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EDEXCEL GCSE CHEMISTRY: QUESTIONS BY TOPIC

Separate Chemistry 1 (5)

GCSE Chemistry (Foundation) Topic 5

22 questions · 226 marks · Mark schemes included

Pearson Edexcel GCSE (9-1) Chemistry 1CH0, Foundation 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 · 226 marks · lowest tariff first



6-MARK QUESTIONS

1 question in this booklet



- 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.

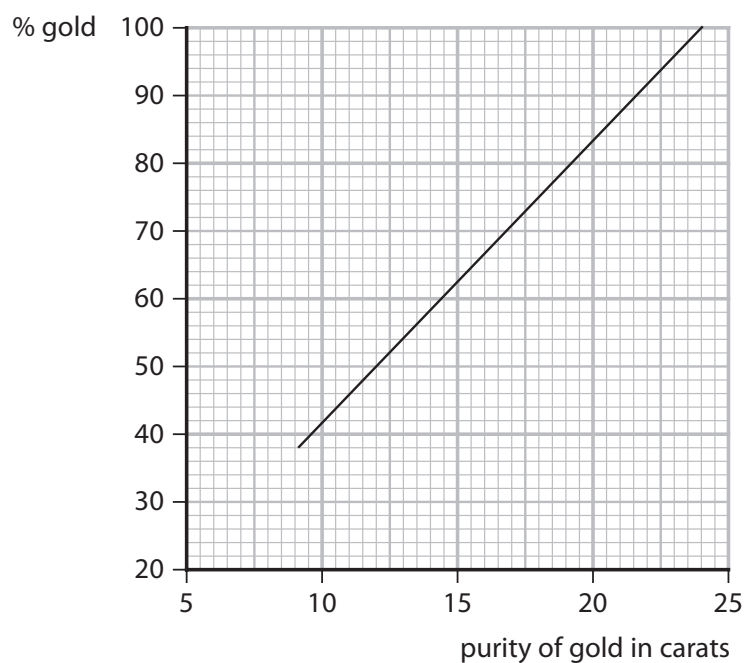


Figure 3

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

(1)

.....

.....

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

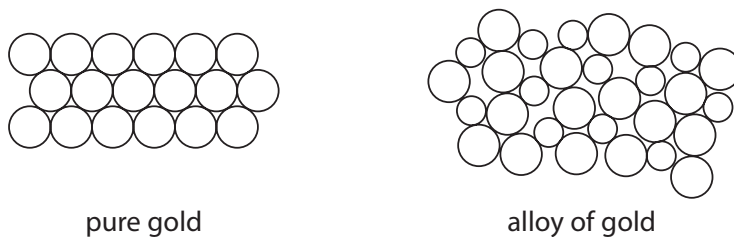


Figure 4

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

(3)

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

(2)

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(Total for Question 2 = 6 marks)



7-MARK QUESTIONS

1 question in this booklet



2 Chemical cells and fuel cells produce a voltage.

- (a) A student sets up a chemical cell by placing two different metal electrodes, magnesium and iron, into a salt solution.

Figure 3 shows an incomplete diagram of the chemical cell used by the student.

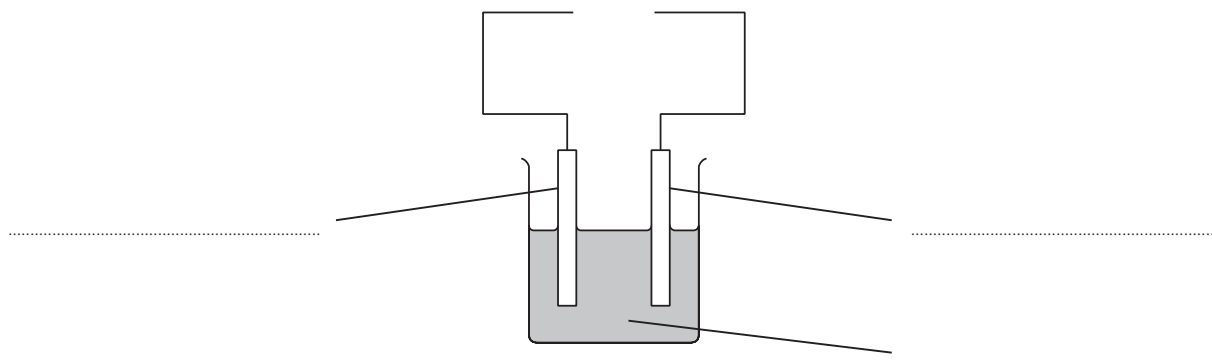


Figure 3

- (i) Complete Figure 3 by adding a suitable piece of apparatus to show that a voltage is produced.

(1)

- (ii) Use words from the box to complete labelling of Figure 3.

electrolyte	magnesium	salt solution
carbon rod	distilled water	iron

(2)

- (iii) Describe what happens to the cell's voltage over a long period of time.

(2)

.....

.....

.....

.....

- (b) One type of fuel cell is the hydrogen-oxygen fuel cell.

Hydrogen-oxygen fuel cells produce water only.

Write the word equation for the reaction.

(2)

..... + ... →

(Total for Question 2 = 7 marks)

8-MARK QUESTIONS

3 questions in this booklet



2 (a) A titration of sodium hydroxide solution with hydrochloric acid can be carried out as follows

- 1 a pipette is used to measure 25.00 cm^3 of sodium hydroxide solution into a conical flask
- 2 a few drops of indicator are added to the sodium hydroxide solution
- 3 the burette is filled with hydrochloric acid
- 4 the hydrochloric acid is added to the sodium hydroxide solution until the indicator changes colour.

(i) Describe how the pipette should be used to measure exactly 25.00 cm^3 of sodium hydroxide solution into the conical flask.

(2)

.....

.....

.....

.....

(ii) The burette is first washed with water.
It is then rinsed with some of the acid before it is filled with the acid to begin the titration.

Explain why the burette is rinsed with the acid.

(2)

.....

.....

.....

.....



(b) Universal indicator solution is not a suitable indicator for an acid-alkali titration.

- (i) Give the name of an indicator that is suitable for use in the titration of sodium hydroxide solution with hydrochloric acid.

(1)

- (ii) Universal indicator goes through a series of gradual colour changes as the pH changes in a solution.

Give a reason why universal indicator is not a suitable indicator to use in an acid-alkali titration.

(1)

- (c) Figure 3 shows some titration results obtained from an experiment in which an alkali is titrated with an acid.

	titration		
	rough	1	2
final burette reading in cm^3	25.75	49.35	23.70
initial burette reading in cm^3	0.00	25.75	0.00
volume of acid used in cm^3	25.75	23.60	23.70

Figure 3

Calculate the accurate volume of acid reacting with the alkali.

(2)

accurate volume of acid reacting cm^3

(Total for Question 2 = 8 marks)



- 3 (a) Hydrogen and oxygen are reactants in some fuel cells.

Which word equation shows the overall reaction that occurs in these fuel cells?

(1)

- ☐ **A** hydrogen + oxygen → hydroxide
- ☐ **B** hydrogen + oxygen → sulfuric acid
- ☐ **C** hydrogen + oxygen → water
- ☐ **D** hydrogen + oxygen → hydrochloric acid

- (b) A torch contains a chemical cell.

The torch is turned on and then left on for many hours.

Describe what you would see happen when the torch is turned on and then left for many hours.

(2)

- (c) A chemical cell can be made by placing two metals into an electrolyte.

Figure 3 shows how the voltage of a simple chemical cell can be measured.

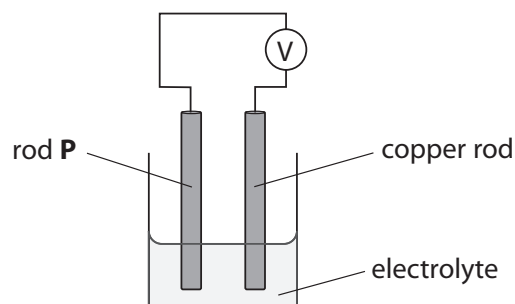


Figure 3

A student investigated how the voltage of this cell was affected by the metal used for the rods.

Which is the only variable that should be changed in the investigation?

(1)

- ☐ **A** the size of the beaker
- ☐ **B** the element used for rod **P**
- ☐ **C** the concentration of the electrolyte
- ☐ **D** the temperature of the electrolyte

(d) (i) Explain why covering iron tools with a thin layer of grease prevents rusting.

(2)

.....

.....

.....

(ii) Sacrificial protection is another way of preventing rusting.

An example of sacrificial protection is when lumps of zinc are connected to the iron-containing structure of an oil rig.

Explain how the zinc protects the iron from rusting.

(2)

.....

.....

.....

(Total for Question 3 = 8 marks)



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.

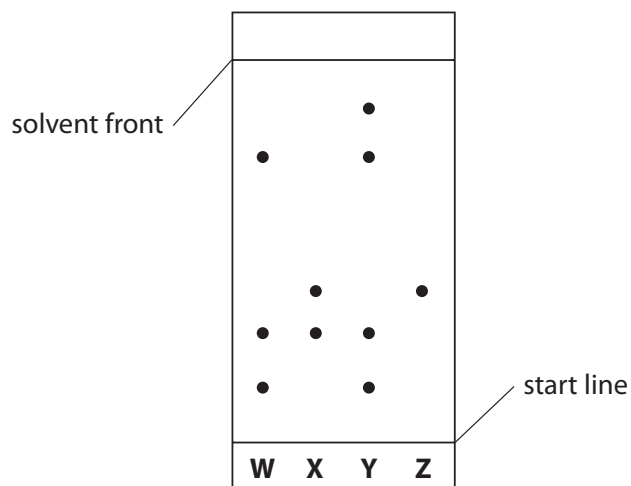


Figure 1

(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)

.....

.....

.....

$R_f =$



- (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.

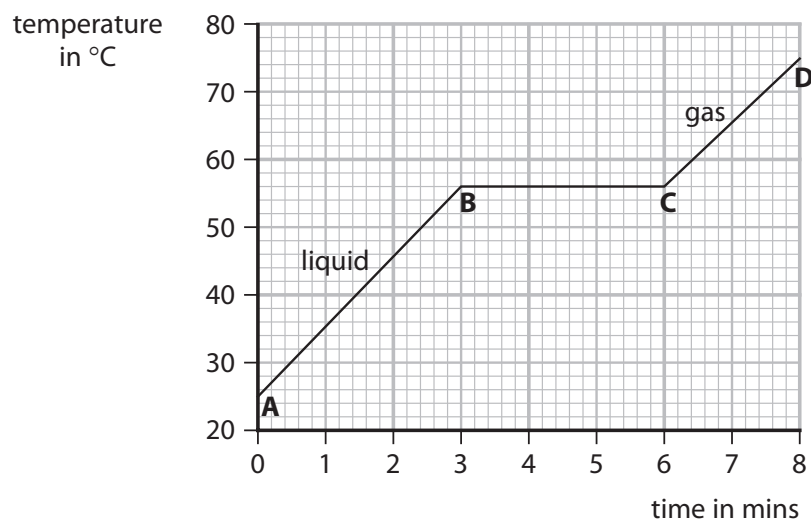


Figure 2

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)

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

(1)

..... °C

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

(1)

..... minutes

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

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

(1)

..... °C

(Total for Question 1 = 8 marks)



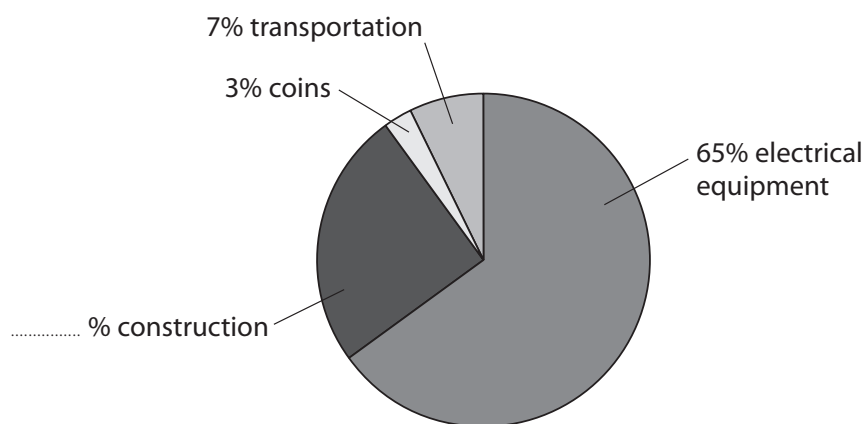
9-MARK QUESTIONS

2 questions in this booklet



5 Transition metals have many uses.

(a) The pie chart in Figure 6 shows the uses of one transition metal.

**Figure 6**

Calculate the percentage of this transition metal used in construction.

(1)

percentage of this transition metal used in construction = ...

(b) Figure 7 shows five statements about iron.

Put ticks (✓) in the boxes in Figure 7 to show which statements are true and which statements are false.

The first one has been done for you.

(3)

	true	false
iron is a poor conductor of heat		✓
iron can act as a catalyst		
iron forms compounds that are coloured		
iron has a low density		
iron has a very high melting point		

Figure 7

(c) Most iron produced is converted into alloys of iron.

(i) State why alloys have more uses than pure metals.

(1)

.....

.....

(ii) An alloy of iron contains 0.40% of molybdenum.

Calculate the mass of molybdenum contained in a 30 g sample of this alloy of iron.

(2)

.....

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.....

.....

mass of molybdenum = ... g



(d) Many transition metals are used to make the reactants in chemical cells.

Figure 8 shows a graph of the voltage produced by a chemical cell as it is used in a torch for many hours.

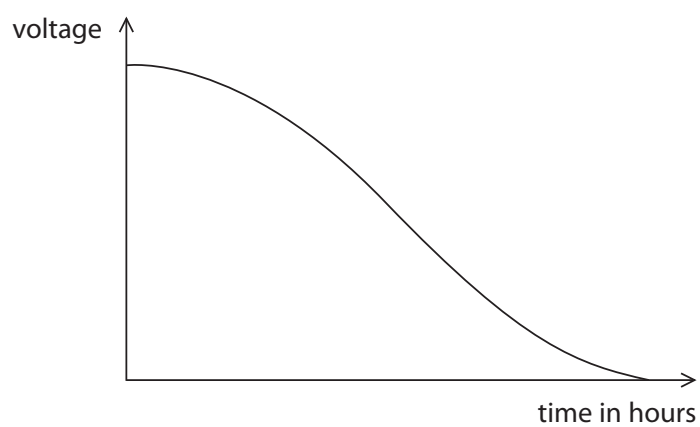


Figure 8

Suggest an explanation for the shape of the graph.

(2)

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(Total for Question 5 = 9 marks)

5 A student makes some ammonium sulfate solution by using a titration.

(a) Which pair of solutions should be used to make the ammonium sulfate solution?

(1)

- ☐ A ammonium solution and concentrated sulfuric acid
- ☐ B ammonia solution and concentrated sulfuric acid
- ☐ C ammonium solution and dilute sulfuric acid
- ☐ D ammonia solution and dilute sulfuric acid

(b) The student uses the following apparatus to make the solution of ammonium sulfate.

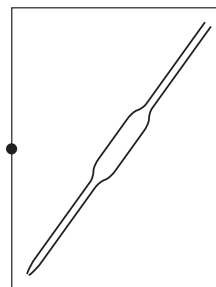
Draw **one** straight line from each apparatus name to the diagram of the apparatus.

(2)

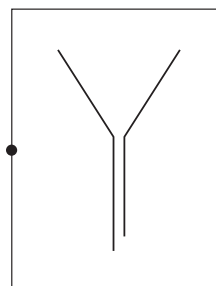
apparatus name

diagram of the apparatus

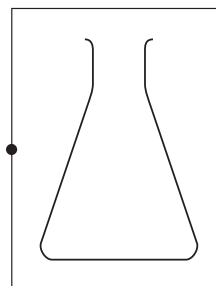
conical flask



filter funnel



pipette



(c) In this titration, the student uses methyl orange as the indicator.

Explain why an indicator is used in a titration.

(2)

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(d) The student carries out a rough titration first.

Figure 9 shows the burette readings at the start and at the end of the titration.

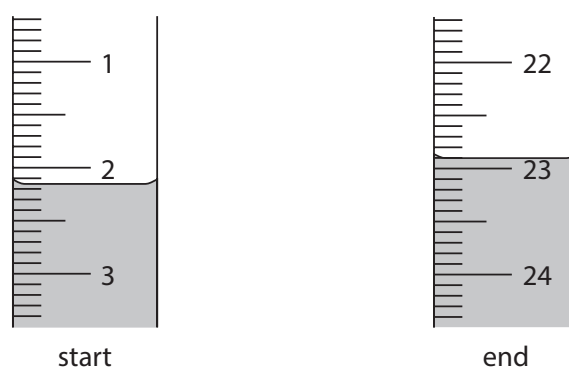


Figure 9

At the start of the titration, the burette reading is 2.15 cm^3 .

Give the reading on the burette at the end of the titration.

(2)

..... cm^3

(e) The student carries out accurate titrations to obtain concordant results.

(i) Figure 10 shows the volume of solution delivered by the burette in the three accurate titrations.

Circle the volumes the student should use to calculate the mean volume.

	titration 1	titration 2	titration 3
volume in cm^3	20.00	20.10	20.25

Figure 10

(1)

(ii) Using the volumes that you have circled, calculate the mean volume of solution delivered by the burette.

(1)

.....

.....

mean volume of solution = ... cm^3

(Total for Question 5 = 9 marks)



10-MARK QUESTIONS

2 questions in this booklet



- 4 A student wanted to find the volume of dilute hydrochloric acid that would react with 25.0 cm^3 of lithium hydroxide solution.

They used the equipment in Figure 7 to carry out a rough titration and then a further two accurate titrations.

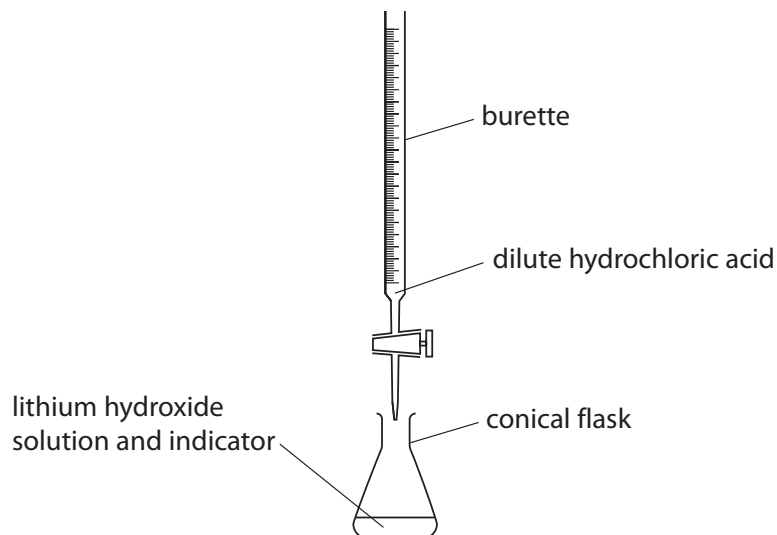


Figure 7

- (a) Suggest why the student carried out a rough titration before the two accurate titrations.

(1)

- (b) Figure 8 shows the results of the rough titration.

final reading on burette in cm^3	30.10
initial reading on burette in cm^3	2.50

Figure 8

What was the volume of acid added in the rough titration?

(1)

- ☐ A 2.50 cm^3
- ☐ B 27.60 cm^3
- ☐ C 30.10 cm^3
- ☐ D 32.60 cm^3

- (c) Describe how the rough titration should be carried out once the dilute hydrochloric acid, lithium hydroxide solution and indicator are placed in the apparatus in Figure 7.

(4)

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- (d) Which is the name of an indicator that is suitable to use in this titration?

(1)

- ☐ **A** limewater
- ☐ **B** litmus paper
- ☐ **C** methyl orange
- ☐ **D** universal indicator

- (e) During the titration the dilute hydrochloric acid, HCl, is reacting with the lithium hydroxide solution, LiOH.

Explain what type of reaction is taking place in the titration.

(3)

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(Total for Question 4 = 10 marks)



- 4 A student was asked to find the volume of lithium hydroxide solution that would react exactly with 25.0 cm^3 of dilute hydrochloric acid.

The student used the equipment in Figure 6 to carry out a rough titration and then a further three accurate titrations.

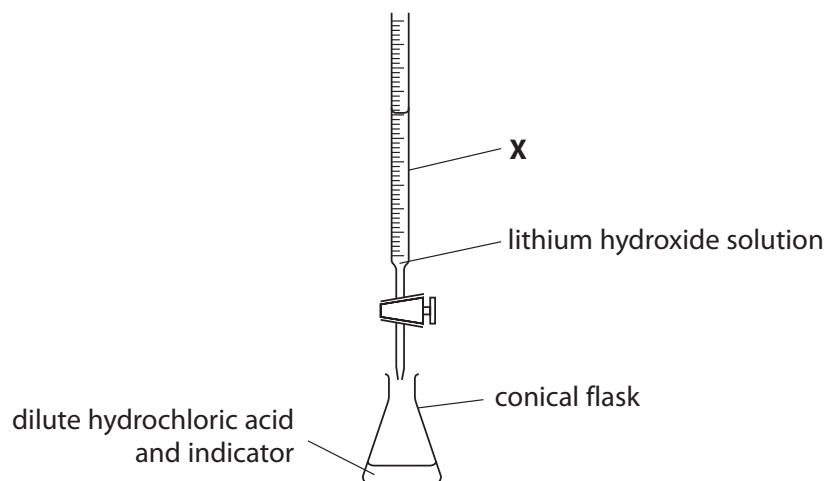


Figure 6

- (a) (i) Which is the name of the piece of equipment labelled **X** in Figure 6?

(1)

- ☐ **A** boiling tube
- ☐ **B** burette
- ☐ **C** funnel
- ☐ **D** measuring cylinder

- (ii) Describe how the student should measure the 25.0 cm^3 of dilute hydrochloric acid accurately into the conical flask.

(2)

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(b) Figure 7 shows the results of the student's titrations.

	rough titration	accurate titration 1	accurate titration 2	accurate titration 3
final reading on X in cm ³	29.15	28.20	27.30	27.60
initial reading on X in cm ³	1.50	3.50	2.50	3.00
volume of lithium hydroxide solution added in cm ³		24.70	24.80	24.60

Figure 7

- (i) Calculate the volume of lithium hydroxide solution added in the **rough** titration.

(1)

.....

.....

volume of lithium hydroxide solution = ... cm³

- (ii) Calculate the mean volume of lithium hydroxide solution used in the **accurate** titrations.

(2)

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.....

.....

mean volume of lithium hydroxide solution = ... cm³

- (c) Methyl orange indicator was added to dilute hydrochloric acid in the conical flask in the titration.

What colour change would be seen in the conical flask at the end point of the titration?

(1)

- ☐ **A** blue to green
- ☐ **B** colourless to black
- ☐ **C** red to orange
- ☐ **D** white to pink



(d) During the titration, lithium hydroxide solution, LiOH, reacts with dilute hydrochloric acid, HCl, to form lithium chloride, LiCl, and water.

(i) Write the balanced equation for the reaction.

(2)

..... + ... → + ...

(ii) State the name of this type of reaction.

(1)

.....

(Total for Question 4 = 10 marks)



11-MARK QUESTIONS

7 questions in this booklet



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

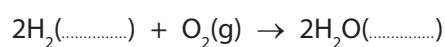
(i) The boiling points of hydrogen and water are shown in Figure 15.

	boiling point in °C
hydrogen	–253
water	100

Figure 15

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%.

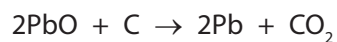
(1)

.....

.....

(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)

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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)

.....

.....

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.....

.....

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 10 = 11 marks)



- 10** Potassium hydroxide reacts with hydrochloric acid to form potassium chloride and 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)

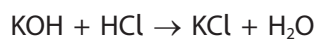
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(iv) The equation for the reaction between potassium hydroxide solution and dilute hydrochloric acid is



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 10 = 11 marks)



10 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 12 shows a graph of the relative strength of aluminium-magnesium alloys when the percentage by mass of magnesium in the alloy is changed.

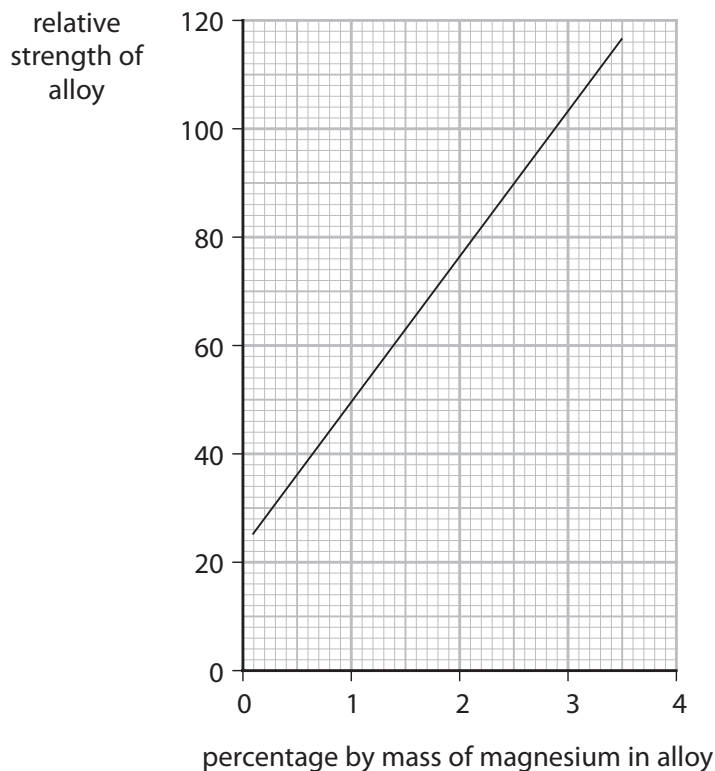


Figure 12

- (i) Describe what Figure 12 shows about the relative strength of these alloys when the percentage by mass of magnesium changes.

(2)

.....

.....

.....

- (ii) Determine, using Figure 12, 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 10 = 11 marks)



10 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 16.

	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 16

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 16 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)

.....

.....

.....

.....

(Total for Question 10 = 11 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)

.....

.....

.....

relative formula mass = ...



- (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)

.....

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

(1)

.....

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

(2)

.....

.....

.....

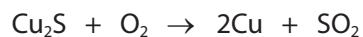
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10 There are several stages to the production of sulfuric acid in industry.

(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.



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)

.....

.....

.....

.....

atom economy = ... %

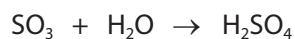
(b) In one stage vanadium oxide, V_2O_5 , is used.

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 10 = 11 marks)



10 (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 16.

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

Figure 16

Use the information in Figure 16 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%.

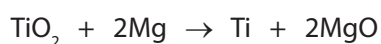
(2)

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.

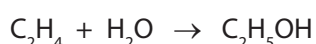
(relative atomic masses: O = 16, Mg = 24, Ti = 48)

(3)

atom economy = ...%

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

- by the hydration of ethene, C₂H₄



atom economy = 100%

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



atom economy = 51.1%

(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 10 = 11 marks)



12-MARK QUESTIONS

4 questions in this booklet



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(b) Iron objects can corrode when exposed to the atmosphere.

(i) Corrosion involves the oxidation of iron.

State what is meant by **oxidation**.

(1)

.....

.....

.....

(ii) Painting iron objects prevents corrosion.

Explain why painting iron objects prevents corrosion.

(2)

.....

.....

.....

.....

(iii) Corrosion of iron objects can be prevented by painting them or by electroplating them.

State one **other** way of preventing the corrosion of iron objects.

(1)

.....



(c) The apparatus shown in Figure 13 was used to electroplate a spoon with nickel.

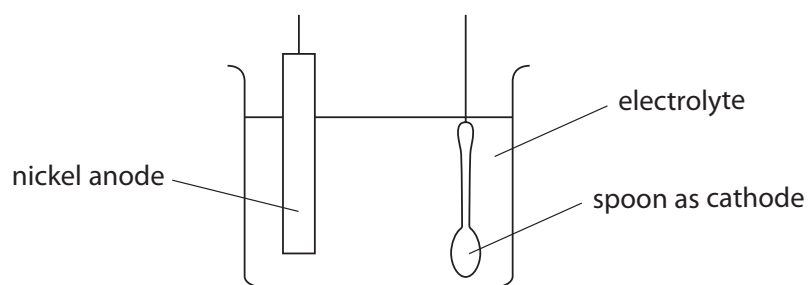


Figure 13

- (i) State to what the anode and cathode have to be connected in order to carry out the electroplating.

(1)

- (ii) Predict the name of a substance that could be dissolved in water to form the electrolyte for this electroplating.

(1)

(Total for Question 7 = 12 marks)

7 (a) Iron rusts when it is left in certain conditions.

(i) Figure 9 shows the apparatus used to investigate the rusting of some iron nails.

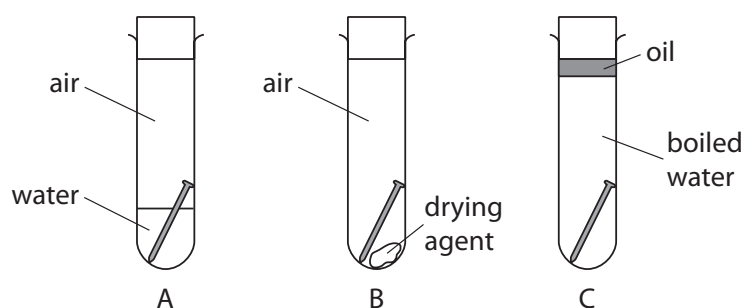


Figure 9

Explain why the iron nail in tube A would rust but the iron nails in tubes B and C would not rust.

(3)

.....

.....

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- (ii) Magnesium is more reactive than iron.
Figure 10 shows an iron nail with a strip of magnesium wrapped around it,
placed in some water.
The tube was left for a few days.

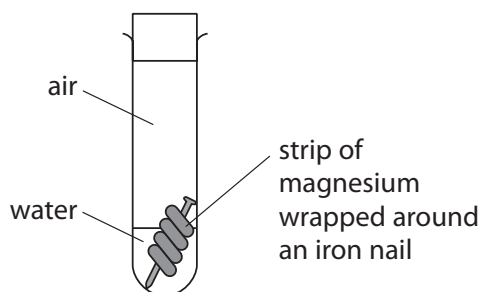


Figure 10

State what would happen to this iron nail.

(1)

- (iii) When iron rusts, a brown solid forms on the surface of the iron.

What happens to the iron as the rust forms?

(1)

- ☐ A the iron is hydrated
- ☐ B the iron is neutralised
- ☐ C the iron is oxidised
- ☐ D the iron is reduced

- (b) Give **one** reason why metals are electroplated.

(1)

*(c) The pure metals aluminium, copper and gold and the alloys brass and magnalium are used to make many useful articles.

The way in which these metals and alloys are used is related to their properties, such as their density, electrical conductivity, resistance to corrosion and strength.

State some uses of aluminium, copper, gold, brass and magnalium and explain how each use is related to their properties.

(6)



(Total for Question 7 = 12 marks)



- 7 (a) When iron wool reacts with oxygen from the air, the iron corrodes and iron oxide is formed.

What happens to the iron in this reaction?

(1)

- ☐ A it is decomposed
- ☐ B it is neutralised
- ☐ C it is oxidised
- ☐ D it is reduced

- (b) A piece of damp iron wool was placed in a measuring cylinder with 50 cm³ of air, as shown in Figure 12.

Figure 13 shows the apparatus one week later.

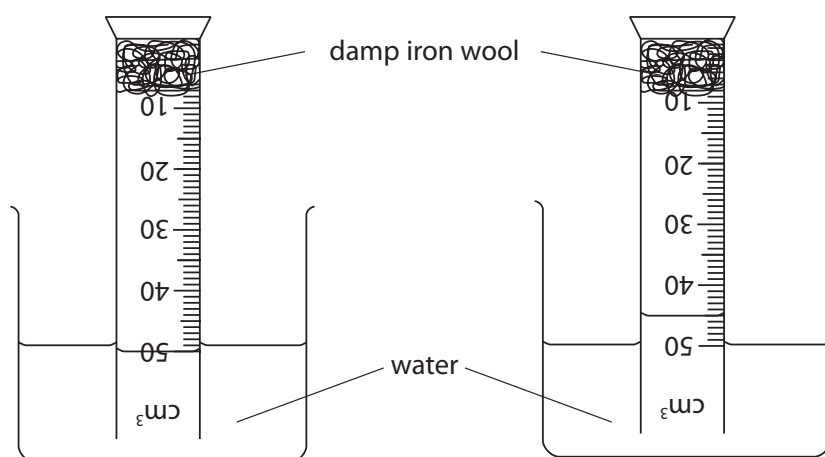


Figure 12

Figure 13

- (i) Complete the table of results.

(1)

volume of gas in Figure 12 in cm ³	50
volume of gas in Figure 13 in cm ³	

- (ii) Use these results to calculate the percentage decrease in the volume of gas in the measuring cylinder after one week.

(3)

.....

.....

.....

percentage decrease in volume of gas = ...

- (iii) Not all of the oxygen in the air in the measuring cylinder has reacted with the iron.

Give a reason why.

(1)

.....

.....



* (c) Pure metals can be made more useful by converting them into alloys or by electroplating them.

Explain what alloying and electroplating are and how they can make metals more useful.

(6)

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(Total for Question 7 = 12 marks)



7 (a) A student investigated the rusting of iron rods using the following method.

step 1 find the mass of two identical iron rods

step 2 wrap magnesium ribbon around one of the iron rods

step 3 place each rod in separate boiling tubes containing 10 cm³ of water

step 4 leave the iron rods for one week

step 5 find the new mass of the iron rods.

Figure 10 shows the apparatus used.

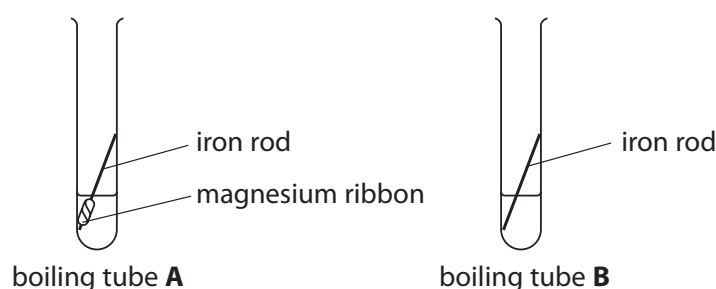


Figure 10

Figure 11 shows the results of the investigation.

	initial mass of iron rod in g	final mass of iron rod in g	change in mass in g
boiling tube A	7.00	7.00	0.00
boiling tube B	7.00	7.56	

Figure 11

- (i) Use the results in Figure 11 to calculate the percentage increase in the mass of the iron rod in boiling tube B.

$$\% \text{ increase} = \frac{\text{change in mass}}{\text{initial mass}} \times 100$$

(3)

.....

.....

.....

percentage increase in mass of iron rod = ...

(ii) Which gas from the air has reacted with the iron rod in boiling tube **B**?

(1)

- ☐ **A** argon
- ☐ **B** carbon dioxide
- ☐ **C** nitrogen
- ☐ **D** oxygen

(iii) The iron rod did not rust in boiling tube **A**.

Explain why.

(2)

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.....



*(b) Figure 12 shows some uses of copper metal.



Figure 12

Describe how the properties of copper metal make it a suitable material for the uses shown.

Your answer should include

- uses of copper metal shown in the photographs
- properties of copper metal including:
 - chemical reactivity
 - electrical conductivity
 - malleability
 - thermal conductivity

(6)

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(Total for Question 7 = 12 marks)



13-MARK QUESTIONS

2 questions in this booklet



7 (a) This question is about the metal gold.

(i) Gold can be hammered into shape.

State the name of this property.

(1)

(ii) Gold alloys can be used to repair teeth.

One reason that gold alloys are used is that they can be hammered into shape.

Give **one other** reason why gold alloys are used to repair teeth.

(1)

(b) A gold alloy contains 78 % gold by mass.

Calculate the mass of gold in 2.00 kg of this alloy.

Give your answer in grams.

(3)

mass = ... g



- (c) A substance used to purify gold is kept in a container.
There are some hazard symbols on the container.

Draw one straight line from each hazard symbol to its meaning.

(2)

hazard symbol



meaning

corrosive

flammable

hazardous to the
environment

oxidising

*(d) Some gold alloys contain copper.

Copper reacts with oxygen when heated.



A teacher calculates that 1.20g of copper reacts completely with oxygen to form 1.50g of copper oxide.

A student heats 1.20g of copper pieces in a container.
Then they heat 1.20g of copper powder in another container.
After heating, the mass of the solid in the containers is found.

The results are shown in Figure 7.

	colour before heating	mass before heating in g	time of heating in mins	colour after heating	mass after heating in g
copper pieces	red-brown	1.20	5	black	1.28
copper powder	red-brown	1.20	10	black	1.42

Figure 7

Explain the observations and give reasons why the masses after heating are less than expected.

(6)

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(Total for Question 7 = 13 marks)



7 This question is about the transition metals iron and copper.

(a) When iron rods are left out in the rain for a few weeks, the rods corrode and become covered in a brown solid.

(i) State the name of this brown solid.

(1)

(ii) Place ticks (✓) in boxes to show which **two** substances in the air react with iron to form the brown solid.

(2)

substance	(✓)
neon	
carbon dioxide	
nitrogen	
oxygen	
water vapour	

(iii) State **one** way to prevent the corrosion of iron rods that will be used outside.

(1)

(iv) In an experiment, 5 iron rods were left outside in the rain for a few weeks.

The mass of the iron rods was found before they were left outside and again after a few weeks.

Figure 12 shows the recorded masses.

mass of 5 iron rods before being left outside	3.75 g
mass of 5 iron rods after being outside for a few weeks	4.53 g

Figure 12

Use this information to calculate the mean increase in mass of **one** iron rod.

(2)

mean increase in mass of one iron rod = ... g



(b) Figure 13 shows the atoms in pure gold and in a gold alloy.

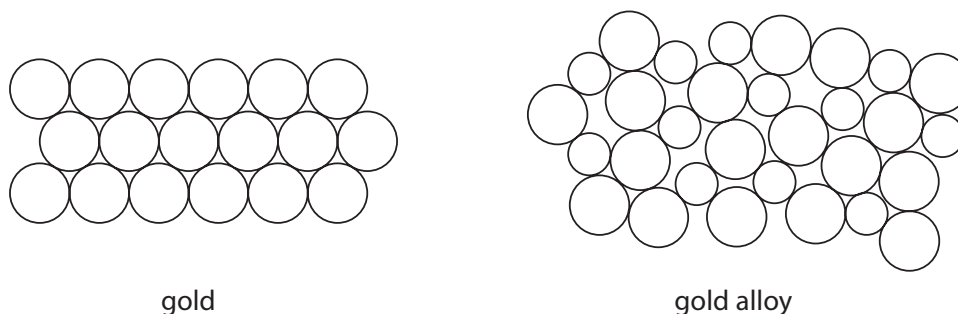


Figure 13

(i) State the meaning of the term **alloy**.

(1)

*(ii) Using Figure 13, compare pure gold and the gold alloy by

- describing how their atoms are arranged
- explaining the differences between the strength of the pure gold and the gold alloy.

(6)

(Total for Question 7 = 13 marks)



MARK SCHEMES

official Pearson Edexcel mark schemes



Question number	Answer	Additional guidance	Mark
2(a) Group A	the higher the {(number of) carats / purity}, the greater the percentage of gold (OWTTE)		A03-1 (1)

Question number	Answer	Additional guidance	Mark
2(b) Group A	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)	allow 'they' to mean gold alloys allow ions / particles allow regular arrangement allow slip / move for 'slide' allow atoms roll	A02-1 (3)

Question number	Answer	Additional guidance	Mark
2(c) Group A	an explanation linking a property with a suitable reason (gold is) unreactive (1) - so will not react with skin / will not corrode (1) OR - malleable (1) - so can be shaped (1) OR - shiny (1) - looks attractive owtte (1)	mark independently ignore references to cost and irrelevant properties allow will not react with oxygen / water / other household substances allow will not tarnish ignore rust ignore corrosive allow ductile in place of malleable ignore references to colour	A02-1 (2)

Total for Question 2 = 6 marks



Question number	Answer		Mark
2(a)(i)	(symbol for) voltmeter  / lamp 	mark is for knowledge of piece of apparatus, so allow any clear indication of lamp/ voltmeter even if symbol or wiring incorrect ignore any other apparatus including ammeter	(1) AO2-2

Question number	Answer	Additional guidance	Mark
2(a)(ii)	one electrode: 'magnesium' / Mg one electrode: 'iron' / Fe liquid: label 'salt solution' / 'electrolyte' all 3 labels correct (2) 1 or 2 labels correct (1)	allow incorrect case e.g. MG allow incorrect case e.g. fe ignore chemical name/ formula for liquid label	(2) AO2-2

Question number	Answer	Additional guidance	Mark
2(a)(iii)	A description including (it / voltage) decreases (1) - to zero (1)	must say zero or equivalent – ignore statements such as 'until reaction finished' ignore any attempts at explanation, correct or otherwise	(2) AO1-1

Question number	Answer	Additional guidance	Mark
2(b)	hydrogen + oxygen → (1) → water (1)	reject if additional reactants reject hydrogen oxide/ hydroxide or if additional products allow $2\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O}$ (2) all three formulae correct but incorrect balancing scores 1 allow incorrect format of capital letters and subscripts if symbols and words both given, ignore symbols	(2) AO2-1

Total for Question 2 = 7 marks



Question Number	Answer	Additional guidance	Mark
2(a)(i)	A description including any two from : • use a pipette filler (1) • wash pipette with sodium hydroxide solution (1) • draw the liquid up so (the bottom of the meniscus) touches the line (1)		(2) AO 1 2

Question Number	Answer	Additional guidance	Mark
2(a)(ii)	An explanation linking any two from : • to remove water from the burette (1) • because this would dilute the original acid (1) • this will give an inaccurate result / ORA (1)	ignore to avoid contamination ignore to kill bacteria	(2) AO 1 2

Question Number	Answer	Additional guidance	Mark
2(b)(i)	phenolphthalein / methyl orange	allow litmus / screened methyl orange / methyl red ignore litmus paper ignore pH meter/probe	(1) AO 2 2

Question Number	Answer	Additional guidance	Mark
2(b)(ii)	it does not show sharp colour change at end point / not known which colour change gives correct end point	ignore goes through a series of gradual colour changes allow does not have a definite end point	(1) AO 3 1b

Question Number	Answer	Additional guidance	Mark
2(c)	23.65 with or without working scores 2 OR $\frac{23.60 + 23.70}{2} (1)$ $= 23.65 (1)$	allow 1 mark for all 3 averaged (24.35)	(2) AO 3 2a AO 3 2b

(Total for Question 2 = 8 marks)

Question number	Answer	Mark
3(a)	C hydrogen + oxygen → water is the only correct answer A, B and D are incorrect as water is the product	(1) AO1

Question number	Answer	Mark
3(b)	A description to include any two from • bright light at start (1) • fades/ gets dimmer (1) • then goes out (1)	(2) AO2

Question number	Answer	Mark
3(c)	B the element used for rod P is the only correct answer A, C and D are incorrect because the electrode material must be changed	(1) AO2

Question number	Answer	Mark
3(d)(i)	An explanation including any two from • air/oxygen excluded (1) • water excluded (1) • air/oxygen/water needed for corrosion (1)	(2) AO2

Question number	Answer	Mark
3(d)(ii)	An explanation including • zinc is more reactive (than iron) (1) • so reacts instead (1)	(2) AO1

Question number	Answer	Mark
1(a)(i)	D Z is the only correct answer. A , B and C are incorrect because they have more than one spot	A01-1 (1)

Question number	Answer	Mark
1(a)(ii)	C Y is the only correct answer. A , B and D are incorrect because those inks have fewer spots	A03-1 (1)

Question number	Answer	Additional guidance	Mark
1(a)(iii) Group B	0.39 scores 2 marks with or without working $\frac{3.60}{9.20} = 0.39(1304\dots)$ (1) = 0.39 (1) (rounded to 2dp)	fraction $\frac{9}{23}$ scores 1 mark 1 mark for correct substitution and evaluation $\frac{3.60}{9.20} = 0.4$ scores 1 only for correct evaluation to 1dp Note: 0.4 alone without working scores 0 1 mark for correct rounding (has to use the numbers 3.60 and 9.20 in the calculation) $\frac{9.20}{3.60} = 2.5\mathbf{6}$ scores 1 (for 2dp) Note: by default $3.60 \times 9.20 = 33.12$ has an answer to 2dp, so 2 nd mark is given	A02-1 (2)



Question number	Answer	Additional guidance	Mark
1(b)(i)	evaporation / evaporating	allow boiling / vaporisation do not allow boiling <u>point</u> / bpt	A01-1 (1)

Question number	Answer	Additional guidance	Mark
1(b)(ii)	56 (°C)		A03-1 (1)

Question number	Answer	Additional guidance	Mark
1(b)(iii)	6 (minutes)		A03-1 (1)

Question number	Answer	Additional guidance	Mark
1(b)(iv)	answers between 49 and 51 score 1 mark with or without working. 75 – 25 = 50 (1)	allow readings between 74 and 76	A03-1 (1)

Total for Question 1 = 8 marks



Question number	Answer	Additional guidance	Mark
5(a)	100 – 65 – 7 – 3 (1) (= 25)	25 alone scores 1	(1)

Question number	Answer			Additional guidance	Mark
5(b)		true	false	(first tick given) 4 correct ticks = 3 marks 3 or 2 correct ticks = 2 marks 1 correct tick = 1 mark	(3)
	iron is a poor conductor of heat		✓		
	iron can act as a catalyst	✓			
	iron forms compounds that are coloured	✓			
	iron has a low density		✓		
	iron has a very high melting point	✓			

Question number	Answer	Additional guidance	Mark
5(c)(i)	alloys stronger / pure metals weaker / alloys more corrosion resistant	ignore harder ignore 'more desirable properties'	(1)

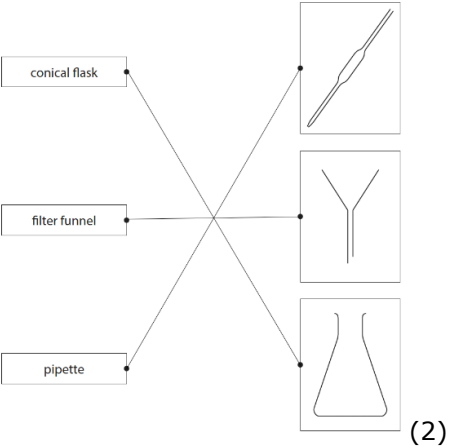
Question number	Answer	Additional guidance	Mark
5(c)(ii)	0.40×30 (1) (= 12) $\frac{12}{100}$ (1) (= 0.12)(g)	0.12 (g) without working (2)	(2)

Question number	Answer	Additional guidance	Mark
5(d)	An explanation linking - voltage decreases - as {reactant / transition metal} used up	allow highest rate of reaction at the beginning of the reaction gives most voltage (1) allow reaction is complete when voltage = 0 (1)	(2)

Total for Question 5 = 9 marks



Question number	Answer	Mark
5(a)	C ammonia solution and dilute sulfuric acid is the only correct answer A & B are not correct because concentrated sulfuric acid would not be used in a titration D is not correct because ammonium solution is not the correct name for ammonia solution	(1) AO1-2

Question number	Answer	Additional guidance	Mark
5(b)	 (2)	three correct lines scores 2 one or two correct lines scores 1 if there is more than one line from any box then ignore those lines (including any correct line from that box) and mark what remains	(2) AO1-2

Question number	Answer	Additional guidance	Mark
5(c)	An explanation linking - colour <u>change</u> (1) (to show that) the acid has been neutralised / shows when neutralisation occurs / at end point (1)	allow it is a different colour in acid and alkali / to see if it is an acid or alkali allow goes from colour 1 to colour 2 even if colours incorrect allow to see when {reaction/ titration} finished	(2) AO1-1

Question number	Answer	Additional guidance	Mark
5(d)	22.90 (2)	mark is for reading the value, so even if answer goes on to do a calculation, award 2 if 22.90 seen 22.9 seen (1)	(2) AO2-1

Question number	Answer	Additional guidance	Mark						
5(e)(i)	<table><tr><th>titration 1</th><th>titration 2</th><th>titration 3</th></tr><tr><td>20.00</td><td>20.10</td><td>20.25</td></tr></table>	titration 1	titration 2	titration 3	20.00	20.10	20.25		(1) AO2-1
	titration 1	titration 2	titration 3						
	20.00	20.10	20.25						
(1)									

Question number	Answer	Additional guidance	Mark
5(e)(ii)	Mark depends on (e)(i), which if correct: $(20.00 + 20.10) / 2 = 20.05$ (1)	must mark answer depending on 5(e)(i) if only no or one value circled in 5(e)(i) only 20.05 scores if two values circled in 5(e)(i), then: 1 and 2: mean = 20.05 scores 1 and 3: mean = 20.125/ 20.13 scores 2 and 3: mean = 20.175/ 20.18 scores if all three value circled in 5(e)(i) mean = 20.1166666666....= 20.12/ 20.117 scores answers in every case must be 2 or more d.p.	(1) AO1-1

Total for Question 5 = 9 marks



Question number	Answer	Additional guidance	Mark
4(a)	so the student knows where to slow the flow (of acid) on the second and third attempt / so that the student has an {estimate / idea} of the volume (of acid needed)	ignore to make it more accurate / to see if method works ignore to make it a fair test ignore as a practice run allow {how much / amount} for volume	(1) A01-2

Question number	Answer	Mark
4(b)	B 27.60 is the only correct answer A is incorrect as this is the initial reading on the burette C is incorrect as this is the final reading on the burette D is incorrect as the values have been added rather than subtracted	(1) A02-1

Question number	Answer	Additional guidance	Mark
4(c)	a description including any four from: • read the (initial) volume on the burette (1) • open the tap / add acid to {alkali/flask} (1) • swirl the mixture (1) • until end point / until indicator changes colour (1) • (close tap then) read (final) volume of acid in burette (1)	allow initial burette reading allow add HCl to LiOH allow open tap ignore dropwise / drop by drop allow any change of colour given allow final burette reading	(4) A01-1



Question number	Answer	Mark
4(d)	C methyl orange is the only correct answer A is incorrect as it tests for carbon dioxide/not an acid-alkali indicator. B is incorrect as no distinct/discrete change of colour D is incorrect as the colour change is not clear enough	(3) A02-2

Question number	Answer	Additional guidance	Mark
4(e)	an explanation linking: - neutralisation reaction (1) {hydrogen ions / H^+} react with {hydroxide ions / OH^-} (1) - to form water (1)	allow reaction between an acid and a {base/alkali} allow acid + alkali (1) $\rightarrow$ salt + water (1) $H^+ + OH^-$ (1) $\rightarrow$ H_2O (1)	(3) A02-1

Question number	Answer	Mark
4(a)(i)	B burette is the only correct answer A, C and D are not correct as X is a burette	(1) AO1-2

Question number	Answer	Additional guidance	Mark
4(a)(ii)	A description to include - use a pipette (1) then any one from - rinse (pipette) with dilute hydrochloric acid (1) - draw solution up to line (of pipette) (1) - touch tip (of pipette) on side of conical flask (1)	allow use of syringe - max 1 allow burette (1) and any one from then any one from - rinse with dilute hydrochloric acid (1) - fill burette with acid using a funnel (1) - fill jet below tap with acid (1) - manipulation of tap to deliver exact volume (of acid) (1) - adding acid slowly (to the flask) (1) - read burette volumes from bottom of meniscus (1) ignore use of measuring cylinder	(2) AO1-2

Question number	Answer	Additional guidance	Mark
4(b)(i)	$29.15 - 1.50 = 27.65 \text{ (cm}^3\text{)}$		(1) AO1-2



Question number	Answer	Additional guidance	Mark
4(b)(ii)	24.7(0) with or without working scores 2 $24.70 + 24.80 + 24.60 = 74.1$ (1) $\frac{74.1}{3} = 24.7(0)$ (1)	allow $27.65 + 24.70 + 24.80 + 24.60 = 101.75$ (0) then $\frac{101.75}{4} = 25.4375$ (1) / or correctly rounded to a min of 3 sig figs	(2) A03-1

Question number	Answer	Mark
4(c)	C red to orange is the only correct answer A , B and D are incorrect as the colour change is red to orange	(1) A01-2

Question number	Answer	Additional guidance	Mark
4(d)(i)	$\text{LiOH} + \text{HCl} \rightarrow \text{LiCl} + \text{H}_2\text{O}$ LHS (1) RHS (1)	allow reactants and products in either order allow multiples incorrect balancing max 1	(2) A02-1

Question number	Answer	Additional guidance	Mark
4(d)(ii)	neutralisation	allow acid-base / exothermic	(1) A01-1

Total for Question 4 = 10 marks



Question Number	Answer	Mark
10(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
10(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
10(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 : $2 \times 207 = 414$ $\frac{414}{458} (1) \times 100 (1) (= 90.39)$ 458 $= 90 (1)$	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
10(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 x 100 (1) 153.84.... scores 1	(2) AO 2 1

Question Number	Answer	Additional guidance	Mark
10(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 10 = 11 marks)

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

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

Question number	Answer	Additional guidance	Mark
10(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 dependent on MP1 allow original mixture was contaminated by indicator so doesn't form a pure salt (2)	(2)

Question number	Answer	Additional guidance	Mark
10(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
10(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
10(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)

Total for Question 10 = 11 marks



Question number	Answer	Additional guidance	Mark
10(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
10(b)	$\frac{2.00}{100} \times 695.0 \text{ (1) (= 13.9)}$ $695.0 - 13.9 \text{ (1) (= 681.1 (g))}$ OR $\frac{98.00}{100} \text{ (1) } \times 695.0 \text{ (1) (= 681.1 (g))}$	award full marks for correct final answer without working allow 2 or more sig.fig.	(2) AO2

Question number	Answer	Additional guidance	Mark
10(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
10(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
10(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 10 = 11 marks)

Question number	Answer	Additional guidance	Mark
10(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) A01-1

Question number	Answer	Additional guidance	Mark
10(a)(ii)	$\frac{8.07}{53.80}$ (1) (= 0.15) 0.15×100 (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) A03-1a

Question number	Answer	Additional guidance	Mark
10(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) A01-1



Question number	Answer	Additional guidance	Mark
10(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) A02-1
Question number	Answer	Additional guidance	Mark
10(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) A02-1



Question number	Answer	Mark
4(a)(i)	D oxygen is the only correct answer A , B and C are incorrect because they are not required for corrosion to occur.	A01-1 (1)

Question number	Answer	Mark
4(a)(ii)	C the iron has been oxidised is the only correct answer A , B and D are incorrect because in corrosion the metal is oxidised.	A01-1 (1)

Question number	Answer	Additional guidance	Mark
4(b) Group B	162.5 with or without working scores 2 marks 56 + 35.5 + 35.5 + 35.5 (1) = 162.5 (1)	allow 91.5 scores 1 mark	A01-1 (2)

Question number	Answer	Additional guidance	Mark
4(c)(i)	carbon	allow C, c	A03-1 (1)

Question number	Answer	Additional guidance	Mark
4(c)(ii)	chromium	Allow Cr, cr, CR, cR	A03-1 (1)



Question number	Answer	Additional guidance	Mark
4(c)(iii) Group A	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) OR • sacrificial protection (1) • the more reactive metal corrodes instead of iron (1)	allow waterproof as an alternative for preventing water reaching the iron allow • electroplate / plate with another metal (1) • prevents {oxygen / water} reaching the iron (1)	A01-1 (2)

Question number	Answer	Additional guidance	Mark
4(d) Group A	a plan to include • put nails in boiling tubes with water (1) • leave for some time (1) • observe which nail forms rust {first / most} (1)	if answers introduce further variables to one tube then MP1 cannot score. allow any idea of time passing – even if too short for corrosion allow colour change for rust	A03-3 (3)

Total for Question 4 = 11 marks



Question number	Answer	Additional guidance	Mark
10(a) Group A	final answer of 34 with or without working scores 4 total mass = 191 (1) $\frac{64}{191} = 0.33507 \text{ (1)}$ x 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 x 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 x 100 = 17 scores 3 191/64 x 100 = 298 scores 2 64/127(.5) x 100 = 50 scores 3 191/191 x 100 = 100 scores 1	A02-1 (4)

Question number	Answer	Mark
10(b)	D 1910 orange is the only correct answer. A, B and C are incorrect because vanadium pentoxide is a transition metal compound which is coloured and has a high melting point.	A02-1 (1)



Question number	Answer	Additional guidance	Mark
10(c)(i) Group A	final answer of 490 with or without working scores 2 $\frac{400}{80} = 5$ (1) $5 \times 98 = 490$ (1) OR $\frac{98}{80} = 1.225$ (1) $1.225 \times 400 = 490$ (1)	$80 / 400 \times 98 = 19.6$ scores 1 allow ecf for MP2 only if MP1 uses 80 and 98 $80 / 98 \times 400 = 326.5$ 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
10(c)(ii) Group B	final answer of 96% with or without working scores 2 $\frac{672}{700} = 0.96$ (1) $\times 100 = 96$ (1)	allow 24/25 no ecf for MP2 4 scores 1 104 scores 1 mark	A02-1 (2)



Question number	Answer	Additional guidance	Mark
10(c)(iii) Group B	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 transfers/ 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/ byproducts	A01-1 (2)

Total for Question 10 = 11 marks



Question number	Answer	Additional guidance	Mark
10(a)(i)	75.4 with or without working scores 3 marks $\frac{45.26}{60.00} = 0.7543 \text{ (1)}$ $(0.7543) \times 100 = 75.43 \text{ (1)}$ $= 75.4 \text{ (1 dp) (1)}$	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 dp of an incorrectly calculated value only if using numbers from the question 91.2 with working scores 2 marks	(3) A03-1

Question number	Answer	Additional guidance	Mark
10(a)(ii)	any two reasons valid for <u>this</u> process - 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) A02-1



Question number	Answer	Additional guidance	Mark
10(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 of an incorrectly calculated value to 2 sig figs, only if using numbers from the question	(3) A02-1

Question number	Answer	Additional guidance	Mark
10(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 product ignore it is a balanced equation ignore same number of atoms on each side of the equation reject no gas given off	(1) A02-1



Question number	Answer	Additional guidance	Mark
10(b)(ii)	An explanation linking • find use for {carbon dioxide / waste product} (1) • so carbon dioxide becomes a useful product / increase mass of useful product (1)	allow a named use of carbon dioxide e.g in fizzy drinks allow sell the {carbon dioxide / waste product}	(2) A02-1

Total for question 10 = 11 marks



Question Number	Indicative content		Mark
7(a)	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. • an alloy is a mixture of metals • because larger/different sized atoms introduced in alloying, • stop layers moving easily over one another • therefore individual alloy is stronger/harder • an aluminium alloy is magnalium • pure aluminium is not suitable for making aircraft as it bends too easily / too weak • aluminium alloy stronger • magnesium atoms lighter than aluminium atoms, • therefore alloy still low density / lower density than aluminum alone • an iron alloy is stainless steel • pure iron is not suitable for cutlery as it bends too easily / too weak • iron corrodes, • corrosion would contaminate food • stainless steel does not corrode • gold alloy harder • therefore more hard wearing • gold alloys less likely to change shape when worn • alloying can change the colour of the gold		(6) AO 2 1 AO 3 1a AO 3 1b
Level	Mark	Descriptor	
	0	• No awardable content	
Level 1	1-2	• The plan attempts to link and apply knowledge and understanding of scientific enquiry, techniques and procedures, flawed or simplistic connections made between elements in the context of the question. (AO2) • Analyses the scientific information but understanding and connections are flawed. An incomplete plan that provides limited synthesis of understanding. (AO3)	

Question Number	Answer	Additional guidance	Mark
7(b)(i)	gain of oxygen	allow loss of electrons allow addition of oxygen ignore oxygen reacts with metal/substance	(1) AO 1 1

Question Number	Answer	Additional guidance	Mark
7(b)(ii)	An explanation linking - the paint {excludes/acts as a barrier/protective layer/shield} (1) (excludes) air / oxygen / water (1)	allow rain or moisture for water	(2) AO 2 2

Question Number	Answer	Additional guidance	Mark
7(b)(iii)	sacrificial protection	allow coat with plastic / oil / grease allow galvanising allow add a more reactive metal ignore to make an alloy ignore painting ignore electroplating ignore add another metal alone ignore keep away from water/air/oxygen	(1) AO 1 2

Question Number	Answer	Additional guidance	Mark
7(c)(i)	dc (supply) / direct current / battery	allow power pack allow electrical supply allow power supply allow power source ignore electricity	(1) AO 2 1

Question Number	Answer	Additional guidance	Mark
7(c)(ii)	nickel sulfate/nickel chloride/nickel nitrate/soluble nickel salt		(1) AO 3 3a

(Total for question 7 = 12 marks)

Question number	Answer	Mark
7(a)(i)	An explanation linking - both {air/oxygen} and water needed for rusting (1) then any two from - tube a – {air/oxygen} and water present (1) - tube b – only dry {air/oxygen} present / no water (1) - tube c – only water present (with nail) / no {air/oxygen} (1)	(3)

Question number	Answer	Additional guidance	Mark
7(a)(ii)	No rusting / remains clean / does not corrode	ignore any statements about magnesium	(1)

Question number	Answer	Mark
7(a)(iii)	C the iron is oxidised The only correct answer is C A is not correct – hydration is a different reaction B is not correct – neutralisation involves an acid D is not correct – reduction is loss of oxygen or gain of electrons which does not happen here	(1)

Question number	Answer	Additional guidance	Mark
7(b)	improve appearance / more corrosion resistant	allow suitable alternative answers ignore cost	(1)



Question number	Indicative content	Mark
*7(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) • suitable use of aluminium eg cooking foil • related property – malleable, low toxicity, low reactivity • suitable use of copper eg water pipes • related property – low reactivity • suitable use of gold eg electronic contacts • related property – does not corrode, good electrical conductor • suitable use of brass eg pins for electric plugs • related property – strong and hard wearing • suitable use of magnalium eg aircraft parts • related property – low density	(6)



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 planning 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 property OR use of at least one metal or alloy and attempts to relate it to a suitable use.	<u>Possible candidate responses</u> - aluminium has a low density (alone) - gold can be used in jewellery (alone) - copper is used in wiring because it is a good conductor of electricity (upper part of level)
Level 2	3–4	<u>Additional guidance</u> Identifies at least one property of two metals OR alloys and links this to their uses.	<u>Possible candidate responses</u> - copper and gold are both used in electrical wiring because they are good conductors of electricity - copper is used in wiring because it is a good conductor of electricity. Gold is used in jewellery - magnalium has a low density so can be used in aircraft parts. Gold can be used in jewellery because it is unreactive – upper part of level
Level 3	5–6	<u>Additional guidance</u> Identifies properties of at least one metal AND one alloy and explains their uses related to these properties.	<u>Possible candidate responses</u> - copper is used in electrical wiring because it is a good conductor of electricity so a current can pass through it. Magnalium is used in aircraft parts because it has a low density - gold is used in jewellery because it is unreactive and so will not cause irritation to the wearer. Brass is used for making electrical plug pins because it is strong, so will not break easily – upper part of level

Total for Question 7 = 12 marks



Question number	Answer	Mark
7(a)(i)	C it is oxidised is the only correct answer A, B and D are not correct as the reaction of iron with oxygen is an oxidation reaction	(1) A01-1

Question number	Answer	Mark				
7(b)(i)	<table><tr><td>Volume of gas in Figure X in cm³</td><td>50</td></tr><tr><td>Volume of gas in Figure Y in cm³</td><td>45</td></tr></table>	Volume of gas in Figure X in cm ³	50	Volume of gas in Figure Y in cm ³	45	(1) A03-1b
Volume of gas in Figure X in cm ³	50					
Volume of gas in Figure Y in cm ³	45					

Question number	Answer	Additional guidance	Mark
7(b)(ii)	10(%) scores 3 with or without working 50 – 45 (1) (= 5) $\frac{5}{50}$ (1) (= 0.1) 0.1 × 100 (1) (= 10%)	allow ECF from (b)(i) 90% gains 2 marks	(3) A03 2a-1 2b-2

Question number	Answer	Additional guidance	Mark
7(b)(iii)	incomplete reaction / has not been left long enough / insufficient iron	allow iron has fully reacted / no more iron to react allow there was an excess of oxygen allow oxygen cannot reach all of the iron	(1) A03 2b – 1



Question number	Indicative content	Mark
*7(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) • in an alloy another metal is added / a mixture of metals • in a pure metal, all atoms are of the same size • layers of atoms can slide over one another easily • so a pure metal is malleable / soft • alloys are stronger • because atoms of different sizes • disrupt layers of atoms in the alloy • layers cannot slide • alloys can be used e.g. in metal beams / airplanes parts / bridges • because the alloy is stronger than the pure metal • electroplating means that a (corrosion resistant) metal {coating / layer} is added on top of the (pure) metal / alloy • (more reactive) metals can corrode when exposed to air and water • (corrosion resistant) metal coating does not react with oxygen in air • therefore pure metal object does not corrode • object remains shiny • object looks more attractive • base metal is often cheaper e.g. copper plated with gold in jewellery • therefore object may be cheaper • electroplating involves creating a circuit • object to be plated is made the cathode • plating metal is the anode • electrolyte made from plating metal salt solution	(6)

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	Possible candidate response
Read whole answer. Ignore all incorrect material and discard any contradictory material.			
	0	No rewardable material.	
Level 1	1–2	Candidate gives basic ideas about the uses of structure of alloys or electroplated materials: OR Candidate gives a detailed explanation about one processes:	Possible candidate responses alloys can be used for car parts (1) alloys are stronger than pure metals and cutlery is electroplated (2)
Level 2	3–4	Candidate gives basic ideas about both processes: OR Candidate gives a detailed explanation about one processes:	Possible candidate responses alloys make items stronger because the layers of atoms cannot slide, electroplating helps prevent items corroding (3) electroplating is used to coat cheaper metals in more expensive metals to make them look shiny, alloys are a mixture of metals they are more resistant to corrosion (4) alloys used in construction means that they are stronger as different sized atoms in the structure disrupt the layers of atoms so that they can no longer slide so that the metal is now stronger (4) Cutlery can be electroplated with a less corrosive metal so that the metal remains shiny, the layer of metal stops the iron coming into contact with oxygen and water so that it does not rust (4)
Level 3	5–6	Candidate explains ideas about both processes:	Possible candidate responses alloys used in construction means that they are stronger as different sized atoms in the structure disrupt the layers of atoms so that they can no longer slide so that the metal is now stronger. Electroplating coats a cheaper metal in an expensive metal (5) Cutlery can be electroplated with a less corrosive metal so that the metal remains shiny, the layer of metal stops the iron coming into contact with oxygen and water so that it does not rust. Alloys can be used in car parts and in metal beams for construction as it makes them stronger (6)



Question number	Answer	Additional guidance	Mark
7(a)(i)	8 (%) with or without working (3) change in mass = $7.56 - 7.00 = 0.56$ (1) $\frac{0.56}{7.00} = 0.08$ (1) 0.08×100 (1) (= 8%)	ecf throughout	(3) A03-2

Question number	Answer	Mark
7(a)(ii)	D oxygen is the only correct answer A, B and C are not correct as these gases would not react with the iron	(1) A02-1

Question number	Answer	Additional guidance	Mark
7(a)(iii)	an explanation linking any two from: (sacrificial) protection by magnesium (1) - magnesium is more reactive (than iron) (1) - so magnesium reacts rather than the iron (1)	allow magnesium is a sacrifice barrier (for the iron) ignore magnesium prevented rusting/oxidation allow magnesium {reacts with oxygen / corrodes} (instead of iron)	(2) A03-2



Question number	Indicative content	Mark
*7(b)	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) • copper can be used in <u>wiring</u> • because it is ductile • so can be pulled into wires • copper can also conduct electricity • allows (delocalised) electrons to move • copper has a high melting point • so wire will not melt • when heat is produced from the transfer of charge • copper is malleable • so the wire is flexible without breaking • copper is used in water <u>pipes</u> • because it is malleable • tubes can be bent • copper has a low reactivity so will not react with the water • copper can be used for <u>coins</u> • as it has low reactivity • and is malleable • so can be pressed into shape • copper can be used in <u>cooking pans</u> • as it has a high melting point • so will not melt when cooking • and is a good conductor of heat • so heat is transferred from the hob/stove to the food inside • it is also malleable • so can be hammered/pressed into shape • and will not break if dropped	(6) AO1-1



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> Correctly identifies a use of copper / a property of copper Correctly identifies several uses of copper but not linked to any properties Correctly links a correct property of copper to its use	<u>Possible candidate response</u> (all examples, not a definitive list) copper is used to make wires/cables (1) copper is used to make wires, pipes, coins and cooking utensils (2) copper is used to make wires because it conducts electricity (2)
Level 2	3–4	<u>Additional Guidance</u> Correctly identifies at least two uses of copper and links a property to one of the uses / correctly identifies at least one use of copper and links at least two properties to that use Correctly identifies at least two uses of copper and links those uses to a correct property for each Correctly identifies at least three uses of copper and links at least one of those uses with a correct property Correctly identifies at one use of copper with a range of suitable properties	<u>Possible candidate response</u> copper is used to make pipes and to make wires as it conducts electricity (3) copper is used to make wires as it conducts electricity and is flexible (3) copper is used to make pipes as it is malleable and is also used to make wires as it conducts electricity (4) copper is used to make pipes as it is malleable and is also used to make wires and coins (4) copper is used to makes wires as it conducts electricity, is flexible, has a high melting point and copper is ductile (drawn into wires) (4)
Level 3	5–6	<u>Additional Guidance</u> Correctly identifies at least two uses of copper and links a range of properties for each use Correctly identifies at least three uses of copper and links a range of properties for each use	<u>Possible candidate response</u> copper is used to makes wires as it conducts electricity, is flexible, has a high melting point and copper is ductile (drawn into wires); copper is also used to make coins as it is unreactive, and is malleable so can be pressed into shape (5) copper is used to makes wires as it conducts electricity, is flexible, has a high melting point; copper is ductile (drawn into wires); copper is also used to make coins as it is unreactive, and is malleable so can be pressed into shape and copper is used to make pipes as it can be bent into shape, does not react with water (6)

Total for Question 7 = 12 marks



Question number	Answer	Mark
7(a)(i)	malleable / malleability	(1) AO2

Question number	Answer	Additional guidance	Mark
7(a)(ii)	does not corrode/ insoluble/ unreactive/ inert / non-toxic / hard	ignore references to appearance	(1) AO2

Question number	Answer	Mark
7(b)	1560 with or without working scores 3 78 / 100 (1) 78 / 100 x 2.00 (1) (= 1.56 kg) 1.56 x 1000 (1) (= 1560 g)	(3) AO2

Question number	Answer	Additional guidance	Mark
7(c)	<u>hazard</u> symbol  meaning - corrosive - flammable - hazardous to the environment - oxidising	1 mark for each symbol. If more than one line comes from a symbol, that mark cannot be scored	(2) AO1

Question number	Indicative content	Mark
* 7(d)	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. Colour change - copper is red brown - black colour is copper oxide Mass increase - oxygen atoms are added - oxygen atoms have mass - increase in mass due to oxygen atoms - powder heated for longer - powder has more copper atoms exposed - powder reacts more - powder adds more oxygen atoms - powder has larger mass increase Mass increase less than expected - copper is unreactive metal - unreactive metals have slow reactions - time not enough for reaction to be complete - copper oxide only forms on surface so less forms on piece than powder - Bunsen flame not hot enough for full reaction - some copper powder may be lost to air - some copper oxide may be lost to air	(6) AO2 AO3

Level	Mark	Descriptor
	0	No rewardable material.
Level 1	1–2	Interpretation and evaluation of the information attempted but will be limited with a focus on mainly just one variable. Demonstrates limited synthesis of understanding. (AO3) The explanation attempts to link and apply knowledge and understanding of scientific ideas, flawed or simplistic connections made between elements in the context of the question. (AO2)
Level 2	3–4	Interpretation and evaluation of the information on both variables, synthesising mostly relevant understanding. (AO3) The explanation is mostly supported through linkage and application of knowledge and understanding of scientific ideas, some logical connections made between elements in the context of the question. (AO2)
Level 3	5–6	Interpretation and evaluation of the information demonstrating throughout the skills of synthesising relevant understanding. (AO3) The explanation is supported throughout by linkage and application of knowledge and understanding of scientific ideas, logical connections made between elements in the context of the question. (AO2)

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>	<u>Possible candidate response</u> - the longer the heating is the more product is formed (1) - the red-brown copper forms black copper oxide (2) - oxygen is added in heating so the mass increases (2)
Level 2	3–4	<u>Additional Guidance</u>	<u>Possible candidate response</u> the red-brown copper forms black copper oxide by reacting with oxygen, and the added oxygen causes a mass increase (4)
Level 3	5–6	<u>Additional Guidance</u> Must address all aspects of question to score Level 3	<u>Possible candidate response</u> the red-brown copper forms black copper oxide by reacting with oxygen, and the added oxygen causes a mass increase. The longer the copper is heated, the more oxygen is gained. However, copper is not very reactive, so it will not all react in the time given to heating even if a powder heated for 10 minutes (6).

Question number	Answer	Mark
7(a)(i)	rust / iron oxide	(1) AO1-1

Question number	Answer	Additional guidance	Mark
7(a)(ii)			(2) AO1-1
	neon		
	carbon dioxide		
	nitrogen		
	oxygen	✓(1)	
	water vapour	✓(1)	

Question number	Answer	Additional guidance	Mark
7(a)(iii)	paint / grease / oil / galvanising / electroplating / sacrificial protection / coat in plastic	allow cover in another metal ignore generic 'protective covering' / physical barrier / keep dry	(1) AO1-1

Question number	Answer	Additional guidance	Mark
7(a)(iv)	0.156 or 0.16 with or without working scores 2 - mass increase of rods = $4.53 - 3.75 = 0.78$ (1) - mean increase in mass = $\frac{0.78}{5} = 0.156$ (1)	allow ECF for MP2 for number generated using 3.75 and 4.53 allow $\frac{4.53}{5} = 0.906$ and $\frac{3.75}{5} = 0.75$ (1) $0.906 - 0.75 = 0.156$ (1)	(2) AO3-1



Question number	Answer	Additional guidance	Mark
7(b)(i)	mixture of metals	allow metals combined, mixture of metal and {another element / non-metal / carbon} reject compound (of metals)	(1) AO1-1

Question number	Indicative content	Mark
*7(b)(ii)	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. AO1-1 (3 marks) and AO3-1 (3 marks) structures: • (gold atoms / gold ions) in regular arrangement • lattice • alloy - different sized atoms • so have a disrupted arrangement • no definite layers / no regular arrangement strength: • rows/ layers of {atoms or ions} in gold • so they can slide over each other • (slide over each other) easily • gold will not be very strong / is more malleable • alloy – more difficult for atoms /ions to slide over each other • alloy will be stronger / less malleable	(6) AO1-1 AO3-1



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) • Interpretation and evaluation of the information attempted but will be limited with a focus on mainly just one variable. Demonstrates limited synthesis of understanding. (AO3)
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) • Interpretation and evaluation of the information on both variables, synthesising mostly relevant understanding. (AO3)
Level 3	5–6	• Demonstrates accurate and relevant chemical understanding throughout. Understanding of the scientific ideas is detailed and fully developed. (AO1) • Interpretation and evaluation of the information, demonstrating throughout the skills of synthesising relevant understanding. (AO3)



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	Additional Guidance Describes some information about metals and/or alloys OR Attempt to <u>explain</u> strength of metal OR alloy to structure	Possible candidate response - Alloys are strong (1) - Alloys are strong and metals are malleable (2) - In metals atoms are same size (1) - In metals atoms are same size but in alloys different sized atoms (2) - In metals atoms in layers but in alloys atoms jumbled (2) - Metals have atoms the same size. Alloys are strong (2) - Metals have atoms same size so they are weak (2) - Metals are weak because the layers can slide (2)
Level 2	3–4	Additional Guidance Full <u>explanation</u> of strength of metal OR alloy in terms of layers AND atoms AND statement about other material WITH statement about other material OR Partial <u>explanation</u> strength of metal AND alloy to structure	Possible candidate response - Alloys are strong because the atoms different sizes so the layers cannot slide (3) - Pure metals are soft as the particles are the same size, so the layers can slide past each other (3) - Metals are weak because their layers can slide, but layers cannot slide in alloys making alloys stronger (4) - In alloys particles are different sizes so layers cannot slide past each other so they are hard. Metals are weak (4)
Level 3	5–6	Additional Guidance Full <u>explanation</u> of strength of metal AND alloy in terms of layers AND atoms	Possible candidate response - Alloys are hard because particles are different sizes so layers cannot slide past each other. Pure metals are soft as the particles are the same size (5) - In alloys particles are different sizes so layers cannot slide past each other so they are hard. Pure metals are soft as the particles are the same size, so the layers can slide past each other (6)

Total for Question 7 = 13 marks

