and magnesium oxide

Using this method, the mass of magnesium oxide formed is less than expected.

Explain two changes that the student should make to his method to obtain a mass of magnesium oxide closer to the expected mass.

(4)

1 .....

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2 .....

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(Total for question = 10 marks)

Q14.

This question is about reactions that form gases.

(a) Hydrogen peroxide decomposes to form water and oxygen.

The equation for the reaction is

$$2H_2O_2 \rightarrow 2H_2O + O_2$$

25.0 cm^3 of hydrogen peroxide solution are poured into a conical flask and 1.00 g of solid manganese(IV) oxide is added.

Bubbles of oxygen gas are formed.

(i) Give the test for oxygen gas.

(1)

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(ii) Describe a method to show that solid manganese(IV) oxide is a catalyst in this reaction and not a reactant.

(3)

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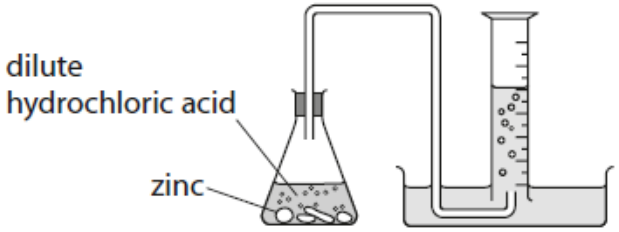
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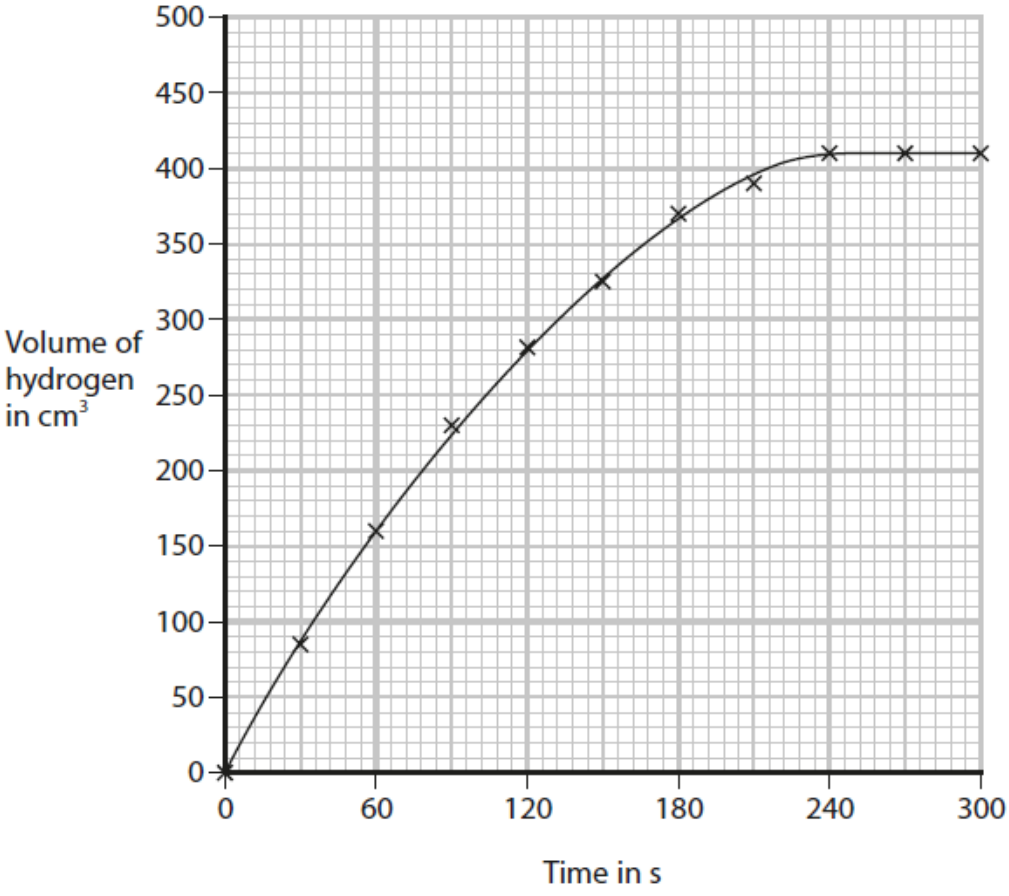
(b) A student uses this apparatus to investigate the rate of the reaction between zinc and an excess of dilute hydrochloric acid.



This is the student's method.

- pour 50 cm^3 of dilute hydrochloric acid into a conical flask
- add about 1.2 g of zinc lumps
- record the volume of hydrogen gas collected every 30 s until no more hydrogen is collected

The graph shows the student's results.



(i) Calculate the mean (average) rate of reaction, in cm^3 / s, in the first 120 s.

(2)

mean rate = ... cm^3 / s

(ii) The equation for the reaction between zinc and hydrochloric acid is

$$Zn(s) + 2HCl(aq) \rightarrow ZnCl_2(aq) + H_2(g)$$

Use this equation and the particle collision theory to explain why the rate of reaction is greatest at the start
of the reaction.

(3)

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(iii) The student repeats the experiment at a higher temperature but keeps all other conditions the same.

On the grid, draw the curve you would expect to see in this experiment.

(2)

(iv) Explain why the rate of reaction is greater if the same mass of zinc powder is used instead of zinc lumps. All other conditions are kept the same.

(2)

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(c) In another experiment, the student adds 0.55 g of zinc to a solution containing 2.50×10^{-2} moles of hydrochloric acid.

Use the equation to show that hydrochloric acid is in excess.

$$Zn(s) + 2HCl(aq) \rightarrow ZnCl_2(aq) + H_2(g)$$

[Ar of Zn = 65]

(2)

(Total for question = 15 marks)

Q15.

This question is about rusting.

(a) A simplified formula for rust is Fe_2O_3

(i) Name the two substances needed for iron to rust.

(2)

1 .....

2 .....

(ii) Give the chemical name for rust.

(1)

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(iii) What type of reaction occurs in the rusting of iron?

(1)

☒ **A** combustion

☒ **B** neutralisation

☒ **C** oxidation

☒ **D** thermal decomposition

(b) Some iron objects are coated with a layer of zinc to prevent rusting.

(i) Name this type of rust prevention.

(1)

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(ii) Explain how this type of rust prevention continues to protect iron when the layer of zinc is damaged.

(2)

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(iii) Give two other methods used to prevent iron from rusting.

(2)

1 .....

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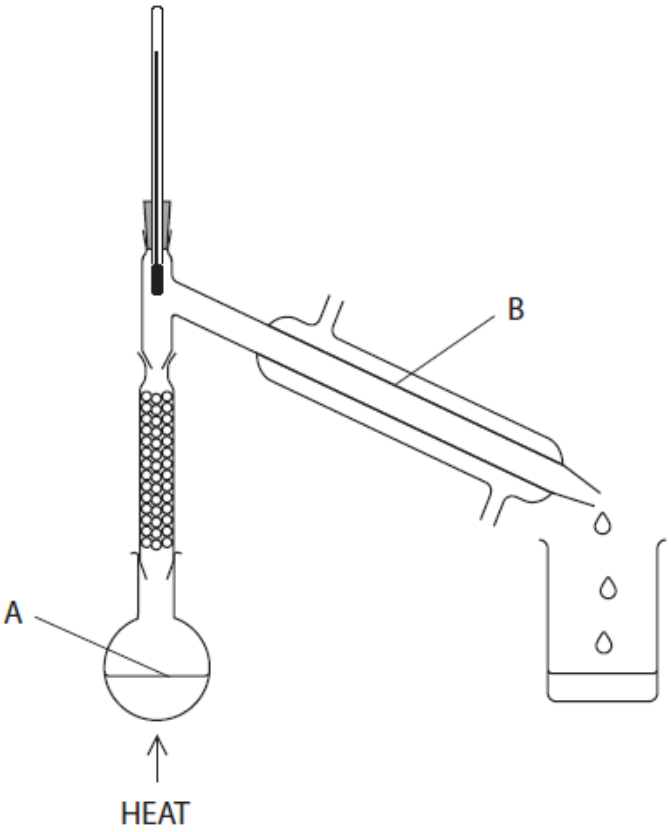
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(Total for question = 9 marks)

Q16.

A teacher uses this apparatus to separate a mixture of ethanol and water.



(a) (i) Name this method of separation.

(1)

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(ii) Name the change of state taking place at A.

(1)

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(iii) Name the change of state taking place at B.

(1)

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(b) The mixture contains 15.5 cm^3 of ethanol.

1.0 cm^3 of ethanol has a mass of 0.79 g.

One mole of ethanol contains 6.00×10^{23} molecules.

[M_r of ethanol = 46]

(i) Calculate the amount, in moles, of ethanol in 15.5 cm^3 of ethanol.

(2)

amount = ... mol

(ii) Calculate the number of molecules of ethanol in 15.5 cm^3 of ethanol.

(1)

number of molecules = ...

(c) After five minutes, the teacher collects a sample of colourless liquid in a new beaker.

(i) Describe a chemical test to show that the colourless liquid contains water.

(2)

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(ii) Describe a physical test to show if the colourless liquid is pure water.

(2)

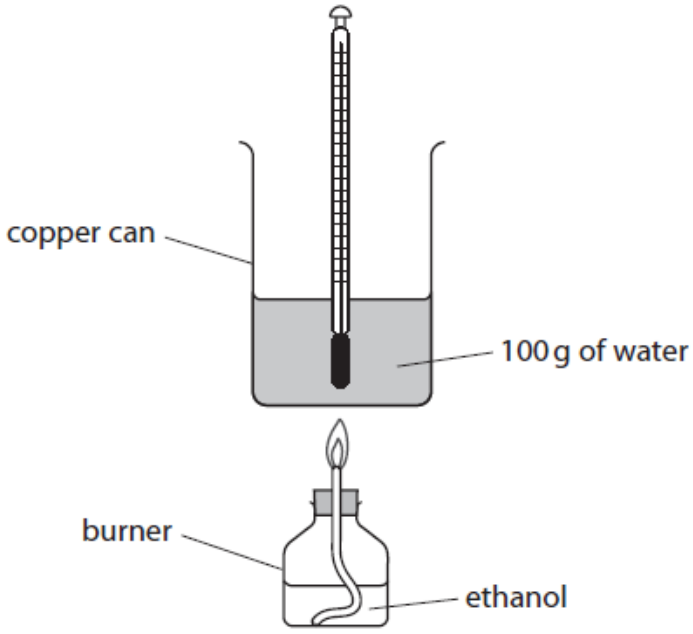
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(d) The teacher uses this apparatus to heat 100 g of water.



He records the temperature of the water before and after heating.

temperature of water before heating = 21.0 °C

temperature of water after heating = 70.5 °C

(i) Calculate the heat energy change (Q) in joules.

[specific heat capacity of water is 4.2 J /g/°C]

(3)

Q = ... J

(ii) The student burns 0.0200 mol of ethanol.

Use this information and your value for Q to calculate the molar enthalpy change (ΔH), in kJ/mol, for the combustion of ethanol.

Include a sign in your answer.

(2)

ΔH = ... kJ/mol

(Total for question = 15 marks)

Q17.

This question is about sodium carbonate, Na_2CO_3

(a) A teacher finds an unlabelled bottle containing a white solid.

Describe tests the teacher could do to show that the white solid is sodium carbonate.

(5)

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(b) Sodium carbonate is an ionic compound.

Explain why sodium carbonate has a high melting point.

Refer to structure and bonding in your answer.

(3)

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(Total for question = 8 marks)

Q18.

This question is about soluble and insoluble compounds.

A precipitate is an insoluble compound formed when solutions of soluble compounds react after mixing.

(a) Different solutions are mixed in separate test tubes.

Tube 1 copper(II) sulfate solution and calcium chloride solution

Tube 2 magnesium nitrate solution and potassium sulfate solution

Tube 3 sodium carbonate solution and copper(II) sulfate solution

In which of the tubes will a precipitate form?

(1)

☒ **A** 1 and 2 only

☒ **B** 2 and 3 only

☒ **C** 1 and 3 only

☒ **D** 1, 2 and 3

(b) A student mixes solutions, containing equal amounts in moles, of silver nitrate and sodium chloride.

The equation for the reaction between silver nitrate solution and sodium chloride solution is

$$AgNO_3(aq) + NaCl(aq) \rightarrow AgCl(s) + NaNO_3(aq)$$

(i) State the colour of the precipitate of silver chloride.

(1)

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(ii) The student wants to obtain pure, dry crystals of sodium nitrate.

Crystals of sodium nitrate decompose at temperatures above 300 °C.

Describe a method the student could use to obtain pure, dry crystals of sodium nitrate.

(5)

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(iii) Give an advantage of mixing solutions containing equal amounts, in moles, of silver nitrate and sodium chloride.

(1)

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(Total for question = 8 marks)

Q19.

This question is about salts.

(a) When solutions of salts are mixed together, precipitates sometimes form.

The insoluble salt barium carbonate forms as a precipitate when solutions of the soluble salts ammonium carbonate and barium chloride react together.

When solutions of the soluble salts potassium chloride and magnesium sulfate are mixed, no precipitate forms.

Complete the table to show the results of mixing solutions of some soluble salts.

(3)

	ammonium carbonate solution	magnesium sulfate solution
barium chloride solution	precipitate of barium carbonate	
potassium chloride solution		no precipitate
calcium chloride solution		precipitate of calcium sulfate

(b) A student has four unlabelled beakers, each containing a colourless solution of a different salt.

The four solutions are

- potassium carbonate
- potassium chloride
- potassium iodide
- sodium chloride

Describe a method to identify each solution.

Do not refer to safety in your answer.

(6)

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(Total for question = 9 marks)

Q20.

The box shows the names of some substances.

bromine	carbon dioxide	copper	iodine
methane	nitrogen	sulfur dioxide	water

(a) Complete the table by choosing substances from the box that match the description.

Each substance may be used once, more than once or not at all.

(5)

Description	Substance
a good conductor of electricity	
an element that has a basic oxide	
a substance used as a fuel	
a major cause of acid rain	
a non-metallic element that is a solid at room temperature	

(b) Describe a test for carbon dioxide.

(2)

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(Total for question = 7 marks)