Write your name here

| Surname | Other names |
|---|---|
| | |

**Pearson Edexcel**
**Level 1/Level 2 GCSE (9-1)**

Centre Number | | | | | |

Candidate Number | | | | |

# Chemistry

## Paper 1

**Higher Tier**

Thursday 17 May 2018 – Morning
**Time: 1 hour 45 minutes**

Paper Reference
**1CH0/1H**

**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.
- A periodic table is printed on the back cover of this 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* ▶

P52476A



1/1/1/1/1/1/

P 5 2 4 7 6 A 0 1 2 8

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** Alloy steels are made when iron is alloyed with other transition metals such as cobalt and chromium.

(a) Which row of the table shows the typical properties of a transition metal?

**(1)**

| | used as a catalyst | density | colour of metal chloride |
|---|---|---|---|
| ☒ **A** | yes | high | colourless |
| ☒ **B** | no | low | colourless |
| ☒ **C** | yes | high | coloured |
| ☒ **D** | no | low | coloured |

(b) Figure 1 shows the chain on a bicycle.


**Figure 1**

Explain how lubricating the chain with oil prevents corrosion of the steel chain.

**(2)**

.....

.....

.....

.....

(c) Iron fences can be galvanised by coating them with a layer of zinc.
When the layer of zinc is scratched exposing the iron to the weather, the iron does not rust.

Explain why the exposed iron does not rust.

**(2)**

(d) Metals have high melting points.

Explain, in terms of their structure and bonding, why metals have high melting points.

**(2)**

**(Total for Question 1 = 7 marks)**

**2** (a) Salts of metals can be prepared by reacting the metal with an acid to produce the salt and hydrogen.

(i) Describe the test to show the gas is hydrogen.

**(2)**

(ii) Nickel is a metal.

Explain how the structure of a nickel atom, Ni, changes when it forms a nickel ion, $Ni^{2+}$.

**(2)**

(b) A nickel sulfate solution is made by dissolving 23.5 g of nickel sulfate to make 250 $cm^3$ of solution.

Calculate the concentration of the solution in g $dm^{-3}$.

**(2)**

concentration = ..... g $dm^{-3}$

(c) Excess solid nickel carbonate is added to dilute sulfuric acid in a beaker.

$$\text{nickel carbonate} + \text{sulfuric acid} \rightarrow \text{nickel sulfate} + \text{carbon dioxide} + \text{water}$$

Nickel sulfate is formed in solution.

Describe how a sample of pure, dry nickel sulfate crystals can be obtained from the mixture of nickel sulfate solution and excess solid nickel carbonate in the beaker.

**(3)**

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

**3** Most metals are extracted from ores found in the Earth's crust.

The method used to extract a metal from its ore is linked to the reactivity of the metal.

Part of the reactivity series is shown in Figure 2.

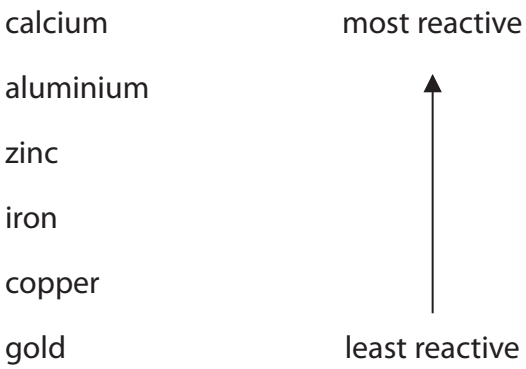



**Figure 2**

(a) Iron ore contains iron oxide.

Iron is extracted from iron oxide by heating the oxide with carbon.

$$\text{iron oxide} + \text{carbon} \rightarrow \text{iron} + \text{carbon dioxide}$$

(i) In this reaction

**(1)**

☒ **A** carbon is reduced

☒ **B** iron oxide is neutralised

☒ **C** iron oxide is reduced

☒ **D** iron is oxidised

(ii) The formula of the iron oxide is $Fe_2O_3$.

Calculate the maximum mass of iron that can be obtained from 240 tonnes of iron oxide, $Fe_2O_3$.

(relative atomic masses: O = 16, Fe = 56)

**(3)**

mass of iron = ..... tonnes

(b) Aluminium cannot be extracted by heating its oxide with carbon.
Aluminium has to be extracted from its oxide by electrolysis.

Explain why.

**(2)**

(c) Predict the method that will have to be used to extract calcium from its ore.

**(1)**

(d) In recent years, researchers have been investigating alternative methods of extracting metals from soils.

Researchers have found that growing certain plants in appropriate areas can result in the phytoextraction of copper.

Describe how growing plants can result in the phytoextraction of copper.

**(2)**

**(Total for Question 3 = 9 marks)**

**4** (a) Hydrogen burns in air at a temperature well above 100 °C to form water.

(i) The boiling points of hydrogen and water are shown in Figure 3.

| | boiling point in °C |
|---|---|
| hydrogen | −253 |
| water | 100 |

**Figure 3**

Use this information to add the missing state symbols to the equation for the reaction taking place as the hydrogen burns.

**(2)**

$2H_2($ ..... $) + O_2(g) \rightarrow 2H_2O($ ..... $)$

(ii) The atom economy for the reaction in (i) is 100%.

State how the equation shows that the atom economy is 100%.

**(1)**

.....

.....

(b) Lead can be obtained by heating its oxide with carbon.
The balanced equation for the reaction is

$$2PbO + C \rightarrow 2Pb + CO_2$$

Calculate the atom economy for the production of lead in this reaction.
(relative atomic masses: C = 12, O = 16, Pb = 207
relative formula masses: PbO = 223, $CO_2$ = 44)

Give your answer to two significant figures.

**(4)**

.....

.....

.....

.....

.....

.....

atom economy = ..... %

(c) (i) In an experiment to produce lead, 7.67 g of lead are obtained.
The theoretical yield of lead for the experiment is 11.80 g.

Calculate the percentage yield of lead in this experiment.

**(2)**

.....

.....

.....

.....

.....

.....

percentage yield = .....

(ii) In most reactions, the percentage yield of any product is less than 100%.

Give **two** reasons why the percentage yield is less than 100%.

**(2)**

reason 1 .....

.....

reason 2 .....

.....

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

**5** (a) Which of the following substances will be a solid at 20 °C and will melt when placed in a beaker of hot water at 80 °C?

**(1)**

| | melting point in °C | boiling point in °C |
|---|---|---|
| ☒ **A** | 122 | 249 |
| ☒ **B** | –7 | 59 |
| ☒ **C** | 30 | 2403 |
| ☒ **D** | –32 | 27 |

(b) A student set up the apparatus shown in Figure 4 to obtain pure water from sea water by distillation.

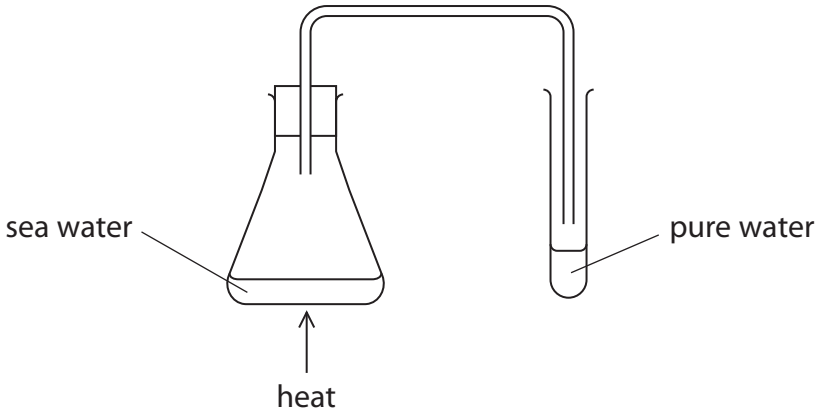



**Figure 4**

(i) Explain how the water in sea water separates to produce the pure water in this apparatus.

**(2)**

(ii) Explain how the apparatus could be improved to increase the amount of pure water collected from the same volume of sea water.

**(2)**

(c) A substance is heated at a constant rate and its temperature is taken every minute. During the heating, the substance undergoes one change of state.

The results are shown on the graph in Figure 5.

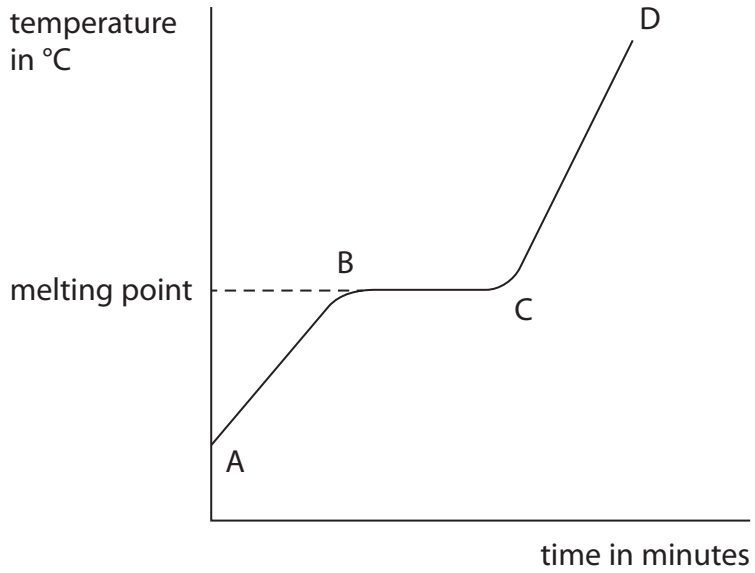



**Figure 5**

Explain the shape of the graph in terms of the changes in the movement and arrangement of the particles as the substance is heated.

**(4)**

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

**6** (a) Molten zinc chloride is an electrolyte.

(i) Which row shows the products formed at the anode and at the cathode when molten zinc chloride is electrolysed?

**(1)**

| | | product at anode | product at cathode |
|---|---|---|---|
| ☒ | **A** | oxygen | zinc |
| ☒ | **B** | chlorine | hydrogen |
| ☒ | **C** | chlorine | zinc |
| ☒ | **D** | oxygen | hydrogen |

(ii) Which of the following is the reason why molten zinc chloride is an electrolyte?

**(1)**

☒ **A** it contains molecules that can move

☒ **B** it has a giant structure

☒ **C** it contains delocalised electrons

☒ **D** it contains ions that can move

(b) Copper sulfate solution was electrolysed using copper electrodes.

(i) Draw a labelled diagram to show the apparatus that is used to carry out this electrolysis in the laboratory.

**(2)**

(ii) Before the electrolysis, the masses of the electrodes were determined. After the electrolysis, the electrodes were washed and dried and their masses re-determined.

Figure 6 shows these masses and the resulting changes in masses of the electrodes.

| | mass of electrode before electrolysis in g | mass of electrode after electrolysis in g | change in mass of electrode in g |
|---|---|---|---|
| anode | 11.27 | 10.42 | −0.85 |
| cathode | 11.32 | 12.17 | +0.85 |

**Figure 6**

Explain these results.

**(4)**

(c) When sodium sulfate solution is electrolysed, using inert electrodes, hydrogen is formed at the cathode.

Write the half equation for the formation of hydrogen gas, $H_2$, from hydrogen ions, $H^+$.

**(2)**

**(Total for Question 6 = 10 marks)**

**BLANK PAGE**

**7** The industrial production of sulfuric acid involves several steps.

One of these steps is the reaction of sulfur dioxide, $SO_2$, with oxygen to form sulfur trioxide, $SO_3$.

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$$

(a) What volume of sulfur trioxide, in $dm^3$, is produced by the complete reaction of 750 $dm^3$ of sulfur dioxide?
(all volumes of gases are measured under the same conditions of temperature and pressure)

**(1)**

☒ **A** 375.5

☒ **B** 750

☒ **C** 1125.5

☒ **D** 1500

(b) Calculate the volume of oxygen needed to react completely with 750 $dm^3$ of sulfur dioxide.
(all volumes of gases are measured under the same conditions of temperature and pressure)

**(1)**

volume of oxygen = ..... $dm^3$

(c) Calculate the mass, in kilograms, of 750 $dm^3$ of sulfur dioxide, measured at room temperature and pressure.
(relative formula mass: $SO_2$ = 64;
1 mol of any gas at room temperature and pressure occupies 24 $dm^3$)

**(3)**

mass of sulfur dioxide = ..... kg

*(d) The reaction to produce sulfur trioxide reaches an equilibrium.

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$$

The forward reaction is exothermic.
The rate of attainment of equilibrium and the equilibrium yield of sulfur trioxide are affected by pressure and temperature.

A manufacturer considered two sets of conditions, A and B, for this reaction.
In each case sulfur dioxide is mixed with excess oxygen.
The manufacturer changed the temperature and the pressure and only used a catalyst in B.
The sets of conditions A and B are shown in Figure 7.

| set of conditions | pressure in atm | temperature in °C | catalyst |
|---|---|---|---|
| A | 2 | 680 | no catalyst used |
| B | 4 | 425 | catalyst used |

**Figure 7**

The manufacturer chooses set of conditions B rather than set of conditions A.

Explain, by considering the effect of changing the conditions on the rate of attainment of equilibrium and on the equilibrium yield of sulfur trioxide, why the manufacturer chooses the set of conditions B rather than the set of conditions A.

**(6)**

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

**BLANK PAGE**

**8** Covalent substances can be simple molecular covalent or giant covalent.

(a) (i) Ammonia is a simple molecular, covalent substance.

Which is the most likely set of properties for ammonia?

**(1)**

| | melting point in °C | boiling point in °C | ability to conduct electricity in liquid state |
|---|---|---|---|
| ☒ **A** | 1713 | 2950 | does not conduct |
| ☒ **B** | −78 | −33 | does not conduct |
| ☒ **C** | −39 | 357 | conducts |
| ☒ **D** | 801 | 1413 | conducts |

(ii) Ammonia, $NH_3$, is made by reacting nitrogen with hydrogen.

Write the balanced equation for this reaction.

**(2)**

(b) Oxygen, $O_2$, is also a simple molecular, covalent substance.

Draw a dot and cross diagram for the molecule of oxygen.

**(2)**

*(c) Figure 8 shows the arrangement of carbon atoms in diamond, graphene and a fullerene ($C_{60}$).

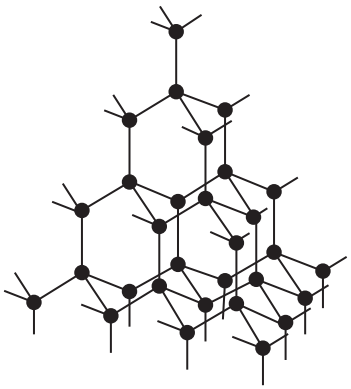
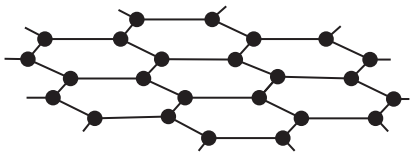
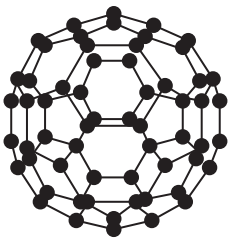
| | | |
|---|---|---|
|  |  |  |
| diamond | graphene | a fullerene, $C_{60}$ |

**Figure 8**

Consider these three substances.

Explain, in terms of their structures and bonding, their relative melting points, strengths and abilities to conduct electricity.

**(6)**

**(Total for Question 8 = 11 marks)**

**9** (a) A student placed a piece of metal **P** in a test tube containing excess dilute sulfuric acid.
The student repeated this with three other metals, **Q**, **R** and **S**.
All the pieces of all four metals were the same size.

(i) The student recorded the observations until each metal had reacted with the acid for two minutes.
The observations are shown in Figure 9.

| metal | observations |
|---|---|
| **P** | bubbles produced very slowly<br>some metal remained |
| **Q** | bubbles produced quickly<br>no metal remained |
| **R** | bubbles produced slowly<br>no metal remained |
| **S** | bubbles produced very quickly<br>no metal remained |

**Figure 9**

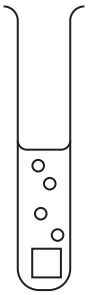
Use this information to put the four metals in order of reactivity from the least reactive to the most reactive.

**(2)**

**least reactive** | | | | | **most reactive**

(ii) Complete the diagram below to show how the student could add to the apparatus to measure the volume of gas produced in the two minutes.

**(2)**



(b) When iron reacts with copper sulfate solution, solid copper is formed.

Two possible equations for this reaction are

**A** $CuSO_4 + Fe \rightarrow Cu + FeSO_4$
**B** $3CuSO_4 + 2Fe \rightarrow 3Cu + Fe_2(SO_4)_3$

It was found that 10.00 g of iron powder reacted with excess copper sulfate solution to produce 11.34 g of copper.

Carry out a calculation to decide which equation, **A** or **B**, represents the reaction taking place.
(relative atomic masses: Fe = 56.0, Cu = 63.5)

**(2)**

(c) Acid solutions contain hydrogen ions.

Aluminium reacts with dilute hydrochloric acid to form a solution containing aluminium ions, $Al^{3+}$.

Complete the balanced ionic equation for this reaction.

**(2)**

..... + ..... $H^+$ → ..... $Al^{3+}$ + .....

(d) The hydrogen ion concentration in a solution is decreased by a factor of 10.

State how the pH of this solution changes.

**(1)**

.....

(e) Calculate the mass, in g, of a hydrogen atom, using the data below.
(relative atomic mass: H = 1.00;
Avogadro constant = $6.02 \times 10^{23}$)

**(3)**

.....

.....

.....

.....

.....

.....

mass of hydrogen atom = .....g

**(Total for Question 9 = 12 marks)**

**BLANK PAGE**

**10** The concentration of dilute sulfuric acid can be determined by titration with sodium hydroxide solution of known concentration.

25.00 $cm^3$ of dilute sulfuric acid was measured out using a pipette and transferred to a conical flask.
A few drops of methyl orange indicator were added to the acid in the conical flask.
Sodium hydroxide solution was added to the acid from a burette until the indicator changed colour.
The titration was repeated until two concordant results were obtained.
The accurate result was the average of the two concordant results.

(a) Describe the colour change seen at the end point of the titration.

**(1)**

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

(b) A brief report of the practical method has been given above.
Further detail can be added to this method to ensure that anyone following the method will obtain an accurate result.

Explain **two** details that could be added to this practical method to ensure an accurate result is obtained.

**(4)**

1 .....

.....

.....

.....

2 .....

.....

.....

.....

(c) In the titration, 25.00 $cm^3$ of dilute sulfuric acid reacted with 24.25 $cm^3$ of 0.200 mol $dm^{-3}$ sodium hydroxide solution, NaOH.

$$H_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2H_2O$$

Calculate the concentration of the dilute sulfuric acid, $H_2SO_4$, in mol $dm^{-3}$.

**(4)**

concentration of sulfuric acid = ..... mol $dm^{-3}$

(d) The concentration of some dilute sulfuric acid, $H_2SO_4$, is 0.250 mol $dm^{-3}$.

Calculate the concentration of sulfuric acid in this solution in g $dm^{-3}$.
(relative formula mass: $H_2SO_4$ = 98)

**(2)**

concentration of sulfuric acid = ..... g $dm^{-3}$

**(Total for Question 10 = 11 marks)**

**TOTAL FOR PAPER = 100 MARKS**

# 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.***