AQA GCSE CHEMISTRY (HIGHER) · 8462

CHEMISTRY



EXAM QUESTION PACK

4.3.1 CHEMICAL MEASUREMENTS, CONSERVATION OF MASS AND QUANTITATIVE INTERPRETATION OF EQUATIONS (PACK 1)

SCORE	PERCENTAGE
/362	%

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Q1.

The halogens are elements in Group 7.

(a) Bromine is in Group 7.

Give the number of electrons in the outer shell of a bromine atom.

_____

(1)

(b) Bromine reacts with hydrogen. The gas hydrogen bromide is produced.

What is the structure of hydrogen bromide?

Tick **one** box.

Giant covalent ☐

Ionic lattice ☐

Metallic structure ☐

Small molecule ☐

(1)

(c) What is the formula for fluorine gas?

Tick **one** box.

F ☐

F_2 ☐

F^2 ☐

2F ☐

(1)

A student mixes solutions of halogens with solutions of their salts.

The table below shows the student's observations.

Potassium chloride	Potassium bromide	Potassium iodide

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	(colourless)	(colourless)	(colourless)
Chlorine (colourless)		Solution turns orange	Solution turns brown
Bromine (orange)	No change		Solution turns brown
Iodine (brown)	No change	No change	

(d) Explain how the reactivity of the halogens changes going down Group 7.

Use the results in the table above.

_____

_____

_____

_____

_____

_____

(3)

A company uses chlorine to produce titanium chloride from titanium dioxide.

(e) What is the relative formula mass (M_r) of titanium dioxide, TiO_2?

Relative atomic masses (A_r): O = 16 Ti = 48

Tick **one** box.

64 ☐

80 ☐

128 ☐

768 ☐

(1)

(f) The company calculates that 500 g of titanium dioxide should produce 1.2 kg of titanium chloride.

However, the company finds that 500 g of titanium dioxide only produces 900 g of titanium chloride.

Calculate the percentage yield.

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_____

_____

_____

_____

Percentage yield = _____ %

(2)

(Total 9 marks)

Q2.

A student investigated the mass of copper oxide produced by heating copper carbonate.

This is the method used.

1. Weigh an empty test tube.
2. Weigh 2.00 g of copper carbonate into the test tube.
3. Heat the copper carbonate until there appears to be no further change.
4. Re-weigh the test tube and copper oxide produced.
5. Subtract the mass of the empty tube to find the mass of copper oxide.
6. Repeat steps 1−5 twice.
7. Repeat steps 1−6 with different masses of copper carbonate.

The table below shows the student's results.

Mass of copper carbonate in g	Mass of copper oxide in g			
	Trial 1	Trial 2	Trial 3	Mean
2.00	1.29	1.27	1.31	1.29
4.00	2.89	2.57	2.59	2.58
6.00	3.85	3.90	3.87	3.87
8.00	5.12	5.15	5.09	**X**
10.00	6.42	6.45	6.45	6.44

The equation for the reaction is:

$$CuCO_3(s) \longrightarrow CuO(s) + CO_2(g)$$

(a) Complete the sentence.

The state symbol shows carbon dioxide is a _____ .

(1)

(b) Why do the contents of the test tube lose mass in the investigation?

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_____

_____

(1)

(c) Calculate the mean mass **X** in the table above.

_____

_____

X = _____ g

(1)

(d) One of the results in the table above is anomalous.

Which result is anomalous?

Mass of copper carbonate _____ g Trial _____

(1)

(e) Suggest how the investigation could be improved to make sure the reaction is complete.

_____

_____

_____

_____

(2)

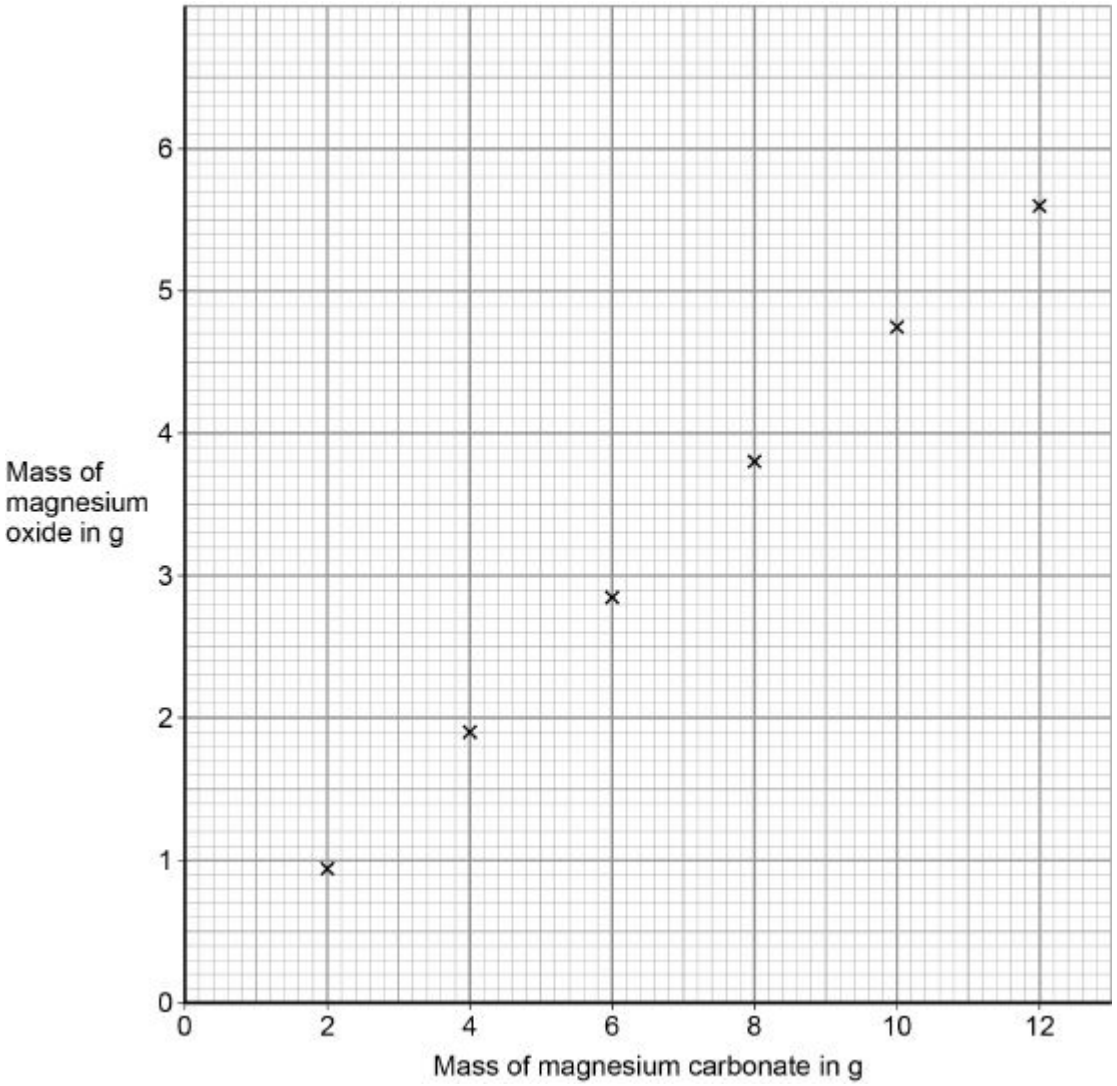
Another student repeated the investigation using magnesium carbonate instead of copper carbonate.

The word equation for the reaction is:

magnesium carbonate ⟶ magnesium oxide + carbon dioxide

The graph below shows the results of the investigation.

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(f) Draw a line of best fit on the graph above.

(1)

(g) Determine the mass of magnesium oxide produced by 8.4 g of magnesium carbonate.

Use the graph above.

Mass = _____ g

(1)

(h) Calculate the mass of magnesium oxide produced when 168 g of magnesium carbonate is heated.

Use your answer to part **(g)**

_____

_____

_____

_____

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Mass of magnesium oxide produced = _____ g

(2)

(Total 10 marks)

Q3.

Older cars are tested each year to measure the amount of pollutants contained in exhaust fumes.

The table below shows the maximum allowed percentages of exhaust pollutants for petrol cars.

Age of car in years	Maximum allowed percentage (%) of exhaust pollutant	
	Carbon monoxide	Unburned hydrocarbons
16−24	0.30	0.02
3−16	0.20	0.02

(a) Explain how carbon monoxide is produced when petrol is burned in car engines.

_____

_____

_____

_____

(2)

(b) Suggest **two** reasons why the maximum allowed percentage of carbon monoxide has been decreased for newer cars.

1. _____

_____

2. _____

_____

(2)

(c) Give **one** reason for having a maximum allowed percentage of unburned hydrocarbons in exhaust fumes.

_____

_____

(1)

Oxides of nitrogen are also pollutants contained in exhaust fumes.

(d) Describe how oxides of nitrogen are produced when petrol is burned in car engines.

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_____

_____

_____

_____

(2)

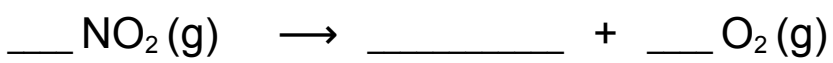
Catalytic converters are fitted to car exhausts to reduce the amount of pollutants released into the atmosphere.

(e) Nitrogen dioxide is an oxide of nitrogen.

Nitrogen dioxide reacts to produce nitrogen and oxygen in catalytic converters.

Complete the equation for this reaction.

The equation should be balanced.



(2)

(f) Give **two** effects of atmospheric pollution which are reduced by using catalytic converters.

1. _____

_____

2. _____

_____

(2)

(g) The catalyst in catalytic converters is a mixture of three elements.

Where in the periodic table are these elements most likely to be found?

Tick **one** box.

Alkali metals ☐

Halogens ☐

Noble gases ☐

Transition metals ☐

(1)

(Total 12 marks)

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Q4.

A student investigated how temperature affects the rate of reaction between magnesium carbonate and dilute hydrochloric acid.

This is the method used.

1. Heat hydrochloric acid to 30 °C in a conical flask.
2. Add magnesium carbonate powder to the conical flask.
3. Measure the loss in mass of the flask and contents every 20 seconds for 140 seconds.
4. Repeat steps 1-3 with hydrochloric acid heated to 50 °C

(a) Explain why the contents of the conical flask lose mass.

_____

_____

_____

_____

(2)

(b) The table below shows the student's results for hydrochloric acid at 30 °C

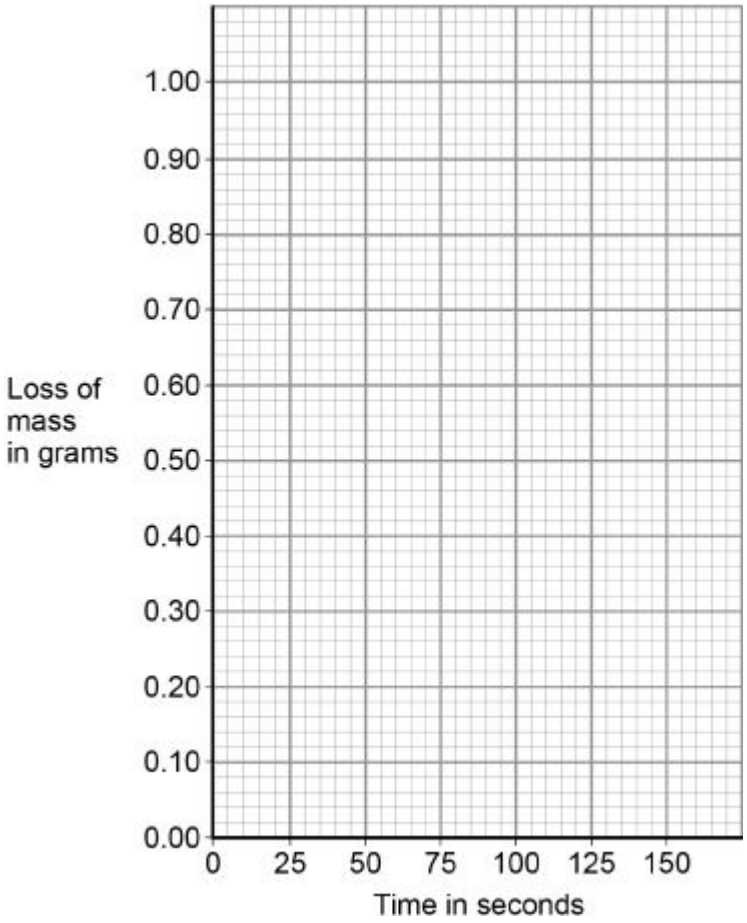
Time in seconds	Loss of mass in grams
0	0.00
20	0.26
40	0.48
60	0.67
80	0.82
100	0.91
120	0.96
140	0.99

Plot the data from the table above on **Figure 1**.

Draw a line of best fit.

Figure 1

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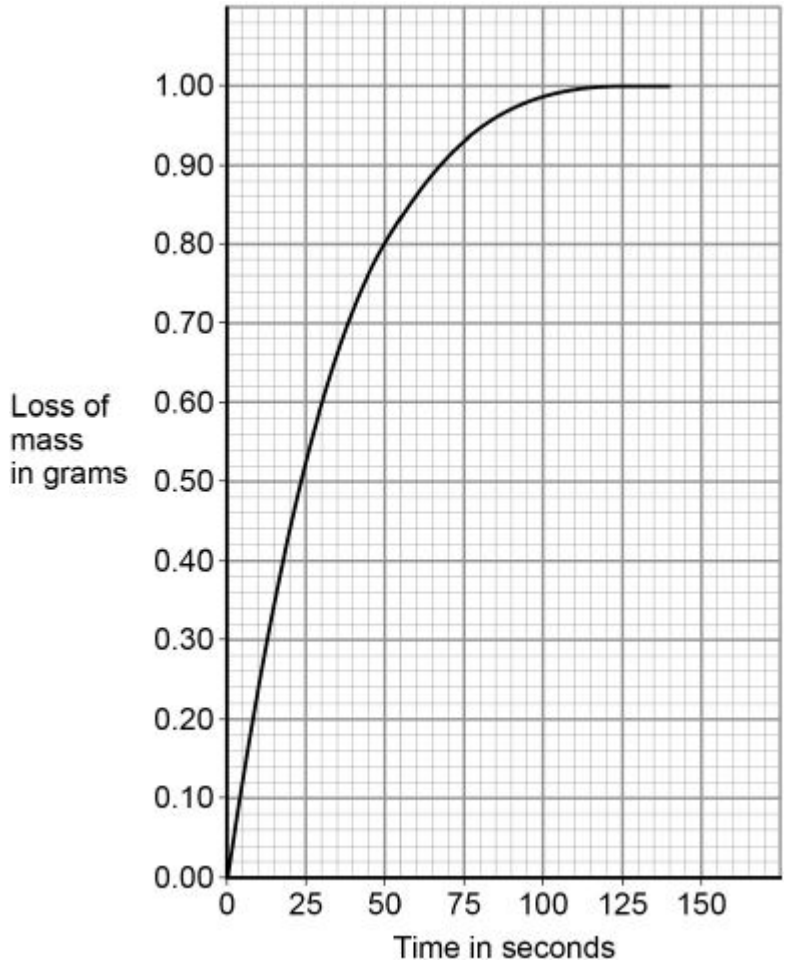


(3)

Figure 2 shows the student's results for hydrochloric acid at 50 °C

Figure 2

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(c) Determine the rate of reaction at 50 °C when the loss of mass is 0.95 g

Show your working on **Figure 2**.

Give your answer to 2 significant figures.

_____

_____

_____

_____

_____

Rate of reaction = _____ g/s

(4)

(Total 9 marks)

Q5.

A student investigated the law of conservation of mass.

The law of conservation of mass states that the mass of the products is equal to the mass of the reactants.

This is the method used.

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1. Pour lead nitrate solution into a beaker labelled **A**.
2. Pour potassium chromate solution into a beaker labelled **B**.
3. Measure the mass of both beakers and contents.
4. Pour the solution from beaker **B** into beaker **A**.
5. Measure the mass of both beakers and contents again.

When lead nitrate solution and potassium chromate solution are mixed, a reaction takes place.

This is the equation for the reaction:

$$Pb(NO_3)_2(aq) + K_2CrO_4(aq) \longrightarrow PbCrO_4(s) + 2KNO_3(aq)$$

(a) What would the student see when the reaction takes place?

_____

_____

(1)

(b) The table shows the student's results.

	Mass in g
Beaker **A** and contents before mixing	128.71
Beaker **B** and contents before mixing	128.97
Beaker **A** and contents after mixing	154.10
Beaker **B** after mixing	103.58

Show that the law of conservation of mass is true.

Use the data from the table above.

_____

_____

_____

_____

(2)

(c) What is the resolution of the balance used to obtain the results in the table?

Tick (✔) **one** box.

0.01 g ☐ 0.1 g ☐ 1 g ☐ 100 g ☐

(1)

(d) Calculate the relative formula mass (M_r) of lead nitrate $Pb(NO_3)_2$

Relative atomic masses (A_r): N = 14 O = 16 Pb = 207

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_____

_____

_____

_____

Relative formula mass = _____

(2)

(e) The formula of potassium chromate is K_2CrO_4

The charge on the potassium ion is +1

What is the formula of the chromate ion?

Tick (✔) **one** box.

CrO_4^+ ☐

CrO_4^{2+} ☐

CrO_4^- ☐

CrO_4^{2-} ☐

(1)

(f) Another student also tests the law of conservation of mass using the same method.

The student uses a different reaction.

This is the equation for the reaction.

$$Na_2CO_3(aq) + 2HCl(aq) \longrightarrow 2NaCl(aq) + CO_2(g) + H_2O(l)$$

Explain why this student's results would **not** appear to support the law of conservation of mass.

_____

_____

_____

_____

_____

_____

(3)

(Total 10 marks)

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Q6.

This question is about hydrocarbons.

The table gives information about four hydrocarbons.

The hydrocarbons are four successive members of a homologous series.

Hydrocarbon	Formula	Boiling point in °C
A	C_4H_{10}	0
B		36
C	C_6H_{14}	69
D	C_7H_{16}	98

(a) What is the formula of hydrocarbon **B**?

Tick (✔) **one** box.

C_4H_{12} ☐

C_5H_{12} ☐

C_5H_{12} ☐

C_6H_{12} ☐

(1)

(b) What is the simplest ratio of carbon : hydrogen atoms in a molecule of hydrocarbon **A**?

Ratio = 2 : _____

(1)

(c) Which hydrocarbon is a gas at room temperature (25 °C)?

Tick (✔) **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐

(1)

(d) Which hydrocarbon is most flammable?

Tick (✔) **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐

(1)

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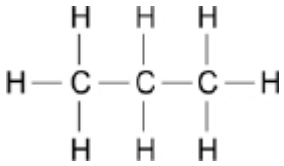
(e) Which **two** substances are produced when a hydrocarbon **completely** combusts in air?

Tick (✔) **two** boxes.

- Carbon ☐
- Carbon dioxide ☐
- Hydrogen ☐
- Sulfur dioxide ☐
- Water ☐

(2)

The diagram shows the displayed structure of a hydrocarbon molecule.



(f) What is the name of the hydrocarbon in the diagram above?

Tick (✔) **one** box.

- Butane ☐
- Ethane ☐
- Methane ☐
- Propane ☐

(1)

(g) Calculate the relative formula mass (M_r) of the hydrocarbon in the diagram above.

Relative atomic masses (A_r): H = 1 C = 12

_____

_____

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Relative formula mass (M_r) = _____

(2)

(Total 9 marks)

Q7.

The Haber Process is used to produce ammonia from nitrogen and hydrogen.

The equation for the reaction is:

$$N_2 + 3H_2 \rightleftharpoons 2NH_3$$

(a) An ammonia molecule has the formula NH_3

How many atoms are there in one molecule of ammonia?

Tick (✔) **one** box.

2 ☐ 3 ☐ 4 ☐ 6 ☐

(1)

(b) What does the symbol ⇌ mean?

_____

(1)

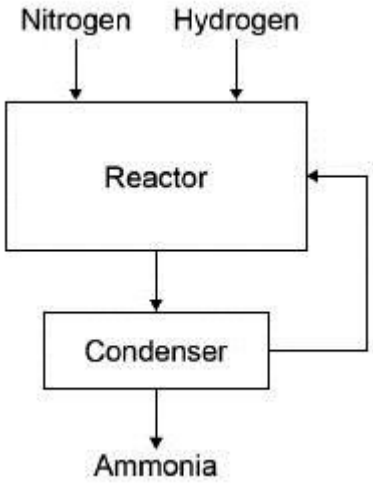
(c) Draw **one** line from each gas to the source of that gas.

Gas	Source
	Air
Hydrogen	Alcohol
	Ammonia
Nitrogen	Iron
	Natural gas

(2)

The diagram shows the Haber process.

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A mixture of ammonia, hydrogen and nitrogen gases leave the reactor.

Table 1 shows the boiling points of the gases.

Table 1

Gas	Boiling point in °C
Ammonia	– 33
Nitrogen	– 196
Hydrogen	– 253

(d) The mixture is cooled to a temperature at which **only** the ammonia condenses to a liquid.

Which temperature could be used?

Tick (✔) **one** box.

− 20 °C ☐

− 40 °C ☐

− 200 °C ☐

− 260 °C ☐

(1)

(e) What happens to the unreacted nitrogen?

Tick (✔) **one** box.

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Collected and sold ☐

Recycled to the reactor ☐

Released into the air ☐

Used as a catalyst ☐

(1)

Ammonia from the Haber process can be used to produce fertilisers.

Table 2 gives information about two compounds used in fertilisers.

Table 2

Fertiliser	Compound	Cost in £ / kg
A	Potassium chloride	0.24
B	Diammonium phosphate	0.35

(f) What type of bonding is present in potassium chloride?

Tick (✔) **one** box.

Covalent ☐

Ionic ☐

Metallic ☐

(1)

(g) Diammonium phosphate has the chemical formula $(NH_4)_2HPO_4$

Which **two** elements in $(NH_4)_2HPO_4$ improve agricultural productivity?

Tick (✔) **two** boxes.

Chlorine ☐

Hydrogen ☐

Nitrogen ☐

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Oxygen ☐

Phosphorus ☐

A farmer uses fertilisers **A** and **B** on a field with an area of 0.05 km^2

(2)

(h) 50 kg of fertiliser A will cover an area of 0.01 km^2

Calculate the cost of fertilising a field with an area of 0.05 km^2 with fertiliser **A**.

Use **Table 2**.

_____

_____

Cost = £ _____

(2)

(i) Fertiliser **B** is more expensive than fertiliser **A**.

Suggest why the farmer uses **both** fertilisers.

_____

_____

(1)

(Total 12 marks)

Q8.

Cobalt forms coloured compounds.

A pink cobalt compound reacts with hydrochloric acid.

The reaction can be represented as:

pink cobalt compound + hydrochloric acid ⇌ blue cobalt compound + water

The forward reaction is endothermic.

When both cobalt compounds are present in a solution at equilibrium, the equilibrium mixture is purple.

(a) What is meant by equilibrium?

_____

_____

_____

_____

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(2)

(b) The equilibrium mixture is cooled.

Explain what happens to the concentration of the pink cobalt compound.

_____

_____

_____

_____

_____

_____

(3)

(c) More hydrochloric acid is added.

Explain what happens to the colour of the equilibrium mixture

_____

_____

_____

_____

_____

_____

(3)

(d) Why does cobalt form different coloured compounds?

_____

(1)

(e) An oxide of cobalt has the formula Co_2O_3

Which cobalt ion is present in this oxide?

Tick (✔) **one** box.

Co^+ ☐

Co^{2+} ☐

Co^{3+} ☐

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Co^{4+} ☐

(1)

(f) Cobalt compounds can act as catalysts.

Which two statements about cobalt compounds are correct?

Tick (✔) **two** boxes.

They allow reactions to reach equilibrium more quickly. ☐

They are reactants in reactions catalysed by cobalt compounds. ☐

They are used up when acting as catalysts. ☐

They increase the equilibrium yield of reactions. ☐

They provide a different reaction pathway. ☐

(2)

(g) The reaction of hydrogen with carbon monoxide is catalysed by cobalt metal.

Balance the equation for the reaction.

$$H_2 \quad + \quad CO \quad \longrightarrow \quad C_6H_{14} \quad + \quad H_2O$$

(1)

(h) C_6H_{14} is an alkane.

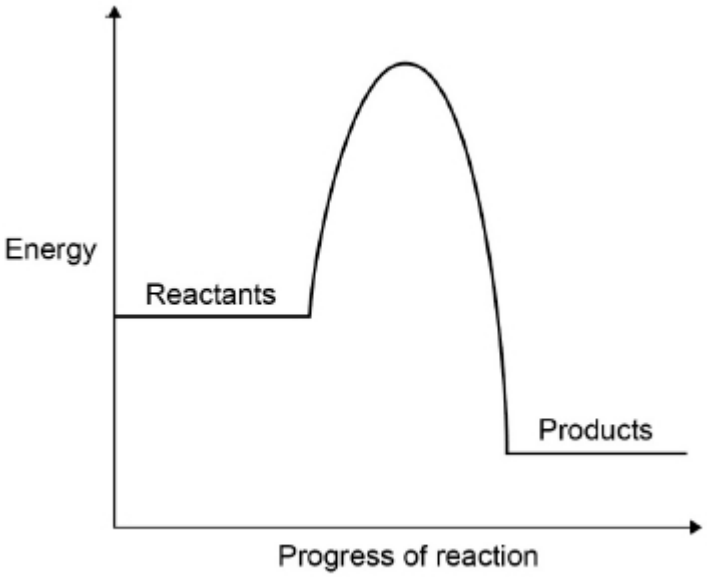
What is the formula of an alkane containing 18 hydrogen atoms?

_____

(1)

(i) The graph shows a reaction profile diagram for a reaction **without** a catalyst.

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On the graph:

- draw the reaction profile diagram for a catalysed reaction
- draw and label an arrow to show the activation energy for the reaction **without** a catalyst.

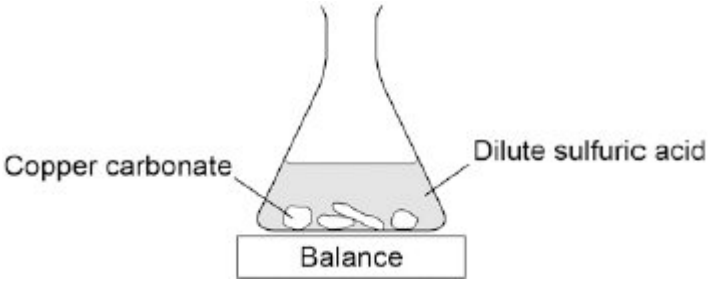
(2)

(Total 16 marks)

Q9.

A student investigated the reaction of copper carbonate with dilute sulfuric acid.

The student used the apparatus shown in the figure below.



(a) Complete the state symbols in the equation.

$$CuCO_3 (___) + H_2SO_4 (aq) \rightarrow CuSO_4 (aq) + H_2O (___) + CO_2 (g)$$

(2)

(b) Why did the balance reading decrease during the reaction?

Tick **one** box.

The copper carbonate broke down. ☐

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A salt was produced in the reaction. ☐

A gas was lost from the flask. ☐

Water was produced in the reaction. ☐

(1)

(c) Describe a safe method for making pure crystals of copper sulfate from copper carbonate and dilute sulfuric acid. Use the information in the figure above to help you.

In your method you should name all of the apparatus you will use.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

(6)

(d) The percentage atom economy for a reaction is calculated using:

$$\frac{\text{Relative formula mass of desired product from equation}}{\text{Sum of relative formula masses of all reactants from equation}} \times 100$$

The equation for the reaction of copper carbonate and sulfuric acid is:

$$CuCO_3 + H_2SO_4 \rightarrow CuSO_4 + H_2O + CO_2$$

Relative formula masses : $CuCO_3$ = 123.5; H_2SO_4 = 98.0; $CuSO_4$ = 159.5

Calculate the percentage atom economy for making copper sulfate from copper carbonate.

_____

_____

_____

_____

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_____

Atom economy = _____ %

(3)

(e) Give **one** reason why is it important for the percentage atom economy of a reaction to be as high as possible.

_____

_____

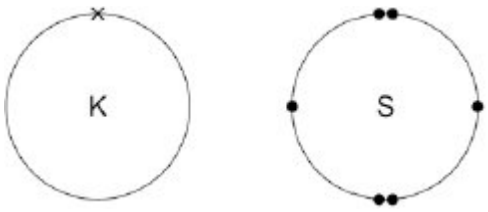
(1)

(Total 13 marks)

Q10.

Figure 1 shows the outer electrons in an atom of the Group 1 element potassium and in an atom of the Group 6 element sulfur.

Figure 1



(a) Potassium forms an ionic compound with sulfur.

Describe what happens when **two** atoms of potassium react with **one** atom of sulfur.

Give your answer in terms of electron transfer.

Give the formulae of the ions formed.

_____

_____

_____

_____

_____

_____

_____

_____

_____

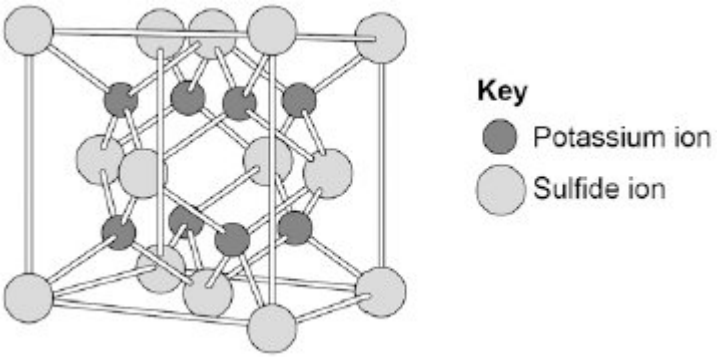
_____

(5)

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(b) The structure of potassium sulfide can be represented using the ball and stick model in **Figure 2**.

Figure 2



The ball and stick model is **not** a true representation of the structure of potassium sulfide.

Give **one** reason why.

_____

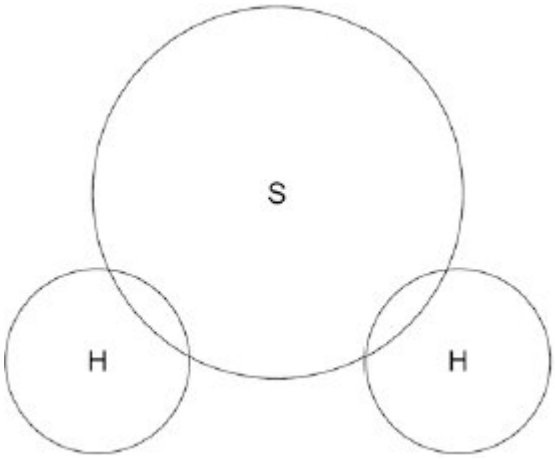
_____

(1)

(c) Sulfur can also form covalent bonds.

Complete the dot and cross diagram to show the covalent bonding in a molecule of hydrogen sulfide.

Show the outer shell electrons only.



(2)

(d) Calculate the relative formula mass (M_r) of aluminium sulfate $Al_2(SO_4)_3$

Relative atomic masses (A_r): oxygen = 16; aluminium = 27; sulfur = 32

_____

_____

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Relative formula mass = _____

(2)

(e) Covalent compounds such as hydrogen sulfide have low melting points and do **not** conduct electricity when molten.

Draw **one** line from each property to the explanation of the property.

Property	**Explanation of property**
	Electrons are free to move
	There are no charged particles free to move
Low melting point	
	Ions are free to move
	Weak intermolecular forces of attraction
Does not conduct electricity when molten	
	Bonds are weak
	Bonds are strong

(2)

(f) Ionic compounds such as potassium sulfide have high boiling points and conduct electricity when dissolved in water.

Draw **one** line from each property to the explanation of the property.

Property	**Explanation of property**
	Electrons are free

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	to move
	There are no charged particles free to move
High boiling point	
	Ions are free to move
	Weak intermolecular forces of attraction
Conduct electricity when molten	
	Bonds are weak
	Bonds are strong

(2)

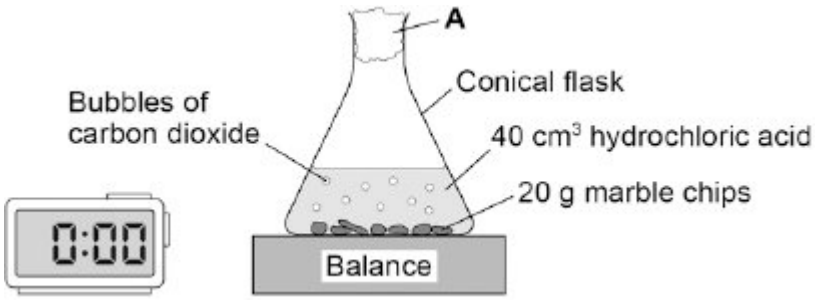
(Total 14 marks)

Q11.

A student investigated the rate of reaction between marble chips and hydrochloric acid.

Figure 1 shows the apparatus the student used.

Figure 1



(a) What is **A**?

Tick **one** box.

cotton wool ☐

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limestone ☐

poly(ethene) ☐

rubber bung ☐

(1)

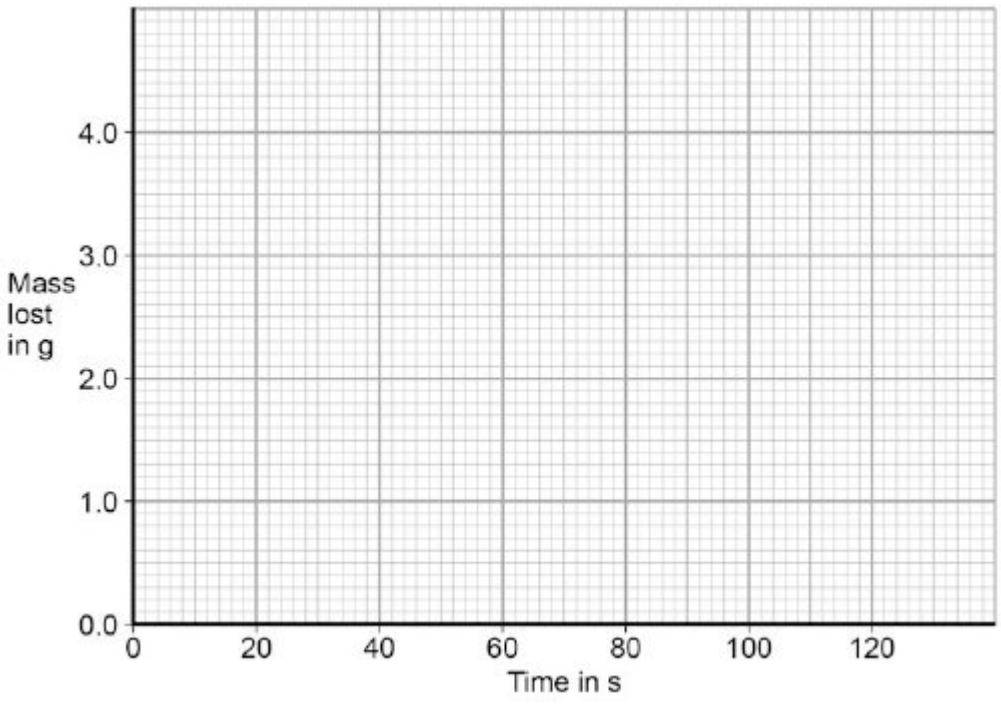
(b) **Table 1** shows the student's results for one investigation.

Table 1

Time in s	Mass lost in g
0	0.0
20	1.6
40	2.6
60	2.9
80	3.7
100	4.0
120	4.0

On **Figure 2**:
- Plot these results on the grid.
- Draw a line of best fit.

Figure 2



(3)

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(c) Use **Figure 2** to complete **Table 2**.

Table 2

Mass lost after 0.5 minutes	_____ g
Time taken to complete the reaction	_____ s

(2)

(d) The equation for the reaction is:

$2HCl(aq) + CaCO_3(s) \rightarrow CaCl_2(aq) + H_2O(l) + CO_2(g)$

Explain why there is a loss in mass in this investigation.

_____

_____

_____

_____

(2)

(e) Another student investigated the rate of a different reaction.

Table 3 shows the results from the different reaction.

Table 3

Mass lost when the reaction was complete	9.85 g
Time taken to complete the reaction	2 minutes 30 seconds

Calculate the mean rate of the reaction using **Table 3** and the equation:

$$\text{mean rate of reaction} = \frac{\text{mass lost in g}}{\text{time taken in s}}$$

Give your answer to two decimal places.

_____

_____

Mean rate of reaction = _____ g / s

(2)

(f) The student measured the change in mass of the reactants.

Describe another method, other than measuring the change in mass of the reactions, that the student could have used to find the rate of the reaction between marble chips and hydrochloric acid.

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_____

_____

_____

_____

(2)

(g) Another student planned to investigate the effect of temperature on the rate of reaction.
The student predicted that the rate of reaction would increase as the temperature was increased.

Give **two** reasons why the student's prediction is correct.

Tick **two** boxes.

The particles are more concentrated.	☐
The particles have a greater mass.	☐
The particles have a larger surface area.	☐
The particles have more energy.	☐
The particles move faster.	☐

(2)

(Total 14 marks)

Q12.

Metals are extracted from ores in the Earth's crust.

(a) Why is copper used in the manufacture of computers?

Tick (✔) **one** box.

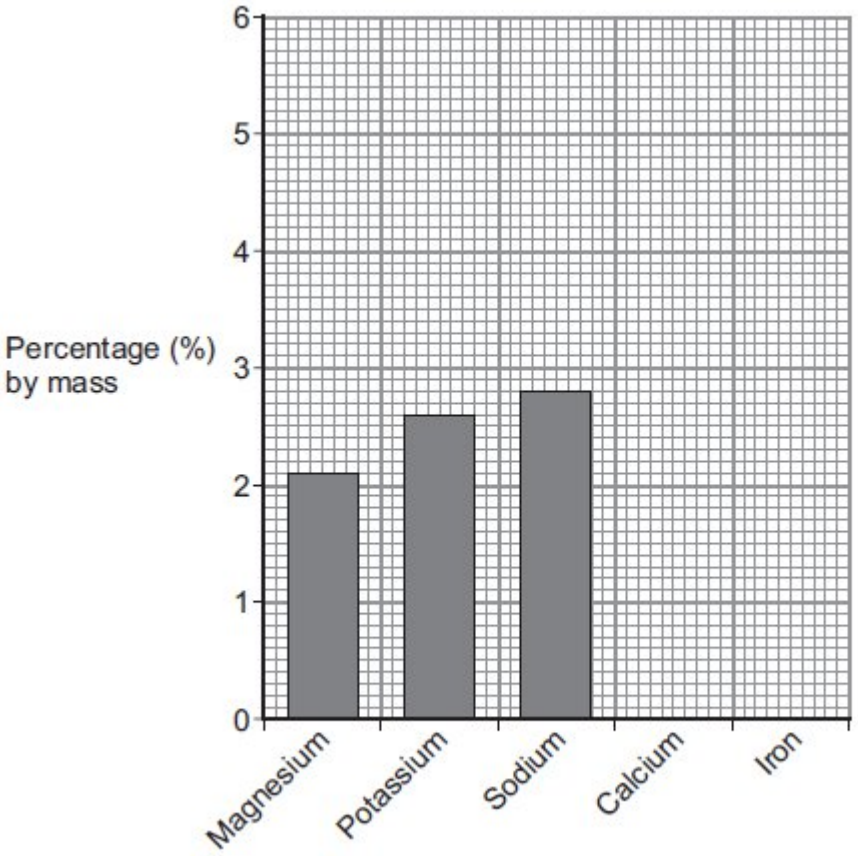
Because it has a high density.	☐
Because it does not react with water.	☐
Because it is a good conductor of electricity.	☐

(1)

(b) **Figure 1** shows the percentage (%) by mass of some metals in the Earth's crust.

Figure 1

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(i) What is the percentage by mass of magnesium in the Earth's crust?

_____ %

(1)

(ii) On **Figure 1** draw the bars for:

- calcium at 3.6% by mass
- iron at 5.0% by mass.

(2)

(c) An ore of zinc contains zinc carbonate.

The equation for the reaction when zinc carbonate is heated is:

$$\underset{\text{zinc carbonate}}{ZnCO_3} \longrightarrow \underset{\text{zinc oxide}}{ZnO} + \underset{\text{carbon dioxide}}{CO_2}$$

(i) What is the name of this type of reaction?

Tick (✔) **one** box.

corrosion ☐

decomposition ☐

electrolysis ☐

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(1)

(ii) Which substance in the equation is a gas at room temperature (20 °C)?

Tick (✔) **one** box.

zinc carbonate ☐

zinc oxide ☐

carbon dioxide ☐

(1)

(iii) Complete the table below to show the number of atoms of carbon and oxygen in the formula of zinc carbonate.

Element	Number of atoms in the formula $ZnCO_3$
zinc, Zn	1
carbon, C	
oxygen, O	

(2)

(iv) When 125 g zinc carbonate is heated, 81 g zinc oxide is produced.

Calculate the mass of carbon dioxide produced.

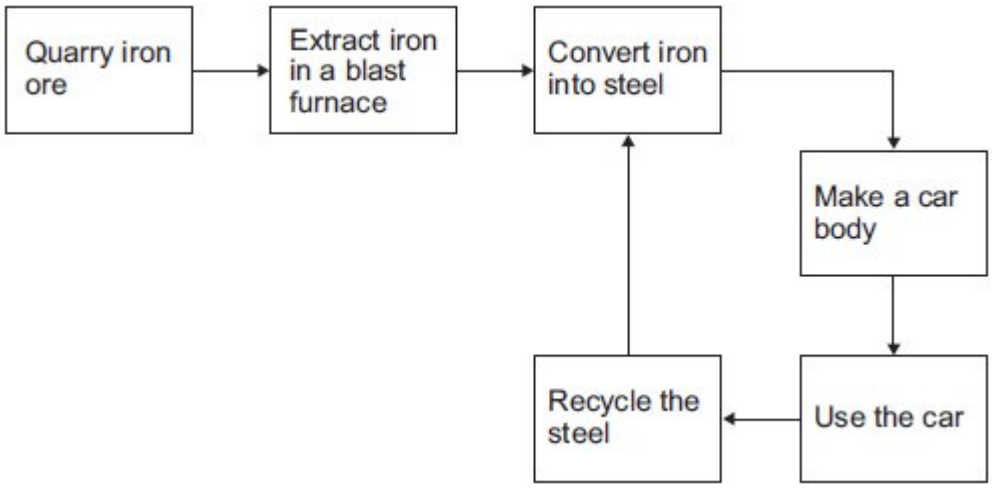
_____

Mass of carbon dioxide = _____g

(1)

(d) **Figure 2** shows a simple life cycle of a car body.

Figure 2



(i) What is **one** reason why iron from the blast furnace is converted into steel?

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Tick (✔) **one** box.

To make the iron pure. ☐

To make the iron more brittle. ☐

To make alloys for specific uses. ☐

(1)

(ii) Apart from cost, give **three different** reasons why steel should be recycled.

1. _____

_____

2. _____

_____

3. _____

_____

(3)

(Total 13 marks)

Q13.

Metals are extracted from ores in the Earth's crust.

Some ores contain metal carbonates and some ores contain metal oxides.

(a) (i) Name the type of reaction that happens when a metal carbonate is heated.

_____

(1)

(ii) Which solid product is formed when copper carbonate is heated?

Tick (✔) **one** box.

copper ☐

copper nitrate ☐

copper oxide ☐

copper sulfide ☐

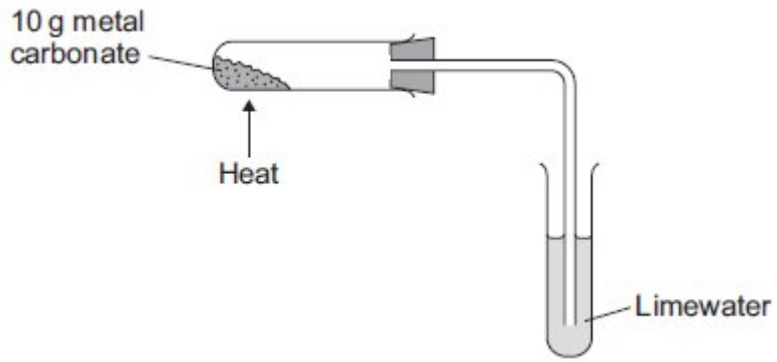
(1)

(b) A student investigated heating four metal carbonates.

Figure 1 shows the apparatus used.

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Figure 1



The student heated each metal carbonate for five minutes.

The table below shows the results.

Metal carbonate	Mass of metal carbonate at start in g	Mass of solid after heating for 5 minutes in g	Observations
Copper carbonate	10.0	6.9	Limewater turns cloudy
Magnesium carbonate	10.0	9.1	Limewater turns cloudy
Potassium carbonate	10.0	10.0	Limewater does not turn cloudy
Zinc carbonate	10.0	8.3	Limewater turns cloudy

(i) Explain the results for potassium carbonate.

_____

_____

_____

_____

_____

_____

_____

(3)

(ii) Suggest how the reactivity series can be used to predict which metal carbonate reacts most easily when heated.

_____

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_____

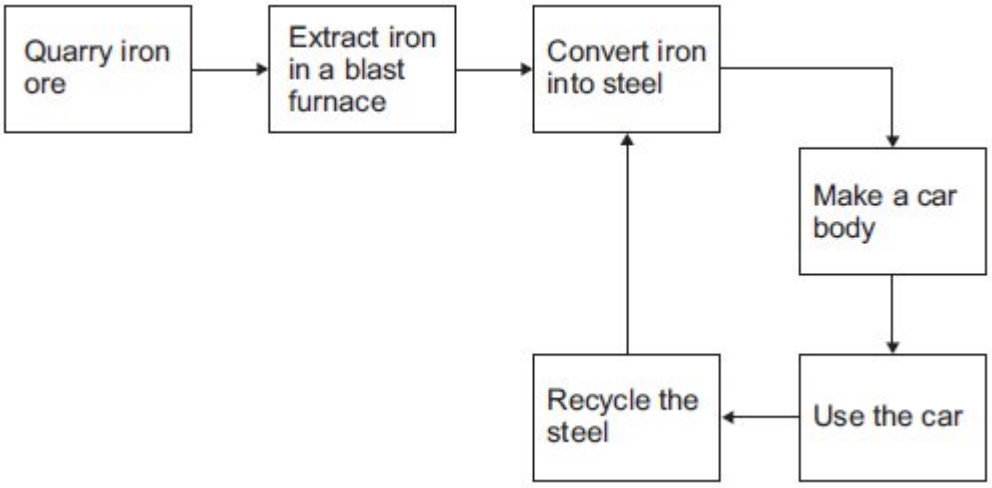
_____

_____

(2)

(c) **Figure 2** shows a simple life cycle of a car body.

Figure 2



(i) Complete the sentence.

Iron ores must contain enough iron to _____

_____

(1)

(ii) Some iron ores contain iron oxide (Fe_2O_3).

Complete and balance the equation for a reaction to produce iron from iron oxide.

_____ Fe_2O_3 + _____ C $\longrightarrow$ _____ + _____ CO_2

(2)

(iii) Give **two** reasons why iron produced in a blast furnace is converted into steel.

_____

_____

_____

_____

(2)

(iv) When a car reaches the end of its useful life, the car body can be:

- recycled

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- reused
- sent to landfill.

Give **three** reasons why a steel car body should be recycled and **not** reused or sent to landfill.

_____

_____

_____

_____

_____

_____

(3)

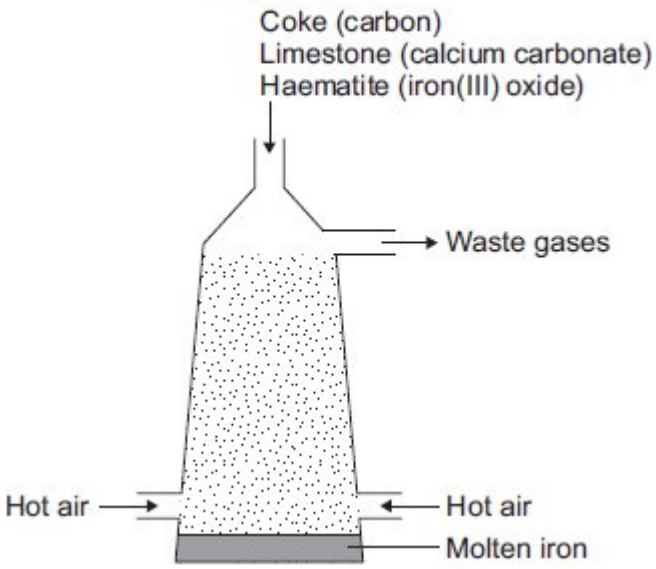
(Total 15 marks)

Q14.

This question is about iron and aluminium.

(a) Iron is extracted in a blast furnace. **Figure 1** is a diagram of a blast furnace.

Figure 1



(i) Calcium carbonate decomposes at high temperatures.

Complete the word equation for the decomposition of calcium carbonate.

calcium carbonate ⟶ _____ +

_____

(2)

(ii) Carbon burns to produce carbon dioxide.

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The carbon dioxide produced reacts with more carbon to produce carbon monoxide.

Balance the equation.

$$C(s) + CO_2(g) \longrightarrow _____ CO(g)$$

(1)

(iii) Carbon monoxide reduces iron(III) oxide:

$$Fe_2O_3(s) + 3\ CO(g) \longrightarrow 2\ Fe(s) + 3\ CO_2(g)$$

Calculate the maximum mass of iron that can be produced from 300 tonnes of iron(III) oxide.

Relative atomic masses (A_r): O = 16; Fe = 56

_____

_____

_____

_____

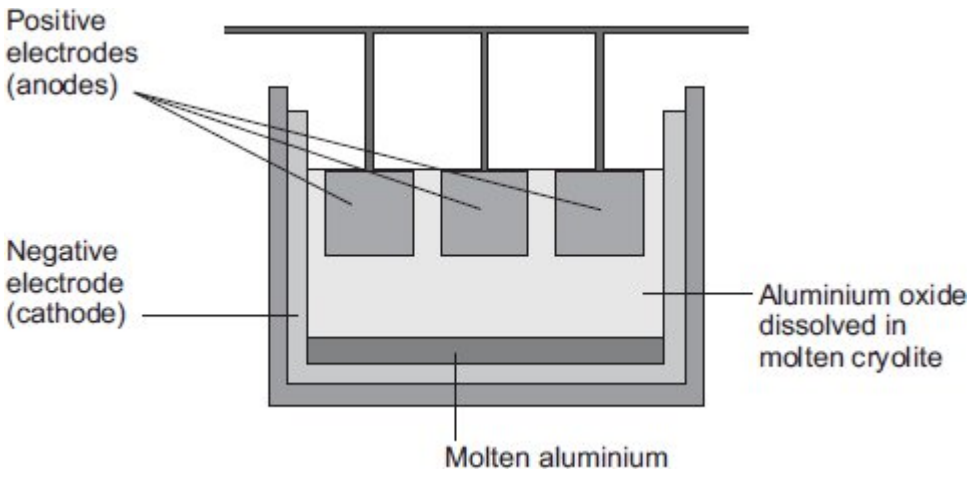
_____

Maximum mass = _____ tonnes

(3)

(b) Aluminium is extracted by electrolysis, as shown in **Figure 2**.

Figure 2



(i) Why can aluminium **not** be extracted by heating aluminium oxide with carbon?

_____

_____

(1)

(ii) Explain why aluminium forms at the negative electrode during electrolysis.

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_____

_____

_____

_____

_____

_____

_____

(3)

(iii) Explain how carbon dioxide forms at the positive electrodes during electrolysis.

_____

_____

_____

_____

_____

_____

(3)

(Total 13 marks)

Q15.

Copper is a transition metal.

(a) (i) Where is copper in the periodic table?

Tick (✓) **one** box.

in the central block ☐

in Group 1 ☐

in the noble gas group ☐

(1)

(ii) What is a property of copper?

Tick (✓) **one** box.

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breaks easily ☐

conducts electricity ☐

does not conduct heat ☐

(1)

(b) Copper ores are quarried by digging large holes in the ground, as shown in **Figure 1**.

Figure 1



© photllurg/iStock/Thinkstock

Give **two** reasons why quarrying is bad for the environment.

_____

_____

_____

_____

(2)

(c) Some copper ores contain only 2% copper.

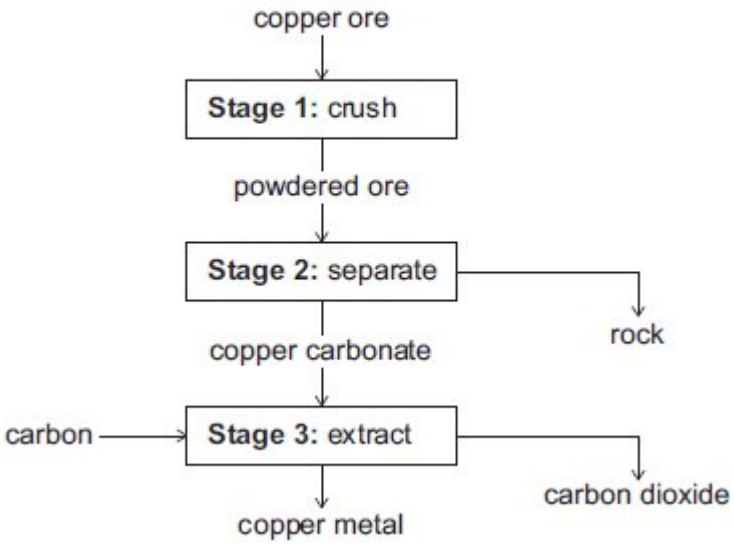
Most of the ore is rock that is not needed.

In one ore, the main compound is copper carbonate ($CuCO_3$).

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Figure 2 shows the stages used in the extraction of copper from this ore.

Figure 2



(i) Why is **Stage 2** important?

_____

_____

(1)

(ii) The equation for the reaction in **Stage 3** is:

$$2\ CuCO_3 + C \longrightarrow 2\ Cu + 3\ CO_2$$

From the symbol equation, a company calculated that 247 tonnes of copper carbonate are needed to produce 127 tonnes of copper and 132 tonnes of carbon dioxide are released.

Calculate the mass of carbon needed to make 127 tonnes of copper.

copper carbonate	+	carbon	→	copper	+	carbon dioxide
247 tonnes		..... tonnes		127 tonnes		132 tonnes

_____

_____

(2)

(iii) Suggest **one** reason why it is important for the company to calculate the mass of reactants in **Stage 3**.

_____

_____

(1)

(Total 8 marks)

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Q16.

This question is about carbon and gases in the air.

(a) Carbon atoms have protons, neutrons and electrons.

Complete the table by writing the relative mass of a neutron and an electron.

Name of particle	Relative mass
proton	1
neutron	
electron	

(2)

(b) What is the total number of protons and neutrons in an atom called?

Tick (✓) **one** box.

The atomic number ☐

The mass number ☐

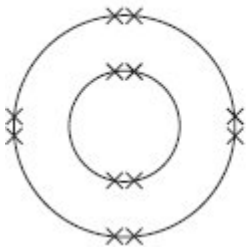
One mole of the atom ☐

(1)

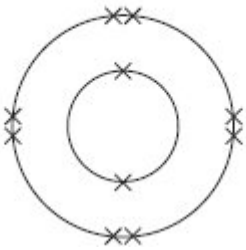
(c) An atom of carbon has six electrons.

Which structure, **A, B** or **C**, represents the electronic structure of the carbon atom?

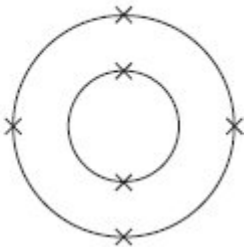
Structure A



Structure B



Structure C



The carbon atom is structure ☐

(1)

(d) Carbon reacts with oxygen to produce carbon dioxide (CO_2).

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(i) How many different elements are in one molecule of carbon dioxide?

_____

(1)

(ii) What is the total number of atoms in one molecule of carbon dioxide?

_____

(1)

(e) Sometimes carbon reacts with oxygen to produce carbon monoxide (CO).

(i) Calculate the relative formula mass (M_r) of carbon monoxide.

Relative atomic masses (A_r): C = 12; O = 16

_____

_____

M_r of carbon monoxide = _____

(1)

(ii) Calculate the percentage by mass of carbon in carbon monoxide.

_____

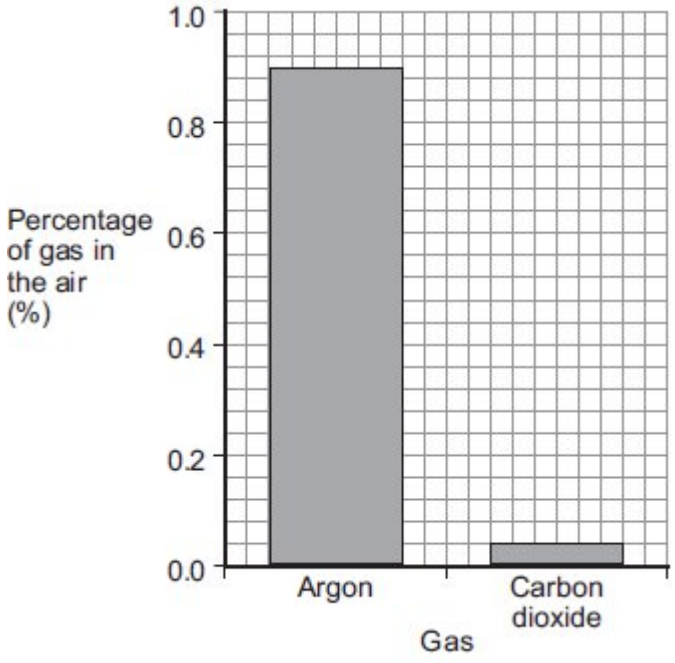
_____

Percentage by mass of carbon in carbon monoxide = _____%

(1)

(f) Carbon dioxide is one of the gases in the air.

(i) The graph shows the percentage of argon and the percentage of carbon dioxide in the air.



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What is the percentage of argon in the air?

Percentage of argon = _____ %

(1)

(ii) An instrumental method is used to measure the amount of carbon dioxide in the air.

Give **one** reason for using an instrumental method.

_____

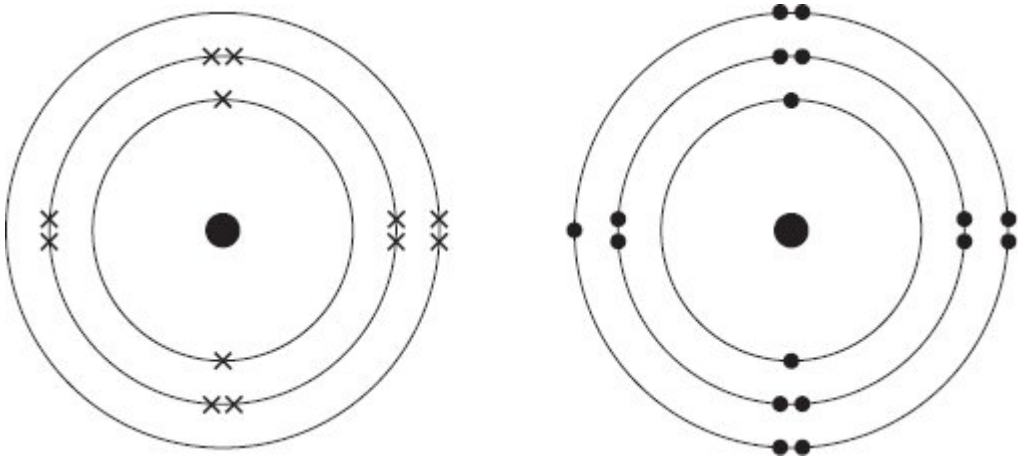
_____

(1)

(Total 10 marks)

Q17.

(a) The diagram shows an atom of magnesium and an atom of chlorine.



Magnesium **Chlorine**

Describe, in terms of electrons, how magnesium atoms and chlorine atoms change into ions to produce magnesium chloride ($MgCl_2$).

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(b) Calculate the relative formula mass (M_r) of magnesium chloride ($MgCl_2$).

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Relative atomic masses (A_r): magnesium = 24; chlorine = 35.5

_____

_____

_____

Relative formula mass (M_r) = _____

(2)

(Total 6 marks)

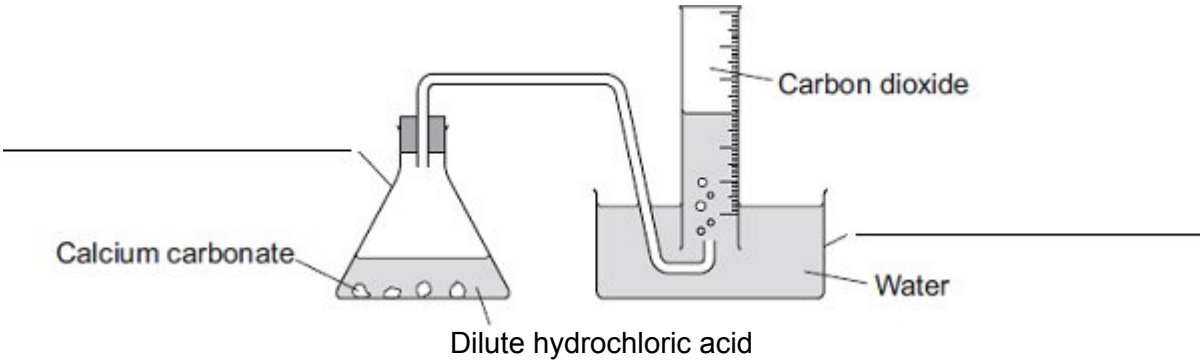
Q18.

Some students were investigating the rate at which carbon dioxide gas is produced when metal carbonates react with an acid.

One student reacted 1.00 g of calcium carbonate with 50 cm^3, an excess, of dilute hydrochloric acid.

The apparatus used is shown in **Diagram 1**.

Diagram 1



(a) Complete the **two** labels for the apparatus on the diagram.

(2)

(b) The student measured the volume of gas collected every 30 seconds.

The table shows the student's results.

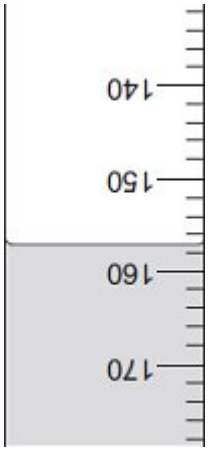
Time in seconds	Volume of carbon dioxide collected in cm^3
30	104
60	
90	198
120	221
150	232

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180	238
210	240
240	240

(i) **Diagram 2** shows what the student saw at 60 seconds.

Diagram 2



What is the volume of gas collected?

Volume of gas = _____ cm^3

(1)

(ii) Why did the volume of gas stop changing after 210 seconds?

_____

_____

(1)

(c) Another student placed a conical flask containing 1.00 g of a Group 1 carbonate (M_2CO_3) on a balance.

He then added 50 cm^3, an excess, of dilute hydrochloric acid to the flask and measured the mass of carbon dioxide given off.

The equation for the reaction is:

$$M_2CO_3 + 2HCl \longrightarrow 2MCl + H_2O + CO_2$$

The final mass of carbon dioxide given off was 0.32 g.

(i) Calculate the amount, in moles, of carbon dioxide in 0.32 g carbon dioxide.

Relative atomic masses (A_r): C = 12; O = 16

_____

_____

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_____

Moles of carbon dioxide = _____ moles

(2)

(ii) How many moles of the metal carbonate are needed to make this number of moles of carbon dioxide?

_____

_____

Moles of metal carbonate = _____ moles

(1)

(iii) The mass of metal carbonate used was 1.00 g.

Use this information, and your answer to part **(c) (ii)**, to calculate the relative formula mass (M_r) of the metal carbonate.

If you could not answer part **(c) (ii)**, use 0.00943 as the number of moles of metal carbonate. This is **not** the answer to part **(c) (ii)**.

_____

_____

Relative formula mass (M_r) of metal carbonate = _____

(1)

(iv) Use your answer to part **(c) (iii)** to calculate the relative atomic mass (A_r) of the metal in the metal carbonate (M_2CO_3) and so identify the Group 1 metal in the metal carbonate.

If you could not answer part **(c) (iii)**, use 230 as the relative formula mass of the metal carbonate. This is **not** the answer to part **(c) (iii)**.

To gain full marks, you must show your working.

_____

_____

_____

_____

Relative atomic mass of metal is _____

Identity of metal _____

(3)

(d) Two other students repeated the experiment in part **(c)**.

(i) When the first student did the experiment some acid sprayed out of the flask as the metal carbonate reacted.

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Explain the effect this mistake would have on the calculated relative atomic mass of the metal.

_____

_____

_____

_____

_____

_____

_____

(3)

(ii) The second student used 100 cm^3 of dilute hydrochloric acid instead of 50 cm^3.

Explain the effect, if any, this mistake would have on the calculated relative atomic mass of the metal.

_____

_____

_____

_____

_____

_____

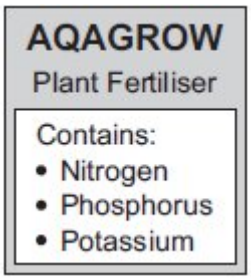
_____

(3)

(Total 17 marks)

Q19.

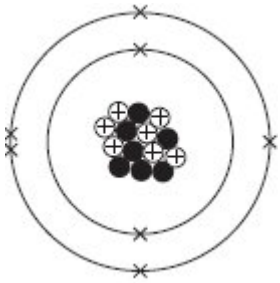
Fertilisers contain elements that plants need.



(a) **Figure 1** represents a nitrogen atom.

Figure 1

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Complete each sentence.

(i) The mass number of this nitrogen atom is _____ .

(1)

(ii) Atoms of nitrogen with different numbers of neutrons are called

_____ .

(1)

(iii) Compared with a proton, the mass of an electron is

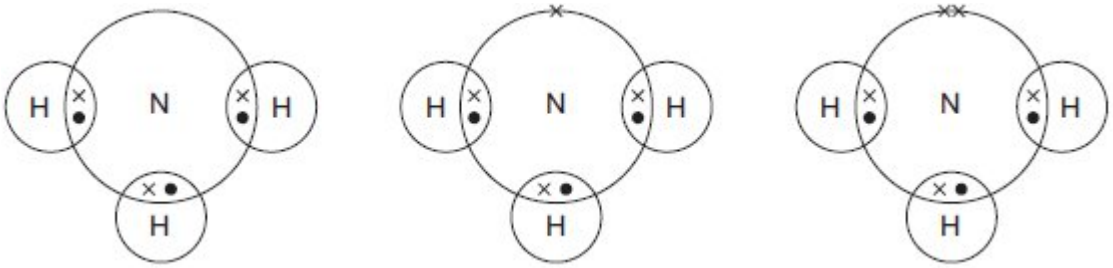
_____ .

(1)

(b) Fertilisers can be made from ammonia.

(i) Which diagram, **A**, **B**, or **C**, represents the electronic structure of an ammonia molecule?

A **B** **C**



(1)

The electronic structure of an ammonia molecule is shown in diagram ☐

(ii) What is the correct formula of ammonia?

Draw a ring around the correct answer.

N_3H **NH_3** **NH^3**

(1)

(c) A student made ammonium nitrate by reacting ammonia solution with an acid.

(i) Name the acid used to make ammonium nitrate.

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_____

(1)

(ii) Complete the sentence.

The student added a few drops of _____, which changed colour when the ammonia solution had neutralised the acid.

(1)

(iii) The student added charcoal and filtered the mixture.

This produced a colourless solution of ammonium nitrate.

How is solid ammonium nitrate obtained from the solution?

_____

(1)

(iv) A farmer put ammonium nitrate fertiliser onto a field of grass.

Suggest what would happen to the grass.

_____

_____

(1)

(d) Some fertilisers contain potassium chloride.

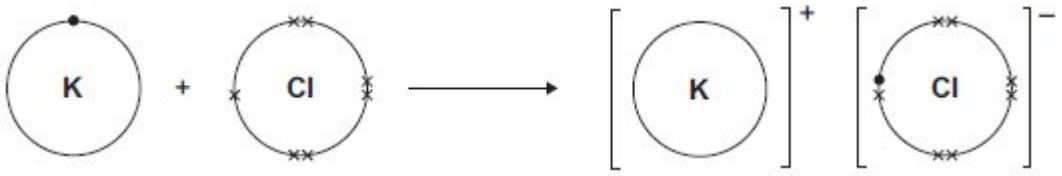
Potassium reacts with chlorine to produce potassium chloride.

Figure 2 shows how this happens.

The dots (•) and crosses (x) represent electrons.

Only the outer shell is shown.

Figure 2



Use **Figure 2** to help you answer this question.

Describe, as fully as you can, what happens when potassium reacts with chlorine to produce potassium chloride.

_____

_____

_____

_____

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_____

_____

_____

_____

_____

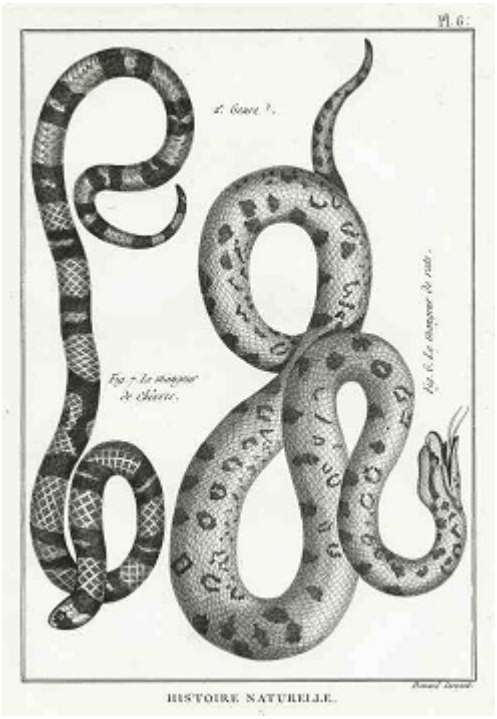
_____

(4)

(Total 13 marks)

Q20.

Printed pictures can be made using etchings.



© Eduardo Jose Bernardino/iStock

An etching can be made when a sheet of brass reacts with iron chloride solution.

(a) Brass is a mixture of two metals, copper and zinc.

(i) A mixture of two metals is called _____ .

(1)

(ii) Draw a ring around the correct answer to complete the sentence.

Copper and zinc atoms are different sizes.

This makes brass | harder / more flexible | than the pure metals.

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softer

(1)

(b) Iron chloride has the formula $FeCl_3$

Relative atomic masses (A_r): Cl = 35.5; Fe = 56.

(i) Calculate the relative formula mass (M_r) of iron chloride ($FeCl_3$).

_____

_____

_____

Relative formula mass (M_r) of iron chloride = _____

(2)

(ii) Calculate the percentage of iron in iron chloride ($FeCl_3$).

_____

_____

_____

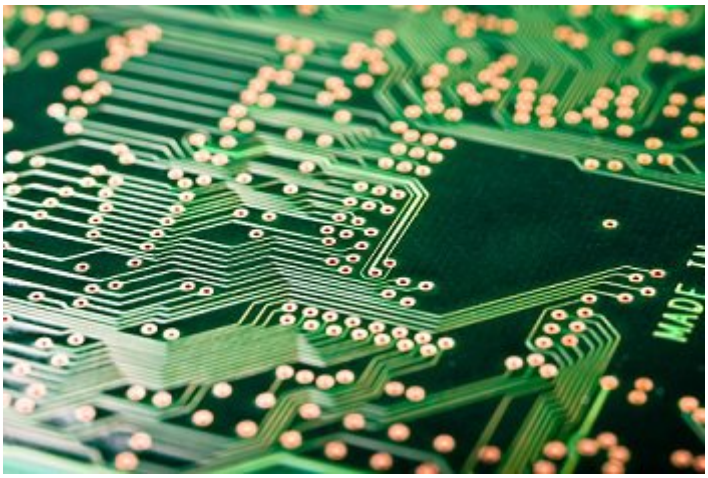
Percentage of iron in iron chloride = _____%

(2)

(Total 6 marks)

Q21.

Etching is a way of making printed circuit boards for computers.



© Dario Lo Presti/Shutterstock

Printed circuit boards are made when copper sheets are etched using iron(III) chloride solution. Where the copper has been etched, only plastic remains.

(a) Copper is a good conductor of electricity.

Explain why.

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_____

_____

_____

_____

(2)

(b) Iron(III) chloride can be produced by the reaction shown in the equation:

$$2\ Fe + 3\ Cl_2 \rightarrow 2\ FeCl_3$$

(i) Calculate the maximum mass of iron(III) chloride ($FeCl_3$) that can be produced from 11.20 g of iron.

Relative atomic masses (A_r): Cl = 35.5; Fe = 56.

_____

_____

_____

_____

_____

Maximum mass of iron(III) chloride = _____ g

(3)

(ii) The actual mass of iron(III) chloride ($FeCl_3$) produced was 24.3 g.

Calculate the percentage yield.

(If you did not answer part (b)(i) assume that the maximum theoretical mass of iron(III) chloride ($FeCl_3$) is 28.0 g. This is **not** the correct answer to part (b)(i).)

_____

_____

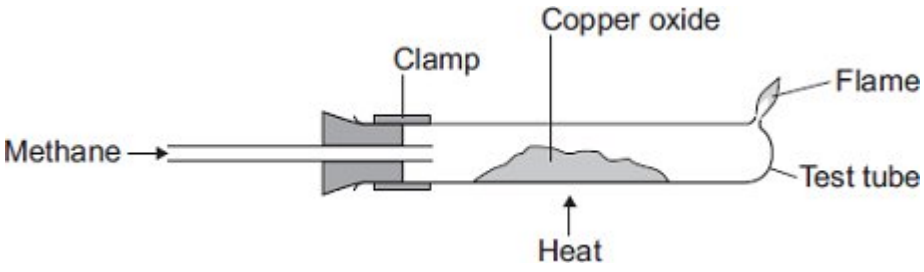
Percentage yield = _____%

(1)

(Total 6 marks)

Q22.

This apparatus is used for the reaction of copper oxide (CuO) with methane (CH_4).



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(a) The symbol equation for this reaction is shown below.

$$4\ CuO(s) + CH4(g) \rightarrow 4\ Cu(s) + 2\ H_2O(g) + CO_2(g)$$

The water and carbon dioxide produced escape from the test tube.

Use information from the equation to explain why.

_____

_____

(1)

(b) (i) Calculate the relative formula mass (M_r) of copper oxide (CuO).

Relative atomic masses (A_r): O = 16, Cu = 64

_____

_____

_____

Relative formula mass (M_r) = _____

(2)

(ii) Calculate the percentage of copper in copper oxide.

_____

_____

_____

Percentage of copper = _____ %

(2)

(iii) Calculate the maximum mass of copper that could be produced from 4.0 g of copper oxide.

_____

_____

Mass of copper produced = _____ g

(1)

(c) The experiment was done three times.

The mass of copper oxide used and the mass of copper produced were measured each time.

The results are shown in the table.

	Experiment

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	1	2	3
Mass of copper oxide used in g	4.0	4.0	4.0
Mass of copper produced in g	3.3	3.5	3.2

(i) Calculate the mean mass of copper produced in these experiments.

_____

_____

Mean mass of copper produced = _____ g

(1)

(ii) Suggest how the results of the experiment could be made more precise.

_____

_____

(1)

(iii) The three experiments gave different results for the amount of copper produced.

This was caused by experimental error.

Suggest two causes of experimental error in these experiments.

1. _____

_____

2. _____

_____

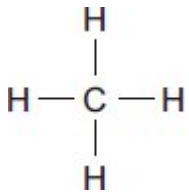
(2)

(Total 10 marks)

Q23.

Saturated hydrocarbons, for example methane and octane, are often used as fuels.

(a) Methane can be represented as:



(i) The formula of methane is

_____ .

(1)

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(ii) Draw a ring around the correct answer to complete the sentence.

In a saturated hydrocarbon molecule all of the bonds are

double.
ionic.
single.

(1)

(iii) Draw a ring around the correct answer to complete the sentence.

The homologous series that contains methane and octane

is called the

alcohols.
alkanes.
alkenes.

(1)

(b) (i) The complete combustion of petrol produces carbon dioxide, water vapour and sulfur dioxide.

Name **three** elements petrol must contain.

1. _____

2. _____

3. _____

(3)

(ii) The exhaust gases from cars can contain oxides of nitrogen.

Complete the sentence.

Nitrogen in the oxides of nitrogen comes from _____ .

(1)

(iii) The sulfur dioxide and oxides of nitrogen from cars cause an environmental problem.

Name the problem and describe **one** effect of the problem.

Name of problem _____

Effect of problem _____

_____

(2)

(c) When a fuel burns without enough oxygen, there is incomplete combustion.

One gaseous product of incomplete combustion is carbon monoxide.

Name **one** solid product of incomplete combustion.

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_____

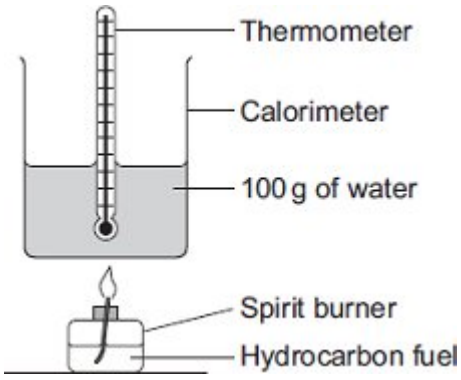
(1)

(d) A student investigated how well different hydrocarbon fuels would heat up 100 g of water.

Her hypothesis was:

The more carbon atoms there are in a molecule of any fuel, the better the fuel is.

The apparatus the student used is shown in the diagram.



She burned each hydrocarbon fuel for 2 minutes.

Her results are shown in the table.

Name of hydrocarbon fuel	Number of carbon atoms in a molecule of hydrocarbon fuel	Temperature change of water in °C after 2 minutes	Temperature change per g of fuel burned	Observations
Pentane	5	30	60	no smoke
Hexane	6	40	57	very small amount of smoke
Octane	8	55	55	small amount of smoke
Decane	10	57	52	large amount of smoke
Dodecane	12	60	43	very large amount of smoke

The student investigated only hydrocarbons.

Look carefully at her results.

How well do the student's results support her hypothesis?

The more carbon atoms there are in a molecule of any fuel, the better the fuel is.

Give reasons for your answer.

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_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(e) A 0.050 mol sample of a hydrocarbon was burned in excess oxygen.

The products were 3.60 g of water and 6.60 g of carbon dioxide.

(i) Calculate the number of moles of carbon dioxide produced.

Relative atomic masses: C = 12; O = 16.

_____

_____

Moles of carbon dioxide = _____

(2)

(ii) When the hydrocarbon was burned 0.20 mol of water were produced.

How many moles of hydrogen atoms are there in 0.20 mol of water?

_____

Moles of hydrogen atoms = _____

(1)

(iii) The amount of hydrocarbon burned was 0.050 mol.

Use this information and your answers to parts **(e) (i)** and **(e) (ii)** to calculate the molecular formula of the hydrocarbon.

If you could not answer parts **(e) (i)** or **(e) (ii)** use the values of 0.20 moles carbon dioxide and 0.50 moles hydrogen. These are **not** the answers to parts **(e) (i)** and **(e) (ii)**.

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_____

_____

_____

_____

Formula = _____

(2)

(Total 19 marks)

Q24.

This question is about lithium and sodium.

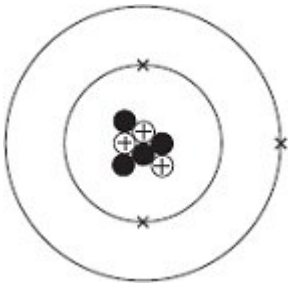
(a) Use the Chemistry Data Sheet to help you to answer this question.

In which group of the periodic table are lithium and sodium? Group ☐

(1)

(b) A lithium atom can be represented as $^{7}_{3}Li$

The diagram represents the lithium atom.



(i) Some particles in the nucleus have a positive charge.

What is the name of these particles?

_____

(1)

(ii) Some particles in the nucleus have no charge.

What is the name of these particles?

_____

(1)

(iii) Use the correct answer from the box to complete the sentence.

3	**4**	**7**

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The mass number of this atom of lithium is ☐

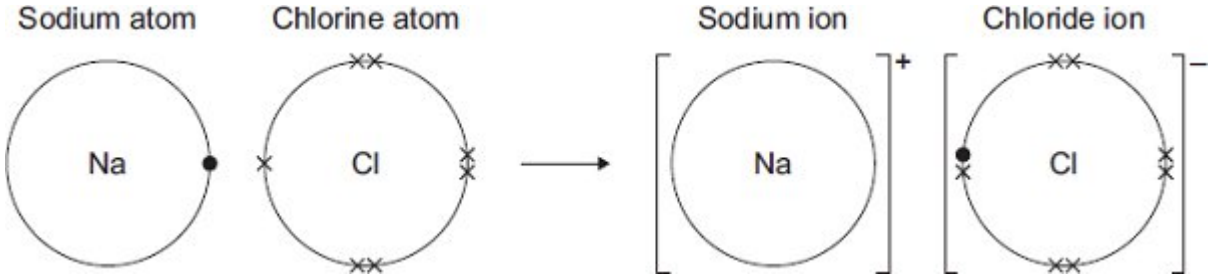
(1)

(c) Sodium reacts with chlorine to produce sodium chloride.

sodium + chlorine ⟶ sodium chloride

The diagram shows how the reaction happens.

Only the outer electrons are shown.



Draw a ring around the correct answer to complete each sentence.

(i) A sodium atom changes into a sodium ion by [gaining / losing / sharing] an electron.

(1)

(ii) A sodium ion has [a negative / no / a positive] charge.

(1)

(iii) The ions in sodium chloride are held together by

strong [covalent / electrostatic / magnetic] forces.

(1)

(d) Sodium chloride is an ionic compound.

Tick (✓) **two** properties of ionic compounds.

Property	**Tick (✓)**

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Do **not** dissolve in water	
High melting points	
Low boiling points	
Strong bonds	

(2)

(e) (i) The formula of sodium chloride is NaCl

Calculate the relative formula mass of sodium chloride.

Relative atomic masses: Na = 23; Cl = 35.5

_____

_____

Relative formula mass = _____

(1)

(ii) Draw a ring around the correct answer to complete each sentence.

The relative formula mass of a substance, in grams,

is one | ion / isotope / mole | of the substance.

(1)

(f) Nanoparticles of sodium chloride (salt) are used to flavour crisps.

What are nanoparticles?

_____

_____

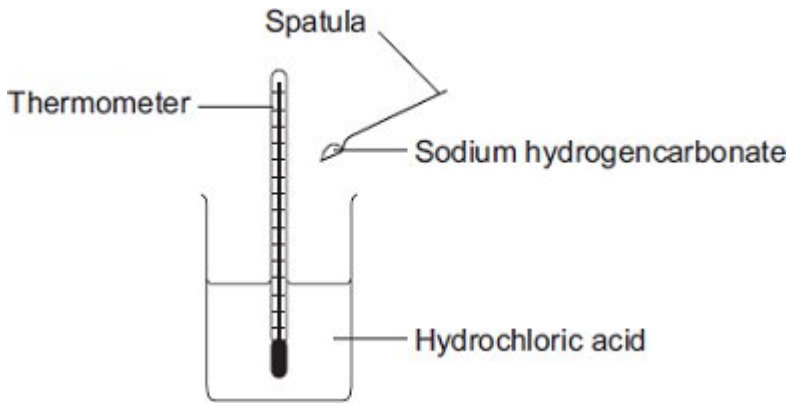
(1)

(Total 12 marks)

Q25.

(a) Some students did an experiment to find the temperature change when hydrochloric acid reacts with sodium hydrogencarbonate.

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The results are in the table.

Number of spatula measures of sodium hydrogencarbonate	Start temperature in °C	Final temperature in °C	Change in temperature in °C
2	20	16	4
4	20	14	6
6	19	11	8
8	20	10	10
10	19	9	10
12	20	10	10

(i) Describe, as fully as you can, the trends shown in the students' results.

_____

_____

_____

_____

_____

_____

_____

_____

(3)

(ii) State the type of energy transfer for this reaction.

_____

_____

(1)

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(b) Sodium hydrogencarbonate is used as baking powder for making cakes.

When the cake mixture is baked the sodium hydrogencarbonate decomposes.

The equation for the reaction is:

$$2\,NaHCO_3(s) \xrightarrow{Heat} Na_2CO_3(s) + H_2O(g) + CO_2(g)$$

(i) The cake mixture rises when baked.



© Michael Valdez/iStock

Use the equation to suggest why.

_____

_____

(1)

(ii) The same reaction can be reversed to produce sodium hydrogencarbonate from sodium carbonate.

$$Na_2CO_3 + H_2O + CO_2 \longrightarrow 2NaHCO_3$$

Do the reactants need to be heated?

Give a reason for your answer.

_____

_____

(1)

(c) (i) Calculate the relative formula mass of sodium hydrogencarbonate ($NaHCO_3$).

Relative atomic masses (A_r): H=1; C=12; O=16; Na=23

_____

_____

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_____

Relative formula mass (M_r) = _____

(2)

(ii) Calculate the percentage by mass of carbon in sodium hydrogencarbonate.

_____

_____

Percentage of carbon = _____ %

(1)

(Total 9 marks)

Q26.

Ammonia is produced from nitrogen and hydrogen.

The equation for this reaction is:

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$

(a) (i) A company wants to make 6.8 tonnes of ammonia.

Calculate the mass of nitrogen needed.

Relative atomic masses (A_r): H = 1; N = 14

_____

_____

_____

_____

_____

Mass of nitrogen = _____ tonnes

(3)

(ii) The company expected to make 6.8 tonnes of ammonia.

The yield of ammonia was only 4.2 tonnes.

Calculate the percentage yield of ammonia.

_____

_____

Percentage yield of ammonia = _____ %

(2)

(iii) Use the equation above to explain why the percentage yield of ammonia was less than expected.

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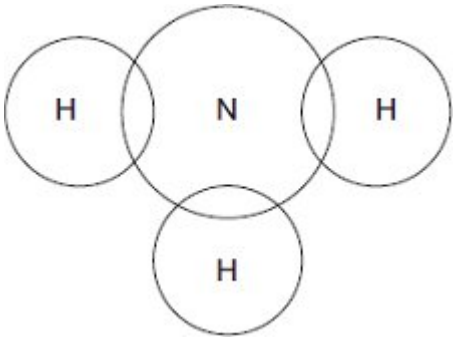
_____

_____

(1)

(b) Complete the diagram to show the arrangement of the outer shell electrons of the nitrogen and hydrogen atoms in ammonia.

Use dots (●) and crosses (x) to represent the electrons.



(2)

(c) Ammonia dissolves in water to produce an alkaline solution.

(i) Which ion makes ammonia solution alkaline?

_____

(1)

(ii) Name the type of reaction between aqueous ammonia solution and an acid.

_____

(1)

(iii) Name the acid needed to produce ammonium nitrate.

_____

(1)

(iv) The reaction of ammonia with sulfuric acid produces ammonium sulfate.

Use the formulae of the ions on the Chemistry Data Sheet.

Write the formula of ammonium sulfate.

_____

(1)

(Total 12 marks)

Q27.

Some students investigated magnesium oxide.

(a) Magnesium oxide has the formula MgO.

(i) Calculate the relative formula mass (M_r) of magnesium oxide.

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Relative atomic masses: O = 16; Mg = 24.

_____

_____

Relative formula mass = _____

(2)

(ii) Calculate the percentage by mass of magnesium in magnesium oxide.

_____

_____

Percentage by mass of magnesium in magnesium oxide = _____%

(2)

(iii) Calculate the mass of magnesium needed to make 25 g of magnesium oxide.

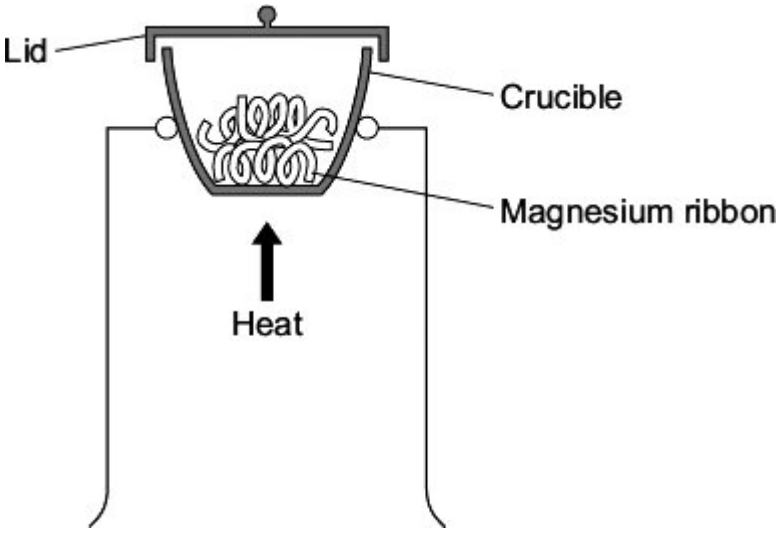
_____

Mass of magnesium = _____ g

(1)

(b) The students calculated that if they used 0.12 g of magnesium they should make 0.20 g of magnesium oxide.

They did this experiment to find out if this was correct.



- The students weighed 0.12 g of magnesium ribbon into a crucible.
- They heated the magnesium ribbon.
- They lifted the lid of the crucible slightly from time to time to allow air into the crucible.
- The students tried to avoid lifting the lid too much in case some of the magnesium oxide escaped.

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- When all of the magnesium appeared to have reacted, the students weighed the magnesium oxide produced.

The results of the experiment are shown below.

Mass of magnesium used in grams	0.12
Mass of magnesium oxide produced in grams	0.18

(i) The mass of magnesium oxide produced was lower than the students had calculated.
They thought that this was caused by experimental error.

Suggest **two** experimental errors that the students had made.

_____

_____

_____

_____

(2)

(ii) The students only did the experiment once.

Give **two** reasons why they should have repeated the experiment.

_____

_____

_____

_____

(2)

(Total 9 marks)

Q28.

Aluminium is extracted from aluminium oxide.

(a) The formula of aluminium oxide is Al_2O_3

The relative formula mass (M_r) of aluminium oxide is 102.

Calculate the percentage of aluminium in aluminium oxide.

Relative atomic masses (A_r): O = 16; Al = 27.

_____

_____

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_____

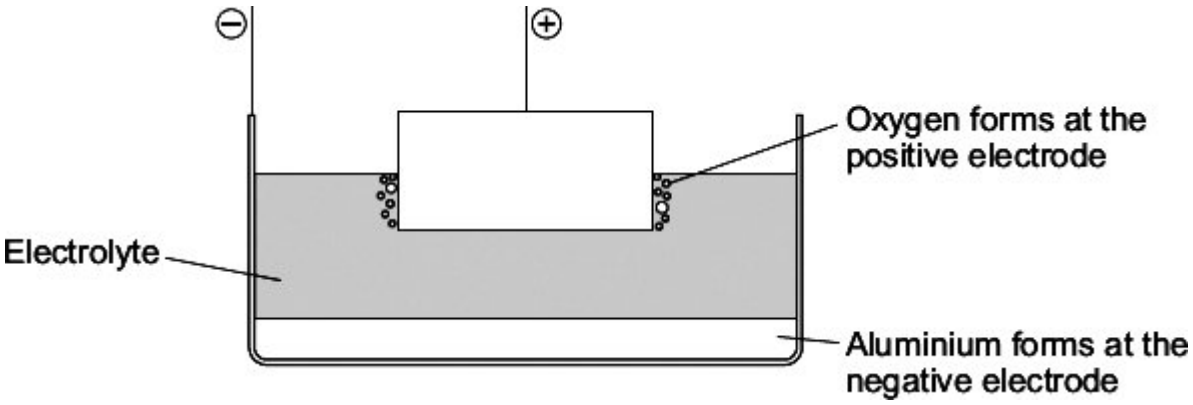
_____

Percentage of aluminium = _____ %

(2)

(b) Aluminium is extracted from aluminium oxide using electrolysis.

The diagram shows a cell used for the extraction of aluminium.



(i) The electrolyte contains cryolite.

Explain why.

_____

_____

_____

_____

(2)

(ii) Oxygen is formed at the positive electrode. Complete and balance the equation for this reaction.

$$___\ O^{2-} \rightarrow O_2 + _____$$

(2)

(iii) The positive electrode in the cell is used up during the process.

Explain why.

_____

_____

_____

_____

_____

_____

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(2)
(Total 8 marks)

Q29.

This question is about calcium hydroxide.

Ancient artworks and monuments can be protected from acid rain if the surface is sprayed with calcium hydroxide nanoparticles.



By Svilen Enev (Own work) [GFDL or CC-BY-SA-3.0], via Wikimedia Commons

(a) Calcium hydroxide has the formula $Ca(OH)_2$

Why are there two hydroxide ions for each calcium ion in the formula?

_____

_____

_____

(1)

(b) The calcium hydroxide is used in the form of *nanoparticles*.

What are *nanoparticles*?

_____

_____

(1)

(c) A student added water to calcium oxide to make calcium hydroxide.

The equation for the reaction is shown below.

$$CaO + H_2O \rightarrow Ca(OH)_2$$

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Calculate the maximum mass of calcium hydroxide which could be made from 2.00 g of calcium oxide.

Relative atomic masses (A_r): H = 1; O = 16; Ca = 40.

_____

_____

_____

_____

_____

_____

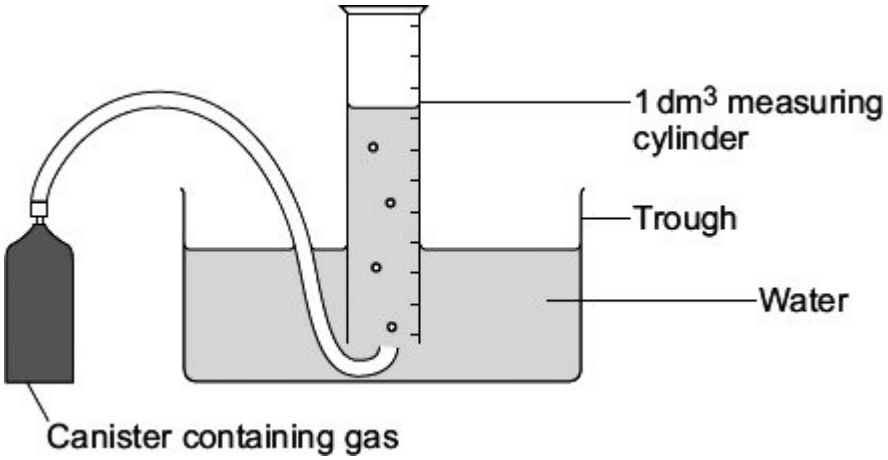
Maximum mass of calcium hydroxide = _____ g

(3)

(Total 5 marks)

Q30.

Some students did an experiment to find the relative formula mass (M_r) of a gas.



This is the method they used.

- The mass of the canister of gas was measured using a balance, which weighed to two decimal places.
- The measuring cylinder was filled with 1 dm^3 of the gas from the canister.
- The mass of the canister of gas was measured again.
- The temperature of the laboratory was measured.
- The air pressure in the laboratory was measured.

The students repeated the experiment three times.

(a) The results for one of the experiments are shown in the table below.

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Mass of the canister of gas before filling the measuring cylinder	53.07 g
Mass of the canister of gas after filling the measuring cylinder	51.21 g

Calculate the mass of the 1 dm^3 of gas in the measuring cylinder.

_____

Mass = _____ g

(1)

(b) How could the results be made more precise?

_____

_____

(1)

(c) The students used their results to calculate values for the relative formula mass (M_r) of this gas.
The results are shown in the table below.

Experiment	**1**	**2**	**3**	**4**
Relative formula mass (M_r)	45.4	51.5	46.3	45.8

(i) Calculate the mean value for these results.

_____

Mean = _____

(2)

(ii) The four results are different.
The students thought this was because of experimental error.

Suggest **two** causes of experimental error in this experiment.

_____

_____

_____

_____

(2)

(iii) It was important for the students to repeat the experiment.
Suggest why.

_____

_____

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(1)

(d) The teacher told the students that the formula of the gas is C_3H_8

Calculate the relative formula mass (M_r) of this gas. You should show your working.

Relative atomic masses: H = 1; C = 12.

_____

_____

Relative formula mass = _____

(2)

(Total 9 marks)

Q31.

Calamine lotion is used to treat itching. The main ingredients are two metal oxides.



(a) One of the metal oxides has a relative formula mass (M_r) of 81.

The formula of this metal oxide is MO.
(M is **not** the correct symbol for the metal.)

The relative atomic mass (A_r) of oxygen is 16.

(i) Calculate the relative atomic mass (A_r) of metal M.

_____

_____

_____

Relative atomic mass (A_r) = _____

(2)

(ii) Use your answer to part (a)(i) and the periodic table on the Data Sheet to name metal M.

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The name of metal M is _____ .

(1)

(b) The other metal oxide is iron(III) oxide.

This contains iron(III) ions (Fe^{3+}) and oxide ions (O^{2-}).

(i) Explain in terms of electrons how an iron atom (Fe) can change into an iron(III) ion (Fe^{3+}).

_____

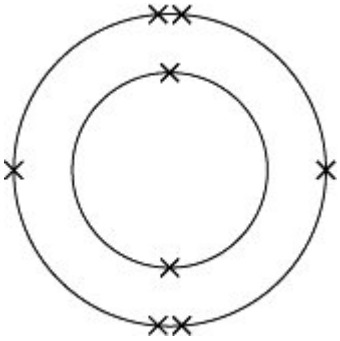
_____

_____

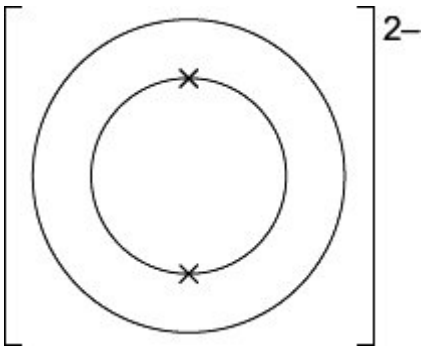
_____

(2)

(ii) The diagram below represents the electronic structure of an oxygen atom (O).



Complete the diagram below to show the electronic structure of an oxide ion (O^{2-}).



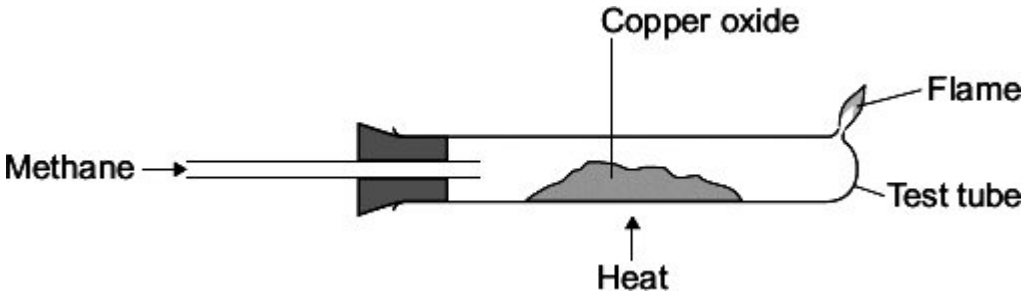
(1)

(Total 6 marks)

Q32.

An experiment was done on the reaction of copper oxide (CuO) with methane (CH_4).

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(a) The equation for this reaction is shown below.

$$4CuO(s) + CH_4(g) \rightarrow 4Cu(s) + 2H_2O(g) + CO_2(g)$$

The water and carbon dioxide produced escapes from the test tube.

Use information from the equation to explain why.

_____

(1)

(b) (i) Calculate the relative formula mass (M_r) of copper oxide (CuO).

Relative atomic masses (A_r): O = 16; Cu = 64.

_____

_____

_____

Relative formula mass (M_r) = _____

(2)

(ii) Calculate the percentage of copper in copper oxide.

_____

_____

_____

Percentage of copper = _____ %

(2)

(iii) Calculate the mass of copper that could be made from 4.0 g of copper oxide.

_____

_____

Mass of copper = _____ g

(1)

(c) The experiment was done three times.
The mass of copper oxide used and the mass of copper made was measured each

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time.
The results are shown in the table.

	Experiment		
	1	**2**	**3**
Mass of copper oxide used in g	4.0	4.0	4.0
Mass of copper made in g	3.3	3.5	3.2

(i) Calculate the mean mass of copper made in these experiments.

_____

_____

Mean mass of copper made = _____ g

(1)

(ii) Suggest how the results of these experiments could be made more precise.

_____

_____

(1)

(iii) The three experiments gave slightly different results for the mass of copper made.
This was caused by experimental error.

Suggest **two** causes of experimental error in these experiments.

1. _____

_____

2. _____

_____

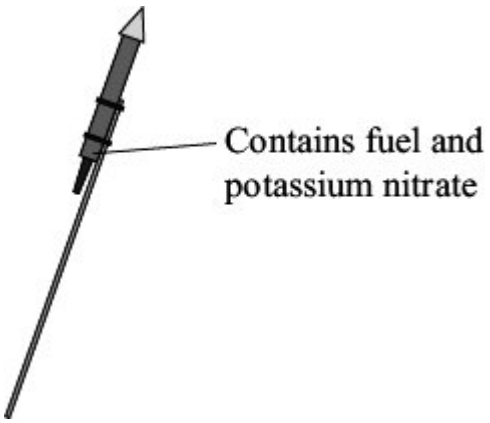
(2)

(Total 10 marks)

Q33.

Firework rockets contain fuel and potassium nitrate.

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The potassium nitrate provides oxygen for the fuel to react.

(a) The table shows how a student worked out the relative formula mass (M_r) of potassium nitrate.

Some of the numbers are missing.

Relative atomic masses (A_r): N = 14; O = 16; K = 39.

Name of atom (symbol)	**Number of atoms**	**A_r**	**Mass**
potassium (K)	1	39	39
nitrogen (N)	1	14	14
oxygen (O)		16	
		The M_r of potassium nitrate =	101

(i) The mass of oxygen is not shown in the table.

Draw a ring around the correct mass of oxygen.

16 **32** **48**

(1)

(ii) Draw a ring around the number of oxygen atoms in the formula of potassium nitrate.

1 **2** **3**

(1)

(b) When the fuel reacts with the oxygen an *exothermic* reaction takes place.

What does *exothermic* mean?

_____

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_____

_____

_____

(2)

(c) The fuel contains carbon. Carbon reacts with oxygen to make carbon dioxide.

Which **two** statements in the table explain why carbon dioxide is a gas at room temperature?

Tick (✓) the **two** statements.

Statement	**Tick (✓)**
It has a giant structure	
It has a low boiling point.	
It is made of small molecules.	
It is made of ions.	

(2)

(Total 6 marks)

Q34.

(a) The table gives information about two isotopes of hydrogen, hydrogen-1 and hydrogen-2.

	Hydrogen-1	**Hydrogen-2**
Atomic number	1	1
Mass number	1	2

An atom of hydrogen-1 is represented as: $^{1}_{1}\mathrm{H}$

Show how an atom of hydrogen-2 is represented.

(1)

(b) (i) Calculate the relative formula mass (M_r) of water, H_2O

Relative atomic masses: H = 1; O = 16.

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_____

_____

Relative formula mass (M_r) = _____

(1)

(ii) Simple molecules like water have low boiling points.

Explain why, in terms of molecules.

_____

_____

_____

_____

(2)

(c) Molecules of heavy water contain two atoms of hydrogen-2 instead of two atoms of hydrogen-1.

Explain why a molecule of heavy water has more mass than a normal water molecule.
You should refer to the particles in the nucleus of the two different hydrogen atoms in your answer.

_____

_____

_____

_____

_____

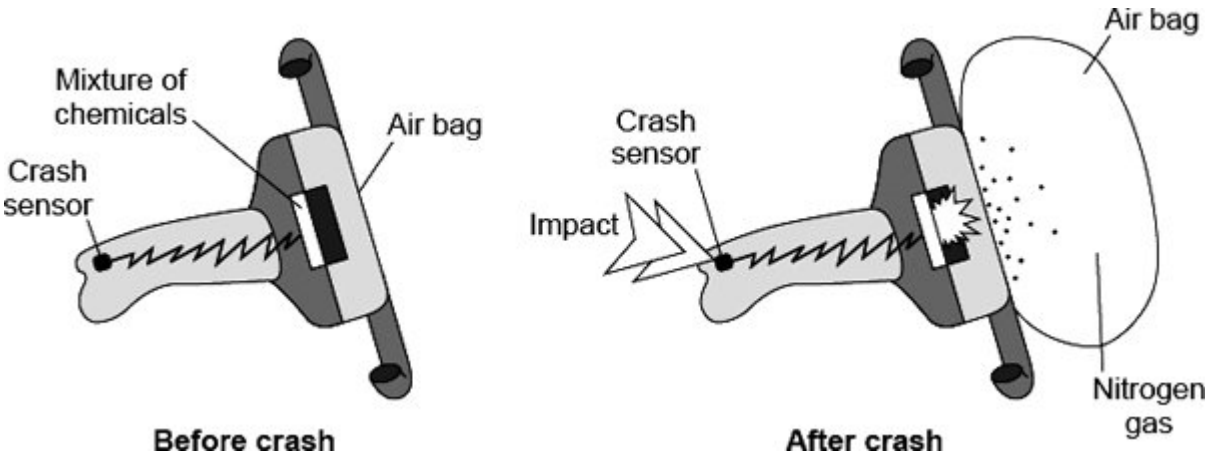
(2)

(Total 6 marks)

Q35.

Air bags are used to protect the passengers in a car during an accident. When the crash sensor detects an impact it causes a mixture of chemicals to be heated to a high temperature. Reactions take place which produce nitrogen gas. The nitrogen fills the air bag.

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(a) The mixture of chemicals contains sodium azide (NaN_3) which decomposes on heating to form sodium and nitrogen.

$2NaN_3 \rightarrow 2Na + 3N_2$

A typical air bag contains 130 g of sodium azide.

(i) Calculate the mass of nitrogen that would be produced when 130 g of sodium azide decomposes.

Relative atomic masses (A_r): N = 14; Na = 23

_____

_____

_____

_____

Mass of nitrogen = _____ g

(3)

(ii) 1 g of nitrogen has a volume of 0.86 litres at room temperature and pressure.

What volume of nitrogen would be produced from 130 g of sodium azide?

(If you did not answer part (a)(i), assume that the mass of nitrogen produced from 130 g of sodium azide is 80 g. This is **not** the correct answer to part (a)(i).)

_____

Volume = _____ litres

(1)

(b) The sodium produced when the sodium azide decomposes is dangerous.
The mixture of chemicals contains potassium nitrate and silicon dioxide which help to make the sodium safe.

(i) Sodium reacts with potassium nitrate to make sodium oxide, potassium oxide and nitrogen. Complete the balancing of the equation for this reaction.

$10Na + _____KNO_3 \rightarrow Na_2O + K_2O + N_2$

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(1)

(ii) The silicon dioxide reacts with the sodium oxide and potassium oxide to form silicates.

Suggest why sodium oxide and potassium oxide are dangerous in contact with the skin.

_____

_____

(1)

(Total 6 marks)

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