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EDEXCEL GCSE CHEMISTRY: QUESTIONS BY TOPIC

Separate Chemistry 1 (5)

GCSE Chemistry (Higher) Topic 5

22 questions · 216 marks · Mark schemes included

Pearson Edexcel GCSE (9-1) Chemistry 1CH0, Higher Tier, June 2018 - June 2025

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HOW TO USE THIS BOOKLET

Questions run from the lowest mark tariff to the highest, so similar questions sit together.

Click any row below to jump straight to that question.

On every question page, click ANSWER in the top-right corner to jump to its mark scheme.

Diagrams, graphs, tables and data are printed exactly as they appeared in the original papers.

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QUESTIONS

22 questions · 216 marks · lowest tariff first



6-MARK QUESTIONS

4 questions in this booklet



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.

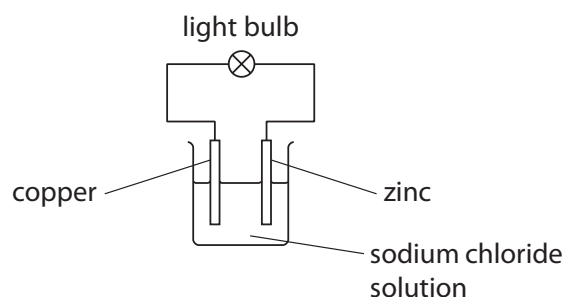


Figure 1

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

(2)

.....

.....

.....

.....

(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

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

What is the size of this copper atom in metres?

(1)

- ☐ **A** 2.56×10^{-8}
- ☐ **B** 2.56×10^{-9}
- ☐ **C** 2.56×10^{-10}
- ☐ **D** 2.56×10^{-11}

(d) Brass is an alloy of copper and zinc.

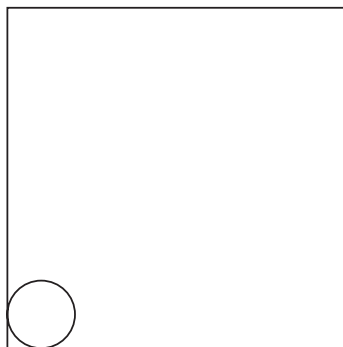
One type of brass contains 70% copper.

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)

- 1 (a) Figure 1 shows information about two isotopes of hydrogen, **A** and **B**.

Complete the table to show the number of subatomic particles in each isotope.

(2)

	isotope A	isotope B
atomic number	1	1
mass number	1	2
number of protons		
number of electrons		
number of neutrons		

Figure 1

- (b) Hydrogen gas and oxygen gas are used in a hydrogen–oxygen fuel cell.

Separate containers of hydrogen and oxygen are used to supply the gases.

A student tests the voltage supplied by the fuel cell every 15 minutes.

The results are shown in Figure 2.

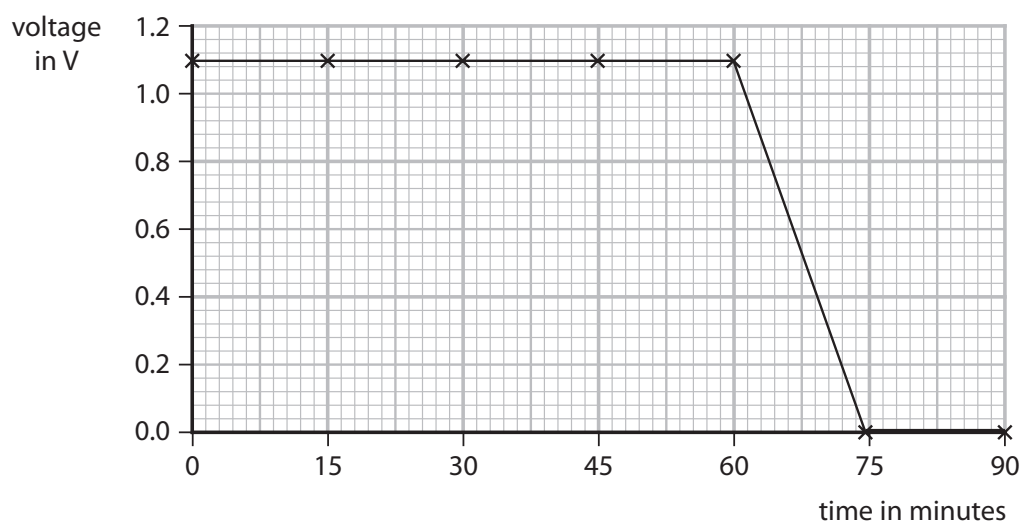


Figure 2



Describe what Figure 2 shows about how the voltage of this fuel cell varies with time.

(2)

.....

.....

.....

.....

(c) A chemical cell is made by placing two electrodes into an aqueous electrolyte.

Figure 3 shows a chemical cell.

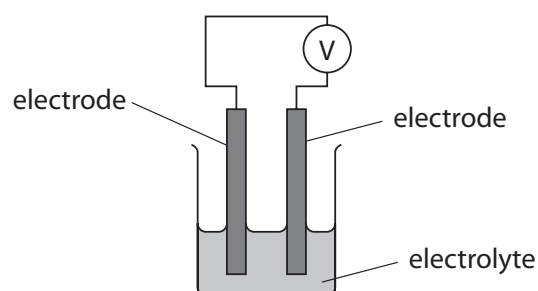


Figure 3

State why sodium and sulfur electrodes are **not** suitable for this experiment.

(2)

sodium

.....

.....

sulfur

.....

.....

(Total for Question 1 = 6 marks)

1 (a) Chemical cells produce a voltage.

A chemical cell can be made by placing the metals copper and iron in a beaker of sodium chloride solution as shown in Figure 1.

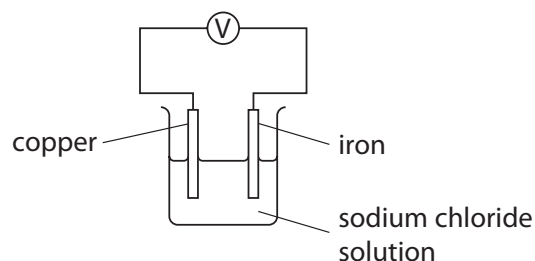


Figure 1

Describe what will happen to the reading on the voltmeter over a long period of time.

(2)

.....

.....

.....

.....

(b) Iron is a transition metal.

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

(1)

- ☐ **A** iron forms a colourless oxide
- ☐ **B** iron is a poor conductor of heat
- ☐ **C** iron has a low boiling point
- ☐ **D** iron has a high density

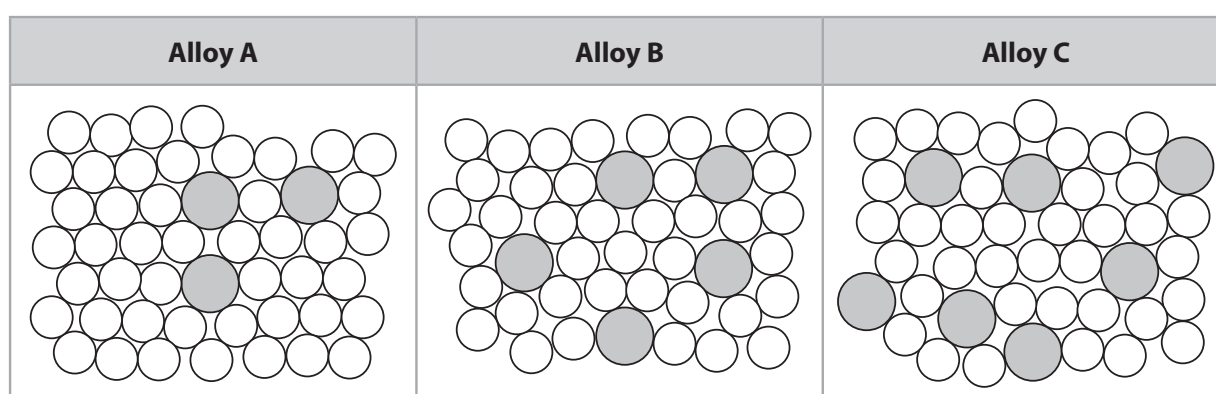
(c) An iron atom has a diameter of 2.52×10^{-10} m.

What is the size of this iron atom in nanometres?

(1)

- ☐ **A** 2.52
- ☐ **B** 0.252
- ☐ **C** 0.0252
- ☐ **D** 0.00252

(d) Figure 2 shows the arrangement of atoms in three different alloys of copper and zinc, **A**, **B** and **C**.



Key:

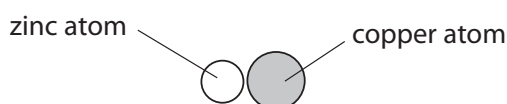


Figure 2

Explain which of the three alloys, **A**, **B** and **C**, is the strongest.

(2)

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(Total for Question 1 = 6 marks)

- 1 (a) Figure 1 shows a chemical cell.

The chemical cell contains two metal electrodes placed into an electrolyte and connected in a circuit with a voltmeter.

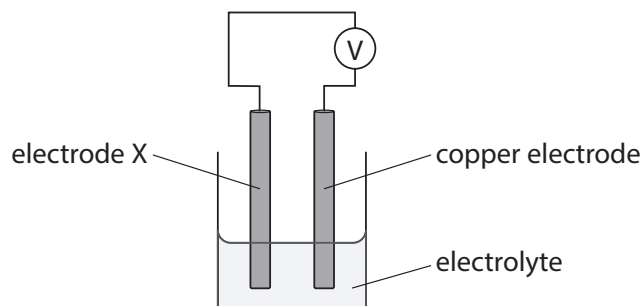


Figure 1

- (i) State what type of compound must be present in the electrolyte.

(1)

- (ii) When the two metal electrodes are placed in the electrolyte, a voltage is produced.

The bigger the difference in reactivity of the metals, the larger the voltage produced.

Which metal, when used for electrode X in Figure 1, would give the largest voltage?

(1)

- ☒ A copper
- ☒ B gold
- ☒ C magnesium
- ☒ D zinc

7-MARK QUESTIONS

2 questions in this booklet



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)



- 1 Alloys of gold are often used to make jewellery.
The purity of gold is measured in carats.
Different alloys of gold have different carats.

(a) Figure 1 shows the percentage of different metals in two samples of gold.

	percentage of metal		
	gold	silver	copper
18 carat gold	75.0	15.0	10.0
24 carat gold	100.0	0.0	0.0

Figure 1

Explain why 18 carat gold is stronger than 24 carat gold.

You may use diagrams to help your answer.

(2)

.....

.....

.....

.....

- (b) Figure 2 shows the relationship between the purity of gold in carats and the percentage of gold in the alloy.

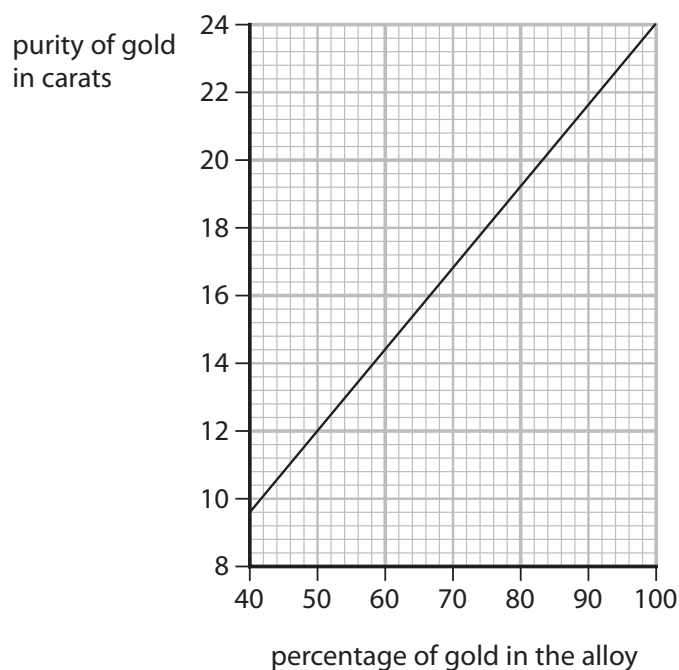


Figure 2

A necklace with a mass of 5.0 g was found to contain 2.9 g of gold.

Determine the purity of the gold necklace in carats.
Show your working.

(3)

.....

.....

.....

purity of the gold necklace = ... carats



(c) A gold ring contains 3.94 g of gold.

Calculate the number of gold atoms in the ring.

(relative atomic mass: Au = 197,
Avogadro constant = 6.02×10^{23})

Show your working.

(2)

.....

.....

number of gold atoms = ...

(Total for Question 1 = 7 marks)



10-MARK QUESTIONS

1 question in this booklet



6 Titration can be used to find the volume of dilute hydrochloric acid needed to neutralise 25.0 cm^3 of barium hydroxide solution.

- (a) Before the titration is carried out, the pipette and conical flask are rinsed out with pure water.

Explain the effect, if any, that traces of water in the pipette and conical flask after rinsing could have on the titration result.

(4)

pipette

.....

.....

.....

.....

conical flask

.....

.....

.....

.....

- (b) In the titration, a few drops of phenolphthalein indicator are added to the barium hydroxide solution.

- (i) State the change in colour of phenolphthalein at the end point, when the barium hydroxide solution has just been neutralised.

(1)

from to

- (ii) Write the ionic equation for the neutralisation reaction that occurs when hydrochloric acid is added to barium hydroxide solution.

(2)

.....



- (c) When barium hydroxide solution is neutralised by dilute sulfuric acid, a white precipitate of barium sulfate is formed in the conical flask.

Describe an experiment to obtain a sample of pure, dry barium sulfate from the contents of the conical flask.

(3)

(Total for Question 6 = 10 marks)



11-MARK QUESTIONS

12 questions in this booklet



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

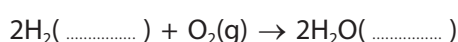
(i) The boiling points of hydrogen and water are shown in Figure 3.

	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)



(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



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, CO₂ = 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)



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

25.00 cm³ 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

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.....

.....

2

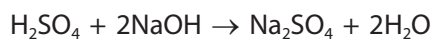
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- (c) In the titration, 25.00 cm^3 of dilute sulfuric acid reacted with 24.25 cm^3 of 0.200 mol dm^{-3} sodium hydroxide solution, NaOH.



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

(4)

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.....

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.....

.....

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: $\text{H}_2\text{SO}_4 = 98$)

(2)

.....

.....

.....

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

(Total for Question 10 = 11 marks)



- 4 Potassium hydroxide reacts with hydrochloric acid to form potassium chloride and water.

potassium hydroxide + hydrochloric acid $\rightarrow$ potassium chloride + water

- (a) A student carried out a titration to find the exact volume of dilute hydrochloric acid that reacted with 25.0 cm^3 of potassium hydroxide solution.

There were five steps in the titration.

The steps shown are not in the correct order.

step J pour the potassium hydroxide solution into a conical flask and add a few drops of indicator to this solution

step K fill a burette with the dilute hydrochloric acid and record the initial reading from the burette

step L use a measuring cylinder to obtain 25 cm^3 of potassium hydroxide solution

step M take a final reading from the burette and calculate the volume of the dilute hydrochloric acid reacted

step N run the dilute hydrochloric acid from the burette into the conical flask until the indicator changes colour

- (i) Write the steps in the correct order.

Some of the steps have been completed for you.

(1)

first step

last step

K				M
---	--	--	--	---

- (ii) Suggest an alternative piece of apparatus that could be used in step L to obtain exactly 25.0 cm^3 of potassium hydroxide solution.

(1)



(b) A student was then asked to produce a pure sample of solid potassium chloride.

After finding the volume of acid reacted in step M, the student added this volume of acid to a fresh 25.0 cm^3 sample of the potassium hydroxide solution. This mixture was then evaporated.

- (i) Explain why this new mixture was evaporated rather than the original mixture from the titration, to produce a pure sample of solid potassium chloride.

(2)

.....

.....

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.....

.....

- (ii) After evaporation, the mass of the potassium chloride was determined.

The theoretical yield of the experiment was 0.70 g.
The actual yield was 0.84 g.

This gave a percentage yield greater than 100%.

Calculate the percentage yield of this experiment.

(2)

.....

.....

.....

percentage yield = ...

- (iii) Suggest a reason why the actual yield was greater than the theoretical yield.

(1)

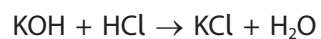
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(iv) The equation for the reaction between potassium hydroxide solution and dilute hydrochloric acid is



Calculate the atom economy for the production of potassium chloride from potassium hydroxide and hydrochloric acid.

(relative formula masses: KOH = 56.0, HCl = 36.5, KCl = 74.5, H₂O = 18.0)

Give your answer to one decimal place.

(4)

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.....

.....

.....

atom economy = ... %

(Total for Question 4 = 11 marks)



4 Aluminium alloys are used instead of pure aluminium in aircraft manufacture.

- (a) Explain, in terms of the arrangement of metal particles, why aluminium alloys are stronger than pure aluminium.

(3)

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.....

.....

.....

- (b) A 695.0 g sample of an aluminium-magnesium alloy contains 2.00% by mass of magnesium.

Calculate the mass of aluminium in this sample.

(2)

.....

.....

mass of aluminium = ... g

- (c) Figure 5 shows a graph of the relative strength of aluminium-magnesium alloys when the percentage by mass of magnesium in the alloy is changed.

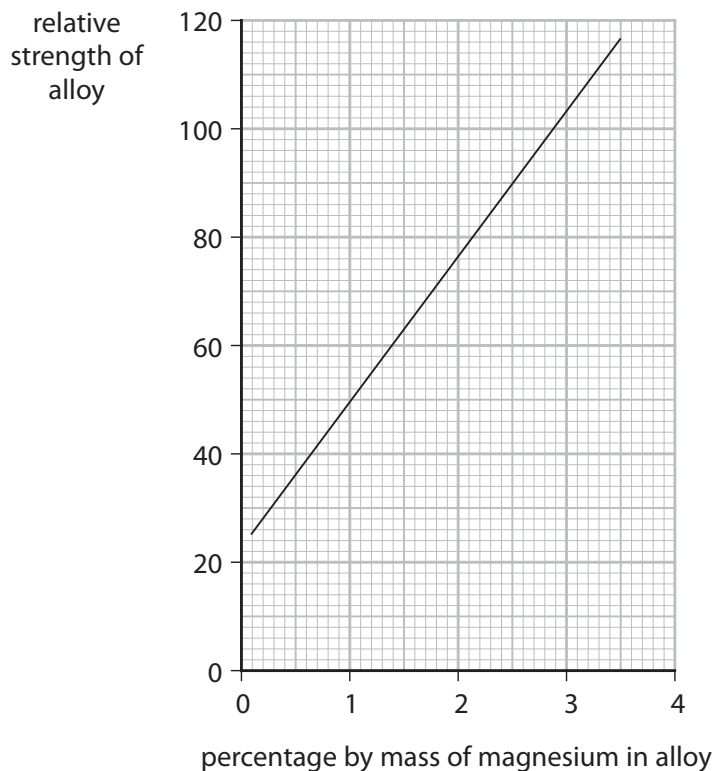


Figure 5

- (i) Describe what Figure 5 shows about the relative strength of these alloys when the percentage by mass of magnesium changes.

(2)

.....

.....

.....

- (ii) Determine, using Figure 5, the percentage by mass of aluminium in an aluminium-magnesium alloy with a relative strength of 103.

(2)

.....

.....

percentage by mass of aluminium = ...

- (d) Metal objects can be electroplated with gold.

Give two reasons why metal objects are electroplated with gold.

(2)

1

.....

2

.....

(Total for Question 4 = 11 marks)



8 Hydrogen-oxygen fuel cells, rather than chemical cells, can be used to power some vehicles.

- (a) Give **one** advantage of using a hydrogen-oxygen fuel cell, rather than using a chemical cell, to power a vehicle.

(1)

.....

.....

- (b) Complete the half-equation for the reaction taking place at one of the electrodes in a hydrogen-oxygen fuel cell.

(2)



- (c) Calculate the volume of 48 g of oxygen at room temperature and pressure.

(relative atomic mass: O = 16,
1 mol of gas occupies 24 dm³ at room temperature and pressure)

(2)

.....

.....

.....

.....

volume of oxygen = ... dm³



(Total for Question 8 = 11 marks)



10 A sample of solid potassium hydroxide contained soluble, unreactive impurities.

A student tried to find the mass of potassium hydroxide in the sample, using the following method.

step 1 measure the mass of the sample of impure potassium hydroxide

step 2 dissolve the sample in 250 cm^3 of water in a beaker

step 3 take a 25 cm^3 sample of the potassium hydroxide solution using a measuring cylinder and pour into a conical flask

step 4 add 3 drops of indicator to the solution

step 5 put the conical flask on a white tile

step 6 using a burette, add dilute sulfuric acid of known concentration drop by drop to the solution, while swirling the flask

step 7 continue adding the sulfuric acid until the colour of the solution changes

step 8 record the volume of sulfuric acid added

step 9 use this result to calculate the mass of pure potassium hydroxide in the sample.

- (a) (i) Suggest **three** ways to improve this method to obtain a more accurate mass of pure potassium hydroxide.

(3)

1

2

3



(ii) The indicator used was phenolphthalein.

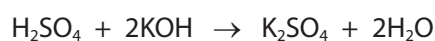
Which row shows the colour change that would be seen in this titration?

(1)

		colour at start	colour at end point
☐	A	yellow	orange
☐	B	orange	yellow
☐	C	pink	colourless
☐	D	colourless	pink

(b) Another student carried out the titration accurately.

12.15 cm³ of dilute sulfuric acid with a concentration of 0.140 mol dm⁻³ reacted completely with 25.00 cm³ of potassium hydroxide solution.



Calculate the concentration of this potassium hydroxide solution.

(4)

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.....

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.....

.....

concentration of potassium hydroxide solution = ... mol dm⁻³



(c) A different solution of potassium hydroxide had a concentration of $0.175 \text{ mol dm}^{-3}$.

This potassium hydroxide solution was made by dissolving 2.56 g of impure potassium hydroxide to form 250 cm^3 of solution.

Calculate the percentage by mass of potassium hydroxide in the impure potassium hydroxide.

(relative formula mass: $\text{KOH} = 56.0$)

(3)

percentage by mass of potassium hydroxide = ...

(Total for Question 10 = 11 marks)



4 Sucrose is a carbohydrate.

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



(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



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

Give your answer to two significant figures.

(relative formula masses: $\text{C}_{12}\text{H}_{22}\text{O}_{11} = 342$, $\text{H}_2\text{O} = 18$, $\text{C}_2\text{H}_5\text{OH} = 46$, $\text{CO}_2 = 44$)

(3)

.....

.....

.....

atom economy = ...%



- (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)



- 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)



- (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

.....

.....

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)



4 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.



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

(relative atomic mass: $\text{Cu} = 63.5$

relative formula masses: $\text{O}_2 = 32.0$, $\text{Cu}_2\text{S} = 159.0$, $\text{SO}_2 = 64.0$)

Give your answer to two significant figures.

(4)

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.....

atom economy = ... %

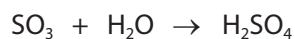
(b) In one stage vanadium oxide, V_2O_5 , is used.

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

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



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

(relative formula masses: $\text{SO}_3 = 80$, $\text{H}_2\text{SO}_4 = 98$)

(2)

.....

.....

maximum mass of sulfuric acid = ... 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)

.....

.....

.....

percentage yield = ...

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

(2)

1

.....

2

.....

(Total for Question 4 = 11 marks)



7 Titration is used to carry out some neutralisation reactions.

(a) Ammonium nitrate can be made by neutralisation.

- (i) State the name of the two reactants that are neutralised to make the salt ammonium nitrate.

(2)

..... and

- (ii) Ammonium nitrate is a fertiliser.
Another fertiliser is ammonium phosphate.

Which elements are combined in ammonium phosphate?

(1)

- ☐ **A** nitrogen, oxygen and phosphorus only
- ☐ **B** hydrogen, oxygen and phosphorus only
- ☐ **C** hydrogen, nitrogen and phosphorus only
- ☐ **D** hydrogen, nitrogen, oxygen and phosphorus only

(b) Titrations involve aqueous solutions and the use of burettes.

- (i) Figure 8 shows readings on part of a burette at the start and at the end of a titration.

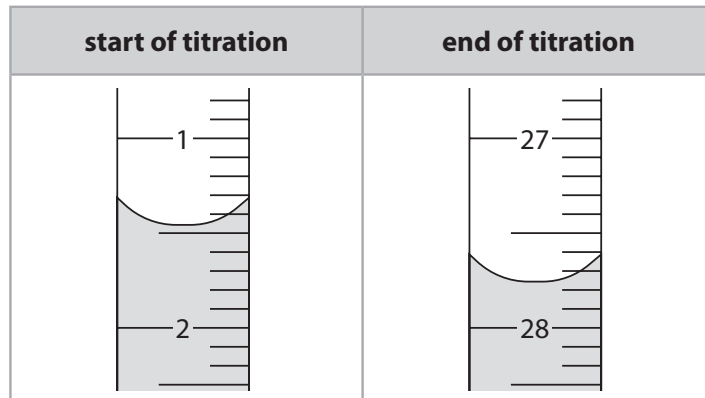


Figure 8

Calculate the volume of solution added from this burette.

Give your answer to a suitable number of decimal places.

(2)

.....
.....

volume = ... cm³

- (ii) A student carries out a titration four times.

The volumes from the student's results table are shown in Figure 9.

	rough	titration 1	titration 2	titration 3
volume in cm ³	25.90	24.90	24.60	25.00
used to calculate mean volume				

Figure 9

Tick the volumes that should be used to calculate the mean volume.

(1)

- (iii) Figure 10 shows the burette and flask prepared for use by the student. The burette is supported vertically by a clamp that is not shown in the diagram.

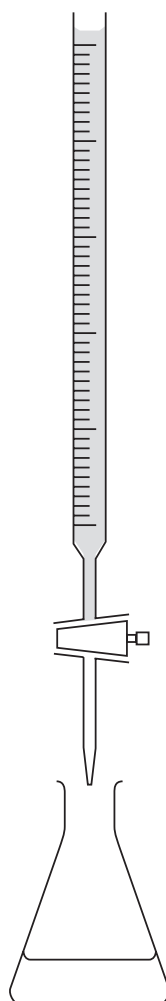


Figure 10

The student wrote a description of how they used the burette.

I took the burette from the cupboard. I closed the tap and filled the burette with the correct solution. I added the solution from the burette drop by drop to the flask until the indicator changed colour.

Give **three** improvements to the way that the student used the **burette**.

(3)

- 1
- 2
- 3

(c) In a titration a student placed alkali in the flask.

By mistake a few drops of litmus **and** a few drops of phenolphthalein were added to the flask.

The student added acid to the flask until the mixture was acidic.

Predict the colour change that would be seen.

(1)

from to

(d) In a titration a student rinsed out the flask with distilled water and did not dry it.

They used the flask for titration, adding the solution from the burette until the indicator changed colour.

State the effect, if any, on the titre volume of using the wet flask rather than a dry flask.

(1)

(Total for Question 7 = 11 marks)



4 (a) Titanium can be extracted from titanium oxide, TiO_2 , by reaction with magnesium.

- (i) 100 tonnes of titanium oxide was heated with magnesium.
The titanium formed in the reaction was separated and purified.
The mass of titanium was then determined.

The results are shown in Figure 4.

	mass in tonnes
mass of titanium oxide	100.00
mass of titanium produced	45.26
theoretical mass of titanium formed	60.00

Figure 4

Use the information in Figure 4 to calculate the percentage yield of titanium in this process.

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

Give your answer to 1 decimal place.

(3)

.....

.....

.....

.....

percentage yield = ...

- (ii) Give **two** reasons why the percentage yield for **this process** is less than 100%.

(2)

1

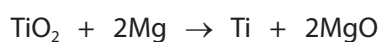
.....

2

.....



(iii) The balanced equation for this process is



Calculate the atom economy of this process to produce titanium.

$$\text{atom economy (\%)} = \frac{\text{total formula mass of desired product}}{\text{total formula mass of all reactants or products}} \times 100$$

Give your answer to 2 significant figures.

(relative atomic masses: O = 16, Mg = 24, Ti = 48)

(3)

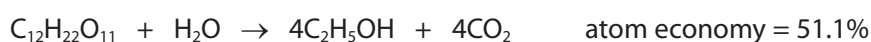
atom economy = ...%

(b) Ethanol, C₂H₅OH, can be produced by two different methods.

- by the hydration of ethene, C₂H₄



- and by the fermentation of a carbohydrate, e.g. sucrose, C₁₂H₂₂O₁₁



(i) State why the hydration of ethene has an atom economy of 100%.

(1)

(ii) Explain how the atom economy of the fermentation reaction can be improved.

(2)

(Total for Question 4 = 11 marks)



10 A student is asked to carry out a titration to find the concentration of a sodium hydroxide solution.

(a) A teacher dilutes some sulfuric acid with distilled water to make a solution with a concentration of $0.250 \text{ mol dm}^{-3}$ for the student to use.

(i) What effect does diluting the sulfuric acid with distilled water have on the pH of the solution and the concentration of the H^+ ions?

(1)

	concentration of the H^+ ions	pH of the solution
☐ A	decreased	decreased
☐ B	increased	increased
☐ C	increased	decreased
☐ D	decreased	increased

(ii) What is the concentration, in g dm^{-3} , of a $0.250 \text{ mol dm}^{-3}$ solution of H_2SO_4 ?

(relative formula mass: $\text{H}_2\text{SO}_4 = 98.0$)

(1)

- ☐ **A** 0.00245
- ☐ **B** 0.394
- ☐ **C** 24.5
- ☐ **D** 394

(b) The student uses the apparatus shown in Figure 10 to carry out the titration.

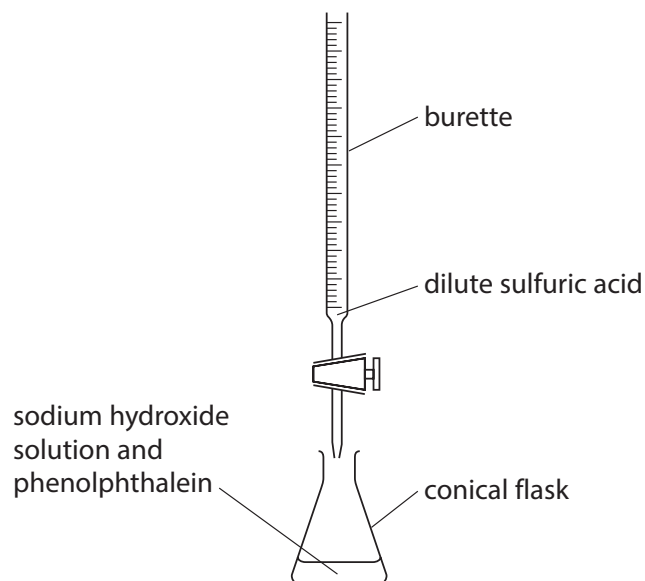


Figure 10

Before using the apparatus, the student rinses the burette with distilled water.

This is an error.

(i) Explain what effect this error has on the result of the titration.

(2)

.....

.....

.....

.....

.....

.....

(ii) State what the student should do to correct the error.

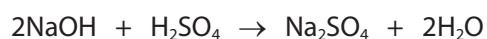
(1)

.....

.....

.....

*(c) The equation for the reaction in the titration is



Explain how the equation for the reaction and the apparatus in Figure 10 can be used to find the concentration of 25.0 cm^3 of sodium hydroxide solution using the 0.250 mol dm^{-3} sulfuric acid.

(6)



(Total for Question 10 = 11 marks)



12-MARK QUESTIONS

3 questions in this booklet



- 9 (a) Figure 11 shows the structure of a molecule of compound **S**.

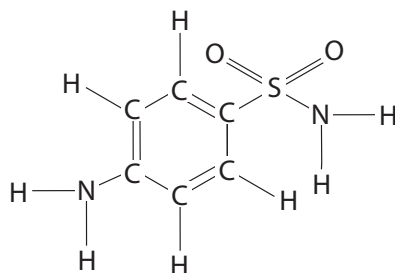


Figure 11

- (i) Use Figure 11 to deduce the empirical formula of compound **S**.

(1)

- (ii) The melting points of three samples of **S** are shown in Figure 12.

sample	melting point in °C
A	160–164
B	166
C	163–165

Figure 12

State whether each of these samples, **A**, **B** and **C**, is pure or impure and justify your answers using the information in Figure 12.

(3)

.....

.....

.....

.....

.....

.....

(b) A scientist uses chromatography in an investigation of compound **S**.

In the conditions used, compound **S** has an R_f value of 0.22.

Calculate the distance the spot of compound **S** moves if the solvent front has moved by 2.4 cm.

(2)

.....

.....

.....

.....

distance = ... cm



(Total for Question 9 = 12 marks)



10 (a) Buildings sometimes have water sprinklers to put out fires.

The pipes in some water sprinklers are filled with nitrogen gas to prevent corrosion when the system is not in use.

(i) State what is meant by the term **corrosion**.

(2)

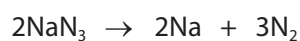
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.....

.....

.....

(ii) Nitrogen can be made from sodium azide, NaN_3 .



Calculate the maximum volume, in cm^3 , of nitrogen produced from 110 g of sodium azide.

(relative formula mass: $\text{NaN}_3 = 65$;

1 mol of gas occupies 24 dm^3 in the conditions used)

(4)

.....

.....

.....

.....

.....

.....

volume = ... cm^3



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*(b) Compare and contrast the properties and uses of pure aluminium and pure copper with the alloys of aluminium and the alloys of copper.

Include in your answer an **explanation** of the similarities and the differences in the properties and the uses of a pure metal and its alloy.

(6)



(Total for Question 10 = 12 marks)



7 Copper, iron, nickel and zinc are all metallic elements.

(a) Which row of the table applies to copper?

(1)

	type of metal	property
☐ A	it is an alkali metal	it has a low melting point
☐ B	it is an alkali metal	it forms coloured compounds
☐ C	it is a transition metal	it has a high melting point
☐ D	it is a transition metal	it forms coloured compounds

(b) Many ships are made of steel.

Steel is an alloy that contains iron.

Figure 4 shows blocks of zinc attached to a steel ship.

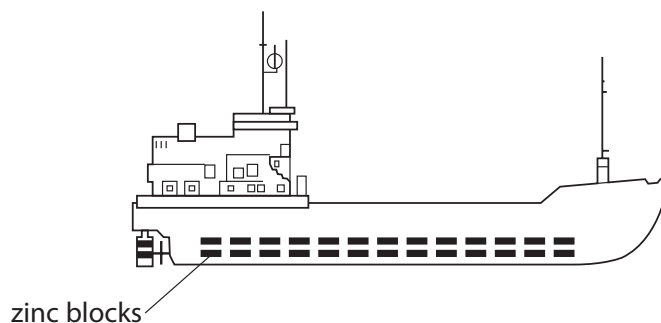


Figure 4

Explain how iron is protected from rusting by the zinc blocks.

(3)

.....

.....

.....

.....

.....

.....

.....

.....

(c) Alloys of copper and nickel are used for some coins.

Figure 5 shows the relative strengths of copper and nickel and some of their alloys.

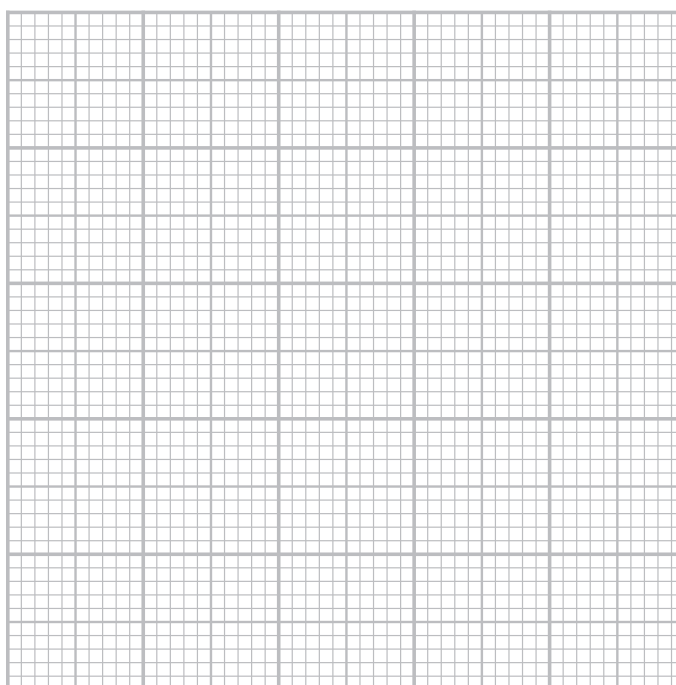
percentage of nickel	relative strength
0	1.00
20	1.52
35	1.77
65	1.90
80	1.78
100	1.56

Figure 5

- (i) On Figure 6
- add suitable scales to the vertical and horizontal axes
 - plot a graph of relative strength against percentage of nickel
 - draw a curve of best fit.

(4)

relative strength



percentage of nickel

Figure 6



- (ii) A coin is made from an alloy that contains 70% copper and 30% nickel.

Determine the relative strength of this coin from your graph on Figure 6.

(1)

relative strength of the coin = ...

- (iii) Explain, using Figure 6, how the percentage of nickel affects the relative strength of the alloys of copper and nickel.

(3)

.....

.....

.....

.....

.....

.....

.....

.....

(Total for Question 7 = 12 marks)



MARK SCHEMES

official Pearson Edexcel mark schemes



Question number	Answer	Additional Guidance	Mark
1(a)	A description to include any two in the correct sequence from - starts bright (1) - becomes dimmer (1) - goes out (over time) (1)	Ignore gets brighter allow bulb stops working	(2) AO1-1

Question number	Answer	Mark
1(b)	B copper has a high melting point is the only correct answer A , C and D are incorrect as they are not typical properties of transition metals	(1) AO1-1

Question number	Answer	Mark
1(c)	C 2.56×10^{-10} is the only correct answer A , B and D are mathematically incorrect	(1) AO2-1

Question number	Answer	Additional Guidance	Mark
1(d)	Diagram showing - arrangement of labelled copper and zinc atoms to show disruption (1) - copper : zinc in (approximate) ratio 7 : 3 (1)	minimum 2 layers for mark allow lack of labelling if clear distinction between Zn & Cu (eg shading)	(2) AO1-1

Total for Question 01 = 6 marks



Question number	Answer			Mark
1(a)		isotope A	isotope B	all 6 correct (2) 4 or 5 correct (1) 0-3 correct scores 0
	atomic number	1	1	
	mass number	1	2	
	number of protons	1	1	
	number of electrons	1	1	
	number of neutrons	0	1	

Question number	Answer	Additional guidance	Mark
1(b)	An description including - voltage {stays same/ constant/ steady/ stable/ at 1.1(V)} <u>for 60 minutes/ 1hr</u> (1) - and then falls <u>to 0(V)</u> (during the time 60-75 mins) (1)	for MP1 units of voltage not essential (but time span required) allow 1.08-1.12(V) allow power for voltage for MP2 units of voltage not required must specify that V decreases to zero/ nothing (but time span not required) ignore phrases such as 'voltage stops', 'no voltage', 'voltage runs out'	A03 1 (2)

Question number	Answer	Additional guidance	Mark
1(c)	- sodium would react with the {electrolyte / water/ solution} (1) - sulfur does not conduct (electricity) (1)	allow sodium is not inert/ is (very) reactive / reacts with the liquid ignore 'sodium will dissolve'/ will react with air/ loses electrons allow poor conductor/ sulfur is a non-metal/ electrons cannot pass through	A02 2 (2)



Question number	Answer	Additional guidance	Mark
1(a)	A description to include two from - shows a constant voltage (1) - decreases (1) - to 0 (v) (1)	mark independently ignore initially increases (when connected)	(2) AO2-2

Question number	Answer	Mark
1(b)	D iron has a high density is the only correct answer A, B and C are incorrect as they are not typical properties of transition metals	(1) AO1-1

Question number	Answer	Mark
1(c)	B 0.252 is the only correct answer A, C and D are mathematically incorrect	(1) AO2-1



Question number	Answer	Additional guidance	Mark
1(d)	An explanation linking - alloy C is the strongest (1) with any one of the following - alloy C has <u>most</u> atoms of a different size (1) <u>greatest</u> disruption of layers of (zinc) atoms / <u>most</u> difficult for layers to slide over one another (1)	allow 3rd alloy MP2 depends on MP1 allow contains <u>most</u> copper (atoms / ions) allow <u>most</u> particles of different size allow <u>highest</u> copper to zinc ratio allow has the <u>most</u> irregular structure ignore 'has an irregular structure' alone	(2) AO3-2

Total for question 01 = 6 marks

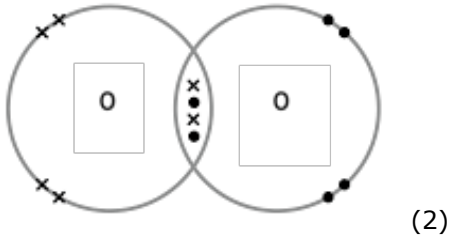


Question number	Answer		Mark
1(a)(i)	ionic	allow containing ions accept (soluble) salt ignore names and formulae of ions even if correct ignore molten / aqueous	(1) AO1 1

Question number	Answer		Mark
1(a)(ii)	C magnesium A is incorrect as no voltage would be produced B is incorrect as there is a bigger difference in reactivity between magnesium and copper than gold and copper D is incorrect as there is a bigger difference in reactivity between magnesium and copper than zinc and copper		(1) AO3 2a

Question number	Answer		Mark
1(a)(iii)	(drops to) zero	allow decreases /stops ignore references to current	(1) AO1 1



Question number	Answer	Additional guidance	Mark
1(b)(i)	 (2) OR two shared pairs of electrons between two oxygen atoms (1) rest of molecule correct (1)	allow dots, crosses or a mixture of both ignore any inner electrons shown MP2 dependent on MP1	(2) AO1 1
Question number	Answer	Additional guidance	Mark
1(b)(ii)	can reuse water produced / water is the only product / produces (constant) voltage (as long as reactants supplied)	ignore does not produce CO₂ / greenhouse gases allow does not make toxic products ignore references to clean energy / less pollution etc.	(1) AO1 1

Total for Question 1 = 6 marks

Question Number	Answer	Mark
1(a)	C yes high coloured The only correct answer is C <i>A is not correct because transition metal chlorides are coloured</i> <i>B is not correct because all properties are incorrect</i> <i>D is not correct because transition metals are used as catalysts and have a high density</i>	(1) AO 1 1

Question Number	Answer	Mark
1(b)	An explanation linking {air/oxygen} excluded / {water/moisture} excluded / oil acts as a barrier (1) {air/oxygen} and {water/moisture/damp conditions} both needed (for iron to rust / corrosion) (1)	(2) AO 1 1

Question Number	Answer	Additional guidance	Mark
1(c)	An explanation linking - zinc corrodes {easier than / in preference to / OWTTE} iron / zinc reacts with air and water instead (1) - zinc is more reactive than iron / zinc is sacrificial / zinc has a higher tendency to form ions (1)	reject zinc rusts	(2) AO 1 1 AO 2 1

Question Number	Answer	Additional guidance	Mark
1(d)	An explanation linking two of the following points • {metal ions / cations} surrounded by (delocalised) electrons (1) • strong {forces of attraction / bonding} (between (delocalised) electrons and {metal ions / cations}) (1) • needs lots of energy to {separate the particles / break bonds / break forces of attraction} (1)	ignore metal nuclei allow electrostatic bonds / metallic bonds ignore separating electrons any mention of intermolecular forces / covalent bonding / molecules / ionic bonding / atoms – max 1 mark marking points independent	(2) AO 1 1

Total for question 1 = 7 marks

Question number	Answer	Additional guidance	Mark
1(a)	An explanation linking (18 carat gold) contains atoms of different sizes/OR (1) - disrupts structure of metal / prevents layers from {slipping / sliding / moving} over one another (1)	reject molecules once allow particles/ions for atoms allow particles / atoms / sheets / rows for layers	(2)

Question number	Answer	Additional guidance	Mark
1(b)	final answer of 14 with or without working (3) OR $\frac{2.9}{5.0} = 0.58$ (1) $0.58 \times 100 = 58\%$ (1) 14 (1)	allow ECF allow 13.8-14.0	(3)

Question number	Answer	Additional guidance	Mark
1(c)	final answer of $1.2(04) \times 10^{22}$ with or without working (2) OR $\frac{3.94}{197} = 0.02$ (1) $0.02 \times 6.02 \times 10^{23} = 1.2(04) \times 10^{22}$ (1)	allow ECF allow $0.12(04) \times 10^{23}$	(2)

Question number	Answer	Additional guidance	Mark
6(a)	An explanation linking pipette: - water causes barium hydroxide solution to be more dilute (1) - titration result is then <u>decreased</u> (1) conical flask: - any water present does not affect <u>amount of barium hydroxide</u> present (1) - no effect (on titration result) (1)	mark independently reject acid is more dilute allow less concentrated allow fewer hydroxide ions allow alkali more dilute allow less {barium hydroxide / alkali} allow less acid needed allow number of hydroxide ions unchanged allow same volume of acid needed	(4) AO1-2
Question number	Answer	Additional guidance	Mark
6(b)(i)	from {magenta / pink} to colourless	both starting and final colours needed allow other shades of magenta / pink / purple-pink for starting colour ignore clear for final colour reject red for starting colour	(1) AO1-2



Question number	Answer	Additional guidance	Mark
6(b)(ii)	$\text{H}^+ + \text{OH}^- \rightarrow \text{H}_2\text{O}$ (2) left side : $\text{H}^+ + \text{OH}^- \rightarrow$ (1) right side : $\rightarrow \text{H}_2\text{O}$ (1)	reject spectator ions on each side ignore state symbols even if incorrect reject lower case H reject superscript 2 incorrect balancing of correct species scores 1 max	(2) AO1-1

Question number	Answer	Additional guidance	Mark
6(c)	A plan to include - filter (barium sulfate / precipitate) (1) AND - wash (barium sulfate / precipitate on filter paper) (1) - leave (to dry) in a warm place (1)	reject crystallisation MP2 and MP3 are dependent on MP1 allow any <u>method</u> to dry reject washing after MP3	(3) AO3-3a

Total for question 06 = 10 marks



Question Number	Answer	Mark
4(a)(i)	$2\text{H}_2 (\text{g}) + \text{O}_2 (\text{g}) \rightarrow 2\text{H}_2\text{O} (\text{g})$	(2) AO 3 1a AO 3 1b

Question Number	Answer	Additional guidance	Mark
4(a)(ii)	all <u>atoms</u> in the reactants are present in the product / only one product is formed	allow no atoms are wasted (in the reaction) / no waste products / nothing is wasted allow total mass of reactants = mass of useful products allow complete calculation to show that atom economy is 100% ignore equation is balanced / same number of atoms on both sides	(1) AO 1 1

Question Number	Answer	Additional guidance	Mark
4(b)	final answer of 90 with or without working (4) OR total mass : $2 \times 223 + 12 / (2 \times 207) + 44 (= 458)$ (1) mass of useful products : $2 \times 207 = 414$ $\frac{414}{458} (1) \times 100 (1) (= 90.39)$ $= 90 (1)$	allow ECF throughout 458 seen (1) 90.39 / 90.4 for 3 marks 110.628... / 111 (2) 110 (3) correct rounding of an answer with working to 2 sig fig (1)	(4) AO 2 1

Question Number	Answer	Additional guidance	Mark
4(c)(i)	final answer of 65(%) with or without working (2) OR $\frac{7.67}{11.80} (= 0.65)$ (1) $\frac{7.67}{11.80} \times 100 (= 65(\%))$ (1)	allow any fraction $\times 100$ (1) 153.84.... scores 1	(2) AO 2 1

Question Number	Answer	Additional guidance	Mark
4(c)(ii)	any two from - incomplete / reversible reactions - competing/unwanted/side reactions - practical losses during the experiment / loss on transfer from one piece of equipment to another	ignore gases formed / impure substances / losses through incompetence / products not used up	(2) AO 1 1

Total for question 4 = 11 marks



Question Number	Answer	Mark
10(a)	from pink / red to orange / yellow	(1) AO 1 2

Question Number	Answer	Mark
10(b)	Any two linked explanations Any two suitable precautions to make use of pipette or burette as accurate as possible or to carry out the titration as accurate as possible (1) linked explanation (1) e.g. read bottom of the meniscus on the burette/pipette scale / read burette/pipette at eye-level (1) to obtain accurate volume of sodium hydroxide solution / sulfuric acid added (1) add {solution from burette / alkali} one drop at a time near end point (1) to identify exactly when colour change of indicator takes place (1) use a white tile (1) to make it easier to see exactly when colour change of indicator takes place (1) make sure no air bubbles in burette or pipette when measuring volumes (1) so exact volumes are recorded (1) continually swirl flask (1) to ensure complete mixing of acid with alkali (1) wash inside of conical flask with a little deionised/distilled water (1) to wash reactants into reaction mixture (1) wash burette / pipette with appropriate solution before titration (1) to ensure burette / pipette is not contaminated (1) do not award marks for concordancy / reliability / changes of indicator	(4) AO 1 2



Question Number	Answer	Mark
10(c)	0.097 (mol dm⁻³) with or without working (4) OR moles of NaOH = $\frac{24.25 \times 0.200}{1000}$ (1) (= 4.85 x 10⁻³) from reaction equation moles acid = $\frac{1}{2}$ x moles alkali = $\frac{1}{2}$ x 4.85 x 10⁻³ (1) (= 2.425 x 10⁻³) concentration of H₂SO₄ = $\frac{2.425 \times 10^{-3} \times 1000}{25.00}$ (1) = 0.097 (1) (mol dm⁻³) OR $\frac{1}{2}$ (1) x 24.25 x 0.200 = 25.00 x conc H₂SO₄ (1) conc H₂SO₄ = $\frac{1}{2} \times \frac{24.25 \times 0.200}{25.00}$ (1) = 0.097(1) (mol dm⁻³) on answer line 0.388 / 0.39 (3) [x2 instead of x$\frac{1}{2}$] 0.194 / 0.19 (3) [not x$\frac{1}{2}$] Ignore sig figs except for 1	(4) AO 3 2a AO 3 2b

Question Number	Answer	Additional guidance	Mark
10(d)	24.5 (g dm⁻³) with or without working (2) OR concentration = 98 x 0.25 (1) = 24.5 (1) (g dm⁻³)	allow 2.45 / 24500 (1)	(2) AO 2 1

Total for question 10 = 11 marks



Question number	Answer	Additional guidance	Mark
4(a)(i)	K, L, J, N, M		(1)

Question number	Answer	Additional guidance	Mark
4(a)(ii)	(volumetric) pipette	allow burette reject dropping pipette ignore balance	(1)

Question number	Answer	Additional guidance	Mark
4(b)(i)	An explanation linking • solution from titration contains an indicator (1) • therefore second solution used with no indicator / indicator would contaminate salt (1)	MP2 dependant on MP1 allow original mixture was contaminated by indicator so doesn't form a pure salt (2)	(2)



Question number	Answer	Additional guidance	Mark
4(b)(ii)	final answer of 120% with or without working (2) OR $\frac{0.84}{0.70} (=1.2) (1)$ $\frac{0.84}{0.70} \times 100 (=120(\%)) (1)$	allow any fraction x100 (1)	(2)

Question number	Answer	Additional guidance	Mark
4(b)(iii)	{the salt/solid/potassium chloride} was still wet/ not all of the water had been evaporated off		(1)

Question number	Answer	Additional guidance	Mark
4(b)(iv)	final answer of 80.5 with or without working (4) OR total mass: $56 + 36.5 (=92.5) /$ $74.5 + 18 (=92.5) (1)$ $\frac{74.5}{92.5} (= 0.8054) (1)$ $\frac{74.5}{92.5} \times 100 (=80.540) (1)$ $= 80.5 (1)$	allow ECF throughout 92.5 seen (1) incorrect answer with working to 1 decimal place (1) 50.0/100.0 does not score MP4	(4)

Question number	Answer	Additional guidance	Mark
4(a)	An explanation linking (in pure aluminium all the atoms are the same (size) whereas) in alloy atoms are different sizes (1) (in aluminium) {layers/rows/sheets} of atoms easily slide over each other (1) (in alloy) {layers/rows/sheets} of atoms cannot easily slide over each other (1)	reject the use of 'molecules' once only allow ion/particle in place of atom throughout	(3) AO1

Question number	Answer	Additional guidance	Mark
4(b)	$\frac{2.00}{100} \times 695.0$ (1) (= 13.9) $695.0 - 13.9$ (1) (= 681.1 (g)) OR $\frac{98.00}{100} (1) \times 695.0$ (1) (= 681.1 (g))	award full marks for correct final answer without working allow 2 or more sig.fig.	(2) AO2



Question number	Answer	Additional guidance	Mark
4(c)(i)	A description to include - the strength increases (1) AND any one from - as percentage of magnesium (by mass in the alloy) increases (1) - linearly (1) - from 0.1 % to 3.5 % magnesium (1)	MP2 is dependent on MP1	(2) AO3

Question number	Answer	Additional guidance	Mark
4(c)(ii)	(from graph) percentage by mass of magnesium = 3.0 % (1) percentage aluminium in alloy = 100 - 3 (1) (= 97 (%))	credit MP1 if written on graph ecf	(2) AO3

Question number	Answer	Additional guidance	Mark
4(d)	- improve the appearance (1) - increase resistance to corrosion (1)	allow - to improve electrical conductivity (1) - cheaper than using solid gold (1)	(2) AO1

(Total for question 4 = 11 marks)



Question number	Answer	Additional guidance	Mark
8(a)	voltage constant OR chemical cells <u>contain</u> harmful/toxic substances (which need careful disposal after use)	allow produces a voltage as long as hydrogen/oxygen/reactants are supplied fuel cells have longer lifetime does not discharge when left unused	(1) AO1

Question number	Answer	Additional guidance	Mark
8(b)	$O_2 + 4H^+ + 4e^{(-)} \rightarrow 2H_2O$ (2) $e^{(-)}$ (on left) (1) balancing (1)	allow equation with e^+ to score MP2 if this is only error allow equation missing electrons but with no extraneous substances to score MP2 if correctly balanced	(2) AO2

Question number	Answer	Additional guidance	Mark
8(c)	moles of oxygen = $48/32$ (1) (= 1.5 mol) volume of oxygen = $1.5 \times 24.0 \text{ dm}^3$ (= 36 dm^3) (1)	award full marks for correct final answer without working allow ecf on incorrect number of moles	(2) AO2



Question number	Indicative content	Mark
*8(d)	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material that is indicated as relevant. Additional content included in the response must be scientific and relevant. (effect of using a catalyst) • increases rate of attainment of equilibrium • increasing rate of both forward and back reaction • lowers activation energy • provides an alternative reaction pathway • no effect on equilibrium yield (effects of using a temperature of 220°C rather than lower temperatures) • equilibrium attained in a shorter period of time / faster rate of attainment of equilibrium • because particles move faster/ have higher (kinetic) energy • increased collision frequency and more energetic collisions • equilibrium yield of hydrogen increases with higher temperatures • because heat energy is taken in the forward reaction (endothermic) • increasing the temperature shifts equilibrium further to the right-hand side	(6) AO1



Level	Mark	Additional Guidance	General additional guidance – the decision within levels Eg - At each level, as well as content, the scientific coherency of what is stated backed up by detail will help place the answer at the top, or the bottom, of that level.
	0	No rewardable material.	
Level 1	1–2	<u>Additional guidance</u> Identifies at least ONE way that use of a catalyst OR temperature affects equilibrium. OR A simple explanation of one way that catalyst or temperature affects equilibrium.	<u>Possible candidate responses</u> - Increasing temperature increases rate of attainment. - Increasing temperature shifts equilibrium to the right. - Using a catalyst has no effect on the equilibrium yield / position of equilibrium - Using a catalyst increases rate of attainment. - Increasing temperature increases the rate of attainment and produces more hydrogen (2) - Using a catalyst lowers activation energy so equilibrium is reached faster (2)
Level 2	3–4	<u>Additional guidance</u> A simple explanation of at least TWO ways that the use of a catalyst OR temperature affects equilibrium. OR A detailed explanation of ONE way that equilibrium is affected	<u>Possible candidate responses</u> - Increasing temperature favours the endothermic reaction so more hydrogen is produced. - A catalyst has no effect on the equilibrium yield but provides an alternative reaction pathway, so the rate of attainment of equilibrium increases. - Increasing temperature means that particles have more kinetic energy, so there are more frequent, successful collisions and the rate of attainment of equilibrium increases.
Level 3	5–6	<u>Additional guidance</u> A detailed explanation of at least TWO ways that the use of a catalyst AND temperature affects equilibrium	<u>Possible candidate responses</u> - Increasing the temperature favours the endothermic reaction and so a higher temperature will produce more hydrogen. A catalyst has no effect on the equilibrium yield as it increases the rate of both the forward and reverse reaction. - Increasing temperature gives the particles more kinetic energy and increases the frequency of collisions, so the rate of attainment of equilibrium increases. Using a catalyst lowers the activation energy, so more particles have the minimum energy required for a successful collision



Level	Mark	Descriptor
	0	No awardable content
Level 1	1-2	• Demonstrates elements of chemical understanding, some of which is inaccurate. Understanding of scientific ideas lacks detail. (AO1) • Presents an explanation with some structure and coherence. (AO1)
Level 2	3-4	• Demonstrates chemical understanding, which is mostly relevant but may include some inaccuracies. Understanding of scientific ideas is not fully detailed and/or developed. (AO1) • Presents an explanation that has a structure which is mostly clear, coherent and logical. (AO1)
Level 3	5-6	• Demonstrates accurate and relevant chemical understanding throughout. Understanding of the scientific ideas is detailed and fully developed. (AO1) • Presents an explanation that has a well-developed structure which is clear, coherent and logical. (AO1)

(Total for question 8 = 11 marks)



Question number	Answer	Additional guidance	Mark
10(a)(i)	Suggestions to include any three from • make the potassium hydroxide solution using a volumetric flask (1) • use distilled / deionised water (to make up solution) (1) • make solution of total volume 250 cm³ (rather than adding 250 cm³ water to the solid) (1) • use of pipette to measure out the potassium hydroxide solution (1) • repeat until titres within $\pm 0.2(0)$ cm³ of each other / concordant titres and use to calculate the mean titre (1)	allow add solution from burette dropwise only near end point (1) allow conduct rough titration first (1)	(3) AO3

Question number	Answer	Mark
10(a)(ii)	C pink colourless is the only correct answer A and B have colours for methyl orange. D has the colours reversed.	(1) AO1



Question number	Answer	Additional guidance	Mark
10(b)	moles of sulfuric acid = $0.140 \times \frac{12.15}{1000}$ (1) $(= 0.001701 \text{ mol})$ ratio 2 : 1 KOH to H_2SO_4 (1) moles of KOH = 2×0.001701 (1) $(= 0.003402 \text{ mol})$ concentration of KOH = $0.003402 \times \frac{1000}{25.00}$ (1) $(= 0.136 \text{ mol dm}^{-3})$	award full marks for correct final answer without working allow ecf from moles of sulfuric acid allow ecf from moles of KOH	(4) AO2

Question number	Answer	Additional guidance	Mark
10(c)	$0.175 \times 56.0 = 9.80 \text{ g dm}^{-3}$ (1) mass in 250 cm^3 sample = $0.25 \times 9.80 = 2.45 \text{ g}$ (1) % pure KOH = $2.45 / 2.56 \times 100 = 95.7 \text{ (\%)}$ (1)	award full marks for correct final answer without working	(3) AO2

(Total for question 10 = 11 marks)



Question number	Answer	Additional guidance	Mark
4(a)(i)	Actual yield – {mass/amount/yield} (of product) formed in the {reaction / experiment} (1) Theoretical yield – calculated {mass/amount/yield} of product formed (using the balanced equation) / {mass/amount/yield} of product formed if all reactant used to form product only with no losses (1)	allow how much (product) formed ignore 'actual' allow maximum {mass / amount/yield} of product that could be formed (with no losses) ignore estimated / predicted / expected mass formed ignore what would form theoretically	(2) AO1-1

Question number	Answer	Additional guidance	Mark
4(a)(ii)	$\frac{8.07}{53.80}$ (1) (= 0.15) 0.15 x 100 (1) (= 15)	award correct answer of 15(%) with or without working (2) allow $\frac{53.80}{8.07} \times 100$ / 666.7/667/666.6 for 1 mark	(2) AO3-1a

Question number	Answer	Additional guidance	Mark
4(a)(iii)	Any two from: - Some reactant remained unreacted (1) - Some product is lost during {the reaction / processes/extraction/purification} (1) - Side reactions occur (1)	allow reaction not left long enough allow above 15% ethanol, enzymes in yeast denature allow oxidation of ethanol ignore reactants are lost in experiment ignore yield is lost / loss of yield do not allow self-deprecating answers allow impurities in the reactants ignore reversible reaction	(2) AO1-1



Question number	Answer	Additional guidance	Mark
4(b)(i)	$342 + 18 = 360$ / $4 \times 46 + 4 \times 44 = 360$ and 4×46 (1) (=184) $\frac{(4 \times 46)}{360} \times 100$ (1) (= 51.111...) 51(%) (to 2 sig figs) (1)	award full marks for 51 with or without working 0.5111 scores 1 mark 12.8 or 12.78 or 12.778 scores 1 mark 13 scores 2 51.1 / 51.11 (or more sig figs) scores 2 marks 25.555 scores 1 26 scores 2 marks sig fig mark can still be awarded if answer from an incorrect calculation has been given to 2 sig figs if using numbers from question	(3) AO2-1
Question number	Answer	Additional guidance	Mark
4(b)(ii)	An explanation linking - carbon dioxide becomes {useful/a desired product /no longer a waste product} (1) - so atom economy increases (to 100%) (1)	ignore any increased atom economy less than 51%	(2) AO2-1

Total for Question 04 = 11 marks

Question number	Answer	Additional guidance	Mark
7(a)	from yellow (1) to orange (1)	Allow to pink	(2) AO1-2

Question number	Answer	Additional guidance	Mark
7(b)	$2 \text{NH}_3 + \text{H}_2\text{SO}_4 \rightarrow (\text{NH}_4)_2\text{SO}_4$ (2) MP1 : formula of product (1) MP2 : balancing (of correct formulae) (1)	MP2 dependent on MP1 allow correct multiples throughout	(2) AO2-1

Question number	Answer	Additional Guidance	Mark
7(c)	An explanation linking two practical steps with reasons • use of white tile (1) • easier to see precisely when indicator changes colour (1) • (near to end point) {add (acid) slowly / in small quantities each time} (1) • easier to stop excess acid being added (when indicator changes colour) (1) • swirl flask when adding acid (1) • ensures complete mixing of both reactants (1) • touch tip of burette on inside wall of flask and/or rinse walls of flask (1) • ensures all acid takes part in reaction (1) • rinse burette (with acid)/ pipette (with ammonia)/flask (with water) beforehand (1) • no impurities to affect result (1) ▪ remove funnel from burette (1) ▪ to stop any extra drop of acid falling into burette (1)	ignore any improvements to measuring volumes of solution. only allow drop by drop if near end point ignore stir allow wash final drop from end of burette.	(4) AO1-2



Question number	Answer	Additional guidance	Mark
7(d)	A plan to include (stand alone marks) • heat solution (in an evaporating basin) (to concentrate) (1) • (cool and) crystallise (1) • dry ammonium sulfate crystals (between filter papers) (1)	do not accept crucible reject heat to dryness allow leave in a warm place (to crystallise) allow other suitable methods of drying, e.g. warm in an oven to dry	(3) AO3-3a

Total for Question 07 = 11 marks



Question number	Answer	Additional guidance	Mark
4(a)	final answer of 34 with or without working scores 4 - total mass = 191 (1) $\frac{64}{191} = 0.33507$ (1) $\times 100 = 33.507$ (1) $= 34$ (1)	allow ecf at MPs 2-4 MP2 must be for 64/ total mass from MP1 note: 63.5/191 is not correct MP3 must be for multiplying fraction from MP2 that has been produced using question data $\times 100$ MP4 for rounding correctly number produced using question data to 2s.f. and must be <100% 33.5/ 33.51 scores 3 0.33 scores 2 0.34 scores 3 33 scores 3 64/382 $\times 100 = 17$ scores 3 191/64 $\times 100 = 298$ scores 2 64/127(.5) $\times 100 = 50$ scores 3 191/191 $\times 100 = 100$ scores 1	A02 1 (4)

Question number	Answer	Mark
4(b)	D 1910 orange is the only correct answer. A, B and C are incorrect because the melting point of transition metals are high and transition metals have coloured compounds	A02 1 (1)



Question number	Answer	Additional guidance	Mark
4(c)(i)	final answer of 490 with or without working scores 2 $\frac{400}{80} = 5 \text{ (1)}$ $5 \times 98 = 490 \text{ (1)}$ OR $\frac{98}{80} = 1.225 \text{ (1)}$ $1.225 \times 400 = 490 \text{ (1)}$	80/ 400 x 98 = 19.6 scores 1 allow ecf for MP2 only if MP1 uses 80 and 98 80/98 x 400 = 326.5 scores 1 allow ecf for MP2 only if MP1 uses 80 and 98 allow 490000 kg <u>only if unit given</u> allow 490000000 g <u>only if unit given</u>	A02 1 (2)

Question number	Answer	Additional guidance	Mark
4(c)(ii)	final answer of 96% with or without working scores 2 $\frac{672}{700} = 0.96 \text{ (1)}$ $\times 100 = 96 \text{ (1)}$	allow 24/25 no ecf for MP2 4 scores 1 104 scores 1	A02 1 (2)



Question number	Answer	Additional guidance	Mark
4(c)(iii)	Any two of the following - incomplete reaction - loss {of substance/reactant/product} (during practical)/ practical losses - unwanted reactions/ side-reactions	ignore impure reactants/ contaminants/ reaction conditions/ human error/ measurement errors/ reversible reaction allow reaction incomplete/ reactant left over/ not all reactants used allow reasonable examples e.g. left in apparatus/ in transfer/ escape to air/ not in a closed system/ lost to surroundings ignore incompetence e.g. spillages allow reasonable example e.g product reacts with air ignore waste products/ by-products	A01 1 (2)

Question number		Additional guidance	Mark
7(a)(i)	- ammonia (solution) (1) - nitric acid (1)	allow ammonium hydroxide for ammonia. ignore any formulae	A01 1 (2)

Question number	Answer	Mark
7(a)(ii)	D hydrogen, nitrogen, oxygen and phosphorus only is the only correct answer A, B and C are incorrect because they each lack one of the elements	A02 1 (1)

Question number	Answer	Additional guidance	Mark
7(b)(i)	- two readings: 27.75 and 1.45 (1) $27.75 - 1.45 = \mathbf{26.30}$ (1)	MP1 for these values only MP2 for correct subtraction of 2 volumes (to 1 or 2 d.p.) but answer must be 2 d.p. Any 1 d.p. answer including 26.3 does not score MP2. Answers with NO working 26.30 (2); any other answer (0) 26.30 with working may score 2 (if 2 correct values used) or score 1 (e.g. $27.78 - 1.48 = 26.30$; $27.8 - 1.5 = 26.30$)	A03 1 (2)

Question number	Answer					Mark
7(b)(ii)		25.90	24.90	24.60	25.00	A03 2 (1)
			✓		✓	



Question number	Answer	Additional Guidance	Mark
7(b)(iii)	An answer including any three from • rinse the burette with titrant (1) • fill the jet / tip (1) • do not fill burette over 0 cm^3 / overfill/ run liquid out until volume at or below 0 cm^3 (1) • add drop by drop only near {end point/ colour change} (1)	allow clean/ wash the burette / wash with water allow rinse with (named) acid or alkali ignore dry the burette allow indication of this part of apparatus e.g. below tap allow ensure no gas bubbles/ air note: diagram shows overfilled burette ignore measure start volume allow do not fill to top allow rough titration first (then add similar volume before going dropwise) ignore any remarks about taking readings ignore additional method points e.g. use funnel, clamping burette	A03 3 (3)

Question number	Answer	Additional Guidance	Mark
7(c)	from: pink-blue/ pink-purple/ blue-purple/ purple to red	in colours allow any qualifiers e.g. light/ dark etc FROM allow any type of purple alone e.g lilac allow any combination of pink/blue/purple reject blue <u>alone</u> or pink <u>alone</u> reject any red TO Reject any other colours with red	A01 2 (1)

Question number	Answer	Additional Guidance	Mark
7(d)	None / volume the same	Must be clear there is NO effect e.g. 'little to no change' (0)	A01 2 (1)



Question number	Answer	Additional guidance	Mark
4(a)(i)	75.4 with or without working scores 3 marks $\frac{45.26}{60.00} = 0.7543 \text{ (1)}$ (0.7543) x 100 = 75.43 (1) = 75.4 (1 dp) (1)	75.43 / 75.40 with or without working scores 2 marks allow ECF using numbers from the question allow 1 mark for correct rounding to 1 d.p. of an incorrectly calculated value only if using numbers from the question 91.2 with working scores 2 marks	(3) AO3-1

Question number	Answer	Additional guidance	Mark
4(a)(ii)	any two reasons valid for <u>this</u> reaction - not enough magnesium used (1) - not all titanium oxide reacted (1) - magnesium reacts with something else (1) - some titanium lost during {separation / purification} (1)	allow impurities in reactants allow not all reactants used allow incomplete reaction allow side reactions allow practical losses during {separation / purification} allow left on equipment ignore spillages ignore {reactants / products} lost	(2) AO2-1



Question number	Answer	Additional guidance	Mark
4(a)(iii)	38 with or without working scores 3 marks $48 + (2 \times 16) + (2 \times 24) = 128$ (1) $\frac{48}{128} \times 100 = 37.5$ (1) 38 % (1)	37.5 with or without working scores 2 marks to score MP1, 128 must have working or appear as denominator in MP2. allow ECF from MP1 as long as working is shown allow MP3 for correct rounding to 2 sig figs of an incorrectly calculated value only if MP2 scored	(3) AO2-1

Question number	Answer	Additional guidance	Mark
4(b)(i)	only one product / ethanol is the only product	allow this is an addition reaction allow there are no unwanted products / no waste produced / no by-products allow all atoms from reactants in product allow mass of reactants = mass of desired products ignore it is a balanced equation ignore same number of atoms on each side of the equation reject no gas given off	(1) AO2-1



Question number	Answer	Additional guidance	Mark
4(b)(ii)	An explanation linking • find a use for the {carbon dioxide / waste product} (1) • so carbon dioxide becomes a <u>useful product</u> / increase mass of <u>useful product</u> (1)	allow a named use of carbon dioxide e.g in fizzy drinks allow sell the {carbon dioxide / waste product}	(2) AO2-1

Total for question 04 = 11 marks



Question number	Answer	Mark
10(a)(i)	D A , B and C are incorrect because hydrogen ions concentration decreases and the pH increases	(1) AO2 1

Question number	Answer	Mark
10(a)(ii)	C 24.5 A , B and D are incorrect as the concentration g dm ⁻³ is 24.5 g dm ⁻³	(1) AO2 1

Question number	Answer	Additional guidance	Mark
10(b)(i)	an explanation linking (left over water will) decrease the concentration of the sulfuric acid (1) - so more acid would be needed / concentration of sodium hydroxide will appear higher (1)	allow dilute the acid (more) ignore references to changing pH allow H ⁺ (ions) for acid	(2) AO3 2

Question number	Answer	Additional guidance	Mark
10(b)(ii)	rinse (inside of burette) with (sulfuric) acid	ignore any reference to drying ignore use a different burette	(1) AO3 3b



Question number	Indicative content	Mark
*10(c)	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material that is indicated as relevant. Additional content included in the response must be scientific and relevant. AO1 6 marks • add white tile under apparatus • so that colour change can be seen clearly • run sulfuric acid into sodium hydroxide • swirl the mixture in the flask • to ensure all the reactants react • phenolphthalein is pink in alkali but colourless in acid • add acid dropwise towards the end point • so the exact amount of acid can be obtained • rinse the end of the burette and the inside of the conical flask • to ensure all the acid is in the mixture • repeat until results are concordant • average concordant results • the exact volume of acid is now known, so with concentration of acid no of mols can be found • no of mols = concentration x volume • H_2SO_4 reacts in a 1:2 ratio with NaOH / ORA • so number of mols of alkali = 2 x number of mols of acid / ORA • volume of sodium hydroxide is known so with no of mols of alkali, concentration can be determined • concentration = number of moles divided by volume	(6) AO1 2

Level	Mark	Descriptor
	0	• No rewardable material.
Level 1	1-2	• Demonstrates elements of chemical understanding, some of which is inaccurate. Understanding of scientific ideas lacks detail. (AO1) • Presents an explanation with some structure and coherence. (AO1)
Level 2	3-4	• Demonstrates chemical understanding, which is mostly relevant but may include some inaccuracies. Understanding of scientific ideas is not fully detailed and/or developed. (AO1) • Presents an explanation that has a structure which is mostly clear, coherent and logical. (AO1)
Level 3	5-6	• Demonstrates accurate and relevant chemical understanding throughout. Understanding of the scientific ideas is detailed and fully developed. (AO1) • Presents an explanation that has a well-developed structure which is clear, coherent and logical. (AO1)



Level	Mark	Descriptor	Additional Guidance
	0	No rewardable material	Read whole answer and ignore all incorrect material and any references to other metals / discard any contradictory material then:
Level 1	1–2	<u>Additional Guidance</u> Gives simple statements about the titration or the calculation OR Gives a simple description of the titration or the calculation	<u>Possible candidate response: (examples)</u> phenolphthalein will go from pink to colourless (1) moles = concentration x volume (1) Add sulfuric acid to sodium hydroxide. Stop when the phenolphthalein loses its colour (2) The acid will neutralise the alkali. The number of moles of acid can be calculated knowing the volume used (2)
Level 2	3–4	<u>Additional Guidance</u> Gives a simple explanation of the titration AND the calculation with at least 1 linked statement OR Gives a detailed explanation of the titration OR the calculation with at least 1 linked statement plus other simple statements	<u>Possible candidate response:</u> The acid will react with the alkali in a neutralisation reaction, the phenolphthalein will change colour when all alkali has been neutralised, we can then read off the exact amount of acid needed to neutralise the sodium hydroxide. (3) Calculate the number of moles of sulfuric acid. Then multiply by 2 to calculate moles of sodium hydroxide (3) Acid reacts with alkali to form salt + water in neutralisation reaction. The indicator has a sharp end point which will change colour at equivalence point, so the volume of acid is now known so with the concentration of acid the number of mols of sodium hydroxide can be found (4)
Level 3	5–6	<u>Additional Guidance</u> Gives a explanation of the titration AND the calculation with at least 3 linked statements	<u>Possible candidate response:</u> The acid will react with the alkali in a neutralisation reaction, the phenolphthalein will go from pink to colourless when all alkali has been neutralised, we can then read off the exact amount of acid needed to neutralise the sodium hydroxide. the number of mols of acid used = concentration x volume (5) Acid reacts with alkali to form salt + water in neutralisation reaction, $H^+ + OH^- \rightarrow H_2O$, the indicator has a sharp end-point which will change colour at equivalence point, so the volume of acid is now known this along with the concentration of acid, the no of mols of sodium hydroxide can be found. When the volume of sodium hydroxide is known and the number of mols of alkali known, concentration can be determined using concentration = number of moles divided by volume (6)

Total for Question 10 = 11 marks



Question number	Answer	Additional guidance	Mark
9(a)(i)	$C_6H_8N_2SO_2$	Letters can be in any order e.g. $C_6N_2H_8O_2S$ (1) must be written as a formula numbers do not have to be subscripts ignore any formula with brackets	A02 1 (1)

Question number	Answer	Additional Guidance	Mark
9(a)(ii)	A description including: - B is pure and A is impure and C is impure (1) - B has a sharp/ single melting point (1) - A and C have melting points {over a range / lower than (the sharp melting point of) B} (1)	ignore repeats the stem e.g. melting point is 160-164 ignore suggestions about composition e.g B is an element mark independently (can score MP2 and MP3 even if MP1 incorrect) allow fixed / specific / definite/ one/ exact/ no range ignore accurate/ precise melting point allow the melting points vary /gradual change/ not sharp/ not exact ignore these have two melting points/ different melting points (i.e idea that melts at 160 and at 164) reject boiling point only once in MP2 or MP3	A03 1 (3)

Question number	Answer	Additional Guidance	Mark
9(b)	0.528/ 0.53 with or without working scores 2 - distance = $R_f \times \text{solvent front distance} / 0.22 \times 2.4$ (1) = 0.528/ 0.53 (cm) (1)	MP1 for rearranged equation or values note : any unambiguous wording accepted in formula If additional calculation steps used, score 0 for whole question. 0.5 scores 2 only with working No ecf for MP2	A02 1 (2)



Question number	Indicative content	Mark
*9(c)	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlines in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. Do not credit separation techniques other than distillation (e.g. crystallisation/ simply evaporating off the water) or additional steps to distillation that would not work. Allow distil off (some) water and then crystallise the remaining (concentrated) sodium chloride solution. Allow fractional distillation. AO1 (6 marks) SODIUM CHLORIDE • ionic compound • giant lattice • positive (sodium) ions and negative (chloride) ions • strong electrostatic attraction between ions • lots of energy to overcome attraction/ bonds WATER • simple covalent/ molecular • strong covalent bonds between atoms in a molecule • weak forces between molecules • little energy needed to overcome the intermolecular forces SEPARATION • use distillation – with condenser or simple apparatus: delivery tube into test tube in ice water • water has much <u>lower</u> boiling point • water will distil but sodium chloride will not • water collected after being condensed • sodium chloride remains in flask	(6) AO1 1 AO1 2



Level	Mark	Descriptor
	0	No rewardable material.
Level 1	1–2	• Demonstrates elements of chemical understanding, some of which is inaccurate. Understanding of scientific ideas lacks detail. (AO1) • Presents an explanation with some structure and coherence. (AO1)
Level 2	3–4	• Demonstrates chemical understanding, which is mostly relevant but may include some inaccuracies. Understanding of scientific ideas is not fully detailed and/or developed. (AO1) • Presents an explanation that has a structure which is mostly clear, coherent and logical. (AO1)
Level 3	5–6	• Demonstrates accurate and relevant chemical understanding throughout. Understanding of the scientific ideas is detailed and fully developed. (AO1) • Presents an explanation that has a well-developed structure which is clear, coherent and logical. (AO1)



Level	Mark	Descriptor	Additional Guidance
	0	No rewardable material.	Read whole answer and ignore all incorrect material/ discard any contradictory material then:
Level 1	1–2	<u>Additional Guidance</u> a basic description of one of the types of bonding or the separation technique	<u>Possible candidate response</u> sodium chloride is ionic (1) use distillation (1) sodium chloride has ionic bonding and water has covalent bonding (2) sodium chloride has strong ionic bonds which take a lot of energy to break (2) heat the mixture and condense the water (2)
Level 2	3–4	<u>Additional Guidance</u> a description of two of the aspects: bonding in NaCl/ intermolecular forces in water/ distillation	<u>Possible candidate response</u> water is a simple molecular covalent compound, there are weak intermolecular forces which take little energy to break but sodium chloride is ionic (3) sodium chloride has ionic bonding, there are strong electrostatic forces of attraction between oppositely charged ions, which take a lot of energy to break and the solution is separated by distillation (3) use distillation because water has a lower boiling point than sodium chloride so water will distil but sodium chloride will not, water can be collected after it has been condensed and the sodium chloride will remain in the flask. This is because sodium chloride is ionic with strong bonds. (4)
Level 3	5–6	<u>Additional Guidance</u> An explanation of both of the types of bonding and of the separation technique	sodium chloride has strong ionic bonds which take a lot of energy to break whereas water has intermolecular forces which does not take a lot of energy to break. Heat the mixture and condense the water, sodium chloride is left in the flask (5) Sodium chloride is ionic, the electrostatic attractions between ions take a lot of energy to break. Water is covalent, not a lot of energy is used to overcome the intermolecular forces. Use distillation because water has a lower boiling point than sodium chloride so water will distil but sodium chloride will not, water can be collected after it has been condensed and the sodium chloride will remain in the flask. (6)



Question number	Answer	Additional Guidance	Mark
10(a)(i)	a description to include • reaction of a metal (1) • with oxygen/ oxidation (1)	allow specified metals ignore 'rusting' allow to form oxide/ air for oxygen ignore mention of water oxidation of a metal scores 2 when a metal oxide forms scores 2	AO1 1 (2)

Question number	Answer	Additional Guidance	Mark
10(a)(ii)	61 000 / 60 923 cm ³ with or without working scores 4 • amount of sodium azide = 110/65 = 1.692... mol (1) • amount of nitrogen = 3/2 x 1.692 = 2.538... mol (1) • volume of nitrogen = 24 x 2.538 = 60.923... dm³ (1) • volume in cm³ = 60.923 x 1000 = 60923/ 61 000 cm³ (1)	allow ecf and correct rounding at each stage 110/130 does not score MP1 but 110/130 x 3 = 2.538 scores MP1 and MP2 130g NaN ₃ → 84g N ₂ then 110g NaN ₃ → 71g N ₂ scores MP1, then mark on MP3 for attempt at moles of nitrogen worked out using data in question x 24 MP4 for attempt at volume of nitrogen worked out using data in question x 1000 Allow 2 s.f. or more 30462 scores 3 40615 scores 3 40.615 scores 2 20308 scores 2 20.308 scores 1	AO2 1 (4)

Question number	Indicative content	Mark
*10(b)	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlines in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. Marks can be awarded for suitable diagrams. AO1 (6 marks) METAL PROPERTIES • good conductors of heat • good conductors of electricity • malleable • ductile • shiny (when pure) • copper is unreactive • aluminium samples are resistant to corrosion due to oxide layer • aluminium has low density ALLOY PROPERTIES • good conductors of heat • good conductors of electricity • malleability is lower than pure metal • ductility lower than pure metal • specific properties of magnalium e.g. low density (ignore light) • specific properties of brass METAL USES • aluminium for cooking foil, food trays • copper for water pipes, electrical wires, roofing ALLOY USES • aluminium alloys for aircraft parts, vehicles, ladders	(6) A01 1



	- copper alloys for coins, brass instruments, jewellery, plug prongs COMPARE/ SIMILARITIES <u>between metal and alloy</u> - both exist as lattices of ions with delocalised electrons - conduct heat because delocalised electrons in both to carry thermal energy - conduct electricity because delocalised electrons in both can move - high melting and boiling points due to strong metallic bonds CONTRAST/ DIFFERENCES <u>between metal and alloy</u> - layers of ions/ atoms/ particles in alloys disrupted - harder for layers to slide - therefore alloys typically stronger, less malleable and less ductile - alloys can be more corrosion resistant - pure aluminium used (e.g. cooking foil) where conducting heat required but strength not needed - aluminium alloy used (e.g aircraft, ladders) where low density required but greater strength of alloy needed - pure copper used (e.g. electrical wires) where conducting electricity needed but high strength not required - copper alloys used (e.g. plug pins) where conducting electricity needed but needs to be harder than pure copper - metals have fixed melting point but alloys a range as a mixture	
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Level	Mark	Descriptor
	0	No rewardable material.
Level 1	1–2	- Demonstrates elements of chemical understanding, some of which is inaccurate. Understanding of scientific ideas lacks detail. (AO1) - Presents an explanation with some structure and coherence. (AO1)
Level 2	3–4	- Demonstrates chemical understanding, which is mostly relevant but may include some inaccuracies. Understanding of scientific ideas is not fully detailed and/or developed. (AO1) - Presents an explanation that has a structure which is mostly clear, coherent and logical. (AO1)
Level 3	5–6	- Demonstrates accurate and relevant chemical understanding throughout. Understanding of the scientific ideas is detailed and fully developed. (AO1) - Presents an explanation that has a well-developed structure which is clear, coherent and logical. (AO1)



Level	Mark	Descriptor	Additional Guidance
	0	No rewardable material.	Read whole answer and ignore all incorrect material/ discard any contradictory material then:
Level 1	1–2	<u>Additional Guidance</u> (Descriptions) A basic description of at least three different properties and/or uses of either aluminium, copper and/or their alloys OR A basic description of the structure of a metal and/or or alloy	<u>Possible candidate response</u> Aluminium (alloy) is used to make aircraft (1) Copper alloys are used to make coins (1) Alloys are stronger than pure metals (1) Copper and aluminium have high melting points. (1) Copper and aluminium conduct electricity and are malleable, and copper is used to make water pipes. (2) Alloys have different sized atoms in their structure so are strong (2)
Level 2	3–4	<u>Additional Guidance</u> (Similarity or difference) A description covering (a) property of metals, (b) a <u>different</u> property of alloys, (c) three uses including at least one metal and at least one alloy. AND An explanation of a similarity or difference.	<u>Possible candidate response</u> Metals are malleable. Alloys are strong. Alloys and metals have high melting points because they have strong metallic bonds. Copper is used to make pipes. (3) Alloys are stronger than metals. This is because alloys have different sized atoms in their structure which stops the layers from sliding. Copper is a good conductor so is used in wires. Copper is also used to make trumpets. Aluminium alloys have low density and are used to make aircraft bodies. (4)
Level 3	5–6	<u>Additional Guidance</u> (Similarity AND difference) One description and one explanation covering at least (a) one similar property of pure metals and alloys, and (b) one difference. Three uses including at least one metal and an at least one alloy given.	<u>Possible candidate response</u> Metals and alloys conduct electricity, but alloys are stronger than metals. This is because alloys have different sized atoms in their structure. Ladders and aircraft are made from aluminium and copper alloys make coins. (5) Metals and alloys conduct electricity, but alloys are stronger than metals. This is because alloys have different sized atoms in their structure which stops the layers from sliding. Copper alloys are used to make coins and brass instruments and aluminium us used to make cooking foil. (6)



Question number	Answer	Additional guidance	Mark
7(a)	Both C it is a transition metal it has a high melting point and D it is a transition metal it forms coloured compounds are correct A and B are incorrect as copper is a transition metal	allow 1 mark for any of the following: C only is marked D only is marked C and D only are marked all other responses score 0	(1) AO1 1

Question number	Answer	Additional guidance	Mark
7(b)	An explanation linking - sacrificial (protection) (1) (because) zinc is more reactive than iron (1) (so) zinc has a greater tendency to produce ions than iron (1)	ignore galvanise allow zinc reacts {more readily / before iron will react / instead of iron} reject zinc rusts for MP3 only allow steel for iron	(3) AO1 1

Question number	Answer	Additional guidance	Mark
7(c)(i)	- scales linear (1) - scales chosen give points that extend over half way in both directions (1) 6 points plotted correctly ($\pm$ half a square) (1) - curve of best fit (1)	ignore dot to dot line curve must go through / close to all points do not accept obvious tramlines for MP4 if numbers taken directly from table, only MP2 and MP4 can score	(4) AO2 1

Question number	Answer	Additional guidance	Mark
7(c)(ii)	value taken from candidates graph at 30% (1)	± half a square	(1) AO3 1

Question number	Answer	Additional guidance	Mark
7(c)(iii)	An explanation linking: - as the % of nickel increases the strength of the alloy increases then decreases (at higher % of nickel) (1) (therefore) the alloy is strongest when the alloy is most disrupted / ratio of different sized atoms is lowest (1) (because) when nickel is added to pure copper {layers/sheets/atoms} are prevented from {slipping/sliding/moving} (1)	allow more difficult (to slide / move etc)	(3) AO2 1

Total for Question 7= 12 marks

