PEARSON EDEXCEL IGCSE CHEMISTRY · 4CH1

CHEMISTRY



EXAM QUESTION PACK

SECTION 1: PRINCIPLES OF CHEMISTRY (PACK 8)

SCORE	PERCENTAGE
/234	%

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Q1.

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)

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(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.

(5)

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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)

Q2.

This question is about nitrogen and some of its compounds.

(a) Nitrogen and oxygen do not react together at room temperature.

At the high temperatures in a car engine, nitrogen and oxygen react to form nitrogen monoxide, NO

(i) Give a chemical equation for this reaction.

(1)

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(ii) Give a reason why this reaction only occurs at high temperatures.

(1)

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(iii) State why it is important that oxides of nitrogen are not released into the atmosphere.

(1)

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(b) Nitrogen monoxide gas can be removed from car exhaust fumes when it reacts with carbon monoxide gas.

(i) The rate of the reaction is increased by passing the gases over a catalyst.

Explain how a catalyst increases the rate of a reaction.

(2)

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(ii) Explain how increasing the pressure of gases increases the rate of reaction.

(3)

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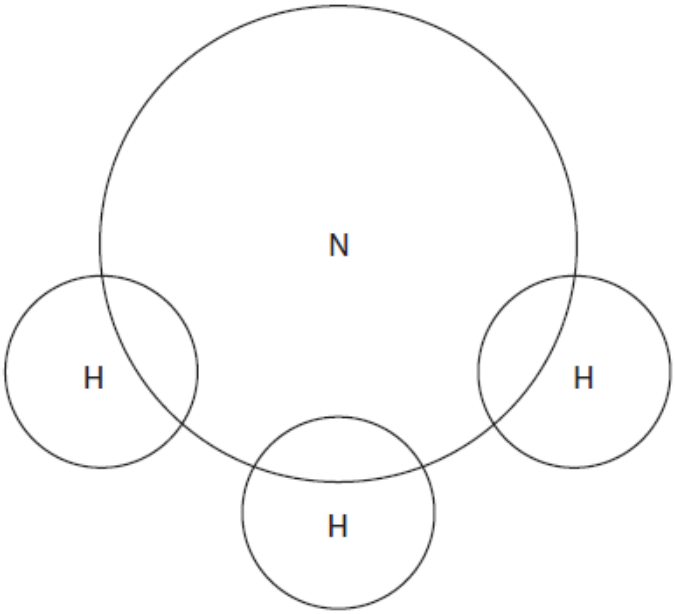
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(c) Ammonia is a simple molecule with the formula NH_3

(i) Complete the diagram to show the outer shell electrons in ammonia.

(2)



(ii) The bonds in ammonia are covalent.

Describe the forces of attraction in a covalent bond.

(2)

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(iii) Explain why ammonia has a low boiling point.

(2)

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(Total for question = 14 marks)

Q3.

Nitrogen dioxide and silicon dioxide are compounds containing covalent bonds.

(a) State what is meant by the term **covalent bond**.

(1)

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(b) In a car engine, nitrogen and oxygen from the air react to form nitrogen dioxide, NO_2

(i) Give a chemical equation for this reaction.

(1)

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(ii) State an environmental problem that occurs when nitrogen dioxide is released into the atmosphere.

(1)

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(c) Nitrogen dioxide and silicon dioxide both contain covalent bonds.

Explain why nitrogen dioxide has a much lower melting point than silicon dioxide.

Refer to structure and bonding in your answer.

(6)

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(Total for question = 9 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)

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(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)

.....

.....

(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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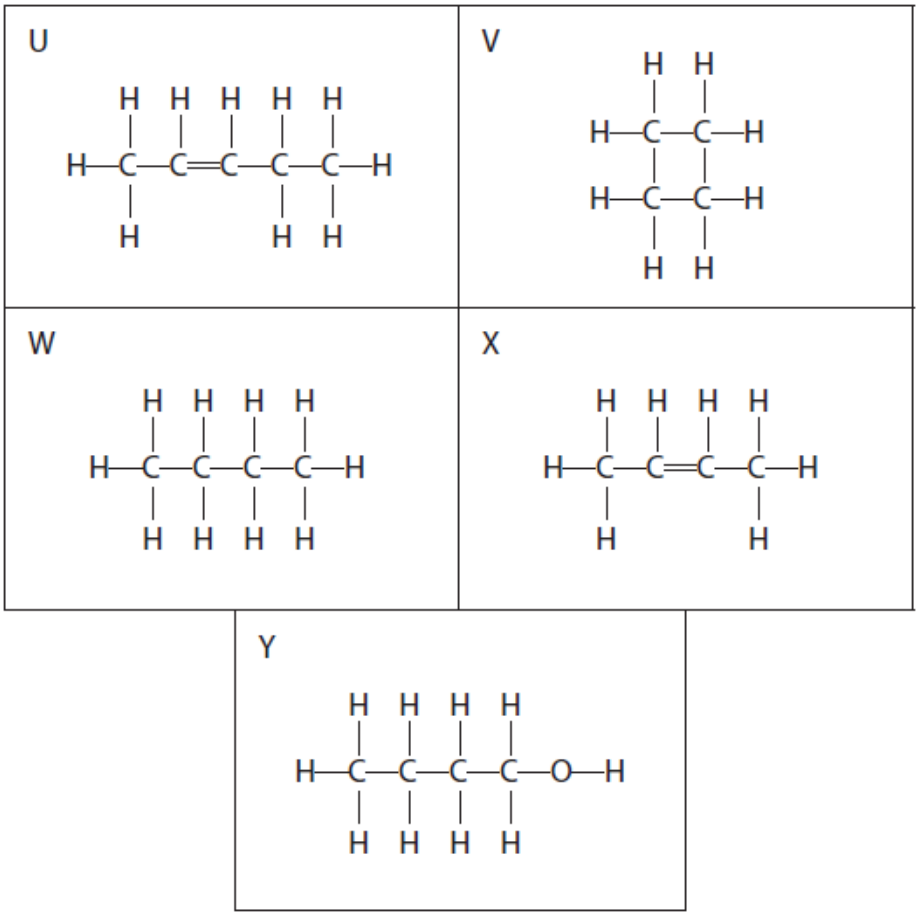
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(Total for question = 11 marks)

Q5.

This question is about organic compounds.

(a) The diagram shows the displayed formulae of five compounds, U, V, W, X and Y.



(i) Give the letter of the compound that is not a hydrocarbon.

(1)

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(ii) Give the letter of the compound that is a saturated hydrocarbon with the empirical formula

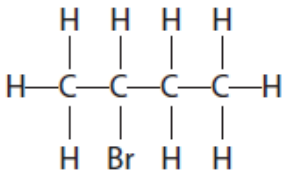
CH_2

(1)

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(iii) Give the letter of the compound that reacts with bromine in the presence of ultraviolet radiation to form this structure.

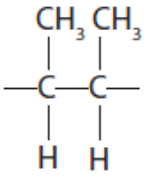
(1)



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(iv) Give the letter of the compound that forms an addition polymer with this repeat unit.

(1)



.....

(v) Give the displayed formula of an alkene that is an isomer of compound X.

(1)

(vi) Compounds U and X are members of the same homologous series.

Members of the same homologous series have the same functional group.

Give two other characteristics of compounds in the same homologous series.

(2)

1 .....

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2 .....

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(b) Compound Z contains 38.7% carbon, 9.7% hydrogen and 51.6% oxygen by mass.

(i) Show by calculation that the empirical formula of compound Z is CH_3O

(2)

(ii) The relative formula mass (M_r) of compound Z is 62

Deduce the molecular formula of compound Z.

(2)

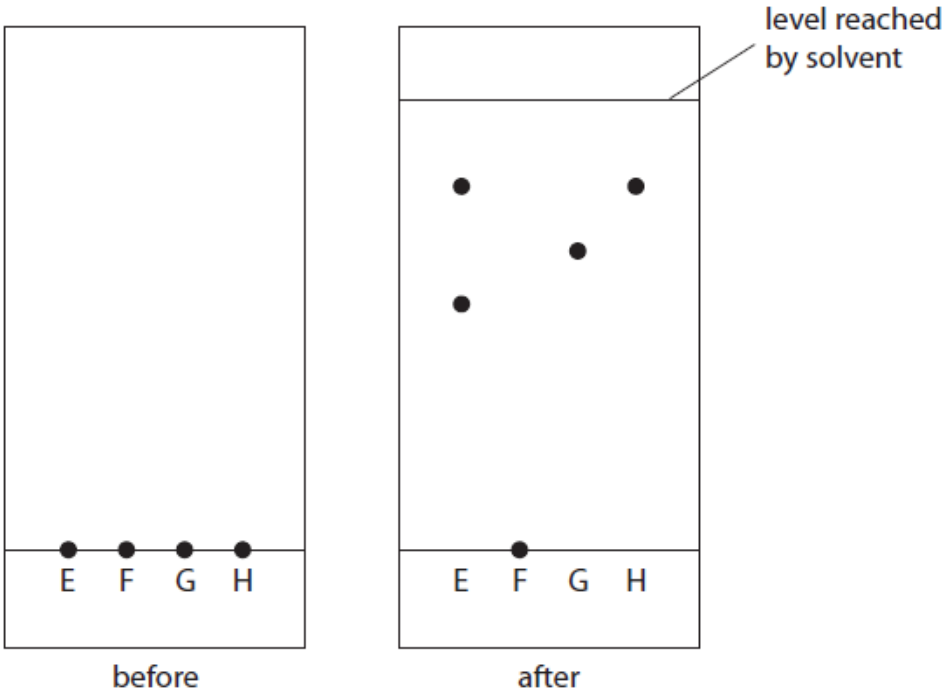
molecular formula = ...

(Total for question = 11 marks)

Q6.

A student uses paper chromatography in an experiment to separate the dyes in four different food colourings, E, F, G and H.

The diagram shows the appearance of the paper before and after the experiment.



(a) (i) Describe how the student should complete the experiment after putting a spot of each food colouring on the paper.

(3)

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(ii) Deduce the number of dyes in food colouring H.

(1)

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(iii) Suggest why food colouring F does not move during the experiment.

(1)

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(iv) Explain which two food colourings contain the dye that is likely to be the most soluble in the solvent.

(2)

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(b) Determine which food colouring contains a dye with R_f value closest to 0.67

Show your working.

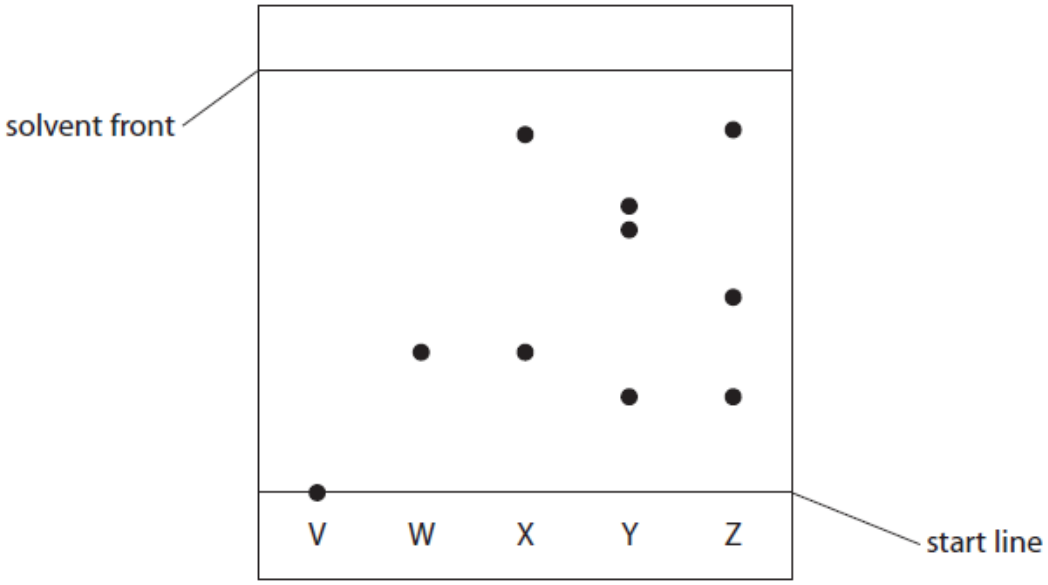
(3)

(Total for question = 10 marks)

Q7.

A student uses paper chromatography to identify the dyes in five different inks, V, W, X, Y and Z.

The chromatogram shows the results of the student's experiment.



(a) (i) State why ink V did not move from the start line.

(1)

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(ii) Explain which two inks contain a dye that is likely to be the most soluble in the solvent.

(2)

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(b) Calculate the R_f value for the dye in ink W.

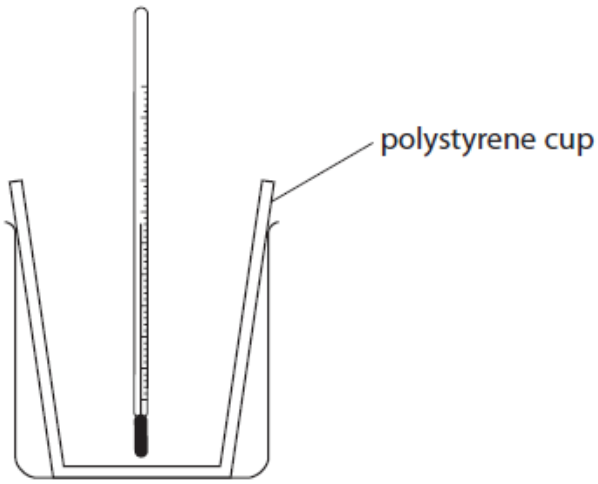
(3)

R_f value = ...

(Total for question = 6 marks)

Q8.

A student uses this apparatus to investigate the reaction between potassium hydroxide solution and dilute hydrochloric acid.



This is her method.

- pour 25 cm^3 of potassium hydroxide solution into a polystyrene cup and record the temperature of the solution
- pour 25 cm^3 of dilute hydrochloric acid into a measuring cylinder and record the temperature of the acid
- add the acid to the polystyrene cup and stir the mixture
- record the highest temperature reached

(a) (i) Give a word equation for the reaction between potassium hydroxide and hydrochloric acid.

(1)

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(ii) Explain why the student needs to stir the mixture.

(2)

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(b) The table gives the temperatures of the solutions before the student mixes them.

potassium hydroxide solution	17.8 °C
dilute hydrochloric acid	18.4 °C

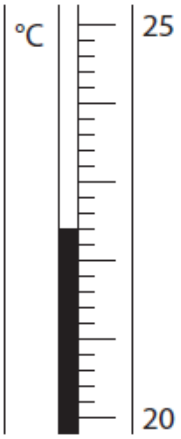
Calculate the mean (average) temperature of the two solutions.

(2)

mean temperature = ... °C

(c) The student repeats the experiment on a different day, using 25 cm^3 of potassium hydroxide solution and 25 cm^3 of
dilute hydrochloric acid.

The thermometer shows the highest temperature reached at the **end** of the experiment.



(i) Complete the table by giving the missing information.

Give both temperatures to the nearest 0.1 °C.

(2)

mean temperature at start in °C	
temperature at end in °C	
temperature rise in °C	5.2

(ii) Show that the heat energy change, *Q*, in the student's experiment is about 1100 J.

[for the mixture, c = 4.2 J/g/°C]

[mass of 1.0 cm^3 of mixture = 1.0 g]

(3)

(iii) The student uses 0.020 mol of potassium hydroxide in his experiment.

Calculate the enthalpy change (ΔH) in kJ/mol, for 1.0 mol of potassium hydroxide.

Include a sign in your answer.

(3)

ΔH = ... kJ/mol

(Total for question = 13 marks)

Q9.

Propane is a hydrocarbon with the formula C_3H_8

(a) State why propane is a hydrocarbon.

(2)

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(b) (i) Name the poisonous gas that forms when propane is burned in a limited supply of air.

(1)

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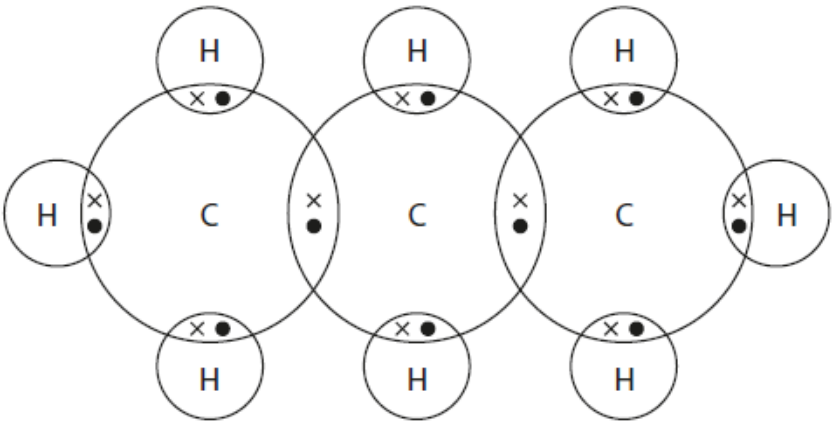
(ii) State why this gas is poisonous to humans.

(1)

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(c) The diagram represents a molecule of propane.



Describe the forces of attraction between the atoms in a molecule of propane.

(2)

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(d) Propane can be produced by cracking.

An equation for cracking is

$$C_{13}H_{28} \rightarrow C_3H_8 + 2C_3H_6 + 2C_2H_4$$

Explain why cracking is an important process in the oil industry.

(3)

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(e) Propane reacts with bromine in the presence of ultraviolet radiation.

(i) Complete the equation for this reaction.

(2)

$C_3H_8 + Br_2 \rightarrow$ ..... + ...

(ii) Give the name of this type of reaction.

(1)

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.....

(Total for question = 12 marks)

Q10.

(a) The table shows the number of protons, neutrons and electrons in species F, G and H.

	Species F	Species G	Species H
number of protons	7	7	7
number of neutrons	7	8	7
number of electrons	7	7	10

(i) Give the mass number of F.

(1)

.....

(ii) Give the electronic configuration of G.

(1)

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(iii) Explain why F and G are isotopes of the same element.

Refer to subatomic particles in your answer.

(2)

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(iv) Explain why H is a negative ion.

Refer to subatomic particles and their charges in your answer.

(2)

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(b) A sample of carbon contains atoms of mass number 12 and 13

The table shows the percentages of these atoms in the sample.

Mass number	Percentage (%)
12	98.930
13	1.070

Calculate the relative atomic mass (A_r) of this sample of carbon.

Give your answer to two decimal places.

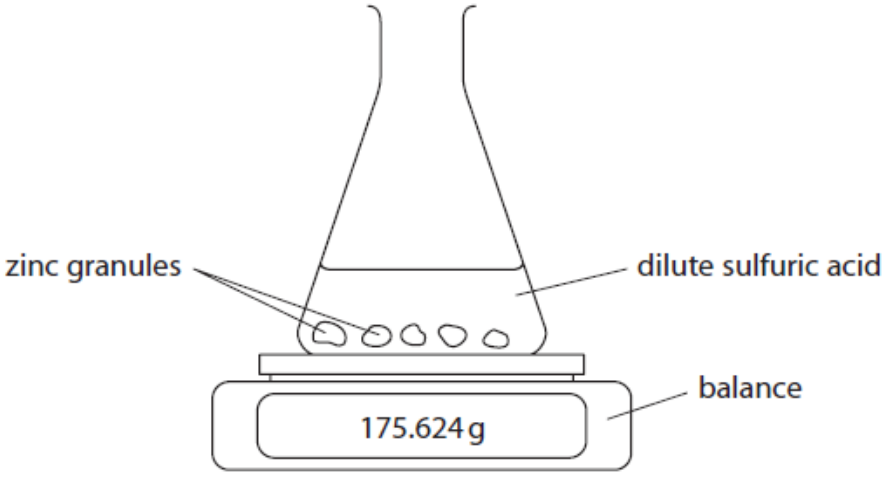
(2)

relative atomic mass = ...

(Total for question = 8 marks)

Q11.

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.

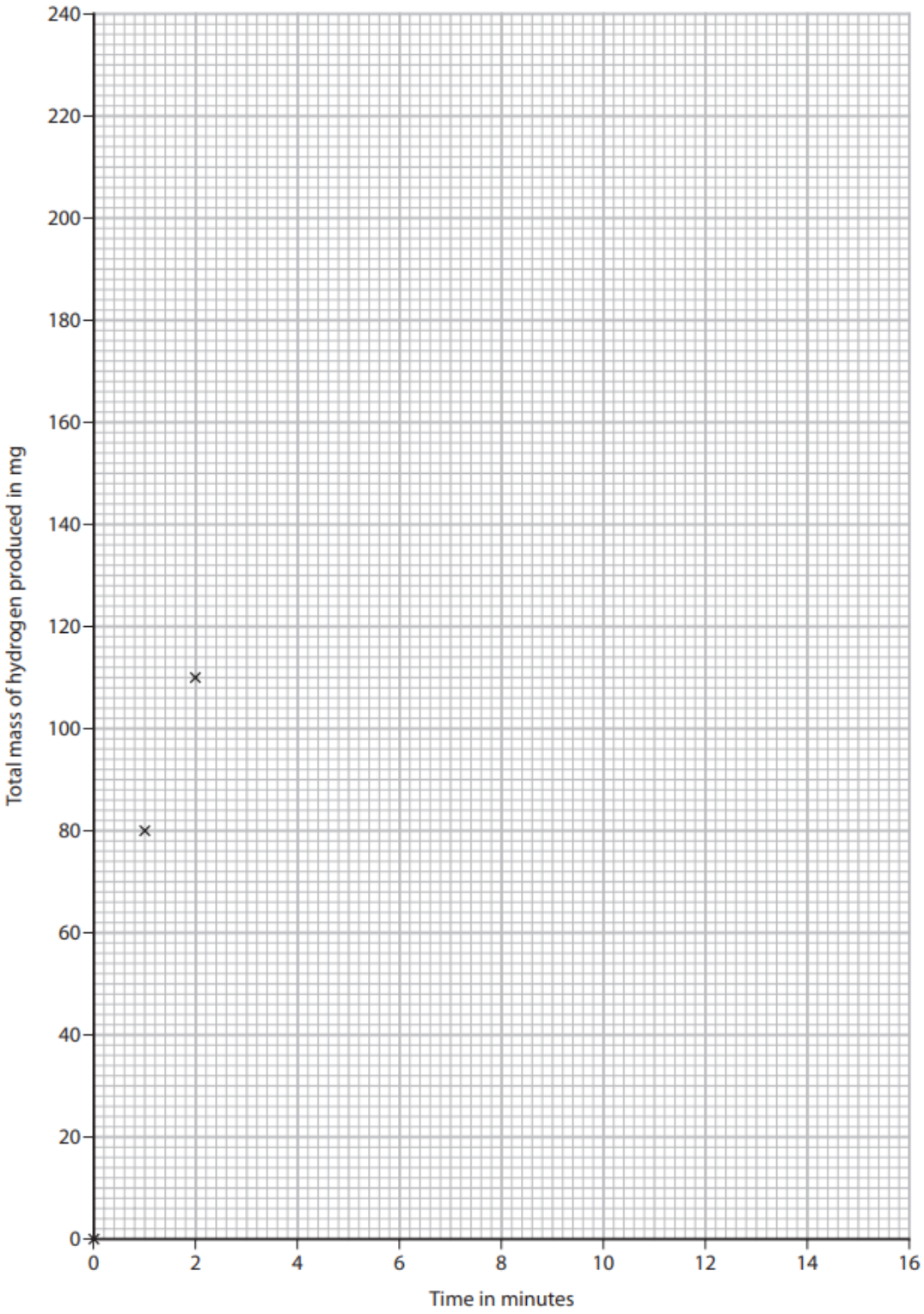
(1)

(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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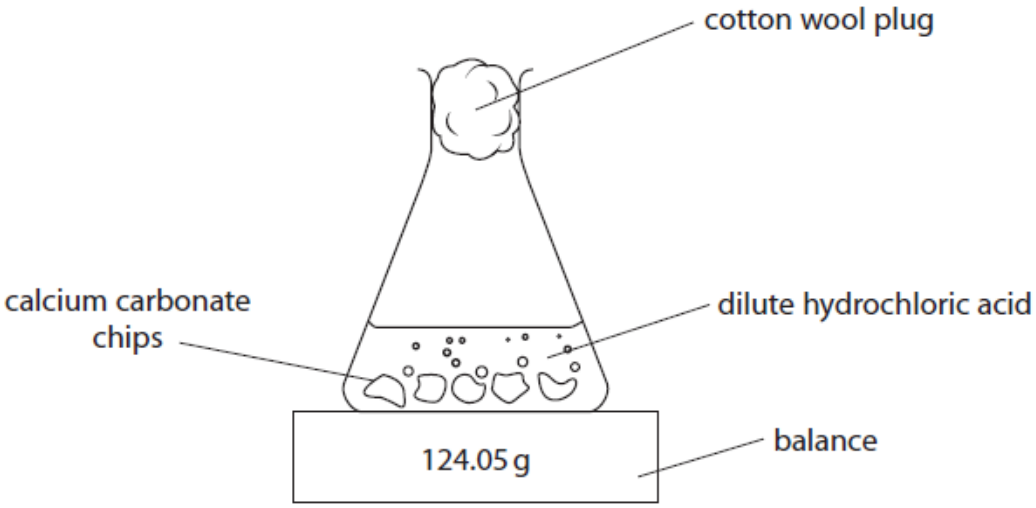
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(Total for question = 15 marks)

Q12.

A student uses this apparatus to investigate the rate of reaction between calcium carbonate chips and dilute hydrochloric acid.



Every 20 seconds the student records the reading on the balance.

(a) Explain why using a cotton wool plug increases the accuracy of the student's results.

(2)

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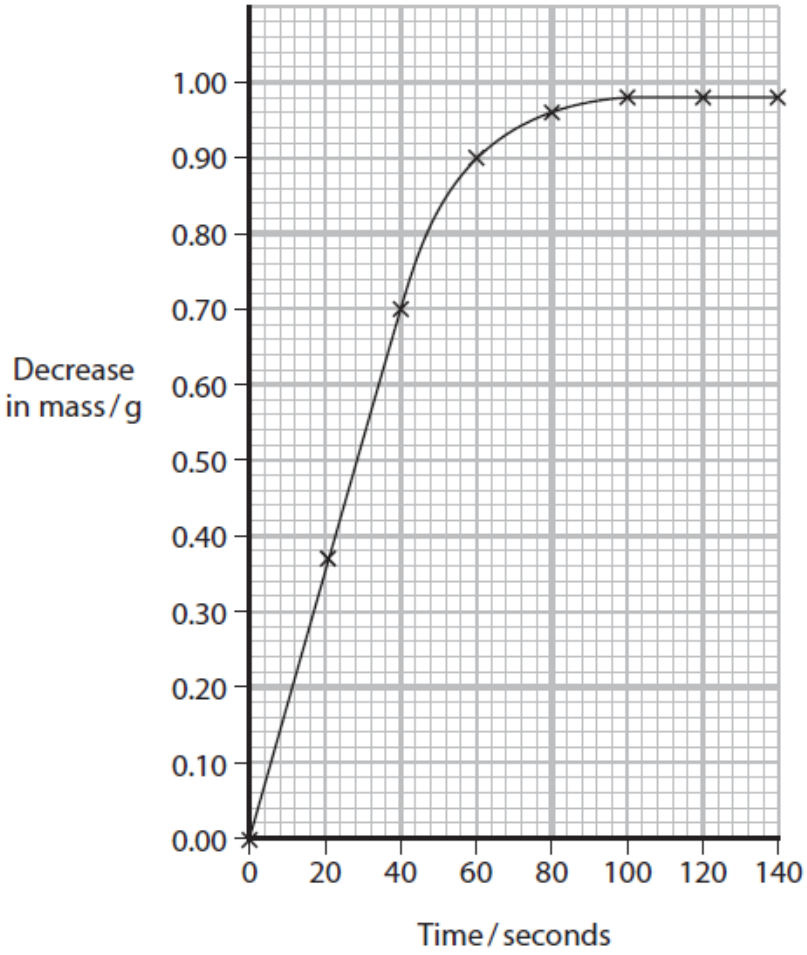
(b) Complete the equation for the reaction by adding the state symbols.

(2)

$CaCO_3$(.....) + 2HCl(.....) → $CaCl_2$(aq) + H_2O(.....) + CO_2(.....)

(c) The student uses the balance readings to find the decrease in mass of the flask and contents.

The graph shows the student's results.



(i) Give a reason why there are some calcium carbonate chips remaining in the flask when the reaction stops.

(1)

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(ii) State how the student would know when the reaction has stopped.

(1)

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(iii) Use the graph to determine the amount, in moles, of carbon dioxide produced during the reaction.

[M_r of CO_2 = 44]

(2)

amount = ... mol

(iv) Use the graph to calculate the rate of reaction, in grams per second, at time 60 seconds.

Show your working on the graph.

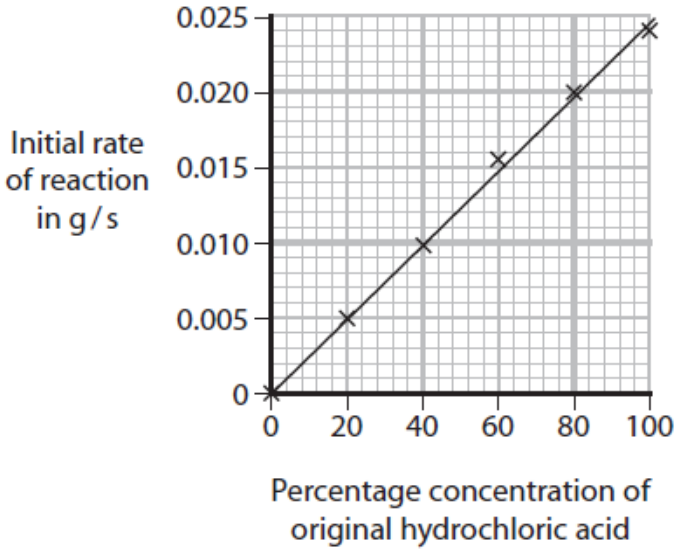
(3)

rate of reaction = ... g / s

(d) The student repeats the investigation by diluting the original hydrochloric acid.

The student then determines the initial rate of reaction at different percentage concentrations of the original hydrochloric acid.

The graph shows the student's results.



(i) Describe the relationship between the initial rate of reaction and percentage concentration of the original hydrochloric acid.

(2)

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(ii) Explain why changing the concentration of hydrochloric acid has an effect on the initial rate of reaction.

(2)

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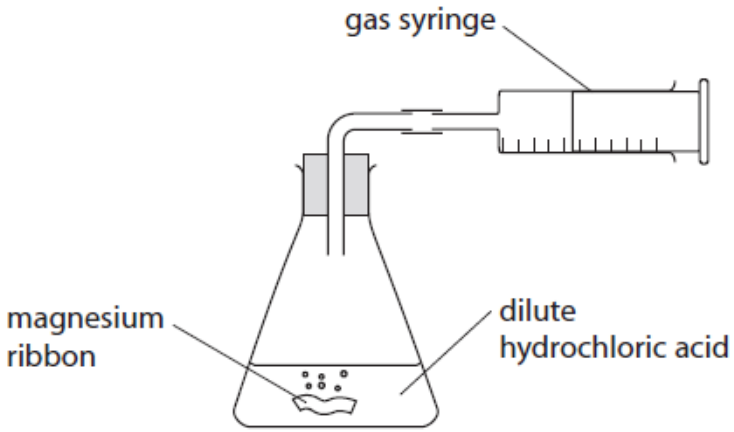
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(Total for question = 15 marks)

Q13.

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.

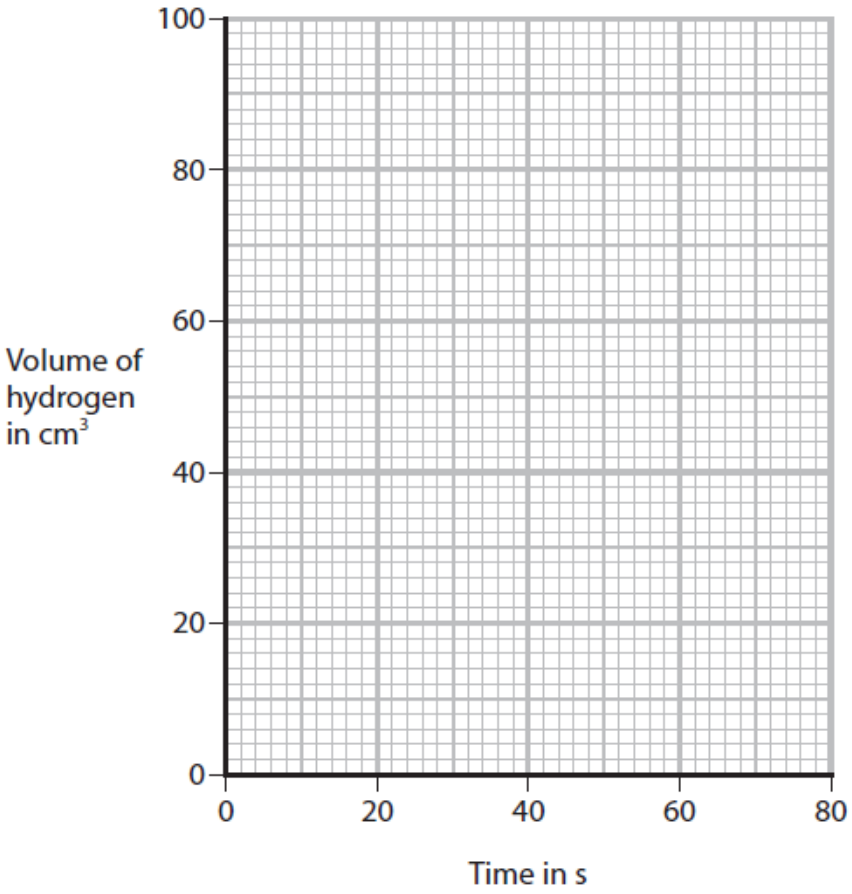
Time in s	0	15	30	45	60	75
Volume of hydrogen in cm^3	0	40	68	80	88	88

(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)

Q14.

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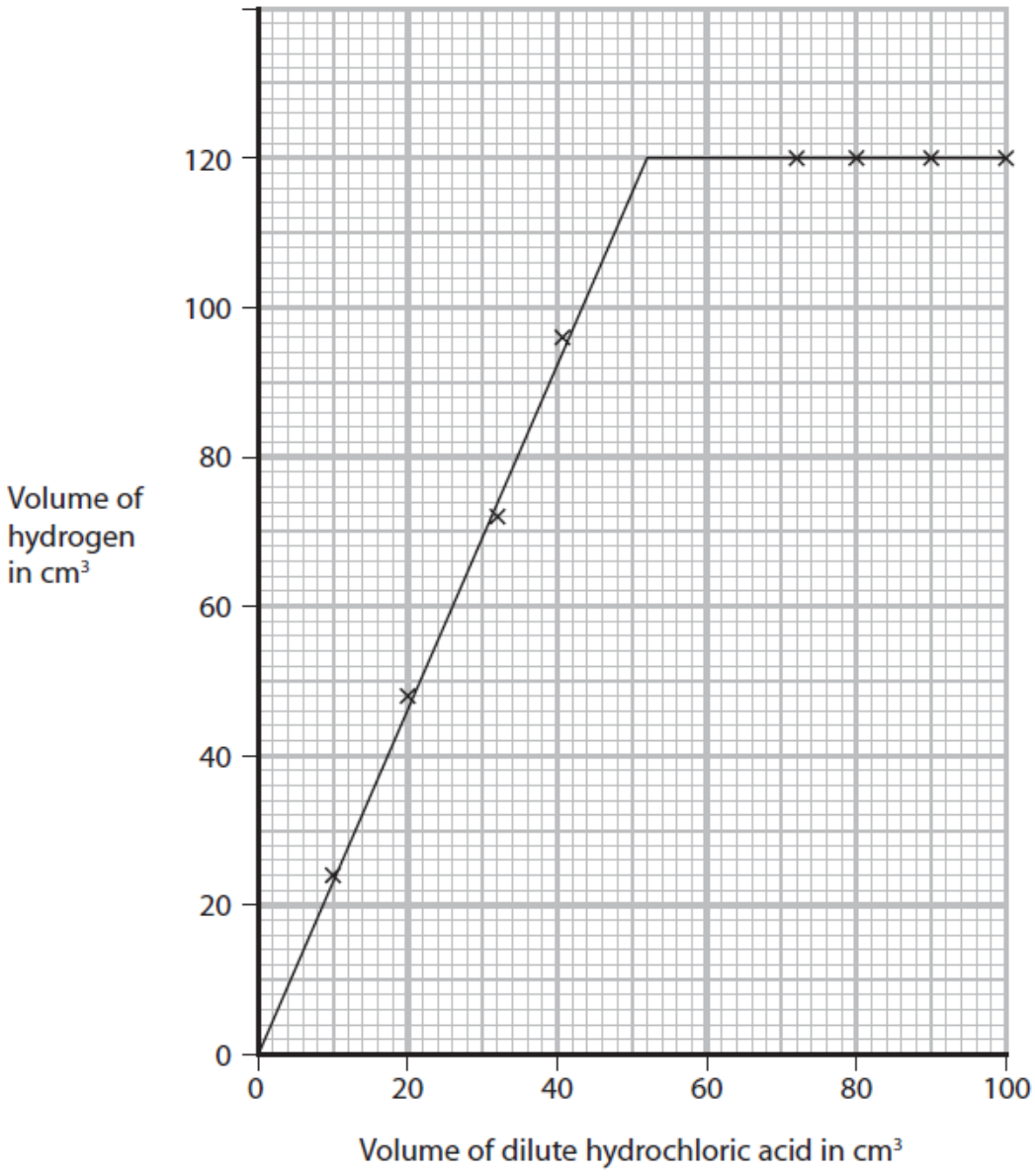
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(b) A student investigates the reaction between pieces of zinc and dilute hydrochloric acid.

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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(Total for question = 12 marks)

Q15.

A student uses the reaction between zinc and dilute sulfuric acid to prepare some zinc sulfate crystals.

(a) (i) Complete the equation for this reaction by giving the correct state symbols.

(1)

Zn (.....) + H_2SO_4 (.....) → $ZnSO_4$ (.....) + H_2 (.....)

(ii) State what would be observed during this reaction.

(1)

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(b) The student adds excess zinc to a beaker of dilute sulfuric acid.

(i) Explain why it is necessary to add excess zinc.

(2)

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(ii) Draw a diagram of the apparatus the student should use to remove the unreacted zinc and collect the zinc
sulfate solution.

(2)

(c) The student obtains a pure, dry sample of zinc sulfate crystals.

The formula of zinc sulfate crystals is $ZnSO_4.7H_2O$

(i) Calculate the relative molecular mass (M_r) of zinc sulfate crystals.

(2)

M_r = ...

(ii) The student uses 0.0200 mol of dilute sulfuric acid in her preparation.

Show that the maximum mass of zinc sulfate crystals that the student could obtain is about 6 g.

(2)

(iii) The student obtains a mass of 4.28 g of zinc sulfate crystals.

Calculate the percentage yield of the zinc sulfate crystals.

Give your answer to three significant figures.

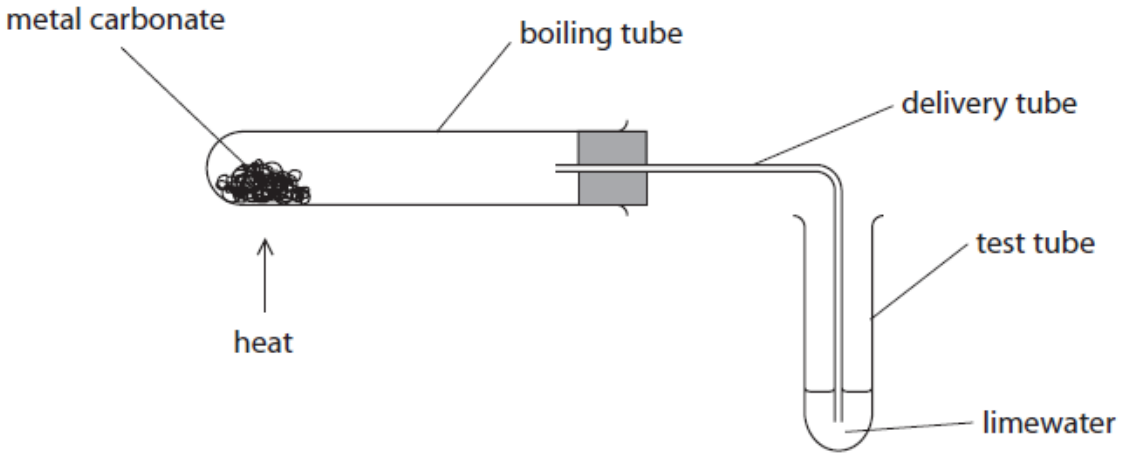
(3)

percentage yield = ... %

(Total for question = 13 marks)

Q16.

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 .....

.....

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)

.....

.....

.....

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

(2)

.....

.....

.....

.....

(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)

.....

.....

(Total for question = 12 marks)

Q17.

(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 .....

.....

2 .....

.....

(ii) State why this is an oxidation reaction.

(1)

.....

.....

(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)

.....

.....

(ii) Give the chemical equation for this reaction.

(1)

.....

.....

(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.

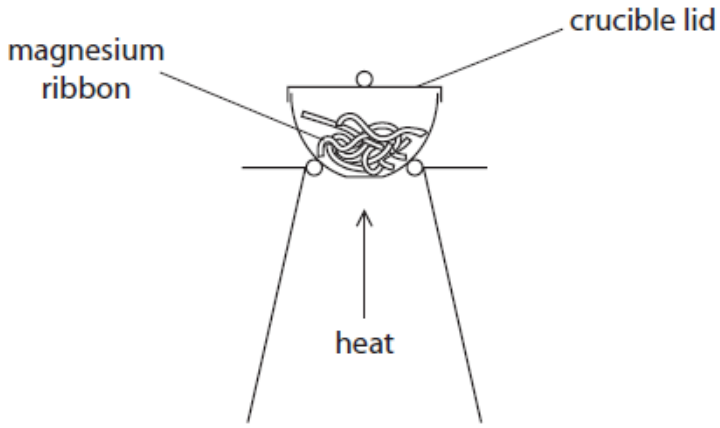
(1)

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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 .....

.....

.....

.....

2 .....

.....

.....

.....

(Total for question = 10 marks)

Q18.

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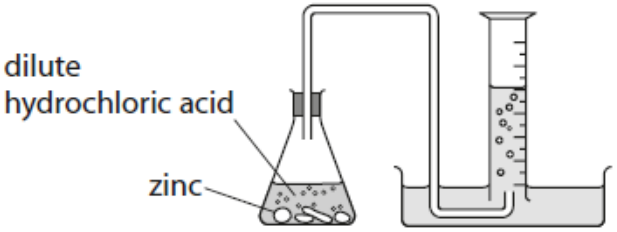
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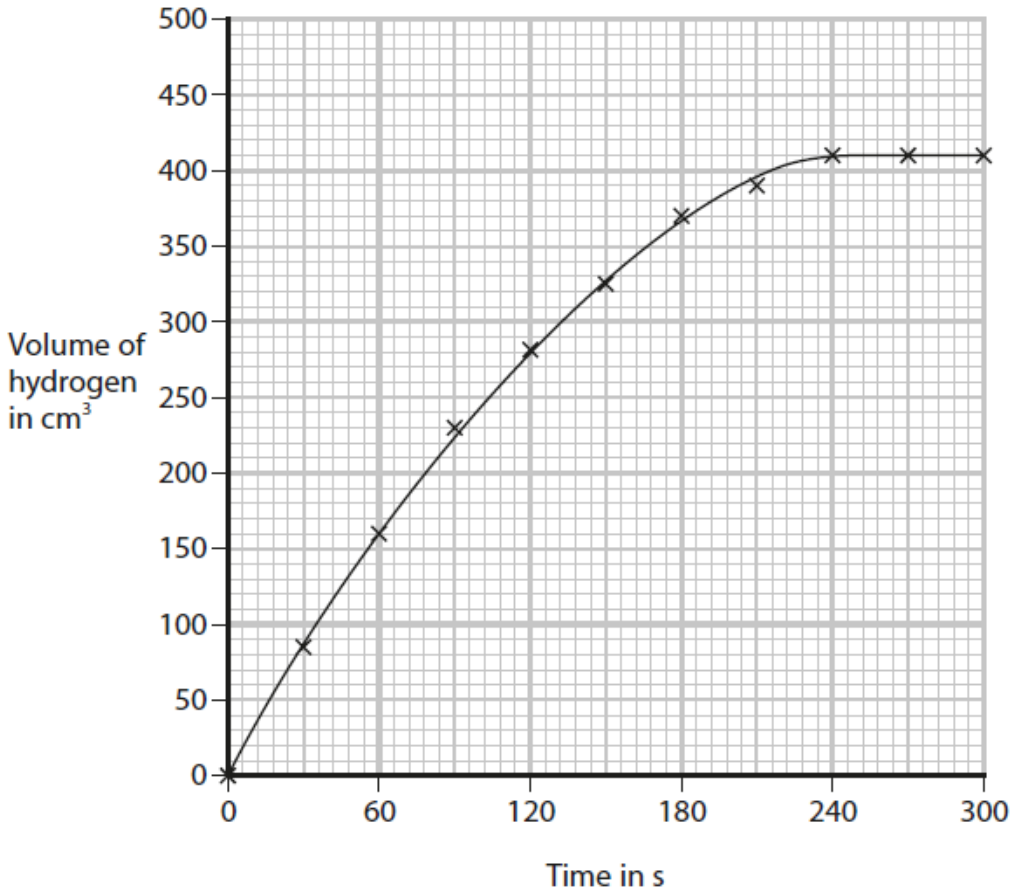
(b) A student uses this apparatus to investigate the rate of the reaction between zinc and an excess of dilute hydrochloric acid.



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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.....

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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)

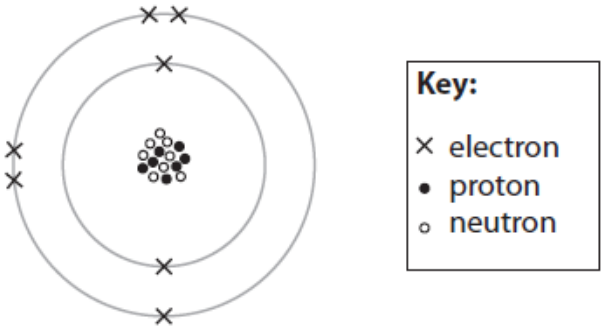
Q19.

(a) Complete the table to show the relative mass and relative charge of a proton and an electron.

(2)

	Neutron	Proton	Electron
Relative mass	1		
Relative charge	0		

(b) The diagram represents an atom of an element.



(i) Use numbers from the box to complete the table.

You may use each number once, more than once or not at all.

2	5	7	8	15

(3)

Atomic number of atom	
Mass number of atom	
Group number of element in Periodic Table	

(ii) Give the name of this element.

(1)

.....

(iii) Give the charge on the ion formed from this element.

(1)

.....

(Total for question = 7 marks)

Q20.

(a) Complete the table to show the relative mass and relative charge of a proton and a neutron.

(2)

	Proton	Electron	Neutron
Relative mass		1/2000	
Relative charge		−1	

(b) Magnesium has three isotopes.

(i) State the meaning of the term **isotopes**.

(2)

.....

.....

.....

.....

(ii) The symbol for an atom of one isotope of magnesium is

$$^{26}_{12}Mg$$

Give the number of protons, neutrons and electrons in one atom of this isotope.

(2)

number of protons

.....

number of neutrons

.....

number of electrons

.....

(iii) A sample of magnesium contains these percentages of the three isotopes.

Mg-24 = 79.00% Mg-25 = 10.00 % Mg-26 = 11.00 %

Use this information to show that the relative atomic mass of magnesium is 24.32

(2)

(iv) One mole of magnesium has a mass of 24.32 g.
There are 6.022×10^{23} atoms in one mole.

Calculate the mass, in grams, of one atom of magnesium.

Give your answer to 4 significant figures.

(2)

mass = ... g

(c) The equation for the reaction between magnesium and oxygen is

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

Determine the maximum amount, in moles, of magnesium oxide that can be produced from 0.50 mol of magnesium and 0.20 mol of oxygen.

(1)

amount = ... mol

(Total for question = 11 marks)