

Questions are for both separate science and combined science students unless indicated in the question

Q1.

A student investigated the reactivity of metals with hydrochloric acid.

This is the method used.

1. Measure 50 cm³ of hydrochloric acid into a polystyrene cup.
2. Measure the temperature of the hydrochloric acid.
3. Add one spatula of metal powder to the hydrochloric acid and stir.
4. Measure the highest temperature the mixture reaches.
5. Calculate the temperature increase for the reaction.
6. Repeat steps 1 to 5 three more times.
7. Repeat steps 1 to 6 with different metals.

The table below shows the student's results.

Metal	Temperature increase in °C				Mean temperature increase in °C
	Trial 1	Trial 2	Trial 3	Trial 4	
Cobalt	6	7	5	9	7
Magnesium	54	50	37	55	X
Zinc	18	16	18	20	18

- (a) Calculate the mean temperature increase **X** for magnesium in the table above.

Do **not** include the anomalous result in your calculation.

$$X = \text{_____} \text{ } ^\circ\text{C}$$

(2)

- (b) Determine the order of reactivity for the metals cobalt, magnesium and zinc.

Use the table above.

Most reactive _____

Least reactive _____

(1)

- (c) The range of measurements either side of the mean shows the uncertainty in the mean temperature increase.

Complete the sentence.

Use the table above.

The mean temperature increase for zinc is $18 \pm$ _____ °C

(1)

- (d) What type of variable is the volume of hydrochloric acid in this investigation?

Tick (✓) **one** box.

Control

Dependent

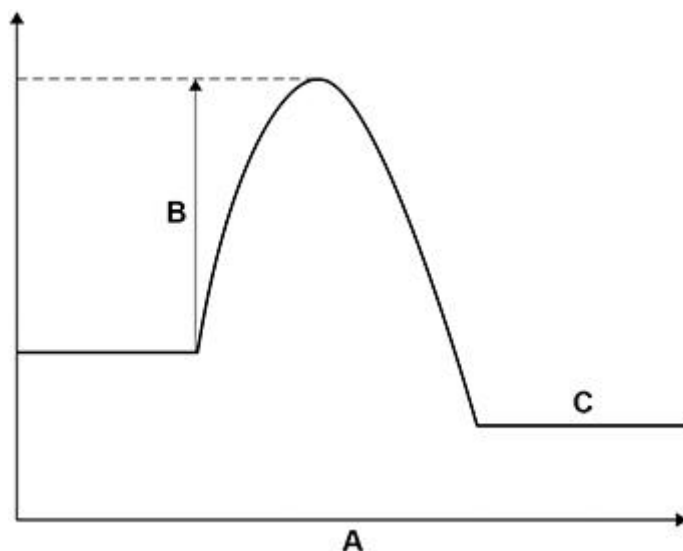
Independent

(1)

- (e) Suggest **one** way of improving **step 3** in the method to give results which are more repeatable.

(1)

- (f) The figure below shows a reaction profile for the reaction of magnesium with hydrochloric acid.



What do labels **A**, **B** and **C** represent on the figure above?

Choose answers from the box.

activation energy	energy	overall energy change
products	progress of reaction	reactants

A _____

B _____

C _____

(3)

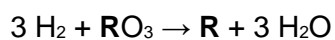
(Total 9 marks)

Q2.

This question is about the extraction of metals.

Element **R** is extracted from its oxide by reduction with hydrogen.

The equation for the reaction is:



- (a) The sum of the relative formula masses (M_r) of the reactants ($3 \text{H}_2 + \text{RO}_3$) is 150

Calculate the relative atomic mass (A_r) of **R**.

Relative atomic masses (A_r): H = 1 O = 16

Relative atomic mass (A_r) of **R** = _____

(2)

(b) Identify element **R**.

You should use:

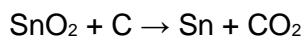
- your answer to part (a)
- the periodic table.

Identity of **R** = _____

(1)

(c) Carbon is used to extract tin (Sn) from tin oxide (SnO_2).

The equation for the reaction is:



Calculate the percentage atom economy for extracting tin in this reaction.

Relative atomic masses (A_r): C = 12 O = 16 Sn = 119 **(separate only)**

Percentage atom economy = _____ %

(3)

(d) Tungsten (W) is a metal.

Tungsten is extracted from tungsten oxide (WO_3).

All other solid products from the extraction method must be separated from the tungsten.

The table below shows information about three possible methods to extract tungsten from tungsten oxide.

Method	Reactant	Relative cost of reactant	Products
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Result _____

(2)

- (b) The table below shows the name and formula of three cycloalkenes.

Name	Formula
Cyclobutene	C ₄ H ₆
Cyclopentene	C ₅ H ₈
Cyclohexene	C ₆ H ₁₀

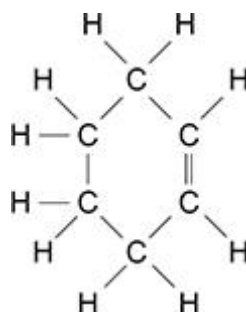
Determine the general formula for cycloalkenes. **(separate only)**

General formula = _____

(1)

Figure 1 shows the displayed structural formula of cyclohexene, C₆H₁₀

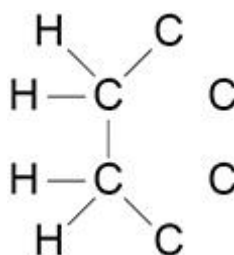
Figure 1



Chlorine reacts with cyclohexene to produce a compound with the formula C₆H₁₀Cl₂

- (c) Complete **Figure 2** to show the displayed structural formula of C₆H₁₀Cl₂
(separate only)

Figure 2



(2)

- (d) Calculate the percentage by mass of chlorine in a molecule of $C_6H_{10}Cl_2$

Relative atomic masses (A_r): H = 1 C = 12 Cl = 35.5

Percentage by mass = _____ %

(3)

(Total 8 marks)

Q4.

This question is about the elements in Group 7 of the periodic table.

Table 1 shows the melting points and boiling points of some of the elements.

Table 1

Element	Melting point in °C	Boiling point in °C
Fluorine	-220	-188
Chlorine	-101	-35
Bromine	-7	59

- (a) What is the state of bromine at 100 °C?

Use **Table 1**.

Tick (✓) **one** box.

Gas

Liquid

Solid

(1)

- (b) What temperature does chlorine gas condense at to form a liquid?

Use **Table 1**.

Temperature = _____ °C

(1)

(c) Complete the sentences.

Going down Group 7 the melting points _____ .

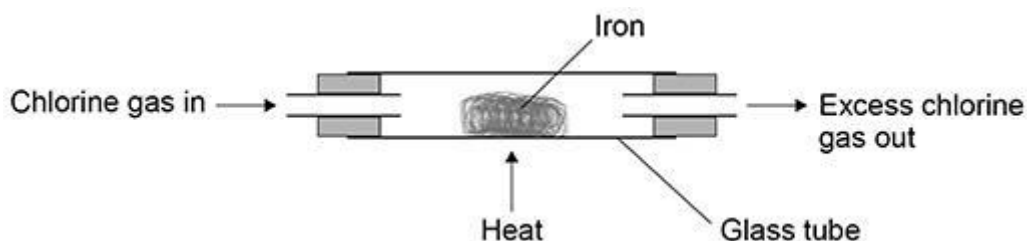
This is because the size of the molecules increases so the intermolecular forces

_____ .

(2)

A teacher investigated the reaction of iron with chlorine.

The diagram below shows the apparatus used.



(d) Why did the teacher do the investigation in a fume cupboard?

Tick (✓) **one** box.

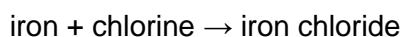
Chlorine gas is coloured.

Chlorine gas is flammable.

Chlorine gas is toxic.

(1)

(e) The word equation for the reaction is:



Iron chloride is a solid.

The teacher weighed the glass tube and contents:

- before the reaction
- after the reaction.

What happened to the mass of the glass tube and contents during the reaction?

Give **one** reason for your answer.

The mass of the glass tube and contents _____

Reason

(2)

The teacher repeated the investigation with bromine gas and with iodine gas.

Table 2 shows the results.

Table 2

Element	Observation
Chlorine	Iron burns vigorously with an orange glow
Bromine	Iron burns with an orange glow
Iodine	Iron slowly turns darker

(f) Fluorine is above chlorine in Group 7.

Predict what you would observe when fluorine gas reacts with iron.

Use **Table 2**.

(1)

(g) Balance the equation for the reaction between iron and bromine.



(1)

(h) Calculate the relative formula mass (M_r) of FeBr_3

Relative atomic masses (A_r): Fe = 56 Br = 80

Relative formula mass (M_r) = _____

(2)

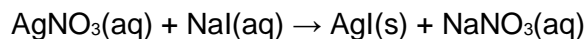
(Total 11 marks)

Q5.

This question is about silver iodide.

Silver iodide is produced in the reaction between silver nitrate solution and sodium iodide solution.

The equation for the reaction is:



- (a) A student investigated the law of conservation of mass.

This is the method used.

1. Pour silver nitrate solution into a beaker labelled **A**.
2. Pour sodium iodide solution into a beaker labelled **B**.
3. Measure the masses of both beakers and their contents.
4. Pour the solution from beaker **B** into beaker **A**.
5. Measure the masses of both beakers and their contents again.

The table below shows the student's results.

	Mass before mixing in g	Mass after mixing in g
Beaker A and contents	78.26	108.22
Beaker B and contents	78.50	48.54

Explain how the results demonstrate the law of conservation of mass.

You should use data from table above in your answer.

(2)

- (b) Suggest how the student could separate the insoluble silver iodide from the mixture at the end of the reaction.

(1)

The student purified the separated silver iodide.

This is the method used.

1. Rinse the silver iodide with distilled water.
 2. Warm the silver iodide.
- (c) Suggest **one** impurity that was removed by rinsing with water.

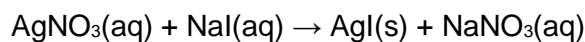
(1)

- (d) Suggest why the student warmed the silver iodide.

(1)

- (e) Calculate the percentage atom economy for the production of silver iodide in this reaction.

The equation for the reaction is:



Give your answer to 3 significant figures.

Relative formula masses:

(M_r): $\text{AgNO}_3 = 170$ $\text{NaI} = 150$ $\text{AgI} = 235$ $\text{NaNO}_3 = 85$ **(separate only)**

Percentage atom economy (3 significant figures) = _____ %

(4)

- (f) Give **one** reason why reactions with a high atom economy are used in industry. **(separate only)**

(1)
(Total 10 marks)

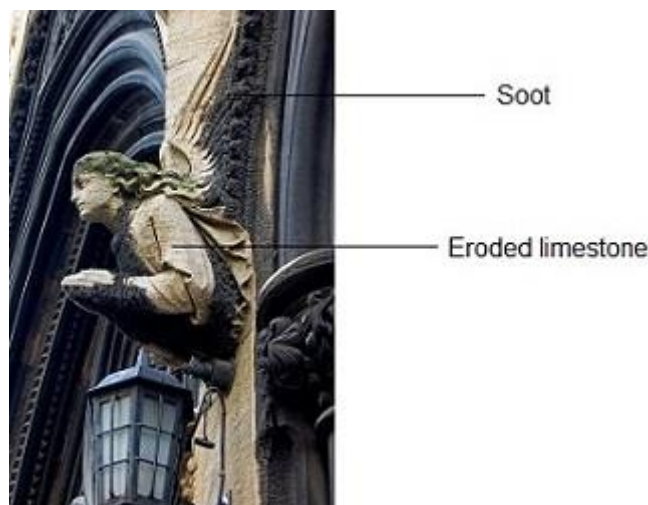
Q6.

This question is about atmospheric pollution.

The image below shows a limestone carving which has been damaged by atmospheric pollution.

The carving has been:

- blackened by soot
- eroded where the limestone has reacted with atmospheric pollutants.



(a) What reacted with the limestone to cause the erosion?

Tick (✓) **one** box.

- | | |
|-----------------|--------------------------|
| Acid rain | <input type="checkbox"/> |
| Ammonia | <input type="checkbox"/> |
| Carbon monoxide | <input type="checkbox"/> |
| Oxygen | <input type="checkbox"/> |

(1)

(b) Soot is produced by the incomplete combustion of diesel oil.

Complete the sentences.

Choose answers from the box.

ammonia	carbon	methane
	nitrogen	oxygen

Incomplete combustion happens when there is not enough _____.

Incomplete combustion produces particles of _____.

(2)

- (c) Complete the sentence.

Particles of soot in the atmosphere cause global _____.

(1)

- (d) Carbon monoxide is produced by the incomplete combustion of methane.

Balance the equation for the reaction.



(1)

- (e) Car engines work at high temperatures.

Complete the sentences.

Choose answers from the box.

air	methane	oxides of nitrogen
oxygen	petrol	sulfur dioxide

In car engines, nitrogen is present.

The nitrogen in car engines comes from _____.

At high temperatures, the nitrogen reacts with _____.

This reaction produces _____.

(3)

(Total 8 marks)

Q7.

A student investigated the reaction between lumps of calcium carbonate and dilute hydrochloric acid.

This is the method used.

1. Pour 100 cm³ of dilute hydrochloric acid into a conical flask.
2. Place the conical flask on a balance.

3. Add 2 g of calcium carbonate lumps to the conical flask.
4. Wait until the calcium carbonate stops reacting.
5. Record the decrease in mass of the conical flask and contents.
6. Repeat steps 1 to 5 three more times.

The equation for the reaction is:



- (a) What is the state symbol **X** in the equation?

Tick (✓) **one** box.

aq g l s

(1)

The following table shows the student's results.

	Result 1	Result 2	Result 3	Result 4
Decrease in mass of the conical flask and contents in g	0.84	0.79	0.86	0.47

- (b) Why does the mass of the conical flask and contents decrease during the reaction?

Tick (✓) **one** box.

A gas escapes.

A new solution is made.

The dilute hydrochloric acid is used up.

The calcium carbonate lumps decrease in size.

(1)

- (c) What is the range of the four results in the table above?

From _____ g to _____ g

(1)

- (d) Calculate the mean decrease in mass of the conical flask and contents.

Do **not** include the anomalous result.

Use the above.

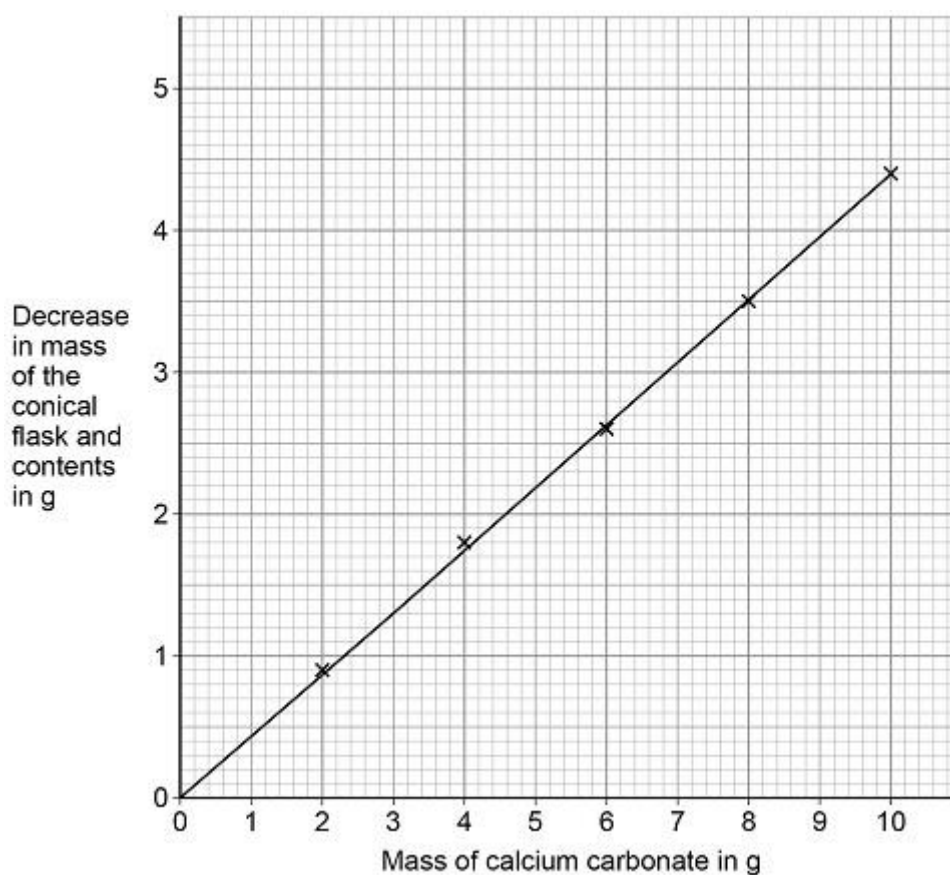
Mean decrease in mass = _____ g

(2)

A teacher demonstrated the investigation.

The teacher used different masses of calcium carbonate.

The following graph shows the teacher's results.



(e) What type of variable is the mass of calcium carbonate?

(1)

Tick (✓) **one** box.

Control

Dependent

Independent

(1)

Use the graph to answer parts (f) and (g)

(f) Complete the sentence.

As the mass of calcium carbonate used increases, the decrease in mass of the conical flask and contents _____.

(1)

(g) What is the decrease in mass of the conical flask and contents when a 3 g sample of calcium carbonate is used?

Decrease in mass = _____ g

(1)

(Total 8 marks)

Q8.

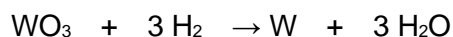
This question is about the extraction of metals.

(a) Tungsten is a metal.

The symbol of tungsten is W

Tungsten is produced from tungsten oxide by reaction with hydrogen.

The equation for the reaction is:



Calculate the percentage atom economy when tungsten is produced in this reaction.

Use the equation:

$$\text{percentage atom economy} = \frac{184}{(M_r \text{ WO}_3) + (3 \times M_r \text{ H}_2)} \times 100$$

Relative formula masses (M_r): $\text{WO}_3 = 232$ $\text{H}_2 = 2$ (separate only)

Percentage atom economy = _____%

(2)

Aluminium is extracted from aluminium oxide.

- (b) 38% of a rock sample is aluminium oxide.

Calculate the mass of aluminium oxide in 40 kg of the rock sample.

Mass of aluminium oxide = _____ kg

(2)

- (c) The formula of aluminium oxide is Al_2O_3

Calculate the relative formula mass (M_r) of aluminium oxide.

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

Relative formula mass (M_r) = _____

(2)

- (d) 60.0 kg of aluminium oxide produces a maximum of 31.8 kg of aluminium.

In an extraction process only 28.4 kg of aluminium is produced from 60.0 kg of aluminium oxide.

Calculate the percentage yield. **(separate only)**

Give your answer to 3 significant figures.

Use the equation:

$$\text{percentage yield} = \frac{\text{mass of product actually made}}{\text{maximum theoretical mass of product}} \times 100$$

Percentage yield = _____%

(3)

- (e) Extracting metals by electrolysis is a very expensive process.

Explain why aluminium is extracted using electrolysis and not by reduction with carbon.

(2)

(Total 11 marks)

Q9.

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

F₂

F²

2F

(1)

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

The table below shows the student's observations.

	Potassium chloride (colourless)	Potassium bromide (colourless)	Potassium iodide (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. (**separate only**)

Percentage yield = _____ %

(2)

(Total 9 marks)

Q10.

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:



- (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?

(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.

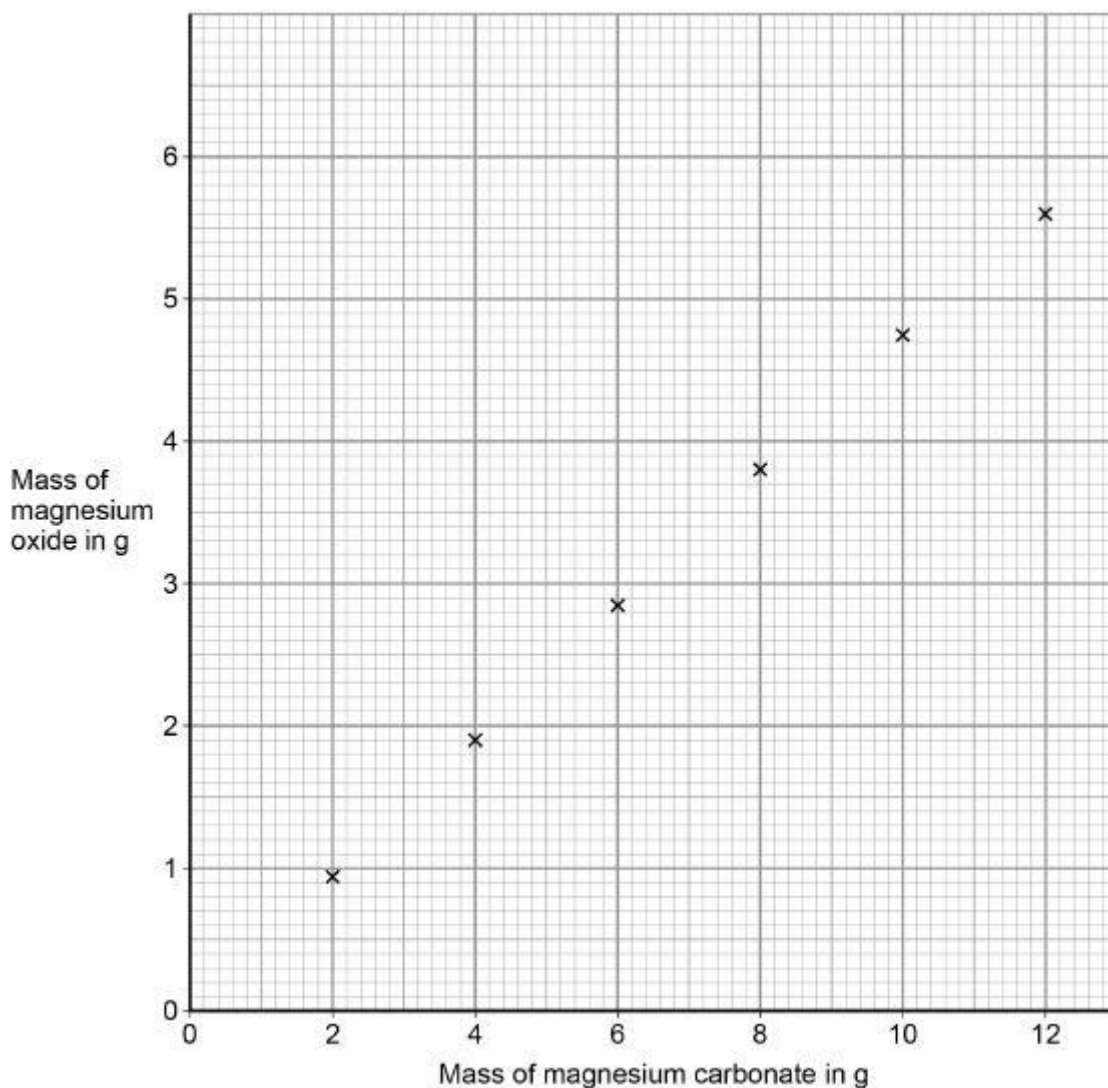
(2)

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

The word equation for the reaction is:



The graph below shows the results of the investigation.



(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)

Mass of magnesium oxide produced = _____ g

(2)

(Total 10 marks)

Q11.

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.

(2)

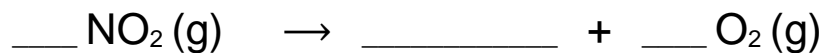
Catalytic converters are fitted to car exhausts to reduce the amount of pollutants released into the atmosphere.

- (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. **(separate only)**

Alkali metals

Halogens	<input type="checkbox"/>
Noble gases	<input type="checkbox"/>
Transition metals	<input type="checkbox"/>

(1)
(Total 12 marks)

Q12.

A student investigated the law of conservation of mass.

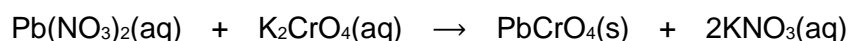
The law of conservation of mass states that the mass of the products is equal to the mass of the reactants.

This is the method used.

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:



- (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 $\text{Pb}(\text{NO}_3)_2$

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

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^-

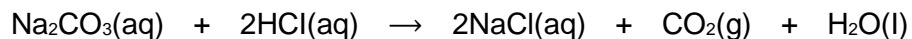


(1)

- (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.



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

(3)

(Total 10 marks)

Q13.

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 ₄ H ₁₀	0
B		36
C	C ₆ H ₁₄	69
D	C ₇ H ₁₆	98

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

Tick (✓) **one** box.

C₄H₁₂

C₅H₁₂

C₅H₁₂

C₆H₁₂

(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)

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

Tick (✓) **two** boxes.

Carbon

Carbon dioxide

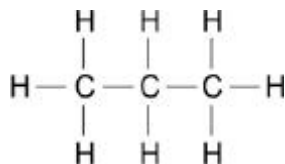
Hydrogen

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

Relative formula mass (M_r) = _____

(2)

(Total 9 marks)

Q14.

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.

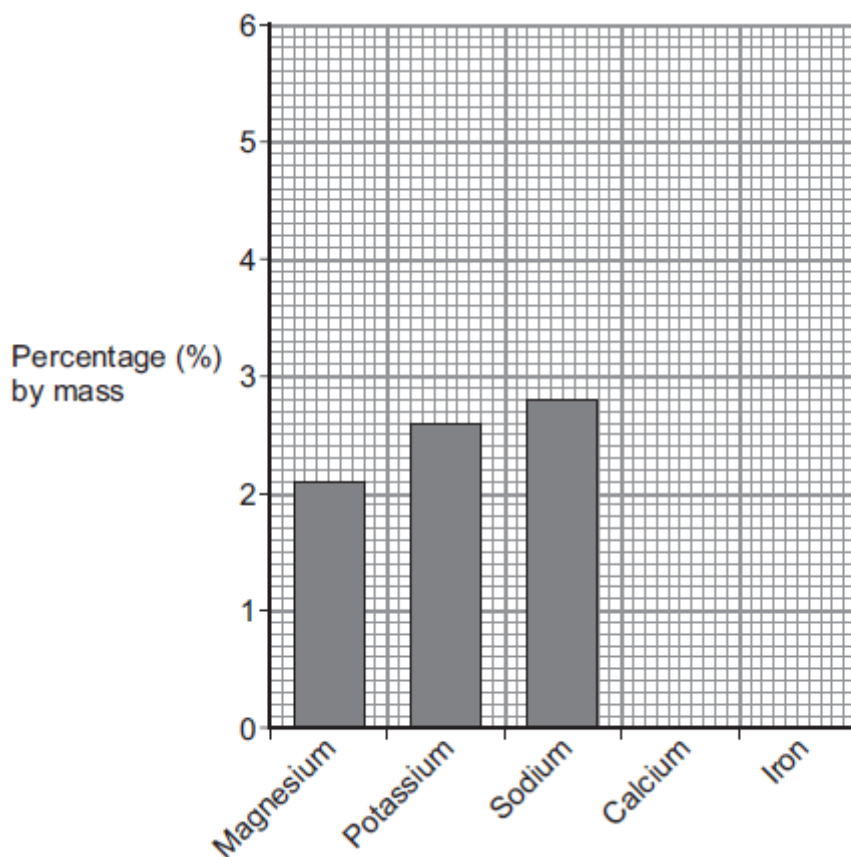
Because it does not react with water.

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



- (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:



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

Tick (✓) **one** box.

corrosion

decomposition

electrolysis

(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.

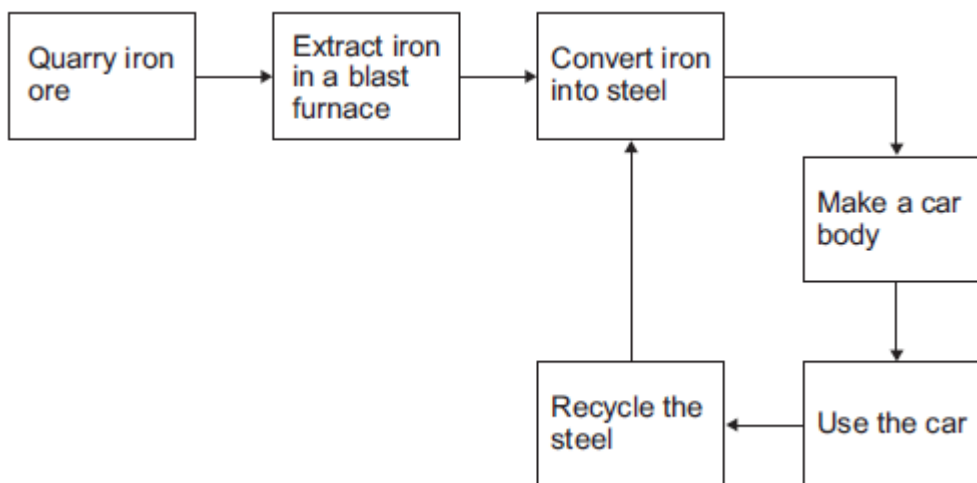
Calculate the mass of carbon dioxide produced.

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?

Tick (✓) **one** box. (**separate only**)

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)

Q15.

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

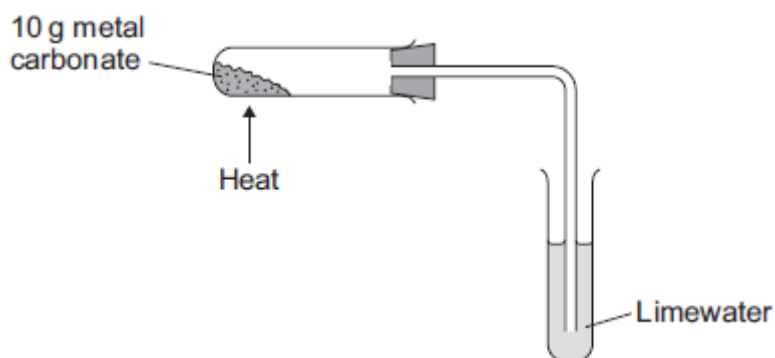
copper sulfide

(1)

- (b) A student investigated heating four metal carbonates.

Figure 1 shows the apparatus used.

Figure 1



The student heated each metal carbonate for five minutes.

The table below shows the results.

Metal carbonate	Mass of metal carbonate at	Mass of solid after heating for 5 minutes	Observations

	start in g	in g	
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.

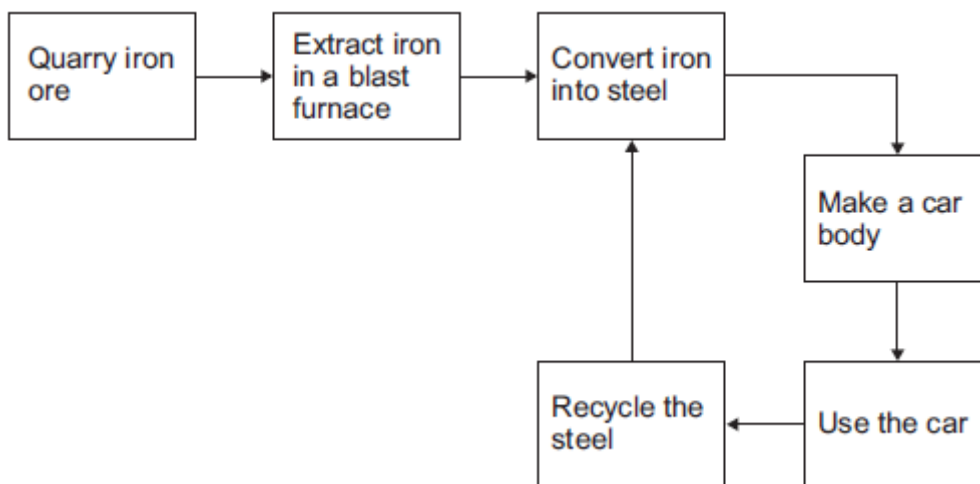
(3)

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

(2)

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

Figure 2



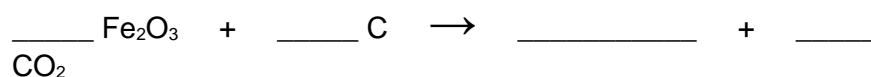
- (i) Complete the sentence.

Iron ores must contain enough iron to _____

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

(1)

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



(2)

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

(2)

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

- recycled
- 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)