MODEL ANSWERS

Please check the examination details below before entering your candidate information

Candidate surname	Other names

Pearson Edexcel International GCSE (9–1)

Centre Number | | | | | |

Candidate Number | | | | |

Thursday 16 May 2019

Morning (Time: 2 hours) | Paper Reference **4CH1/1C 4SD0/1C**

Chemistry

Unit: 4CH1

Science (Double Award) 4SD0

Paper: 1C

You must have:
Calculator, ruler

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided
  – *there may be more space than you need.*
- Show all the steps in any calculations and state the units.
- Some questions must be answered with a cross in a box ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

Information

- The total mark for this paper is 110.
- The marks for **each** question are shown in brackets
  – *use this as a guide as to how much time to spend on each question.*

Advice

- Read each question carefully before you start to answer it.
- Write your answers neatly and in good English.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ▶

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P 5 8 5 6 1 A 0 1 2 8

Pearson

The Periodic Table of the Elements

1	2											3	4	5	6	7	0
							1 H hydrogen 1										4 He helium 2
7 Li lithium 3	9 Be beryllium 4											11 B boron 5	12 C carbon 6	14 N nitrogen 7	16 O oxygen 8	19 F fluorine 9	20 Ne neon 10
23 Na sodium 11	24 Mg magnesium 12											27 Al aluminium 13	28 Si silicon 14	31 P phosphorus 15	32 S sulfur 16	35.5 Cl chlorine 17	40 Ar argon 18
39 K potassium 19	40 Ca calcium 20	45 Sc scandium 21	48 Ti titanium 22	51 V vanadium 23	52 Cr chromium 24	55 Mn manganese 25	56 Fe iron 26	59 Co cobalt 27	59 Ni nickel 28	63.5 Cu copper 29	65 Zn zinc 30	70 Ga gallium 31	73 Ge germanium 32	75 As arsenic 33	79 Se selenium 34	80 Br bromine 35	84 Kr krypton 36
85 Rb rubidium 37	88 Sr strontium 38	89 Y yttrium 39	91 Zr zirconium 40	93 Nb niobium 41	96 Mo molybdenum 42	[98] Tc technetium 43	101 Ru ruthenium 44	103 Rh rhodium 45	106 Pd palladium 46	108 Ag silver 47	112 Cd cadmium 48	115 In indium 49	119 Sn tin 50	122 Sb antimony 51	128 Te tellurium 52	127 I iodine 53	131 Xe xenon 54
133 Cs caesium 55	137 Ba barium 56	139 La* lanthanum 57	178 Hf hafnium 72	181 Ta tantalum 73	184 W tungsten 74	186 Re rhenium 75	190 Os osmium 76	192 Ir iridium 77	195 Pt platinum 78	197 Au gold 79	201 Hg mercury 80	204 Tl thallium 81	207 Pb lead 82	209 Bi bismuth 83	[209] Po polonium 84	[210] At astatine 85	[222] Rn radon 86
[223] Fr francium 87	[226] Ra radium 88	[227] Ac* actinium 89	[261] Rf rutherfordium 104	[262] Db dubnium 105	[266] Sg seaborgium 106	[264] Bh bohrium 107	[277] Hs hassium 108	[268] Mt meitnerium 109	[271] Ds darmstadtium 110	[272] Rg roentgenium 111	Elements with atomic numbers 112-116 have been reported but not fully authenticated						

Key

relative atomic mass
atomic symbol
name
atomic (proton) number

** The lanthanoids (atomic numbers 58-71) and the actinoids (atomic numbers 90-103) have been omitted.*

The relative atomic masses of copper and chlorine have not been rounded to the nearest whole number.

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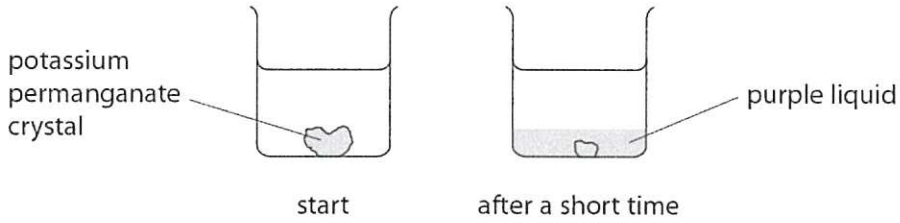
Answer ALL questions.

1 Potassium permanganate is a purple solid that is soluble in water.

A crystal of potassium permanganate is placed in a beaker containing water.



(a) After a short time, the crystal becomes smaller and the liquid at the bottom of the beaker becomes purple.

Which statement explains this observation?

(1)

☐ **A** the crystal condenses in the water

☒ **B** the crystal dissolves in the water

☐ **C** the crystal evaporates in the water

☐ **D** the crystal melts in the water

(b) The beaker is left until there is no further change in the appearance of the liquid.

(i) Which statement describes the final appearance of the liquid?

(1)

☒ **A** all of the liquid is purple

☐ **B** none of the liquid is purple

☐ **C** only the bottom half of the liquid is purple

☐ **D** only the top half of the liquid is purple

(ii) Which process causes this change in appearance?

(1)

☐ **A** condensation

☐ **B** crystallisation

☒ **C** diffusion

☐ **D** evaporation

(c) The formula of potassium permanganate is $KMnO_4$

How many different elements are there in potassium permanganate?

(1)

☒ **A** 3 K Mn O

☐ **B** 4

☐ **C** 6

☐ **D** 7

(Total for Question 1 = 4 marks)

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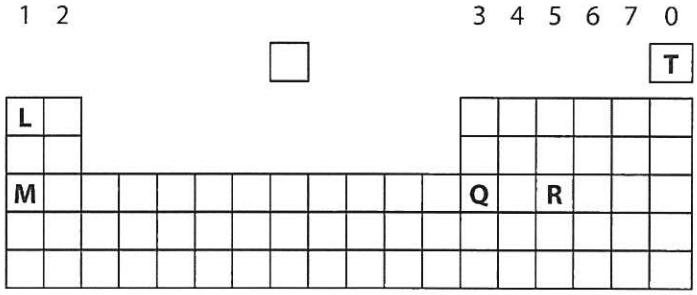
2 The diagram shows part of the Periodic Table, with elements represented by the letters L, M, Q, R and T.

The letters in the diagram represent elements but are **not** their chemical symbols.



(a) Give the letter from the diagram that represents a noble gas.

(1)

T - Noble Gases are in Group 0

(b) Elements L and M are in the same group.

State why they have similar chemical reactions.

(1)

They have the same number of electrons in their outer shell.

(c) An atom of element Q has 31 protons.

Use this information to explain how you can determine the number of protons in an atom of element R.

(2)

- R is 2 places to the right of Q in the period.
- The Atomic number of R is 2 more than Q
- R has 33 protons

(The periodic table is arranged in order of ascending atomic (proton) number.

(Total for Question 2 = 4 marks)

3 A student does these two tests on a solution made from a white solid.

- flame test
- add acidified silver nitrate solution

The table shows his results.

Test	Result
flame test	red flame
add acidified silver nitrate solution	cream precipitate

(a) Give the formula of the ion that produces the red flame.

(1)

Li^+

(b) Name the cream precipitate.

(1)

Silver Bromide

(c) Identify the white solid.

(1)

Lithium Bromide

(d) The student uses a clean metal wire in the flame test.

(i) State why the wire should be clean when used in the flame test.

(1)

Impurities on the wire would otherwise affect the colour of the flame.

(ii) The table lists properties of some metals.

Add ticks (✓) to the table to show the two properties needed in a metal wire used in a flame test.

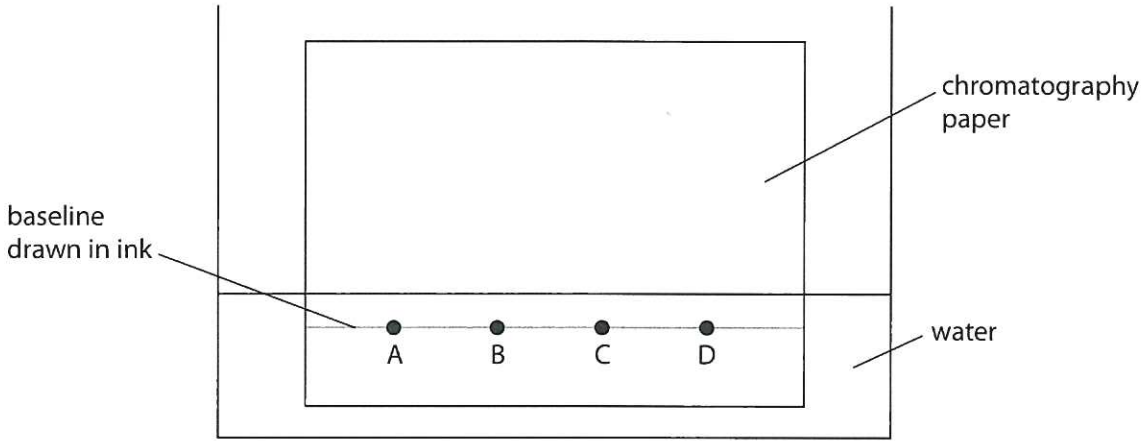
(2)

Property	
good conductor of electricity	
high density	
high melting point	✓
unreactive	✓

(must not melt in flame)
(must not react with the test sample)

(Total for Question 3 = 6 marks)

4 A student uses this apparatus to investigate the colours in four different inks, A, B, C and D.



(a) Explain two mistakes the student made when setting up his experiment.

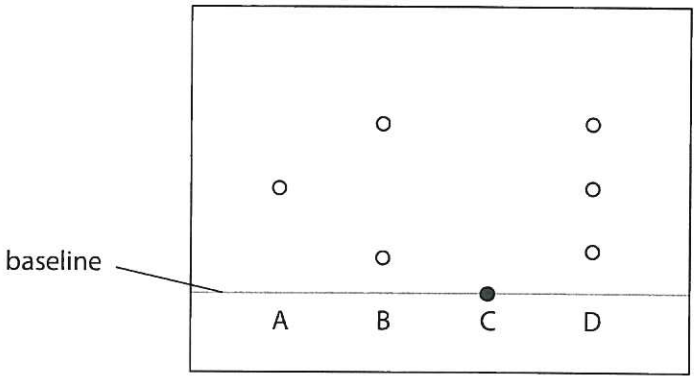
(4)

1 - Baseline drawn in ink
- Ink will Contaminate the results.

2 - Water level is above ink Spots
- Inks will mix with the water.

(b) Another student does the experiment but does not make any mistakes.

The diagram shows her results.



(i) State how many colours ink D contains.

(1)

3 (There are 3 dots above D)

(ii) State which of the inks tested could be mixed together to make ink D.

(1)

A and B

(iii) Explain which of the inks tested is insoluble in water.

(2)

- C

- The ink didn't move from the baseline.

(Total for Question 4 = 8 marks)

5 In 1937 an airship full of hydrogen gas flew from Germany to America.

(a) Which property of hydrogen makes it a suitable gas to use in an airship?

(1)

☐ **A** colourless

☐ **B** insoluble in water

☒ **C** low density

☐ **D** no smell

(b) Explain why helium is now used in airships instead of hydrogen.

(2)

- Helium is inert
- Hydrogen is flammable

(c) Hydrogen is used to manufacture ammonia, NH_3

Hydrogen is reacted with nitrogen using an iron catalyst.

(i) Give a chemical equation for this reaction.

(1)

$N_2 + 3H_2 \rightarrow 2NH_3$

(ii) State why a catalyst is used in this reaction.

(1)

Increase the rate of reaction.

(Total for Question 5 = 5 marks)

6 The reactions of metals with water and with dilute sulfuric acid can be used to determine the order of reactivity of the metals.

The table shows the reactions of four metals, W, X, Y and Z, with water and with dilute sulfuric acid.

Metal	Reaction with water	Reaction with dilute sulfuric acid
W	no reaction	no reaction
X	very slow reaction	reacts quickly
Y	no reaction	reacts slowly
Z	reacts quickly	reacts violently

(a) What is the order of reactivity of these metals?

(1)

	most reactive ⟶			least reactive
☐ **A**	W	X	Y	Z
☒ **B**	Z	X	Y	W
☐ **C**	W	Y	X	Z
☐ **D**	Z	Y	X	W

(b) (i) State which metal, W, X, Y or Z, could be copper.

(1)

W

(ii) State which metal, W, X, Y or Z, could be magnesium.

(1)

X

(c) A displacement reaction can also be used to decide the order of reactivity of two metals.

State two observations made when an excess of magnesium powder is added to an aqueous solution of copper(II) sulfate.

(2)

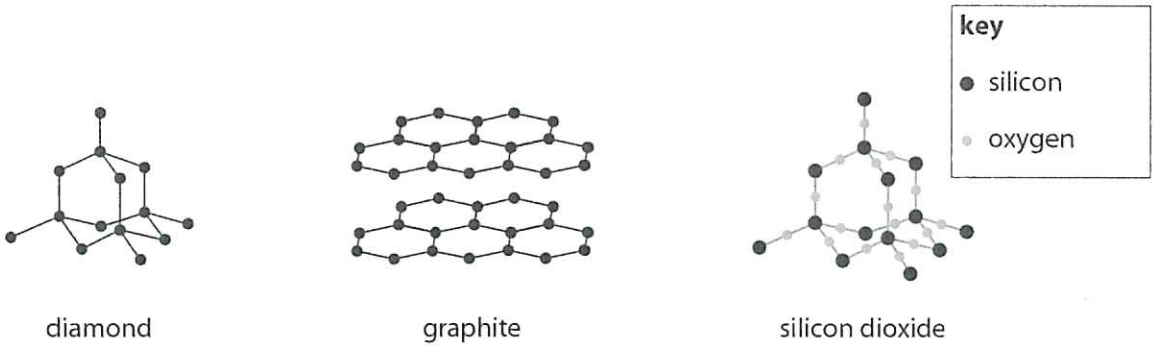
1 Pink-brown solid forms

2 Solution turns colourless.

(Total for Question 6 = 5 marks)

7 Diamond, graphite and silicon dioxide all have giant covalent structures.

The diagram shows the structures of these three substances.



diamond graphite silicon dioxide

(a) Explain why silicon dioxide has a high melting point.

(2)

- Silicon dioxide has many Strong Covalent bonds
- Lots of energy is required to break the bonds.

(b) Explain why graphite conducts electricity.

(2)

Delocalised electrons can move.

(c) State why diamond is hard but graphite is soft.

(2)

Diamond is hard because it has a 3D lattice with every Carbon bonded to four other Carbon atoms.

Graphite is soft because the layers can slide over each other.

(Total for Question 7 = 6 marks)

8 Ethene (C_2H_4) can be converted into chloroethene (C_2H_3Cl) in a two-stage process.

(a) The first stage is to convert ethene into 1,2-dichloroethane, $C_2H_4Cl_2$

Ethene is reacted with hydrogen chloride and oxygen.

Complete the chemical equation for this reaction.

(1)

2 C_2H_4 + 4 HCl + 1 O_2 → 2 $C_2H_4Cl_2$ + 2 H_2O

(b) In the second stage, 1,2-dichloroethane is converted into chloroethene.

$$C_2H_4Cl_2 \rightarrow C_2H_3Cl + HCl$$

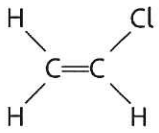
This is a thermal decomposition reaction.

State what is meant by the term **thermal decomposition**.

(1)

Breaking down by heating.

(c) The diagram shows the displayed formula of chloroethene.



(i) State why chloroethene is described as an unsaturated compound.

(1)

It Contains a Carbon-Carbon double bond.

(ii) Describe a test to show that chloroethene is unsaturated.

(2)

Add bromine water which decolorises from orange to colourless.

(d) Name the polymer formed from chloroethene.

(1)

poly Chloroethene

(Total for Question 8 = 6 marks)

9 Halon 1301 is a compound used in some fire extinguishers.

Halon 1301 has the percentage composition by mass of

C 8.05% Br 53.69% F 38.26%

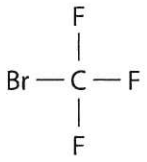
(a) Show, by calculation, that the empirical formula of this compound is $CBrF_3$

(2)

	C	Br	F
mass	8.05	53.69	38.26
A_r	12	80	19
=	0.671 :	0.671 :	2.01
Smallest	0.671	0.671	0.671
=	1 :	1 :	3

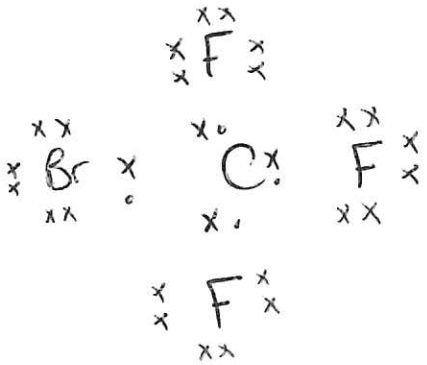
∴ Empirical formula $CBrF_3$

(b) The diagram shows the displayed formula of a molecule of Halon 1301.



Draw a dot-and-cross diagram to show all the outer electrons in this molecule.

(2)



(c) The boiling point of Halon 1301 is −58 °C.

Explain why Halon 1301 has a low boiling point.

(2)

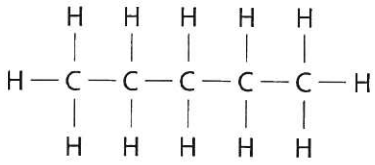
Weak intermolecular forces require little energy to overcome.

(Total for Question 9 = 6 marks)

10 (a) There are three isomers with the molecular formula C_5H_{12}

One of these isomers is pentane.

The displayed formula for pentane is



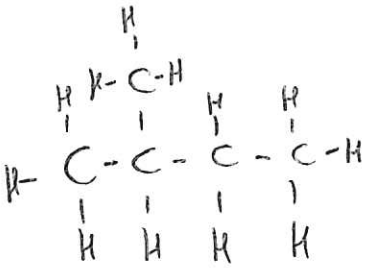
(i) State what is meant by the term **isomers**.

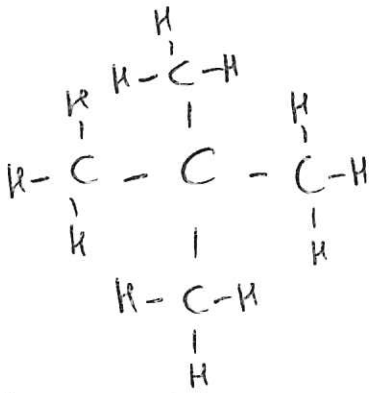
(2)

Compounds with the same molecular formula but different displayed formulae.

(ii) Draw the displayed formula for another isomer of C_5H_{12}

(2)





(b) Pentane reacts with bromine in the presence of ultraviolet radiation.

(i) Complete the equation for this reaction.

(2)

$C_5H_{12} + Br_2 \rightarrow$ $C_5H_{11}Br$ + HBr

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

(1)

Substitution.

(Total for Question 10 = 7 marks)

11 The gas burned in a Bunsen burner is methane.

The equation for the complete combustion of methane is

$$CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(g)$$

(a) Calculate the mass of oxygen required to react with 32 g of methane.
[M_r of methane = 16]

(2)

$n(CH_4) = \frac{mass}{mr} = \frac{32}{16} = 2mol$

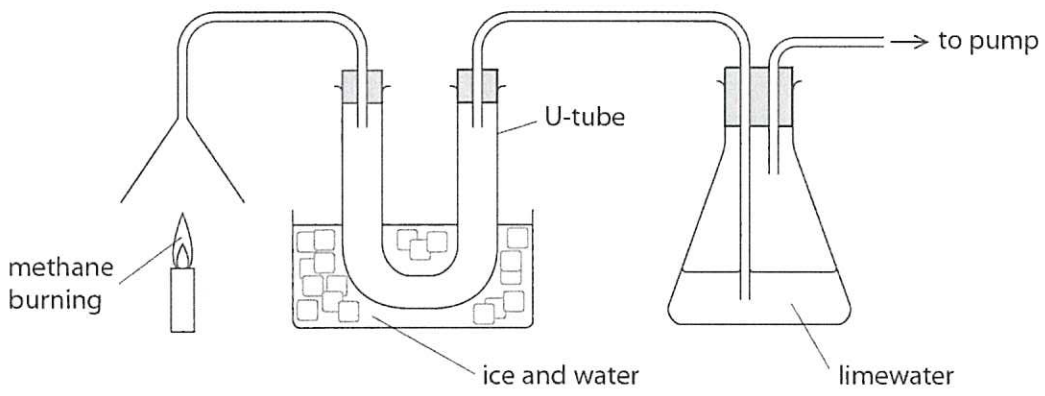
$n(O_2) = 2 \times 2 = 4mol$

$m(O_2) = mr \times mol = 32(4)$

$= 128g$

mass of oxygen = 128 g

(b) The diagram shows methane burning in air. It also shows how the two gases formed are collected and tested.



(i) Explain why water collects in the U-tube.

(2)

Water vapour Condenses as it is Cooled by the ice/water mixture.

(ii) Describe how anhydrous copper(II) sulfate is used to test for water.

(2)

White anhydrous Copper (II) Sulphate turns blue in the presence of water.

(iii) Explain the change in appearance of the limewater.

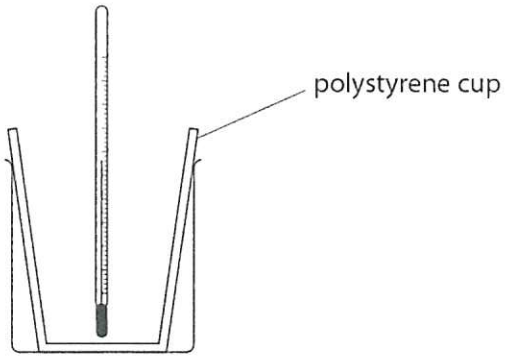
(3)

Limewater turns milky as CO_2 is present.

Calcium Carbonate (insoluble) is formed.

(Total for Question 11 = 9 marks)

12 A student uses this apparatus to investigate the temperature change that occurs when ammonium nitrate is dissolved in water.



She uses this method.

- put 100 cm^3 of water into the polystyrene cup and measure the initial temperature of the water
- add 8.00 g of ammonium nitrate and stir
- record the lowest temperature reached by the solution

The table shows her results.

Initial temperature of water in °C	20.0
Lowest temperature of solution in °C	14.2

(a) Use the results of the experiment to explain what type of reaction is taking place when ammonium nitrate is added to water.

(2)

The reaction is endothermic, taking in thermal energy and causing the decrease in temperature of the reaction mixture.

(b) Show that the heat energy change, Q, is about 2400 J.

[mass of 1.00 cm^3 of solution = 1.00 g]

[for the solution, c = 4.18 J/g/°C]

(3)

$Q = mc\Delta T$

$= 100(4.18)(20 - 14.2)$

$= 100(4.18)(5.8)$

$= 2424.4\ J$

$= 2400\ J$ (2 sig figs)

$Q =$ 2420 J

(c) Use your answer to part (b) to calculate the enthalpy change, ΔH, in kilojoules per mole of ammonium nitrate.

[M_r of ammonium nitrate = 80.0]

n (Ammonium nitrate) $= \frac{\text{mass}}{Mr} = \frac{8}{80} = 0.1$ mol

Include a sign in your answer.

(4)

$\Delta H = \frac{Q}{n} = \frac{2420 \times 10^{-3}}{0.1}$

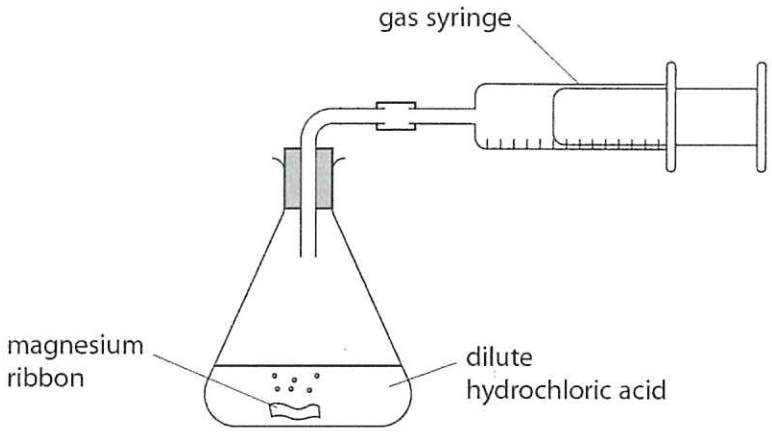
$= +24.2\ kJ\ mol^{-1}$

+ve sign as temperature of surroundings decreases as reaction takes in thermal energy.

$\Delta H =$ +24.2 kJ/mol

(Total for Question 12 = 9 marks)

13 A student uses this apparatus to investigate the rate of reaction between magnesium and an **excess** of dilute hydrochloric acid.



She uses this method.

- use a graduated beaker to pour 50 cm^3 of dilute hydrochloric acid of concentration 2.00 mol/dm^3 into the conical flask
- add a piece of magnesium ribbon of mass 0.086 g to the acid and put the bung into the neck of the flask
- measure the total volume of gas collected every ten seconds until the reaction stops

The table shows the student's results.

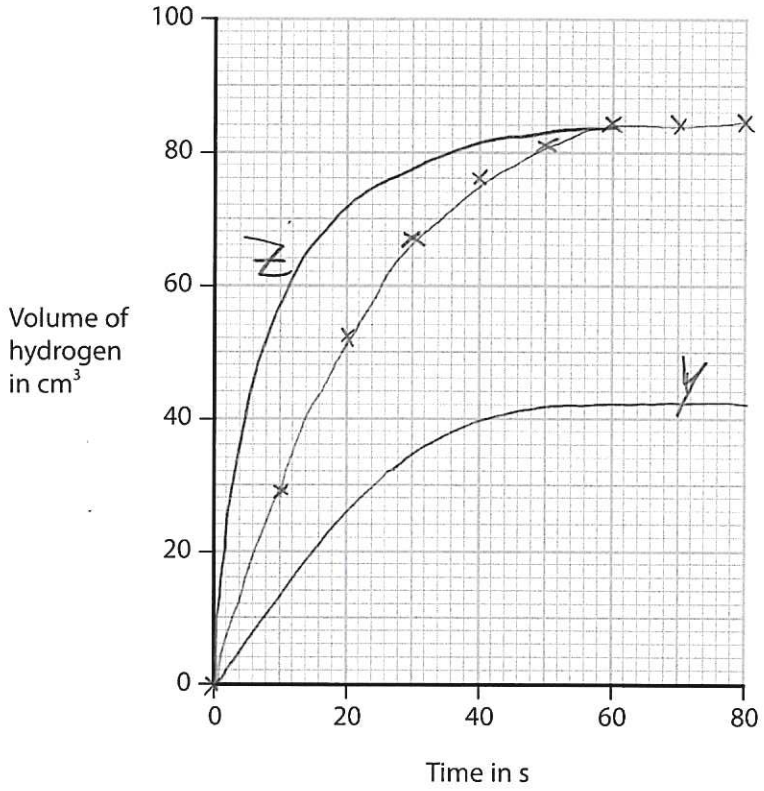
Time in s	Volume of hydrogen in cm^3
0	0
10	29
20	52
30	67
40	76
50	81
60	84
70	84
80	84

(a) (i) Plot the student's results on the grid.

(1)

(ii) Draw a curve of best fit.

(1)



(b) (i) The student repeats the experiment using

- 0.043 g of magnesium ribbon
- 50 cm^3 of 2.00 mol/dm^3 hydrochloric acid

Draw, on the grid in part (a), the curve you would expect in this experiment.

Label this curve Y.

(2)

(ii) The student repeats the experiment again, using

- 0.086 g of magnesium ribbon
- 50 cm^3 of 2.00 mol/dm^3 hydrochloric acid
- a slightly higher temperature than the first experiment

Draw, on the grid in part (a), the curve you would expect in this experiment.

Label this curve Z.

(2)

(c) The expected volume of gas produced in the first experiment is 86 cm^3.

Suggest why the volume collected is less than the expected volume.

(1)

- Some gas escapes before the bung is replaced.
- The Magnesium is impure, with an oxide coating.

(d) The student uses a graduated beaker to measure the volume of dilute hydrochloric acid.

Explain why it is **not** necessary to use a measuring cylinder in this experiment.

(2)

→ The acid is in excess so an accurate measurement of the volume is not required.

(e) The ionic equation for the reaction between magnesium and hydrochloric acid is

$$Mg(s) + 2H^+(aq) \rightarrow Mg^{2+}(aq) + H_2(g)$$

Use the information in this equation, and the particle collision theory, to explain why the rate of reaction decreases during each of the experiments.

(3)

The Concentration of H^+ ions decreases, so there are fewer successful collisions per unit time.

(Total for Question 13 = 12 marks)

14 A salt can be made by reacting an acid with an insoluble base.

A student has a sample of copper(II) oxide.

The student uses this method.

Stage 1 pour 50 cm^3 of dilute sulfuric acid into a beaker

Stage 2 warm the acid using a Bunsen burner

Stage 3 add a small amount of copper(II) oxide to the warm acid and stir the mixture

Stage 4 add further amounts of copper(II) oxide until copper(II) oxide is in excess

Stage 5 filter the mixture

Stage 6 obtain crystals from the filtrate

(a) State why the acid is warmed in stage 2.

(1)

To increase the rate of reaction.

(b) State how the student would know that the copper(II) oxide is in excess in stage 4.

(1)

Copper (II) oxide stops disappearing So black solid settles on the bottom of the beaker.

(c) State why the mixture is filtered in stage 5.

(1)

To remove excess Copper (II) oxide.

(d) State the colour of the filtrate obtained in stage 5.

(1)

Blue.

(e) Describe how the student could obtain a pure, dry sample of hydrated copper(II) sulfate crystals from the filtrate in stage 6.

(5)

- Heat the filtrate until Crystals form on a glass rod.
- Leave the Solution to Cool & Crystalise.
- Filter to remove the Crystals.
- Dry the Crystals on filter paper.

(f) The overall equation for the formation of hydrated copper(II) sulfate crystals from copper(II) oxide is

$$CuO(s) + H_2SO_4(aq) + 4H_2O(l) \rightarrow CuSO_4.5H_2O(s)$$

(i) In an experiment, a student completely reacts 9.54 g copper(II) oxide.

Show that the maximum possible mass of $CuSO_4.5H_2O$ crystals that can be obtained is about 30 g.

[M_r of CuO = 79.5 M_r of $CuSO_4.5H_2O$ = 249.5]

Give your answer to an appropriate number of significant figures.

(3)

$n(CuO) = \frac{9.54}{79.5} = 0.12$ mol

$m(CuSO_4.5H_2O) = 0.12 \times 249.5$

$= 29.94$ g

mass = 29.9 (3 sig fig) g

(ii) In this experiment, the actual yield of $CuSO_4.5H_2O$ crystals is 23.92 g.

Calculate the percentage yield of $CuSO_4.5H_2O$

(2)

$\%$ yield $= \frac{23.92}{29.9} \times 100$

$= 80\%$

percentage yield = 80 %

(Total for Question 14 = 14 marks)

15 Hydrated ammonium iron(III) sulfate is a violet solid that has the formula $(NH_4)_2SO_4.Fe_2(SO_4)_3.xH_2O$

The table shows some tests done on three separate samples of the solid.

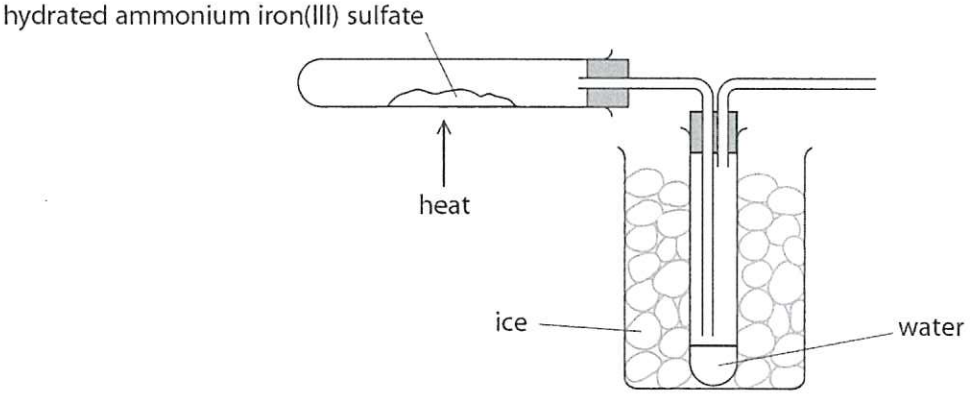
Test	Observation
Dissolve the solid in water and add acidified barium chloride solution.	White precipitate
Dissolve the solid in water and add sodium hydroxide solution.	Brown precipitate.
Add sodium hydroxide solution to the solid and warm the mixture. Test the gas given off with moist universal indicator paper.	Universal indicator turns blue / indigo / purple.

(a) Complete the table to show the observation made in each test.

(3)

(b) A student needs to find the value of x in the formula $(NH_4)_2SO_4.Fe_2(SO_4)_3.xH_2O$

He uses this apparatus.



The hydrated solid decomposes when heated gently.

The equation for the reaction is

$$(NH_4)_2SO_4.Fe_2(SO_4)_3.xH_2O \rightarrow (NH_4)_2SO_4.Fe_2(SO_4)_3 + xH_2O$$

The table shows the student's results.

mass of empty test tube in g	22.04
mass of test tube and $(NH_4)_2SO_4.Fe_2(SO_4)_3.xH_2O$ in g	34.09
mass of test tube and $(NH_4)_2SO_4.Fe_2(SO_4)_3$ in g	28.69

(i) Calculate the mass of $(NH_4)_2SO_4.Fe_2(SO_4)_3$ produced by heating.

(1)

Mass = 28.69 - 22.04

= 6.65g

mass of $(NH_4)_2SO_4.Fe_2(SO_4)_3$ = 6.65 g

(ii) Calculate the mass of water produced.

(1)

Mass = 34.09 − 28.69

= 5.40g

mass of water = 5.40 g

(iii) Calculate the value of x.

[M_r of $(NH_4)_2SO_4.Fe_2(SO_4)_3$ = 532 and M_r of H_2O = 18]

Give your answer to the nearest whole number.

(4)

$n\left((NH_4)_2SO_4.Fe_2(SO_4)_3\right) = \frac{6.65}{532} = 0.0125$ mol

$n(H_2O) = \frac{5.40}{18} = 0.3$ mol

$x = \frac{0.3}{0.0125} = 24$

value of x = 24

(Total for Question 15 = 9 marks)

TOTAL FOR PAPER = 110 MARKS

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