Please check the examination details below before entering your candidate information

| Candidate surname | Other names |
|---|---|
| | |

Centre Number | Candidate Number

# Pearson Edexcel Level 1/Level 2 GCSE (9–1)

**Time** 1 hour 45 minutes

**Paper reference** **1CH0/1H**

# Chemistry

## PAPER 1

## Higher Tier

**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.*
- Calculators may be used.
- Any diagrams may NOT be accurately drawn, unless otherwise indicated.
- You must **show all your working out** with **your answer clearly identified** at the **end of your solution**.

## Information

- The total mark for this paper is 100.
- The marks for **each** question are shown in brackets – *use this as a guide as to how much time to spend on each question.*
- In questions marked with an **asterisk** (*), marks will be awarded for your ability to structure your answer logically, showing how the points that you make are related or follow on from each other where appropriate.
- There is a periodic table on the back cover of the paper.

## Advice

- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.

*Turn over* ▶

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Q:1/1/1/1/1/

P 6 9 4 8 5 A 0 1 3 2

Pearson

**Answer ALL questions. Write your answers in the spaces provided.**

**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** (a) Chemical cells produce a voltage.

A chemical cell can be made by placing the metals copper and zinc in a beaker of sodium chloride solution.

Figure 1 shows a diagram of this chemical cell.

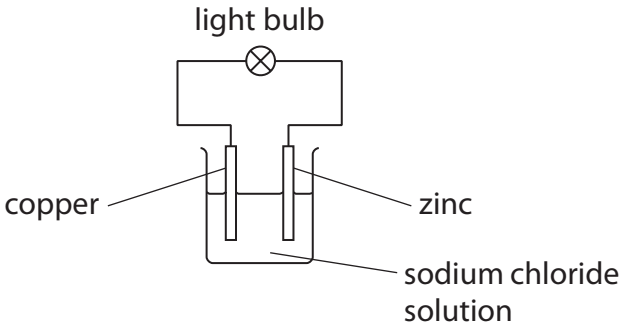


**Figure 1**

Describe what will happen to the brightness of the light bulb over a long period of time.

**(2)**

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(b) Copper is a transition metal.

Which of the following is most likely to be a property of copper?

**(1)**

☒ **A** copper forms a white oxide

☒ **B** copper has a high melting point

☒ **C** copper has a low boiling point

☒ **D** copper has a low density

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(c) A copper atom has a diameter of 0.256 nm.

What is the size of this copper atom in metres?

**(1)**

- ☒ **A** $2.56 \times 10^{-8}$
- ☒ **B** $2.56 \times 10^{-9}$
- ☒ **C** $2.56 \times 10^{-10}$
- ☒ **D** $2.56 \times 10^{-11}$

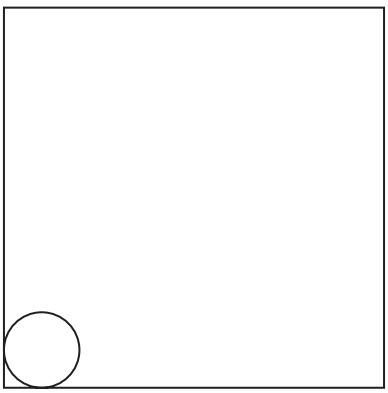
(d) Brass is an alloy of copper and zinc.
One type of brass contains 70% copper.

Zinc atoms are slightly larger than copper atoms.

Draw a labelled diagram in the box to show the arrangement of copper and zinc atoms in this alloy.

Use the circle in the box as a guide to the size of a copper atom.

**(2)**



**(Total for Question 1 = 6 marks)**

**2** Barium hydroxide reacts with dilute hydrochloric acid to form barium chloride and water.

(a) The equation for the reaction is

$$Ba(OH)_2(s) + 2HCl(aq) \rightarrow BaCl_2(aq) + 2H_2O(l)$$

Which row of the table shows the correct state of each of the substances in the equation for the reaction?

**(1)**

| | | barium hydroxide | hydrochloric acid | barium chloride | water |
|---|---|---|---|---|---|
| ☒ | **A** | solid | aqueous | aqueous | liquid |
| ☒ | **B** | solid | liquid | solid | aqueous |
| ☒ | **C** | aqueous | aqueous | solid | liquid |
| ☒ | **D** | aqueous | liquid | aqueous | aqueous |

(b) A student wanted to investigate how the pH of the mixture changes as barium hydroxide is added to dilute hydrochloric acid.

They followed this method.

**step 1** measure out 50.0 $cm^3$ of dilute hydrochloric acid into a beaker using a measuring cylinder

**step 2** use a glass rod to place a drop of the acid onto a piece of universal indicator paper and record the pH

**step 3** add 0.2 g of barium hydroxide to the acid in the beaker and stir

**step 4** use the glass rod to place a drop of the mixture onto a new piece of universal indicator paper and record the pH again

**step 5** repeat steps 3–4 until there is no further change in the pH.

(i) Name a piece of equipment which could be used to measure out 50.0 $cm^3$ of dilute hydrochloric acid more accurately than the measuring cylinder.

**(1)**

.....

(ii) Describe how the pH of the mixture is determined when a drop of it is placed on the universal indicator paper.

**(2)**

(iii) In the method, universal indicator paper is used to determine the pH.

Explain why litmus paper would not be a suitable indicator to use in this experiment.

**(2)**

(iv) Figure 2 shows the student's results.

| mass of barium hydroxide in g | pH of mixture |
|---|---|
| 0.0 | 1 |
| 0.2 | 1 |
| 0.4 | 1 |
| 0.6 | 1 |
| 0.8 | 2 |
| 1.0 | 7 |
| 1.2 | 12 |
| 1.4 | 13 |
| 1.6 | 13 |

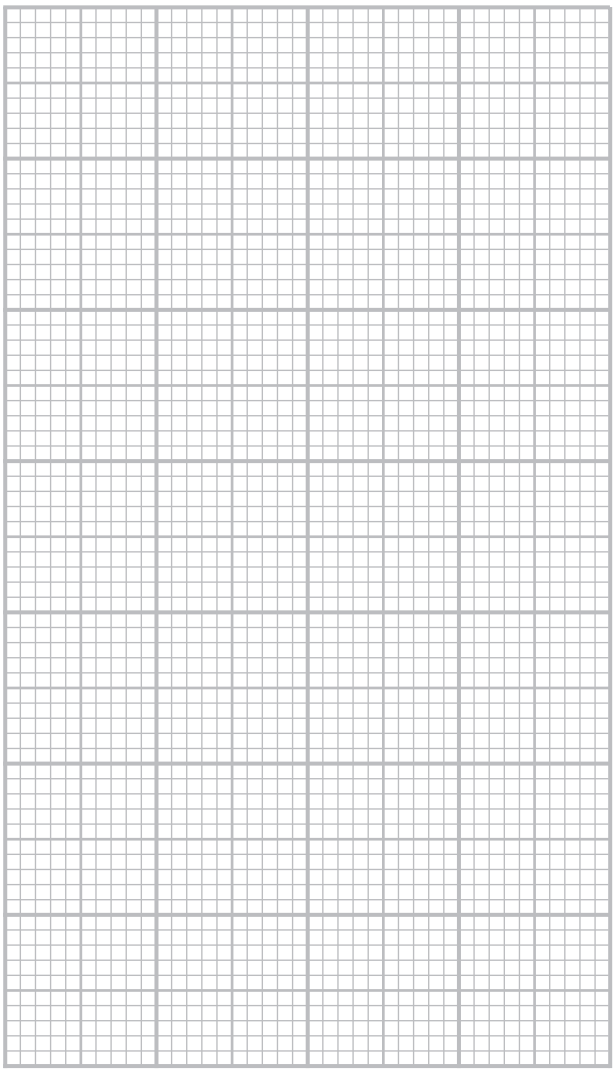
**Figure 2**

On the grid opposite:

- Add suitable scales to the vertical and horizontal axes.
- Plot a graph of the pH of the mixture against the mass of barium hydroxide.

**(3)**

pH of
the mixture



mass of barium hydroxide in g

**(Total for Question 2 = 9 marks)**

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**3** Magnesium carbonate has the formula $MgCO_3$.

(a) Magnesium carbonate contains $Mg^{2+}$ and $CO_3^{2-}$ ions.

(i) The atomic number of magnesium is 12.

What is the electronic configuration of the $Mg^{2+}$ ion?

**(1)**

☒ **A** 2

☒ **B** 2.8

☒ **C** 2.8.2

☒ **D** 2.8.4

(ii) Explain why solid magnesium carbonate cannot conduct electricity but solid magnesium can.

**(3)**

(b) Calculate the percentage by mass of magnesium in magnesium carbonate, $MgCO_3$.

(relative atomic masses: C = 12.0, O = 16.0, Mg = 24.0)

**(3)**

percentage by mass of magnesium = .....

(c) Magnesium carbonate reacts with dilute hydrochloric acid.
Water and carbon dioxide are two of the products of the reaction.

Complete the balanced equation for this reaction.

**(1)**

$MgCO_3 + 2HCl \rightarrow$ ..... $+ H_2O + CO_2$

**(Total for Question 3 = 8 marks)**

**4** Sucrose is a carbohydrate.

When a solution of sucrose is fermented using yeast, ethanol is formed.

$$\text{sucrose} + \text{water} \rightarrow \text{ethanol} + \text{carbon dioxide}$$

(a) In one experiment, 100.00 g of sucrose was dissolved in water.

Yeast was added and the mixture allowed to ferment until no more bubbles of carbon dioxide were seen to be formed.

The ethanol was obtained from the mixture and its mass determined.

The results are shown in Figure 3.

| | **mass in g** |
|---|---|
| mass of sucrose | 100.00 |
| mass of ethanol obtained from the reaction | 8.07 |
| theoretical mass of ethanol formed | 53.80 |

**Figure 3**

The percentage yield is calculated using

$$\text{percentage yield} = \frac{\text{actual yield}}{\text{theoretical yield}} \times 100$$

(i) State the meanings of the terms **actual yield** and **theoretical yield**.

**(2)**

actual yield

.....

.....

theoretical yield

.....

.....

(ii) Use the information in Figure 3 to calculate the percentage yield of ethanol in this experiment.

**(2)**

percentage yield = .....

(iii) State **two** reasons why the actual yield of a reaction is usually less than the theoretical yield.

**(2)**

1 .....

.....

2 .....

.....

(b) The balanced equation for the fermentation of sucrose is

$$C_{12}H_{22}O_{11} + H_2O \rightarrow 4C_2H_5OH + 4CO_2$$

(i) Calculate the atom economy of this reaction to produce ethanol.

Give your answer to two significant figures.

(relative formula masses: $C_{12}H_{22}O_{11} = 342$, $H_2O = 18$, $C_2H_5OH = 46$, $CO_2 = 44$)

**(3)**

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atom economy = .....%

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(ii) Explain the effect on the atom economy of this reaction if the carbon dioxide produced was used to make fizzy drinks.

**(2)**

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**(Total for Question 4 = 11 marks)**

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**5** When copper sulfate solution is electrolysed using copper electrodes, the mass of each electrode changes.

(a) Draw a labelled diagram to show the apparatus that can be used to electrolyse copper sulfate solution using copper electrodes.

**(2)**

(b) Before the electrolysis is carried out, the mass of each electrode is determined.

Explain what should be done to the copper electrodes before their masses are determined.

**(2)**

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(c) Figure 4 shows the results obtained from an electrolysis experiment when copper sulfate solution was electrolysed for 10 minutes.

| | **electrodes** | |
|---|---|---|
| | **anode** | **cathode** |
| mass of electrode before electrolysis in g | 6.43 | 6.17 |
| mass of electrode after electrolysis in g | 5.62 | 6.95 |
| change in mass in g | – 0.81 | + 0.78 |

**Figure 4**

(i) Explain, in terms of ions, the changes in mass of the two electrodes shown in the results in Figure 4.

**(3)**

(ii) The electrolysis was repeated using another pair of copper electrodes of the same masses.

Explain a change that could be made to the electrolysis experiment to cause the mass of the cathode to increase by 2.34 g in 10 minutes.

**(2)**

**(Total for Question 5 = 9 marks)**

**6** The method used to extract a metal from its ore depends on the position of the metal in the reactivity series.

(a) Aluminium is extracted from its ore by electrolysis.

Explain why this method is used to extract aluminium from its ore.

**(2)**

(b) (i) One step in the extraction of titanium metal involves the displacement reaction between titanium chloride, $TiCl_4$, and magnesium.

$$TiCl_4 + 2Mg \rightarrow Ti + 2MgCl_2$$

This equation can be simplified as

$$Ti^{4+} + 2Mg \rightarrow Ti + 2Mg^{2+}$$

Explain why this displacement reaction can be described as a redox reaction.

**(3)**

(ii) The formula of the sulfate ion is $SO_4^{2-}$.

Which of the following is the formula of titanium sulfate containing the $Ti^{4+}$ ion?

**(1)**

☒ **A** $TiSO_4$

☒ **B** $Ti_2SO_4$

☒ **C** $Ti(SO_4)_2$

☒ **D** $Ti_2S_2O_8$

(c) Phytoextraction is an alternative biological method that can be used to extract metals from very low-grade ores.

Give **one** disadvantage of phytoextraction as a method of extraction of metals.

**(1)**

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(d) Copper is low down in the reactivity series and can be obtained from copper oxide.

Devise a simple method to obtain a sample of copper from copper oxide in the laboratory.

**(2)**

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**(Total for Question 6 = 9 marks)**

**7** The volume of dilute sulfuric acid required to neutralise 25.0 $cm^3$ of ammonia solution can be found by titration.

In the titration, a few drops of methyl orange indicator were added to the ammonia solution in a conical flask before adding the dilute sulfuric acid.

(a) State the change in colour of the methyl orange at the end point when the ammonia solution has just been neutralised.

**(2)**

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

(b) When the ammonia solution was neutralised by the dilute sulfuric acid, a solution of ammonium sulfate was formed.

Complete the balanced equation for the reaction between ammonia solution and sulfuric acid.

**(2)**

..... $NH_3$ + $H_2SO_4$ → .....

(c) The titration was repeated to obtain a mean volume of dilute sulfuric acid required to neutralise the 25.0 $cm^3$ of ammonia solution.
The volumes of the two solutions were measured accurately.

Explain **two** other practical steps that should be used in the titration to ensure that an accurate titre volume is obtained.

**(4)**

1 .....

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2 .....

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(d) The mean volume of dilute sulfuric acid required to neutralise the ammonia solution was determined from the results of the titration.

This volume of dilute sulfuric acid was added to 25.0 $cm^3$ of ammonia solution in a conical flask.

Devise a plan to produce a sample of dry ammonium sulfate from the contents of the conical flask.

**(3)**

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**(Total for Question 7 = 11 marks)**

**8** (a) Bromine is a liquid at room temperature and vaporises readily.
Bromine has a simple molecular structure.

Which row of the table shows the most likely melting and boiling points of bromine?

**(1)**

| | melting point in °C | boiling point in °C |
|---|---|---|
| ☒ **A** | –70 | –6.3 |
| ☒ **B** | –17 | 6.3 |
| ☒ **C** | –7 | 63 |
| ☒ **D** | 17 | 630 |

(b) Part of the structure of graphene is shown in Figure 5.

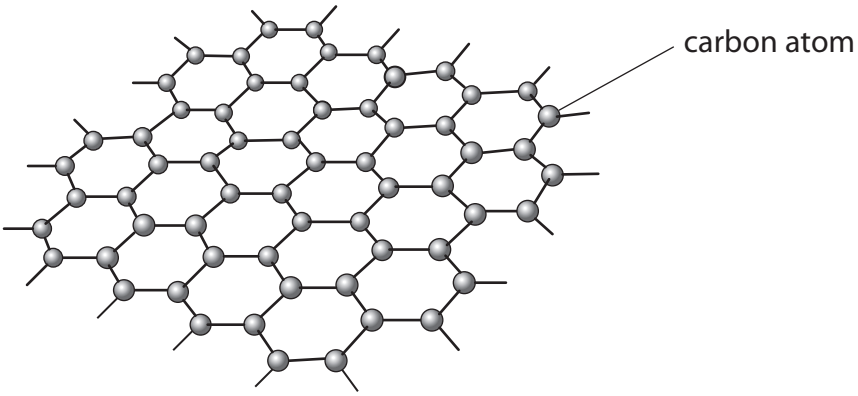


**Figure 5**

Explain why graphene will be a good conductor of an electric current.

**(3)**

(c) Part of the structure of potassium chloride is shown in Figure 6.

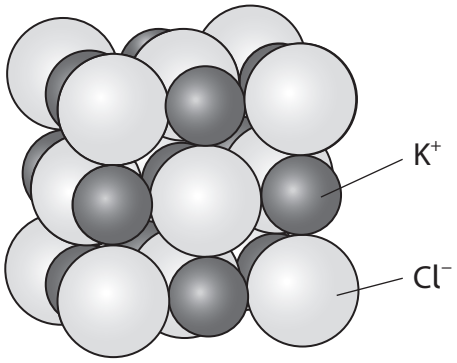


**Figure 6**

Potassium chloride has a melting point of 770 °C.

Explain why potassium chloride has a high melting point.

**(2)**

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*(d) A molecule of methane can be represented in several different ways as shown in Figure 7.
These representations have been labelled **A**–**E** to assist you in your answer.

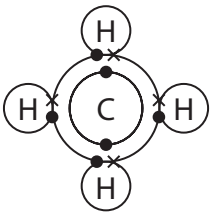
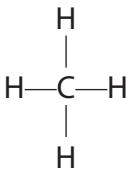
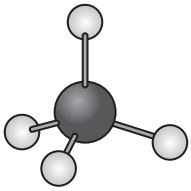
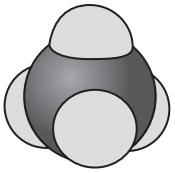
| A | B | C | D | E |
|---|---|---|---|---|
| $CH_4$ |  |  |  |  |





**Figure 7**

Describe what information can be obtained from each representation including the limitations of these representations of methane.

**(6)**

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**(Total for Question 8 = 12 marks)**

**9** (a) A student carried out an investigation to determine the order of reactivity of four metals, **W**, **X**, **Y** and **Z**.
A piece of metal **W** was added to a test tube containing excess dilute hydrochloric acid.
This was repeated with the other three metals, **X**, **Y** and **Z**.
In each case, the size of each piece of metal was the same.
The student recorded observations on each reaction for three minutes.

The observations obtained are shown in Figure 8.

| metal | observations with dilute hydrochloric acid |
|---|---|
| **W** | Bubbles formed quickly with some metal remaining after three minutes. |
| **X** | A few bubbles were seen to form. The metal looked unchanged after three minutes. |
| **Y** | Bubbles formed quickly. After three minutes all the metal had reacted. |
| **Z** | Bubbles formed very quickly with no metal remaining after three minutes. |

**Figure 8**

(i) Use the information in Figure 8 to place the metals in order of reactivity from the least reactive to the most reactive.

**(2)**

least reactive ⟶ most reactive

| | | | |
|---|---|---|---|
| | | | |

(ii) The experiment was repeated using an excess of dilute sulfuric acid in place of the dilute hydrochloric acid.

metal + sulfuric acid → metal sulfate + hydrogen

When metal **Y** reacts with dilute sulfuric acid, bubbles form quickly at first and then the reaction stops.
Most of the solid metal remains.

Explain why the reaction between metal **Y** and excess dilute sulfuric acid stopped even though there was solid metal **Y** left.

**(2)**

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(iii) The reactions between metals and dilute ethanoic acid are slower than reactions between metals and dilute hydrochloric acid.
This is because ethanoic acid is a weak acid.

Explain the meaning of the term **weak acid**.

**(2)**

(b) The formula of aluminium sulfate is $Al_2(SO_4)_3$.

Calculate the total number of atoms that combine to form 5.13 g of aluminium sulfate.

(relative atomic masses: O = 16.0, Al = 27.0, S = 32.0
Avogadro number = $6.02 \times 10^{23}$)

**(4)**

number of atoms = .....

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(c) Iron is more reactive than lead.
Iron reacts with lead nitrate solution to form solid lead.
Two possible balanced equations for the reaction are

Equation **1** $Fe + Pb(NO_3)_2 \rightarrow Fe(NO_3)_2 + Pb$

Equation **2** $2Fe + 3Pb(NO_3)_2 \rightarrow 2Fe(NO_3)_3 + 3Pb$

In one experiment, it was found that 4.48 g of iron reacted with excess lead nitrate solution to form 24.84 g of lead.

Carry out a calculation, using the information above, to show which equation represents the reaction taking place.

(relative atomic masses: Fe = 56.0, Pb = 207)

**(3)**

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**(Total for Question 9 = 13 marks)**

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**10** When hydrogen is removed from an alkane, an alkene is formed.

This is an example of a dehydrogenation reaction.

(a) Under certain conditions the dehydrogenation of propane forms propene and a dynamic equilibrium is reached.

(i) State what is meant by dynamic in this context.

**(1)**

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.....

*(ii) The equation for this equilibrium reaction is

$$\underset{\text{propane}}{C_3H_8(g)} \rightleftharpoons \underset{\text{propene}}{C_3H_6(g)} + H_2(g)$$

The forward reaction takes in heat energy and is endothermic.
A manufacturer produces large quantities of propene using this equilibrium reaction.

Suggest, with explanations, suitable conditions that the manufacturer could use to maximise the yield and rate of production of propene from propane.

**(6)**

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(b)

$$\underset{\text{propane}}{C_3H_8(g)} \rightleftharpoons \underset{\text{propene}}{C_3H_6(g)} + H_2(g)$$

State the maximum volume of propene, in $dm^3$, formed by the dehydrogenation of 300 $dm^3$ of propane.

(assume all volumes of gases are measured under the same conditions of temperature and pressure)

**(1)**

maximum volume of propene = ..... $dm^3$

(c) 900 $dm^3$ of propane, measured at room temperature and pressure, were dehydrogenated to form propene.

$$\underset{\text{propane}}{C_3H_8(g)} \rightleftharpoons \underset{\text{propene}}{C_3H_6(g)} + H_2(g)$$

Calculate the maximum mass, in kg, of hydrogen formed in this reaction.

(relative atomic mass: H = 1.0;
1 mol of any gas at room temperature and pressure occupies 24 $dm^3$)

**(4)**

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mass of hydrogen = ..... kg

**(Total for Question 10 = 12 marks)**

**TOTAL FOR PAPER = 100 MARKS**

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# 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 |

**Key**

relative atomic mass
**atomic symbol**
name
atomic (proton) number

* The elements with atomic numbers from 58 to 71 are omitted from this part of the periodic table.

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