

Please check the examination details below before entering your candidate information

|                      |                      |                      |                      |                      |                      |                      |                      |                      |  |
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| Candidatesurname     |                      |                      |                      |                      | Other names          |                      |                      |                      |  |
| Centre Number        |                      |                      |                      |                      | Candidate Number     |                      |                      |                      |  |
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**Pearson Edexcel International GCSE (9–1)**

|              |                 |                        |
|--------------|-----------------|------------------------|
| Time 2 hours | Paper reference | <b>4CH1/1C 4SD0/1C</b> |
|--------------|-----------------|------------------------|

**Chemistry**

**UNIT: 4CH1**

**Science (Double Award) 4SD0**

**PAPER: 1C**

|                                            |             |
|--------------------------------------------|-------------|
| <b>You must have:</b><br>Calculator, ruler | 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 ►

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The Periodic Table of the Elements

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

\* 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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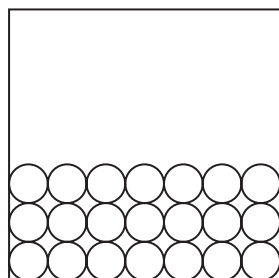


**Answer ALL questions.**

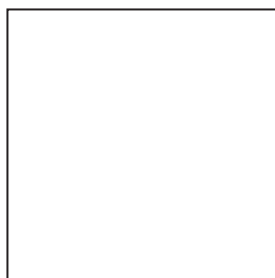
**Some questions must be answered with a cross in a box ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.**

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

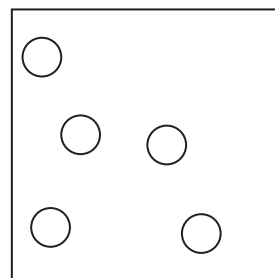
(a) The diagram shows how particles of a substance are arranged in two of these states.



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<sub>2</sub>
- ☐ **C** HCl
- ☐ **D** H<sub>2</sub>O

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

(1)

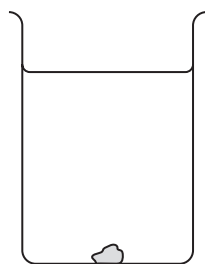
- ☐ **A** crystallisation
- ☐ **B** evaporation
- ☐ **C** filtration
- ☐ **D** simple distillation

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

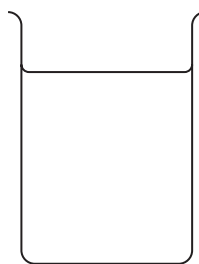
(1)

(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**  $X(s) \rightarrow X(l)$
- ☐ **B**  $X(s) \rightarrow X(g)$
- ☐ **C**  $X(aq) \rightarrow X(s)$
- ☐ **D**  $X(s) \rightarrow X(aq)$

- (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.

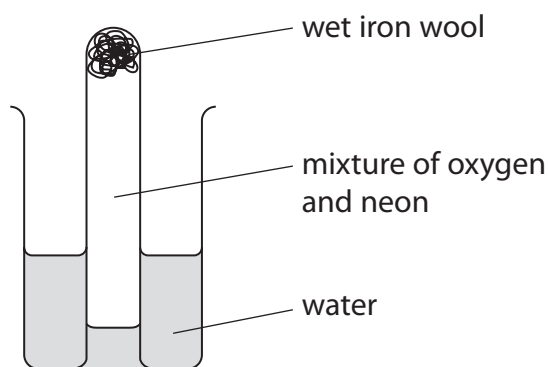
(1)

(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.

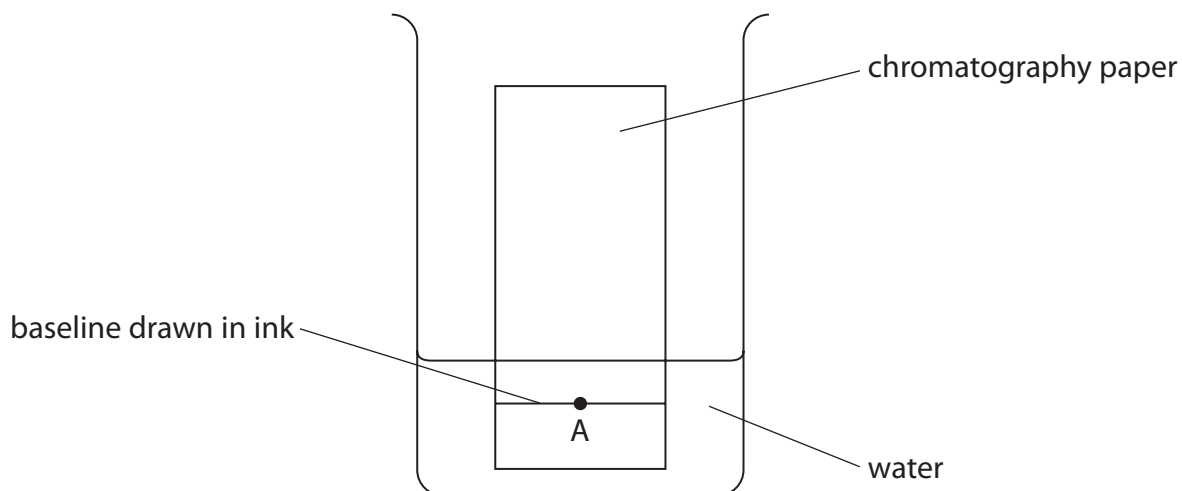
(2)

percentage of oxygen = .....%

**(Total for Question 3 = 6 marks)**



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



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

(4)

1 .....

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2 .....

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

| Dye    | R <sub>f</sub> value |
|--------|----------------------|
| blue   | 0.50                 |
| yellow | 0.25                 |

- (2)

|  |   |
|--|---|
|  |   |
|  | A |

- (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)

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- (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 .....

.....

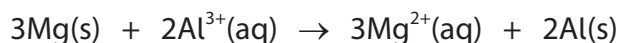
.....

least reactive .....

- (ii) Give a possible identity for metal X.

(1)

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



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

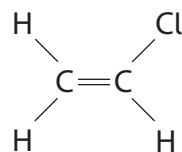
(2)

**(Total for Question 5 = 7 marks)**



6 This question is about polymers.

(a) This is the structure of a monomer.



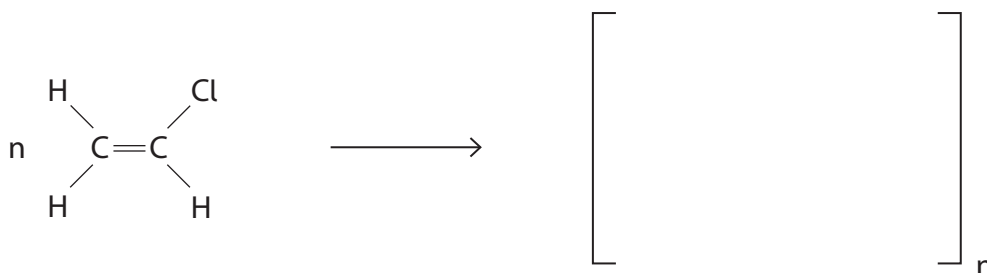
What is the name of this monomer?

(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.

|                                                                                                                                                                                                      |                                                                                                                                                      |                                                                                                                                  |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------|
| <p><b>V</b></p> <pre>      H   H   H   H   H   H   H   H                                 H — C — C — C — C — C — C — C — H                                       H   H   H   H   H   H   H   H</pre> | <p><b>W</b></p> <pre>      H   H             H — C — C — H             H — C — C — H                   H   H</pre>                                   |                                                                                                                                  |
| <p><b>X</b></p> <pre>      H   H   H   H                     H — C — C — C — C — O — H                           H   H   H   H</pre>                                                                 | <p><b>Y</b></p> <pre>      H       H   H   H        \                        C = C — C — C — H        /                      H       H   H   H</pre> | <p><b>Z</b></p> <pre>      H   H   H   H                     H — C — C — C — C — H                           H   H   H   H</pre> |

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

(1)

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(b) Give the letter of the compound that is a saturated hydrocarbon with the empirical formula  $\text{CH}_2$

(1)

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

(1)

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

(1)

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(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)



P 7 1 8 9 2 A 0 1 5 2 8

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.

|                 | $\text{Na}^+$         | $\text{Mg}^{2+}$ |
|-----------------|-----------------------|------------------|
| $\text{Cl}^-$   |                       |                  |
| $\text{O}^{2-}$ | $\text{Na}_2\text{O}$ | $\text{MgO}$     |
| $\text{N}^{3-}$ | $\text{Na}_3\text{N}$ |                  |

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

(3)

- (ii) Give the name of the compound with the formula  $\text{MgO}$

(1)

- (iii) Calculate the relative formula mass ( $M_r$ ) of  $\text{Na}_3\text{N}$

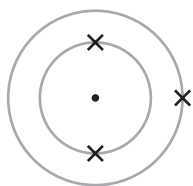
[for Na,  $A_r = 23$     for N,  $A_r = 14$ ]

(1)

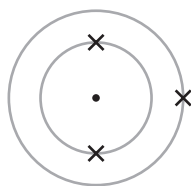
$M_r = \dots\dots\dots$



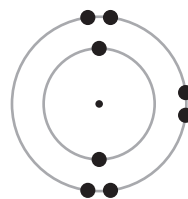
- (b) The diagram shows the arrangement of electrons in atoms of lithium and in an atom of oxygen.



lithium atom



lithium atom



oxygen atom

- (i) Describe the changes in the electron configurations of lithium and oxygen when these atoms form lithium oxide,  $\text{Li}_2\text{O}$

(2)

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- (ii) Lithium oxide has a giant ionic structure.

Explain why lithium oxide has a high melting point.

(3)

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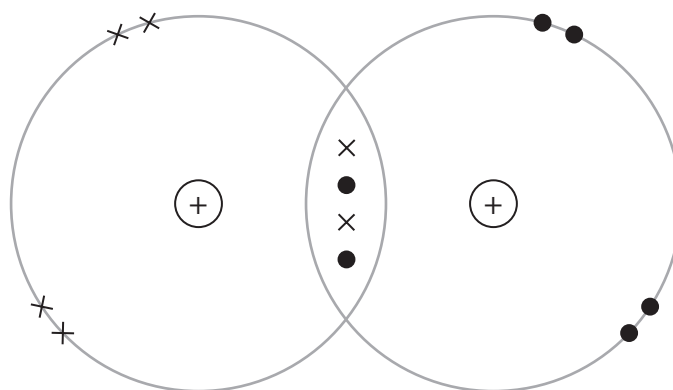
(Total for Question 8 = 10 marks)



P 7 1 8 9 2 A 0 1 7 2 8

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)

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(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)

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

Explain why graphite is soft and conducts electricity.

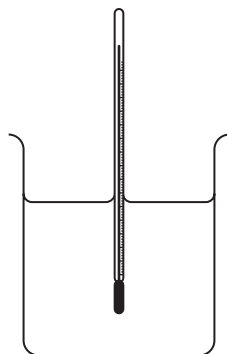
Refer to structure and bonding in your answer.

(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  $25\text{ cm}^3$  of hydrochloric acid to the beaker
- add  $25\text{ cm}^3$  of sodium hydroxide solution to the beaker
- stir the mixture
- record the maximum temperature reached

(a) Name a suitable piece of apparatus to add  $25\text{ cm}^3$  of solution to the beaker.

(1)

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(b) Before the reaction, both solutions have a temperature of  $21.0^{\circ}\text{C}$ .

The heat energy change,  $Q$ , for the reaction is  $2880\text{ J}$ .

- (i) Calculate the theoretical maximum temperature reached by the mixture, which has a mass of  $50\text{ g}$ .

[specific heat capacity of mixture,  $c = 4.2\text{ J/g}^{\circ}\text{C}$ ]

(4)

temperature = .....  $^{\circ}\text{C}$

- (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,  $0.0500\text{ mol}$  of hydrochloric acid completely react.

Calculate the molar enthalpy change,  $\Delta H$ , in kilojoules per mole of hydrochloric acid.

Include a sign in your answer.

(3)

$\Delta H = \dots\dots\dots\text{ kJ/mol}$

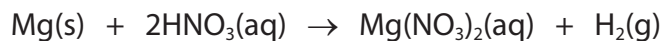
**(Total for Question 10 = 9 marks)**



**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.



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

(2)

.....

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.....

- (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



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

(5)

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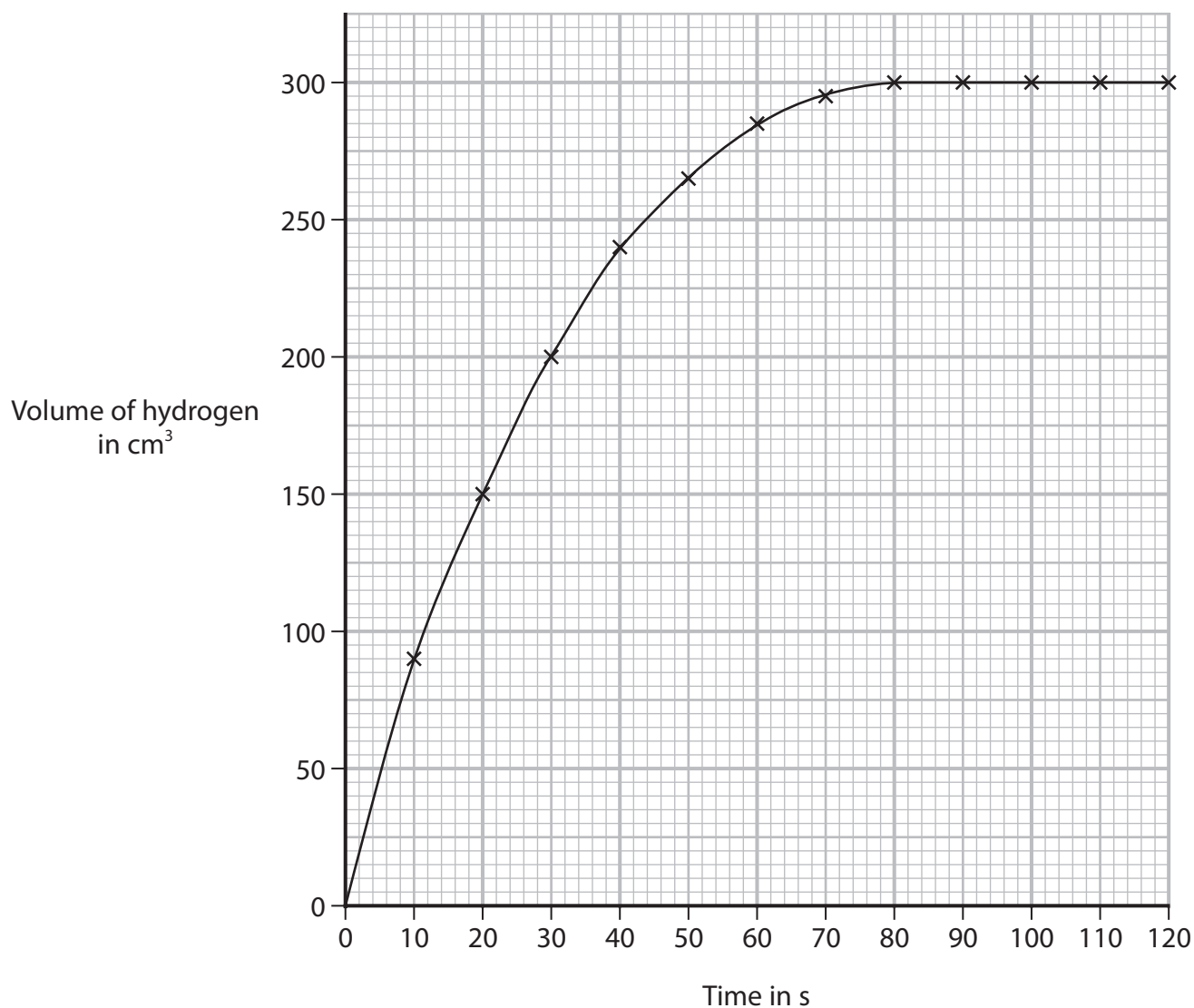
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Area for writing the answer to question (iii). The area is ruled with horizontal dotted lines.



- (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  $\text{cm}^3/\text{s}$ , at  $t = 40\text{ s}$ .

Show your working on the graph.

(3)

rate of reaction = .....  $\text{cm}^3/\text{s}$

(Total for Question 11 = 13 marks)



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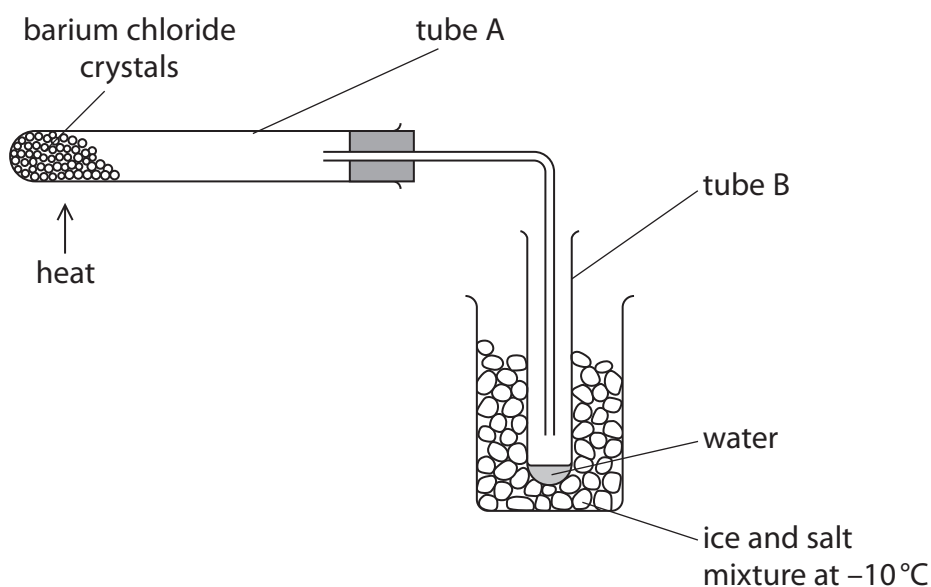
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**12** This question is about hydrated compounds.

Crystals of hydrated barium chloride ( $\text{BaCl}_2 \cdot x\text{H}_2\text{O}$ ) 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  $\text{BaCl}_2 \cdot x\text{H}_2\text{O}$  = 16.65 g

final mass of tube A and  $\text{BaCl}_2$  = 15.75 g

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

(1)

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(ii) Calculate the mass of  $\text{BaCl}_2$  that forms in tube A.

(1)

(iii) Calculate the mass of water lost.

(1)

(iv) Determine the value of  $x$  in  $\text{BaCl}_2 \cdot x\text{H}_2\text{O}$

Show your working.

[for  $\text{BaCl}_2$ ,  $M_r = 208$     for  $\text{H}_2\text{O}$ ,  $M_r = 18$ ]

(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.



- (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  $6 \times 10^{23}$  particles.

(2)

maximum number of molecules = .....

**(Total for Question 12 = 13 marks)**

**TOTAL FOR PAPER = 110 MARKS**

