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)

Monday 22 May 2023

Morning (Time: 1 hour 45 minutes)

Paper reference **1CH0/1F**

Chemistry

PAPER 1

Foundation 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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Pearson

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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 In an experiment, paper chromatography was used to separate the coloured dyes in four different inks, **W**, **X**, **Y** and **Z**.

(a) Figure 1 shows the chromatogram at the end of the experiment.

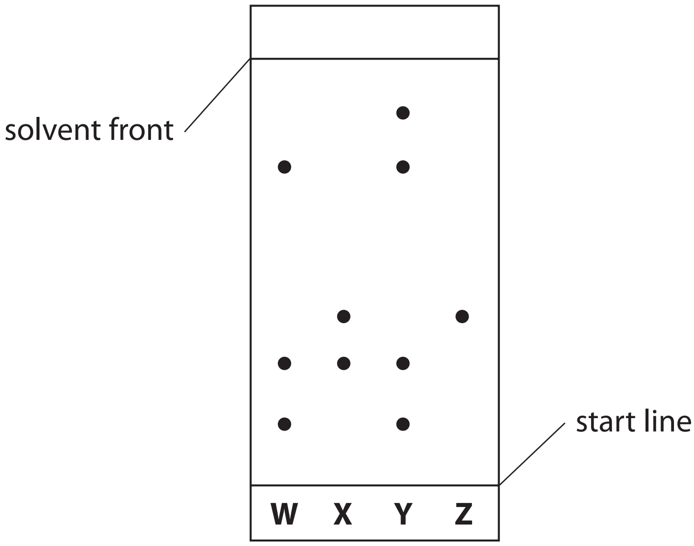

Figure 1

(i) The chromatogram shows that only one of the inks contains a single dye.

Which ink contains a single dye?

(1)

☐ **A** **W**

☐ **B** **X**

☐ **C** **Y**

☒ **D** **Z**

(ii) Which ink contains the greatest number of dyes?

(1)

☐ **A** **W**

☐ **B** **X**

☒ **C** **Y**

☐ **D** **Z**

(iii) The R_f value of a dye can be calculated using the equation

$$R_f = \frac{\text{distance moved by the dye}}{\text{distance moved by solvent front}}$$

At the end of the chromatography one dye had moved 3.60 cm and the solvent front had moved 9.20 cm.

Calculate the R_f value for this dye.

Give your answer to 2 decimal places.

(2)

$\frac{3.60}{9.20}$ = 0.39(1304…) (1)

= 0.39 (1) (rounded to 2dp)

R_f = 0.39

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(b) The substance used as the solvent in the chromatography was heated for 8 minutes.

Figure 2 shows how the temperature of the substance changed with time.

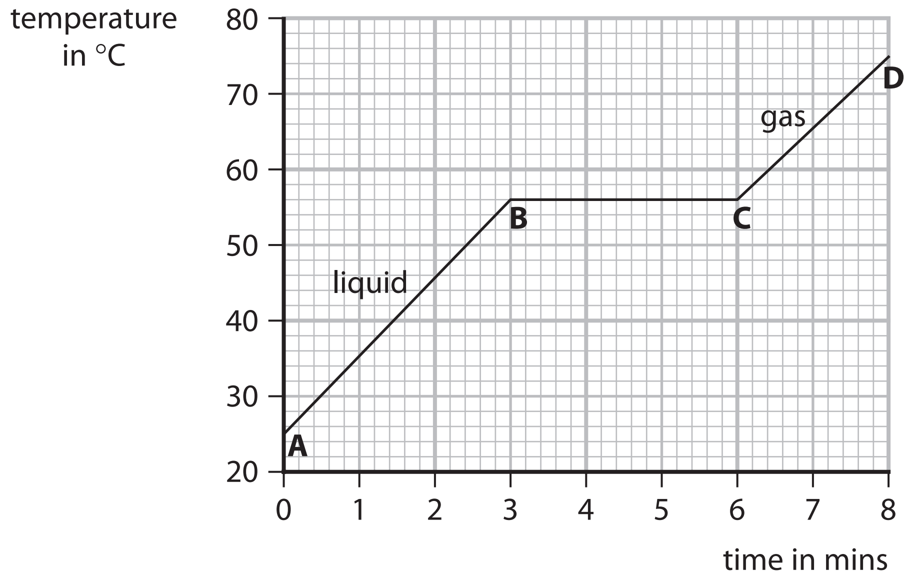

Figure 2

From **A** to **B** the substance was a liquid.

From **C** to **D** the substance was a gas.

(i) Give the name of the change when a liquid becomes a gas.

(1)

evaporation / evaporating

(ii) Use Figure 2 to give the temperature of the substance at 4 minutes.

(1)

56 °C

(iii) Use Figure 2 to give the time when the substance has completely changed into a gas.

(1)

6 minutes

(iv) The temperature of the substance at **A** was 25 °C.

Calculate the temperature rise of the substance from **A** to **D**.

(1)

75 – 25 = 50 (1) °C

(Total for Question 1 = 8 marks)

2 (a) Most of the gold used in jewellery is not pure gold but alloys of gold.

The purity of gold is measured in carats.

Figure 3 shows how the percentage of gold is related to the purity of gold measured in carats.

Figure 3

State the relationship between the percentage of gold and the number of carats.

(1)

the higher the {(number of) carats / purity}, the greater the percentage of gold (OWTTE)

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(b) Figure 4 shows the arrangement of atoms in pure gold and in an alloy of gold.

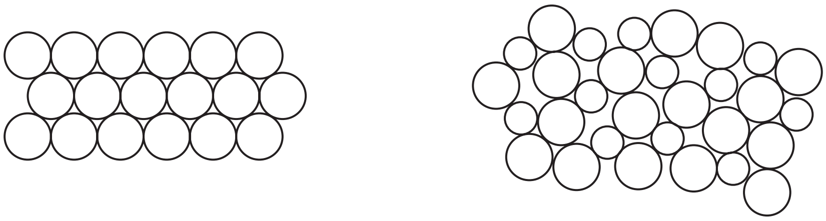

Figure 4

Using Figure 4, explain why alloys of gold are stronger than pure gold.

(3)

an explanation linking

• {atoms are all the same size in pure gold / atoms are different sizes in alloy} (1)

• (atoms in) {layers / rows} in pure gold / ORA (1)

• (layers / rows) can slide easily in pure gold / ORA (1)

(c) Explain **one** property of alloys of gold, other than their strength, that makes them suitable for use in jewellery.

(2)

(gold is) unreactive (1)
• so will not react with skin / will not corrode (1)
OR
• malleable (1)
• so can be shaped (1)

(Total for Question 2 = 6 marks)

3 This question is about electrolysis.

(a) Which statement describes what happens during electrolysis?

(1)

☐ **A** atoms are decomposed

☒ **B** ionic compounds are decomposed

☐ **C** mixtures are separated

☐ **D** molecules are separated

(b) Figure 5 shows the electrolysis of copper chloride solution.

(i) Use the words from the box to complete the labelling of the diagram in Figure 5.

(2)

anode	cathode	electrolyte

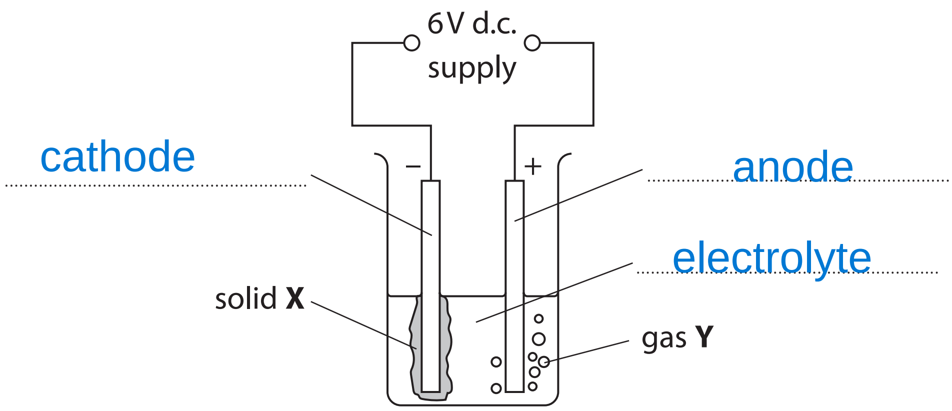

Figure 5

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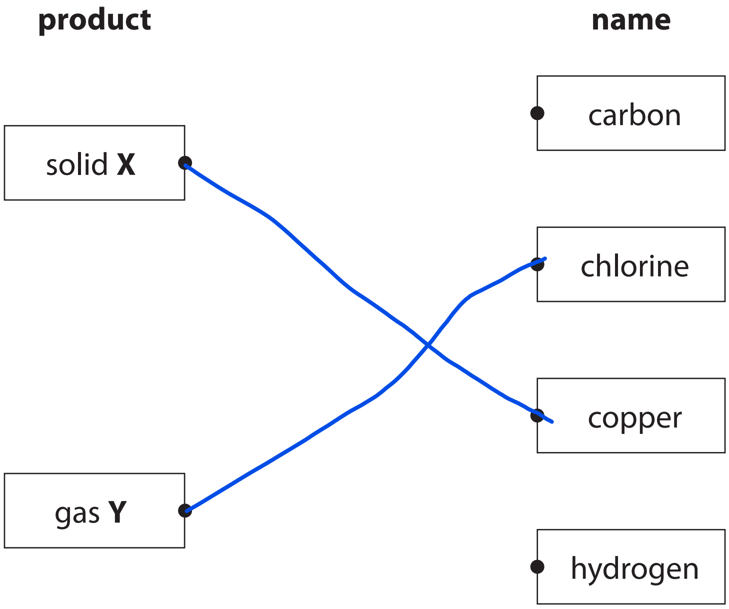
(ii) The products of the electrolysis shown in Figure 5 are solid **X** and gas **Y**.

Draw **one** straight line from each product to its name.

(2)



(iii) The experiment is repeated using powdered solid copper chloride instead of copper chloride solution.

Nothing happens and no products are formed.

Explain why nothing happens and no products are formed.

(2)

An explanation linking the following
- no current will flow / solid ionic compounds do not conduct electricity (1)
- (because) ions can't move / ions in a lattice (1)

(Total for Question 3 = 7 marks)

4 Steel is an alloy containing iron.

When exposed to damp air, some steels will corrode to form rust.

(a) (i) Which gas in the air is needed for corrosion to occur?

(1)

☐ **A** argon

☐ **B** carbon dioxide

☐ **C** nitrogen

☒ **D** oxygen

(ii) What type of reaction happens when the iron in steel corrodes?

(1)

☐ **A** the iron has been displaced

☐ **B** the iron has been neutralised

☒ **C** the iron has been oxidised

☐ **D** the iron has been reduced

(b) Rust can be removed from steel by treating it with dilute hydrochloric acid.

One product formed in this reaction is iron chloride, $FeCl_3$.

Calculate the relative formula mass of this iron chloride.

(relative atomic masses: Fe = 56.0, Cl = 35.5)

(2)

56 + 35.5 + 35.5 + 35.5 (1)

= 162.5 (1)

relative formula mass = ...

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(c) Figure 6 shows the composition of one type of steel that has a low resistance to corrosion and another type of steel that has a high resistance to corrosion.

element	percentage of element in steel	
	steel with low resistance to corrosion	steel with high resistance to corrosion
iron	98.2	80.6
carbon	0.4	1.1
chromium	0.0	17.0
manganese	0.9	0.8
nickel	0.5	0.5

Figure 6

(i) Using Figure 6, state which non-metal is in both types of steel.

(1)

carbon

(ii) Using Figure 6, state which metal is added to steel to increase its resistance to corrosion.

(1)

chromium

(iii) Explain **one** other way that corrosion of steel can be prevented.

(2)

an explanation linking
- paint / grease / coat with plastic (1)
- prevents {oxygen / water} reaching the iron (1)

OR
- galvanising (1)
- prevents {oxygen / water} reaching the iron / sacrificial protection / zinc is more reactive than iron (1)

(d) A student is given **two** nails of the same size but made of different types of steel.

They are also given two boiling tubes and some distilled water.

Devise an experiment to show which nail corrodes more quickly.

(3)

put nails in boiling tubes with water (1)

• leave for some time (1)

• observe which nail forms rust {first / most} (1)

(Total for Question 4 = 11 marks)

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5 (a) When lead nitrate solution and potassium chloride solution are mixed, potassium nitrate and a precipitate of lead chloride are formed.

(i) Complete the word equation for this reaction.

(1)

lead nitrate + potassium chloride → potassium nitrate + lead chloride

(ii) Lead nitrate is toxic.

Which hazard symbol should be on a container of lead nitrate?

(1)

☐ **A** 

☐ **B** 

☐ **C** 

☒ **D** 

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(b) A student put 5 cm³ of potassium carbonate solution into a test tube and added 2 cm³ of calcium nitrate solution.

A precipitate formed and was allowed to settle as shown in Figure 7.

The height of the precipitate was measured.

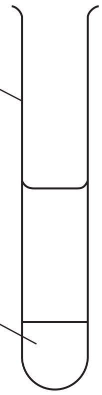

Figure 7

(i) Give the name of the piece of apparatus the student should use to find the volume of the potassium carbonate solution.

(1)

measuring cylinder

(ii) The student repeated the experiment.

The results are shown in Figure 8.

experiment	height of precipitate in cm
1	2.4
2	2.7
3	2.4

Figure 8

Use the data in Figure 8 to calculate the mean height of the precipitate.

(2)

2.4 + 2.4 + 2.7 = 7.5 (1)

$\frac{7.5}{3}$ = 2.5 (1)

mean height of precipitate = 2.5 cm

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(iii) Describe how a pure, dry sample of the precipitate could be obtained from the mixture in the test tube.

(3)

First mark
Filter (the mixture) (1)
Second and third marks
A description including two of the following

Calcium carbonate / the solid / the residue / precipitate is left on (filter) paper / on the funnel (1)

Wash / rinse (the solid/residue/calcium carbonate with distilled water) (1)

any method of drying (1)

(iv) The student investigated whether increasing the volume of calcium nitrate solution increased the height of the precipitate formed.

They repeated the experiment using different volumes of calcium nitrate.

State **one** variable that should be controlled in this investigation.

(1)

volume / concentration of {potassium carbonate / carbonate / potassium solution}

(Total for Question 5 = 9 marks)

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6 (a) Magnesium is a metal.

(i) State **one** physical property of magnesium.

(1)

high {melting / boiling} point

(ii) Which element is in the same group of the periodic table as magnesium? Use the periodic table to help you answer this question.

(1)

- ☐ **A** carbon
- ☐ **B** chromium
- ☐ **C** sodium
- ☒ **D** strontium

(b) (i) Magnesium atoms have 12 electrons.

Complete the electronic configuration of a magnesium atom.

(1)

2.8. 2

(ii) The electronic configuration of a chlorine atom is 2.8.7

Explain how the electronic configuration of chlorine is linked to its period in the periodic table.

(2)

(chlorine has) 3 shells / 3 numbers in electronic configuration (1)

• (so) (chlorine is in) period 3 (1)

• number of shells is the period number (1)

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(c) 1.20 g of magnesium reacts completely with 3.55 g of chlorine to form magnesium chloride.

Calculate the empirical formula of the magnesium chloride.

(relative atomic masses: Mg = 24.0, Cl = 35.5)

You must show your working.

(3)

MP1 for dividing by atomic mass

Mg : Cl

$\frac{1.20}{24.0}$: $\frac{3.55}{35.5}$ (1)

MP2 for deriving ratio from MP1

0.05 : 0.1

OR

1 : 2 (1)

MP3 for formula using ratio in MP2

MgCl2 (1)

empirical formula = ...

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(d) Sodium reacts with chlorine to form sodium chloride, which contains ionic bonds.

Hydrogen reacts with chlorine to form hydrogen chloride, which contains covalent bonds.

Figure 9 shows dot and cross diagrams of these compounds.

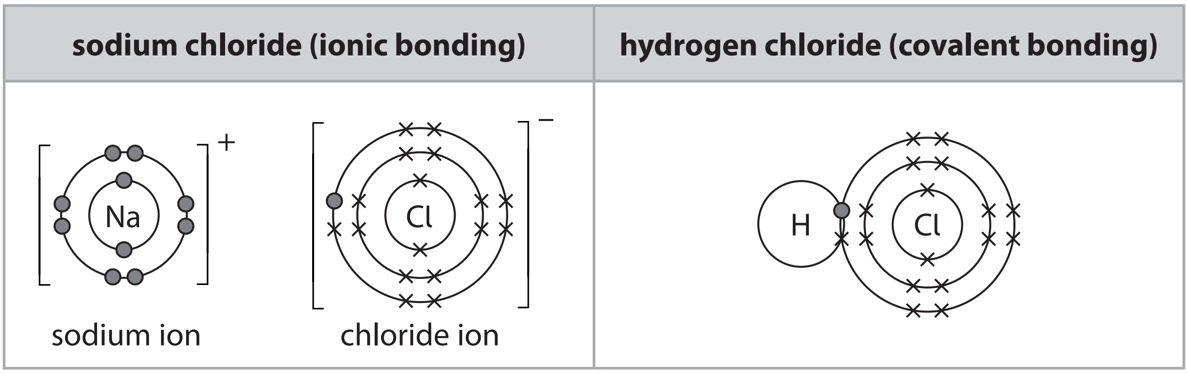

Figure 9

Describe the differences between an ionic bond and a covalent bond.

(4)

ionic (max 2 marks)

• (electrostatic) force between (oppositely charged) ions / between anions and cations (2)

covalent (max 2 marks)

• atoms share a pair electrons (2)

(Total for Question 6 = 12 marks)

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7 (a) Figure 10 shows some information on a container of plant fertiliser.

contains	**percentage by mass**
ammonium nitrate (NH_4NO_3)	46%
phosphorus oxide (P_2O_5)	0%
potassium nitrate (KNO_3)	54%

Figure 10

(i) State which element, often present in fertilisers, is **not** present in this fertiliser.

(1)

phosphorus / P

(ii) Ammonium nitrate, NH_4NO_3, is prepared for use in fertilisers by neutralising ammonia with an acid.

Which acid reacts with ammonia to produce ammonium nitrate?

(1)

☐ **A** ethanoic acid

☐ **B** hydrochloric acid

☒ **C** nitric acid

☐ **D** sulfuric acid

(iii) State why farmers spread fertilisers on their fields.

(1)

to promote plant growth / increase (crop) yield /
provide nutrients to plants

(b) Ammonium sulfate is a fertiliser and is produced on a large scale in industry.

In this process, ammonia reacts with sulfuric acid.

(i) Write the word equation for the reaction between ammonia and sulfuric acid.

(2)

ammonia + sulfuric acid -----> ammonium sulfate (1)

(ii) Ammonium sulfate can also be made in the laboratory by titrating ammonia solution with dilute sulfuric acid.

Give **one disadvantage** of using this laboratory method to produce ammonium sulfate as a fertiliser compared with an industrial method.

(1)

products needed on a larger scale than can be obtained in titration / owtte

*(c) In the laboratory, ammonium sulfate crystals can be made using ammonia solution and dilute sulfuric acid.

The volume of ammonia solution required to neutralise 25 cm^3 of dilute sulfuric acid is found by titration using an indicator.

The results of the titration can be used to prepare a solution of ammonium sulfate.

Pure, dry ammonium sulfate crystals can be made from this solution.

Figure 11 shows some of the equipment that may be used in the experiment.

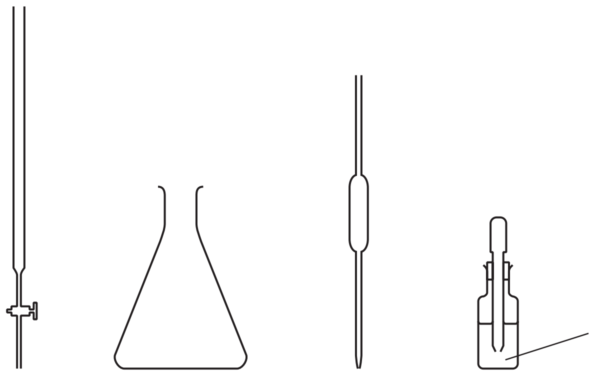

Figure 11

Write a detailed method to make ammonium sulfate crystals starting with ammonia solution and dilute sulfuric acid.

(6)

- pipette to measure out the sulfuric acid
- into a suitable container, e.g. conical flask
- add few drops of (suitable) indicator
- put flask on a white tile
- fill burette with ammonia solution
- read level of liquid in burette
- add ammonia solution from the burette
- swirl flask gently / mix
- add drop-wise near end-point
- until indicator just changes colour
- read level on burette
- repeat experiment until concordant results

CRYSTALLISATION

- mix the same volumes of sulfuric acid and ammonia solution (determined from the titration experiment)
- but leaving out the indicator
- pour solution into an evaporating dish

CRYSTALLISATION

- mix the same volumes of sulfuric acid and ammonia solution (determined from the titration experiment)
- but leaving out the indicator
- pour solution into an evaporating dish
- heat the solution to point of crystallisation
- leave to cool
- filter off / decant crystals
- leave to dry / pat dry with filter paper

(Total for Question 7 = 12 marks)

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8 In an experiment, powdered calcium hydroxide was added to dilute hydrochloric acid and the pH was measured.

The method used was

step 1 measure 200 cm^3 dilute hydrochloric acid into a beaker

step 2 add 0.1 g of powdered calcium hydroxide to the beaker

step 3 find the pH of the mixture

step 4 repeat steps 2 and 3 until the pH stops changing.

(a) State what should be done after **step 2** to make sure that any reaction is complete.

(1)

stir/ swirl/ shake (the beaker) allow mix, warm/ heat

(b) Complete the word equation for the reaction.

(2)

calcium hydroxide + hydrochloric acid → calcium chloride (1) + water (1)

(c) Which row of the table shows the state symbols for powdered calcium hydroxide and dilute hydrochloric acid in the balanced chemical equation?

(1)

		calcium hydroxide	hydrochloric acid
☐	**A**	aq	l
☐	**B**	l	aq
☒	**C**	s	aq
☐	**D**	s	l

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(d) The results of the experiment are shown in Figure 12.

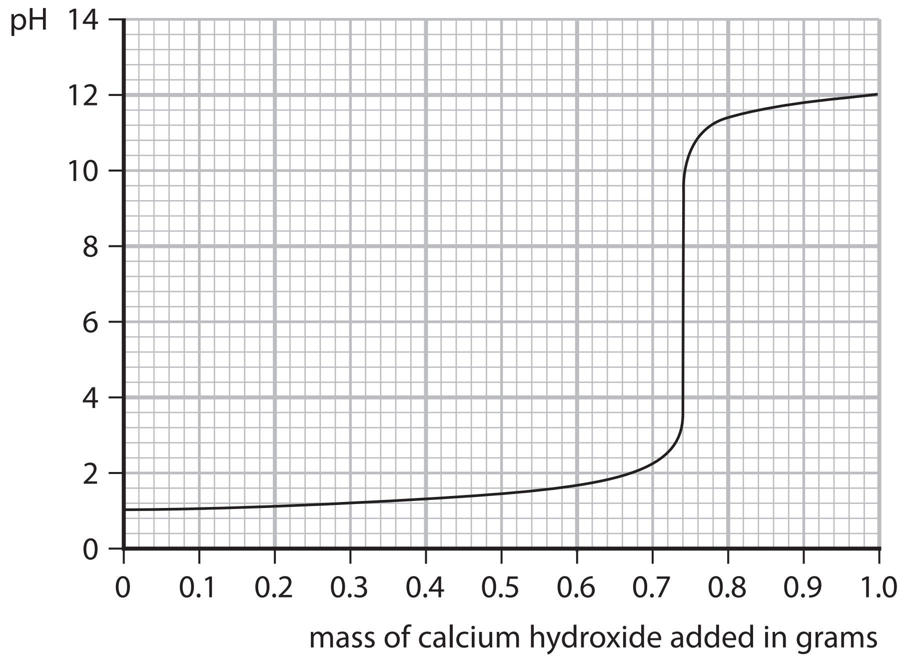

Figure 12

(i) Using Figure 12, give the pH of the acid at the start of the experiment.

(1)

pH = 1

(ii) Using Figure 12, give the mass of calcium hydroxide required to make a neutral mixture.

(1)

mass of calcium hydroxide = 0.74 (g) g

(iii) Explain why the pH starts at a low value and ends at a higher value.

(3)

START
• solution is acidic / acids have low pH / high {concentration/ amount} of H+ ions/ excess H+ ions (1)

REACTION
• neutralisation/ H+ + OH- ----> H2O/ {the hydroxide/ alkali} reacts with the {acid/H+}(1)

END
• {amount/ concentration} of H+ ions has reduced/ {amount/ concentration} of OH- ions has increased / excess OH- ions/ (excess of) hydroxide ions have pH > 7 (1)

(e) State what should be used to measure the pH of the mixture in this experiment.

(1)

pH meter / pH probe

(f) The calcium hydroxide used is corrosive to the eyes and an irritant to skin.

Using this information, state **one** safety precaution that should be taken during the experiment when using any corrosive substance.

(1)

goggles / gloves / eye protection

(Total for Question 8 = 11 marks)

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9 Figure 13 shows part of the reactivity series of metals.

calcium
magnesium
aluminium
zinc
iron
copper
silver
gold

increasing reactivity ↑

Figure 13

(a) Which metal reacts when added to cold water?

(1)

- ☒ **A** calcium
- ☒ **B** copper
- ☒ **C** gold
- ☒ **D** silver

(b) A student investigates the reactivity of four different metals.

The student adds an equal-sized piece of each metal to separate test tubes containing dilute hydrochloric acid.

The student's observations for zinc and copper are recorded in Figure 14.

metal	observations
magnesium	
zinc	bubbles produced at a steady rate test tube feels slightly warm
iron	
copper	no reaction

Figure 14

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(i) Use the information in Figure 13 and in Figure 14 to predict the observations for the reactions of magnesium and of iron with dilute hydrochloric acid.

(2)

magnesium

MAGNESIUM
many bubbles / bubbles produced quickly / bubbles vigorously OR
test tube feels hot / warm / warmer than with zinc
(1)

iron

few bubbles / bubbles produced slowly / some bubbles OR

test tube feels very slightly warm (1)

(ii) When metals react with acids, hydrogen gas is produced.

Describe the test to show that the gas is hydrogen.

(2)

apply lighted splint (to the gas) (1)

• (squeaky) pop (1)

(iii) When magnesium reacts with hydrochloric acid, magnesium chloride and hydrogen are formed.

Complete the balanced equation for the reaction.

(2)

Mg + 2HCl ....HCl → $MgCl_2$ + H2 ....

*(c) There are **three** common methods of obtaining metals from the Earth's crust:

- mine the pure metal
- mine the metal ore and heat it with carbon
- mine the metal ore and electrolyse the molten compound.

The method used to obtain a metal is linked to its position in the reactivity series of metals.

Aluminium, gold, iron, and silver are some commonly used metals.

Use the reactivity series in Figure 13 to state and explain the method chosen to obtain each of these four metals.

(6)

ALUMINIUM
• extracted by electrolysis
• aluminium is more reactive than carbon / ORA
• aluminium compound is reduced / redox reaction
• as heating with carbon will not work
• a more powerful method / more energy is needed
• electrolysis is expensive

IRON
• heating with carbon
• iron is less reactive than carbon
• iron compound is reduced / redox reaction
• method cheaper than electrolysis

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SILVER
• found uncombined / native state / often just mined
• low reactivity
• so reduction not needed
or
• silver is less reactive than carbon

• heating with carbon

• silver compound is reduced / redox reaction

• method cheaper than electrolysis

GOLD
• found uncombined / native state / often just mined
• least reactive / low reactivity
• so reduction not needed

(Total for Question 9 = 13 marks)

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10 There are several stages to the production of sulfuric acid in industry.

(a) Sulfur dioxide is required for the production of sulfuric acid.

Sulfur dioxide can be obtained by heating copper sulfide, Cu_2S, in excess air.

$$Cu_2S + O_2 \rightarrow 2Cu + SO_2$$

Calculate the atom economy for the production of sulfur dioxide, SO_2, in this reaction.

(relative atomic mass: Cu = 63.5
relative formula masses: O_2 = 32.0, Cu_2S = 159.0, SO_2 = 64.0)

Give your answer to two significant figures.

(4)

total mass = 191 (1)

$\frac{64}{191}$ = 0.33507 (1)

x 100 = 33.507 (1)

atom economy = 34 %

(b) In one stage vanadium oxide, V_2O_5, is used.

Based on the position of vanadium in the periodic table, which row shows the most likely melting point of vanadium and colour of vanadium oxide?

(1)

		melting point of vanadium in °C	colour of vanadium oxide
☐	**A**	50	white
☐	**B**	1910	white
☐	**C**	50	orange
☒	**D**	1910	orange

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(c) The equation shows a reaction forming sulfuric acid.

$$SO_3 + H_2O \rightarrow H_2SO_4$$

(i) Calculate the maximum mass of sulfuric acid that could be produced from 400 tonnes of sulfur trioxide, SO_3.

(relative formula masses: $SO_3 = 80$, $H_2SO_4 = 98$)

(2)

$\frac{400}{80} = 5$ (1)

$5 \times 98 = 490$ (1)

maximum mass of sulfuric acid = 490 tonnes

(ii) Using a different amount of sulfur trioxide, it was calculated that 700 tonnes of sulfuric acid could be made.

The actual mass produced was 672 tonnes.

Calculate the percentage yield of sulfuric acid.

(2)

$\frac{672}{700} = 0.96$ (1)

$\times 100 = 96$ (1)

percentage yield = 96

(iii) State **two** reasons why the percentage yield is less than 100 %.

(2)

1 incomplete reaction

2 • loss {of substance/reactant/product} (during practical)/ practical losses
• unwanted reactions / side-reactions

(Total for Question 10 = 11 marks)

TOTAL FOR PAPER = 100 MARKS

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The periodic table of the elements

Key

relative atomic mass
atomic symbol
name
atomic (proton) number

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

* 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.

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