Please check the examination details below before entering your candidate information

Candidate surname	Other names

Centre Number | Candidate Number

Pearson Edexcel International GCSE (9–1)

Time 2 hours

Paper reference 4CH1/1C 4SD0/1C

Chemistry

UNIT: 4CH1

Science (Double Award) 4SD0

PAPER: 1C

You must have:
Calculator, ruler

January 2023

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- If pencil is used for diagrams/sketches/graphs it must be dark (HB or B).
- **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.

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 ▶

P71892A

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P 7 1 8 9 2 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.***

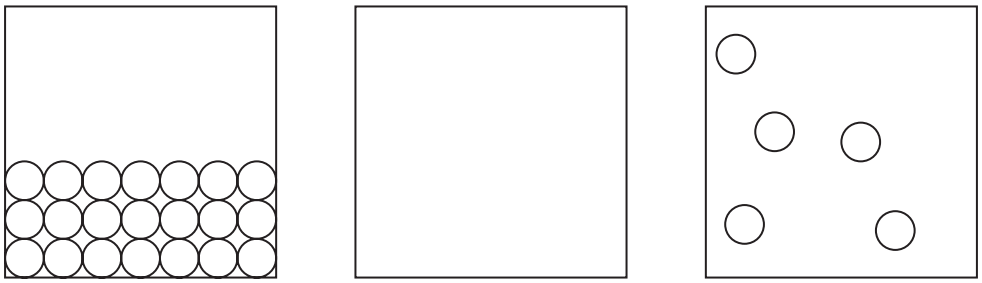
The relative atomic masses of copper and chlorine have not been rounded to the nearest whole number.

Answer ALL questions.

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 ☒.

1 This question is about the three states of matter, solid, liquid and gas.

(a) The diagram shows how particles of a substance are arranged in two of these states.



solid liquid gas

(i) Complete the diagram to show how particles are arranged in the liquid state.

(1)

(ii) Identify the state of matter that contains particles with the least energy.

(1)

(b) The table shows two changes of state.

Complete the table by giving the name of each change of state.

(2)

Change of state	Name
solid to liquid	
solid to gas	

(c) Explain why hot water evaporates more quickly than cold water.

(2)

(Total for Question 1 = 6 marks)

2 This question is about elements, mixtures and compounds.

(a) Which of these is the formula of a molecule of an element?

(1)

- ☒ **A** O
- ☒ **B** Cl_2
- ☒ **C** HCl
- ☒ **D** H_2O

(b) Which method can be used to separate an insoluble solid from a liquid?

(1)

- ☒ **A** crystallisation
- ☒ **B** evaporation
- ☒ **C** filtration
- ☒ **D** simple distillation

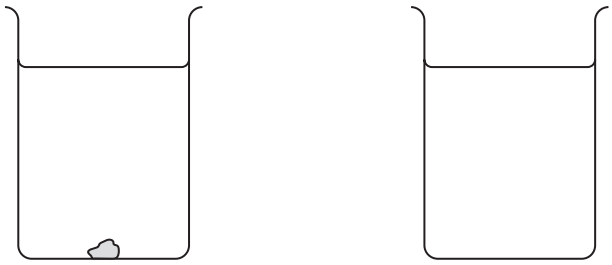
(c) Give the name of a method used to separate a mixture of liquids with different boiling points.

(1)

.....

(d) A student adds a crystal of substance X to some water in a beaker and leaves the beaker for one day.

The diagram shows the beaker immediately after adding the crystal, and after one day.



immediately after adding crystal

after one day

(i) Which equation gives the correct state symbols for a process that occurs in the beaker?

(1)

- ☒ **A** X(s) → X(l)
- ☒ **B** X(s) → X(g)
- ☒ **C** X(aq) → X(s)
- ☒ **D** X(s) → X(aq)

(ii) Which other process occurs in the beaker?

(1)

- ☒ **A** boiling
- ☒ **B** condensing
- ☒ **C** diffusion
- ☒ **D** sublimation

(iii) After one day the student does two tests on the liquid in the beaker.

The table shows the student's results.

Test	Result
flame test	lilac flame
addition of acidified barium chloride solution	white precipitate

Identify substance X.

(2)

.....

(Total for Question 2 = 7 marks)

3 This question is about gases.

(a) (i) Name the gas that is about 1% of dry air by volume.

(1)

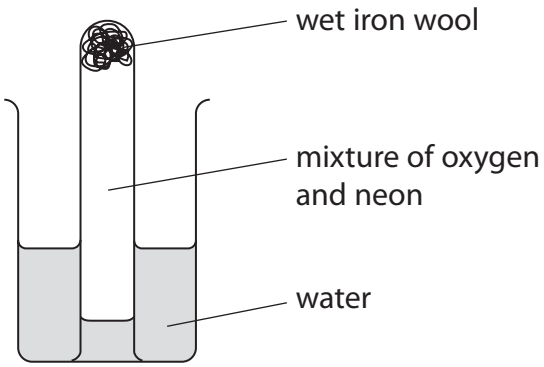
.....

(ii) Which is the most abundant gas in dry air by volume?

(1)

- ☒ **A** carbon dioxide
- ☒ **B** methane
- ☒ **C** nitrogen
- ☒ **D** oxygen

(b) A student uses this apparatus to find the percentage by volume of oxygen in a mixture of oxygen and neon.



This is the student's method.

- measure the initial length of the column of gas in the inverted test tube
- leave the test tube in the beaker for a week
- measure the final length of the column of gas in the test tube

(i) Some of the iron wool rusts.

Give the chemical name for rust.

(1)

.....

(ii) Give a reason why neon does not react with the iron wool.

(1)

.....

.....

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

initial length of column of gas	75 mm
final length of column of gas	30 mm

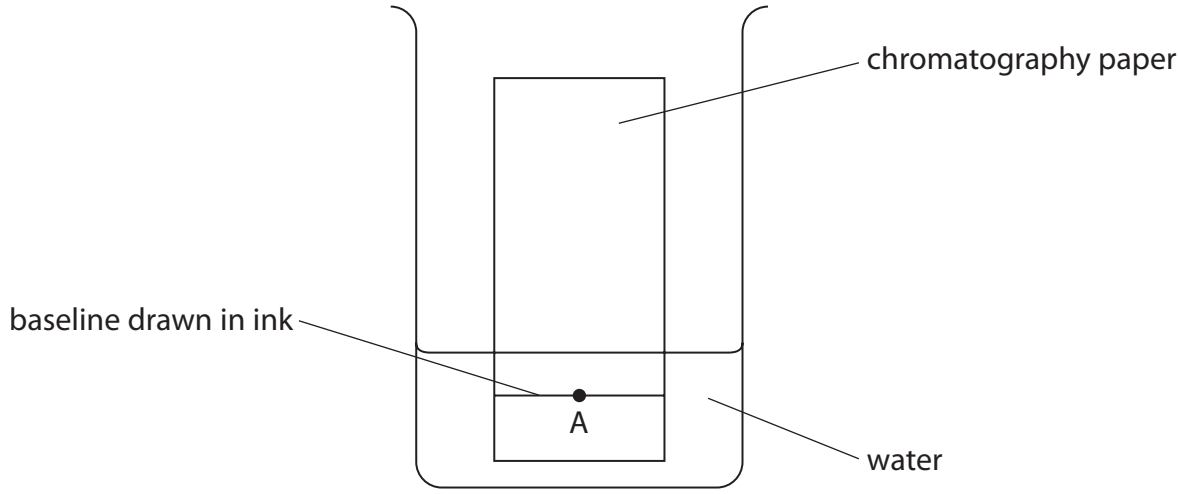
Use the results to calculate the percentage of oxygen in the mixture of oxygen and neon.

(2)

percentage of oxygen = ... %

(Total for Question 3 = 6 marks)

4 A student uses this apparatus to investigate the dyes in a food colouring A.



(a) Explain two mistakes that the student makes when setting up the apparatus.

(4)

1 .....

.....

.....

.....

2 .....

.....

.....

.....

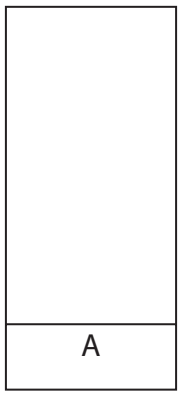
(b) The student repeats the experiment, but with no mistakes.

The table shows the R_f values for the two dyes in food colouring A.

Dye	R_f value
blue	0.50
yellow	0.25

(i) Complete the chromatogram for food colouring A by adding and labelling the dyes.

(2)



(ii) Give a reason why the blue dye has a larger R_f value than the yellow dye.

(1)

.....

.....

(Total for Question 4 = 7 marks)

5 A student investigates the reactivities of four metals, aluminium, magnesium, copper and metal X.

(a) The student adds pieces of magnesium ribbon to aqueous solutions of the sulfates of each metal.

After a few minutes the student removes the pieces of magnesium ribbon and records the appearance of each piece of magnesium.

Table 1 shows the student's results.

Solution	Appearance
aluminium sulfate	grey coating on magnesium
magnesium sulfate	no change
copper(II) sulfate	brown coating on magnesium
sulfate of metal X	grey coating on magnesium

Table 1

(i) Name the substance that causes the brown coating on the magnesium.

(1)

.....

(ii) State why there is no change with magnesium sulfate solution.

(1)

.....

.....

(b) The student repeats the experiment with pieces of metal X instead of pieces of magnesium.

Table 2 shows the student's results.

Solution	Appearance
aluminium sulfate	no change
magnesium sulfate	no change
copper(II) sulfate	brown coating on metal X
sulfate of metal X	no change

Table 2

(i) Use the information from both tables to deduce the order of reactivity of aluminium, magnesium, copper and metal X.

(2)

most reactive .....

.....

.....

least reactive .....

(ii) Give a possible identity for metal X.

(1)

.....

(c) This ionic equation represents the reaction between magnesium and aluminium nitrate.

$$3Mg(s) + 2Al^{3+}(aq) \rightarrow 3Mg^{2+}(aq) + 2Al(s)$$

Explain, in terms of electrons, which species acts as a reducing agent in this reaction.

(2)

.....

.....

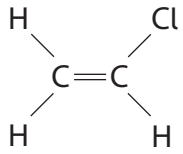
.....

.....

(Total for Question 5 = 7 marks)

6 This question is about polymers.

(a) This is the structure of a monomer.



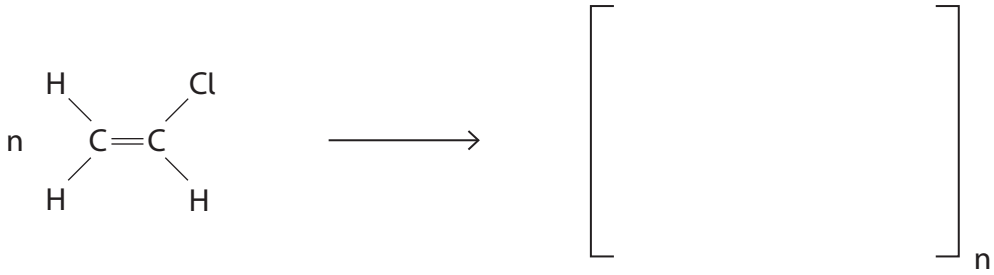
What is the name of this monomer?

(1)

- ☒ **A** chloroethane
- ☒ **B** chloroethene
- ☒ **C** chloropropane
- ☒ **D** chloropropene

(b) Complete the equation to show the repeat unit of the polymer that forms from this monomer.

(1)



(c) A typical molecule of the polymer has a relative molecular mass (M_r) of 2 490 000

Show that the number of monomer molecules needed to make this typical molecule is about 40 000

[for C, A_r = 12 for Cl, A_r = 35.5]

(2)

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(d) These are two methods used to dispose of the polymer.

- burying in landfill sites
- burning

Discuss the environmental problems caused by these two methods of disposal.

(4)

(e) A different polymer molecule contains 10 600 atoms of carbon, 10 600 atoms of hydrogen and 31 800 atoms of chlorine.

Determine the empirical formula of this polymer.

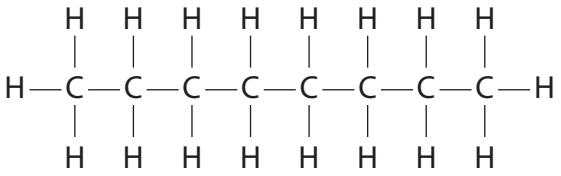
(2)

empirical formula = ...

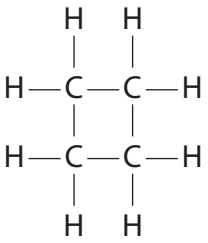
(Total for Question 6 = 10 marks)

7 The table shows the displayed formulae of some organic compounds.

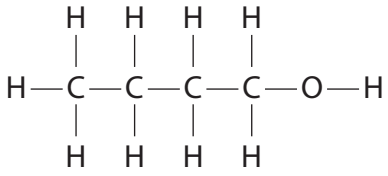
V



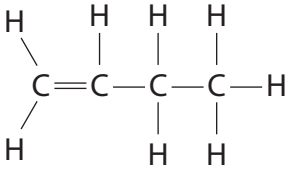
W



X



Y



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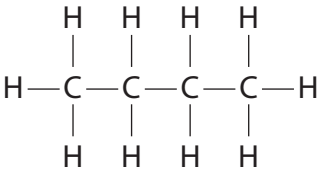

(a) Give a reason why compound **X** is **not** a hydrocarbon.

(1)

.....

.....

(b) Give the letter of the compound that is a saturated hydrocarbon with the empirical formula CH_2

(1)

.....

(c) Give the letter of the compound that produces nine moles of water when one mole undergoes complete combustion.

(1)

.....

(d) Give the structural formula of compound **Y**.

(1)

.....

(e) Explain why compounds **W** and **Y** are isomers.

(2)

(f) Compound **Z** reacts with bromine in the presence of ultraviolet radiation.

(i) Write a chemical equation for this reaction.

(2)

(ii) What is the name for this type of reaction?

(1)

- ☒ **A** addition
- ☒ **B** combustion
- ☒ **C** substitution
- ☒ **D** thermal decomposition

(g) Describe how the combustion of sulfur-free petrol in a car engine produces gases that can cause acid rain.

Do not refer to carbon dioxide in your answer.

(3)

(Total for Question 7 = 12 marks)

8 This question is about ionic compounds.

(a) The table gives the formulae of some positive and negative ions, and the formulae of some compounds containing these ions.

	Na^+	Mg^{2+}
Cl^-		
O^{2-}	Na_2O	MgO
N^{3-}	Na_3N	

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

(3)

(ii) Give the name of the compound with the formula MgO

(1)

.....

(iii) Calculate the relative formula mass (M_r) of Na_3N

[for Na, $A_r = 23$ for N, $A_r = 14$]

(1)

M_r = ...

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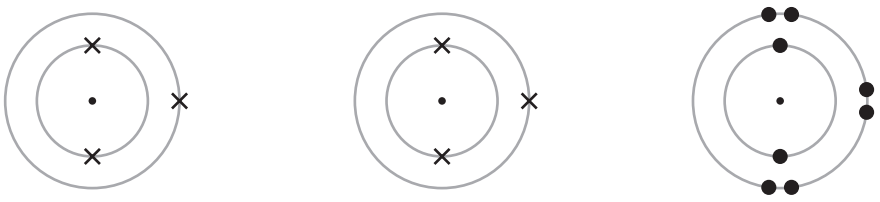
(b) The diagram shows the arrangement of electrons in atoms of lithium and in an atom of oxygen.



lithium atom lithium atom oxygen atom

(i) Describe the changes in the electron configurations of lithium and oxygen when these atoms form lithium oxide, Li_2O

(2)

(ii) Lithium oxide has a giant ionic structure.

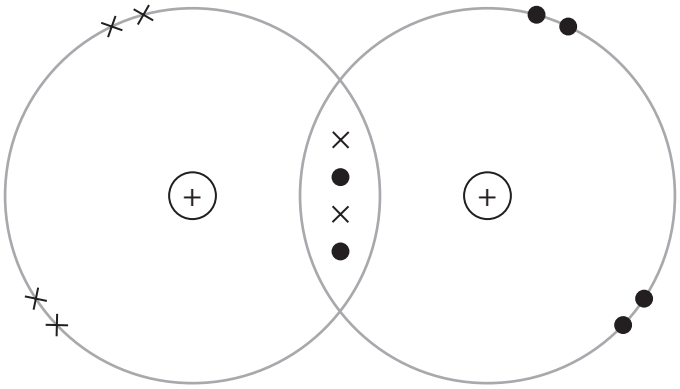
Explain why lithium oxide has a high melting point.

(3)

(Total for Question 8 = 10 marks)

9 This question is about substances that contain covalent bonds.

(a) The diagram represents a molecule of oxygen.



Describe the forces of attraction in a covalent bond.

(2)

(b) The table shows the boiling points of three Group 7 elements.

	Boiling point in °C
fluorine	–188
chlorine	–34
bromine	59

Explain the trend in the boiling points.

(3)

(c) Graphite is a naturally-occurring form of carbon.

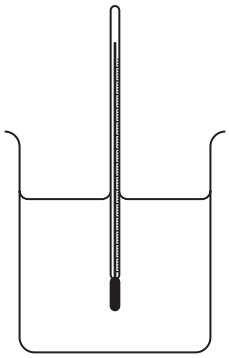
Explain why graphite is soft and conducts electricity.

Refer to structure and bonding in your answer.

(5)

(Total for Question 9 = 10 marks)

10 A student uses this apparatus to record the maximum temperature in the reaction between solutions of hydrochloric acid and sodium hydroxide.



This is the student's method.

- add 25 cm^3 of hydrochloric acid to the beaker
- add 25 cm^3 of sodium hydroxide solution to the beaker
- stir the mixture
- record the maximum temperature reached

(a) Name a suitable piece of apparatus to add 25 cm^3 of solution to the beaker.

(1)

.....

(b) Before the reaction, both solutions have a temperature of 21.0 °C.

The heat energy change, *Q*, for the reaction is 2880 J.

(i) Calculate the theoretical maximum temperature reached by the mixture, which has a mass of 50 g.

[specific heat capacity of mixture, c = 4.2 J / g / °C]

(4)

temperature = ... °C

(ii) Give a reason why the maximum temperature recorded by the student is lower than the theoretical maximum temperature calculated.

(1)

.....

.....

(iii) In the reaction, 0.0500 mol of hydrochloric acid completely react.

Calculate the molar enthalpy change, ΔH, in kilojoules per mole of hydrochloric acid.

Include a sign in your answer.

(3)

ΔH = ... kJ / mol

(Total for Question 10 = 9 marks)

11 This question is about the reaction between magnesium and dilute nitric acid.

(a) A student reacts dilute nitric acid with an excess of magnesium powder as a first step in the preparation of dry crystals of hydrated magnesium nitrate.

This is the equation for the reaction.

$$Mg(s) + 2HNO_3(aq) \rightarrow Mg(NO_3)_2(aq) + H_2(g)$$

(i) Explain why it is important that magnesium is in excess.

(2)

.....

.....

.....

.....

(ii) The student adds 0.75 g of magnesium to 0.025 mol of nitric acid.

Calculate the mass of magnesium, in grams, that remains at the end of the reaction.

[for magnesium, $A_r = 24$]

(3)

mass of magnesium = ... g

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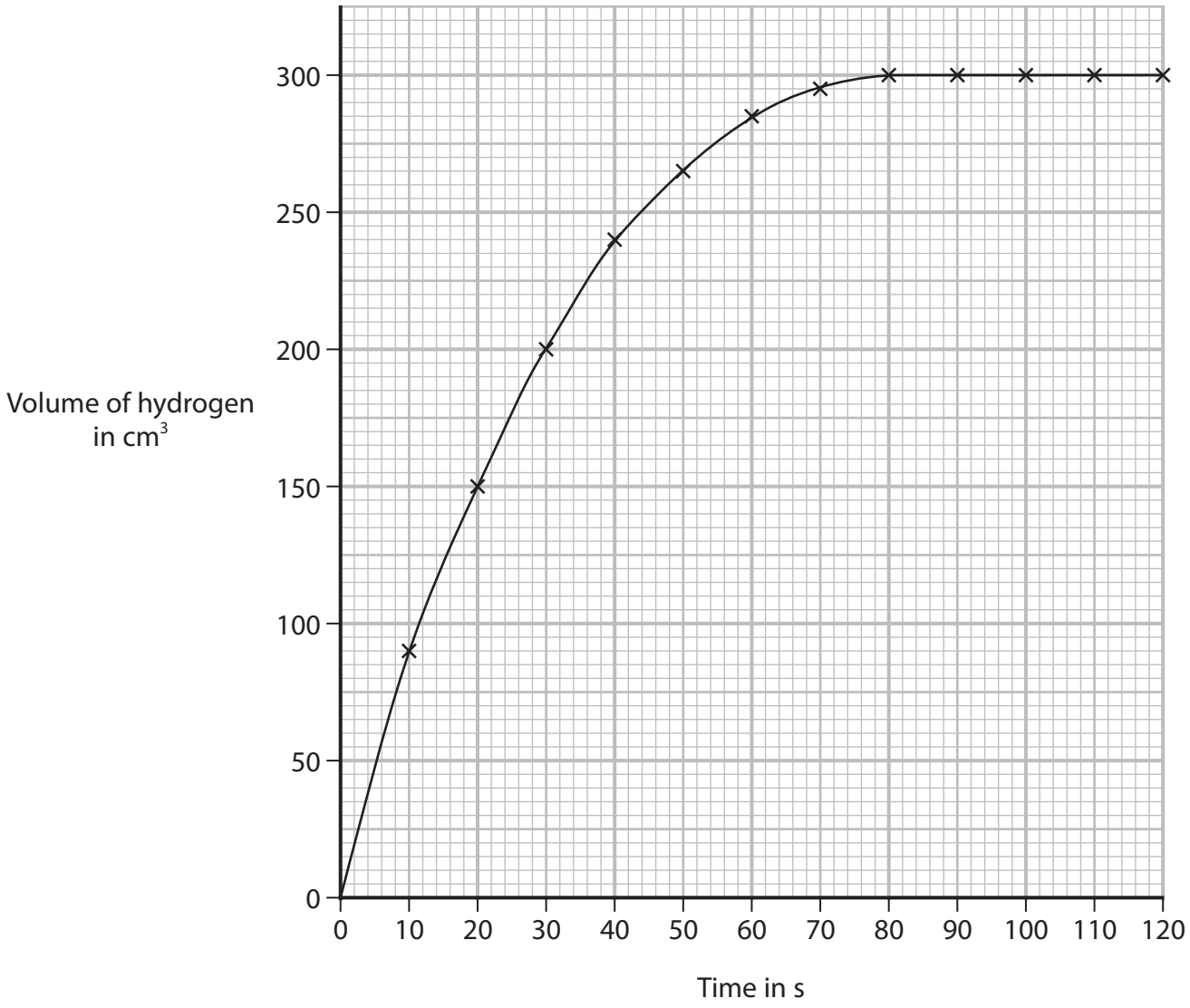
DO NOT WRITE IN THIS AREA

(iii) Describe how the student can obtain dry crystals of hydrated magnesium nitrate from the mixture at the end of the reaction.

(5)

(b) The student repeats the experiment and records the volume of hydrogen gas collected.

The graph shows the student's results.



Use the graph to calculate the rate of reaction, in cm^3/s, at t = 40 s.

Show your working on the graph.

(3)

rate of reaction = ... cm^3/s

(Total for Question 11 = 13 marks)

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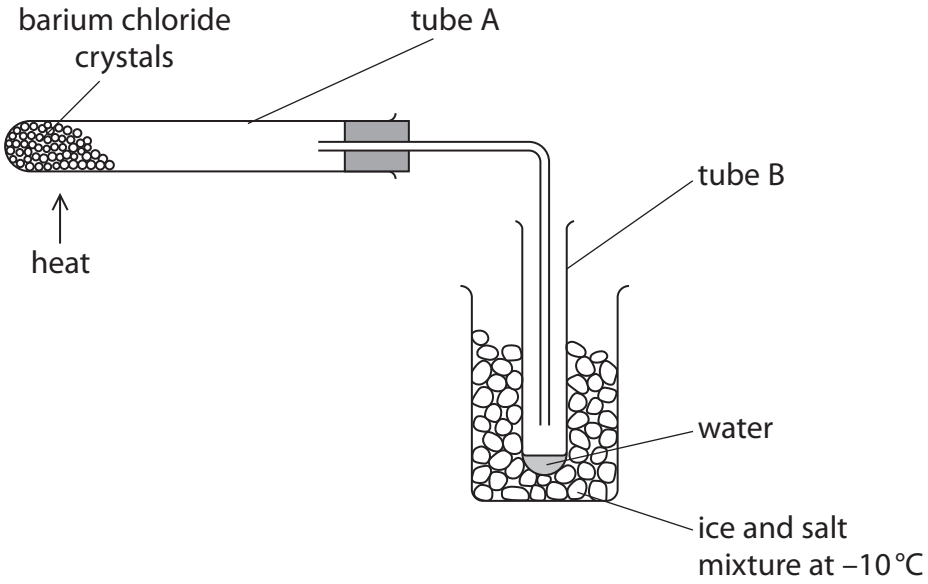
12 This question is about hydrated compounds.

Crystals of hydrated barium chloride ($BaCl_2.xH_2O$) contain water of crystallisation.

A student uses this apparatus to remove and collect the water from some crystals.



This is the student's method.

Step 1 record mass of tube A when empty

Step 2 place a sample of hydrated barium chloride crystals in tube A and record new mass

Step 3 heat tube A

Step 4 allow tube A to cool and record mass

Repeat steps 3 and 4 until the mass recorded in step 4 is constant.

These are the student's results.

mass of tube A = 10.55 g

mass of tube A and $BaCl_2.xH_2O$ = 16.65 g

final mass of tube A and $BaCl_2$ = 15.75 g

(a) (i) Give a reason why the student repeats steps 3 and 4 until the mass is constant.

(1)

.....

.....

(ii) Calculate the mass of $BaCl_2$ that forms in tube A.

(1)

.....

(iii) Calculate the mass of water lost.

(1)

.....

(iv) Determine the value of x in $BaCl_2.xH_2O$

Show your working.

[for $BaCl_2$, $M_r = 208$ for H_2O, $M_r = 18$]

(3)

x = ...

(b) Describe a physical test to show that the water in tube B is pure.

(2)

.....

.....

.....

.....

QUESTION 12 CONTINUES ON NEXT PAGE

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(c) A sample containing 0.02 mol of hydrated copper(II) sulfate is heated using the same apparatus.

The products of the reaction are anhydrous copper(II) sulfate and water.

This is the equation for the reaction.

$$CuSO_4.5H_2O(s) \rightleftharpoons CuSO_4(s) + 5H_2O(l)$$

(i) Give the meaning of the symbol $\rightleftharpoons$

(1)

.....

(ii) Describe how the reaction can be used to show that a liquid contains water.

(2)

.....

.....

.....

.....

(iii) Calculate the maximum number of water molecules in tube B after the sample of hydrated copper(II) sulfate has completely reacted.

One mole of any substance contains 6×10^{23} particles.

(2)

maximum number of molecules = ...

(Total for Question 12 = 13 marks)

TOTAL FOR PAPER = 110 MARKS