

Table 1 shows the student's results.

Table 1

	Total mass of copper produced in mg			
Time in mins	Experiment 1	Experiment 2	Experiment 3	Mean
1	0.60	0.58	0.62	0.60
2	1.17	1.22	1.21	1.20
4	2.40	2.41	2.39	2.40
5	3.02	X	3.01	3.06

[1.1] Determine the **mean** mass of copper produced after 3 minutes.

[1 mark]

Mass = _____ mg

Question 1 continues on the next page

Turn over ►

Table 1 shows the student's results.

Table 1

	Total mass of copper produced in mg			
Time in mins	Experiment 1	Experiment 2	Experiment 3	Mean
1	0.60	0.58	0.62	0.60
2	1.17	1.22	1.21	1.20
4	2.40	2.41	2.39	2.40
5	3.02	X	3.01	3.06

[1.2] Calculate the mass **X** of copper produced in **Experiment 2** after 5 minutes.

Use **Table 1** on page 3

[2 marks]

Mass **X** = _____ mg

- [1.3] The copper chloride solution used in the investigation contained 300 grams per dm^3 of solid CuCl_2 dissolved in 1 dm^3 of water.

The student used 50 cm^3 of copper chloride solution in each experiment.

Calculate the mass of solid copper chloride used in each experiment.

[3 marks]

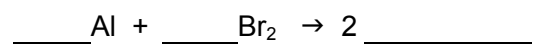
Mass = _____ g

[-]

[2.1] Aluminium reacts with bromine to produce aluminium bromide.

Complete the balanced chemical equation for this reaction.

[2 marks]



[3.1] The relative formula mass (M_r) of a Group 2 metal carbonate is 197

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

Calculate the relative atomic mass (A_r) of the Group 2 metal in the metal carbonate.

Name the Group 2 metal.

[3 marks]

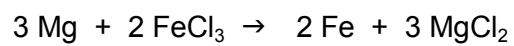
Relative atomic mass (A_r) = _____

Metal _____

Question 6 continues on the next page

Turn over ►

Magnesium reacts with iron chloride solution.



[4.1] 0.120 g of magnesium reacts with excess iron chloride solution.

Relative atomic masses (A_r): Mg = 24 Fe = 56

Calculate the mass of iron produced, in mg

[5 marks]

Mass of iron = _____ mg

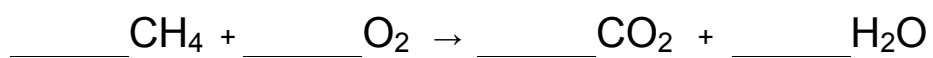
Question 8 continues on the next page

Turn over ►

[5.1] Alkanes burn in oxygen.

Balance the equation for methane burning.

[1 mark]



[6.1] A bag of fertiliser contains 14.52 kg of ammonium nitrate (NH_4NO_3).

Relative formula mass (M_r): $\text{NH}_4\text{NO}_3 = 80$

Calculate the number of moles of ammonium nitrate in the bag of fertiliser.

Give your answer in standard form to 2 significant figures.

[4 marks]

Moles of ammonium nitrate = _____ mol

Question 4 continues on the next page

Turn over ►

[7.1] Calcium nitrate contains the ions Ca^{2+} and NO_3^-

Give the formula of calcium nitrate.

[1 mark]

[8.1] An atom of iron is represented as ${}^{56}_{26}\text{Fe}$

Give the number of protons, neutrons and electrons in this atom of iron.

[3 marks]

Number of protons _____

Number of neutrons _____

Number of electrons _____

[9.1] Complete the balanced equation for the overall reaction in a hydrogen fuel cell.

[2 marks]



[10.1] Element **X** has two isotopes. Their mass numbers are 69 and 71

The percentage abundance of each isotope is:

- 60% of ^{69}X
- 40% of ^{71}X

Estimate the relative atomic mass of element **X**.

[1 mark]

Tick **one** box.

< 69.5

☐

Between 69.5 and 70.0

☐

Between 70.0 and 70.5

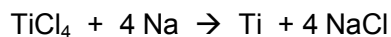
☐

> 70.5

☐

[11.1] In **Stage 2**, 40 kg of titanium chloride was added to 20 kg of sodium.

The equation for the reaction is:



Relative atomic masses (A_r): Na = 23 Cl = 35.5 Ti = 48

Explain why titanium chloride is the limiting reactant.

You **must** show your working.

[4 marks]

[12.1] Nitrogen dioxide is an oxide of nitrogen.

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

Complete the equation for this reaction.

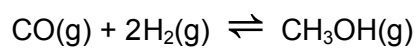
The equation should be balanced.

[2 marks]



In industry, methanol is produced by reacting carbon monoxide with hydrogen.

The equation for the reaction is:



- [13.1] How many moles of carbon monoxide react completely with 4.0×10^3 moles of hydrogen?

[1 mark]

Tick **one** box.

1.0×10^3 moles

☐

2.0×10^3 moles

☐

4.0×10^3 moles

☐

8.0×10^3 moles

☐

[14.1] A solution of hydrochloric acid contains 3.2 g of hydrogen chloride in 50 cm³

Calculate the concentration of hydrogen chloride in g per dm³

[3 marks]

Concentration = _____ g per dm³

[-]

Turn over ►

[15.1] What is the formula of nitric acid?

[1 mark]

Tick (✓) **one** box.

HCl

☐

HNO₃

☐

H₂SO₄

☐

NH₄OH

☐

[16.1] How many atoms are there in 1 g of argon?

The Avogadro constant is 6.02×10^{23} per mole.

Relative atomic mass (A_r): Ar = 40

[2 marks]

Number of atoms in 1 g = _____

Turn over for the next question

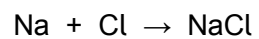
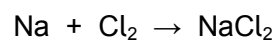
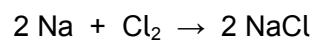
Turn over ►

[17.1] Sodium reacts with chlorine.

What is the balanced equation for the reaction?

[1 mark]

Tick (✓) **one** box.

☐☐☐☐

[18.1] Another method of extracting copper from low-grade ores is bioleaching.

A solution of copper sulfate (CuSO_4) produced by bioleaching has a concentration of 0.319 g/dm^3

Relative atomic masses (A_r): Cu = 63.5 O = 16 S = 32

Calculate the number of moles of copper that can be produced from 1 dm^3 of this solution.

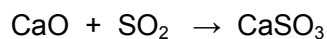
[3 marks]

Number of moles of copper = _____ mol

Turn over ►

[19.1] Sulfur dioxide is an atmospheric pollutant.

Sulfur dioxide pollution is reduced by reacting calcium oxide with sulfur dioxide to produce calcium sulfite.



7.00 g of calcium oxide reacts with an excess of sulfur dioxide.

Relative atomic masses (A_r): O = 16 S = 32 Ca = 40

Calculate the mass of calcium sulfite produced.

[4 marks]

Mass of calcium sulfite produced = _____ g

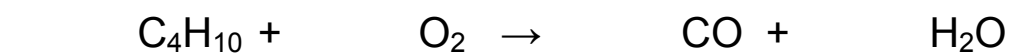
Turn over for the next question

Turn over ►

[20.1] One other product of the combustion of butane is carbon monoxide.

Balance the equation.

[1 mark]



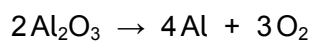
[_{21.1}] Why is the mass number different in the two isotopes?

[1 mark]

Question 4 continues on the next page

Turn over ►

[22.1] The overall equation for the electrolysis of aluminium oxide is:



Calculate the mass of oxygen produced when 2000 kg of aluminium oxide is completely electrolysed.

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

[4 marks]

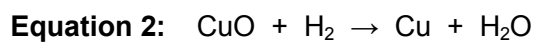
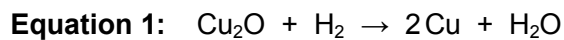
Mass of oxygen = _____ kg

Turn over ►

[23.1] The teacher repeated the experiment with a different sample of the oxide of copper.

The teacher found that the oxide of copper produced 2.54 g of copper and 0.72 g of water.

Two possible equations for the reaction are:



Determine which is the correct equation for the reaction in the teacher's experiment.

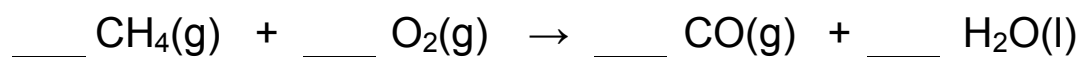
Relative atomic masses (A_r): $\text{H} = 1$ $\text{O} = 16$ $\text{Cu} = 63.5$

[3 marks]

Turn over for the next question

Turn over ►

[24.1] Balance the equation for the combustion of methane to produce carbon monoxide. [1 mark]



[25.1] An aluminium atom is represented as:



Give the number of electrons and neutrons in the aluminium atom.

[2 marks]

Number of electrons _____

Number of neutrons _____

[26.1] Complete the symbol equation for the preparation of sodium sulfate.

You should balance the equation.

[2 marks]



Question 4 continues on the next page

Turn over ►

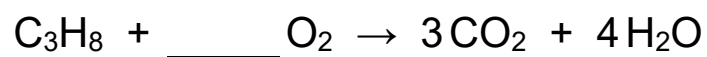
[illegible]

—

Turn over ►

[28.1] Balance the equation for the combustion of propane.

[1 mark]



Another student carried out the investigation correctly.

Table 1 shows the results.

Table 1

Water sample	Mass of dissolved solids in g				
	Test 1	Test 2	Test 3	Test 4	Mean
A	0.22	0.23	0.20	X	0.21
B	0.03	0.08	0.02	0.03	0.04
C	0.45	0.60	0.49	0.58	0.53
D	0.80	0.91	0.79	0.86	0.84

[29.1] Calculate value **X** in **Table 1**.

[2 marks]

X = _____ g

Another student carried out the investigation correctly.

Table 1 shows the results.

Table 1

Water sample	Mass of dissolved solids in g				
	Test 1	Test 2	Test 3	Test 4	Mean
A	0.22	0.23	0.20	X	0.21
B	0.03	0.08	0.02	0.03	0.04
C	0.45	0.60	0.49	0.58	0.53
D	0.80	0.91	0.79	0.86	0.84

[29.2] Which water sample has the greatest range of masses of dissolved solids?

Give the reason for your answer.

[2 marks]

Water sample _____

Reason _____

[30.1] Metal **M** has two isotopes.

Table 2 shows the mass numbers and percentage abundances of the isotopes.

Table 2

Mass number	Percentage abundance (%)
203	30
205	70

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

Give your answer to 1 decimal place.

[2 marks]

Relative atomic mass (1 decimal place) = _____

out

[]

[31.1] 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.

Table 3 shows the student's results.

Table 3

	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

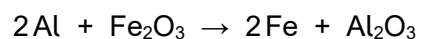
Explain how the results demonstrate the law of conservation of mass.

You should use data from **Table 3** in your answer.

[2 marks]

[32.1] A mixture contains 1.00 kg of aluminium and 3.00 kg of iron oxide.

The equation for the reaction is:



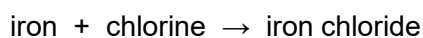
Show that aluminium is the limiting reactant.

Relative atomic masses (A_r): O = 16 Al = 27 Fe = 56

[4 marks]

- [33.1] A teacher investigated the reaction of iron with chlorine using the apparatus in **Figure 5**.

The word equation for the reaction is:



The teacher weighed:

- the glass tube
- the glass tube and iron before the reaction
- the glass tube and iron chloride after the reaction.

Table 6 shows the teacher's results.

Table 6

	Mass in g
Glass tube	51.56
Glass tube and iron	56.04
Glass tube and iron chloride	64.56

Calculate the simplest whole number ratio of:

moles of iron atoms : moles of chlorine atoms

Determine the balanced equation for the reaction.

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

[6 marks]

Moles of iron atoms : moles of chlorine atoms = _____ :

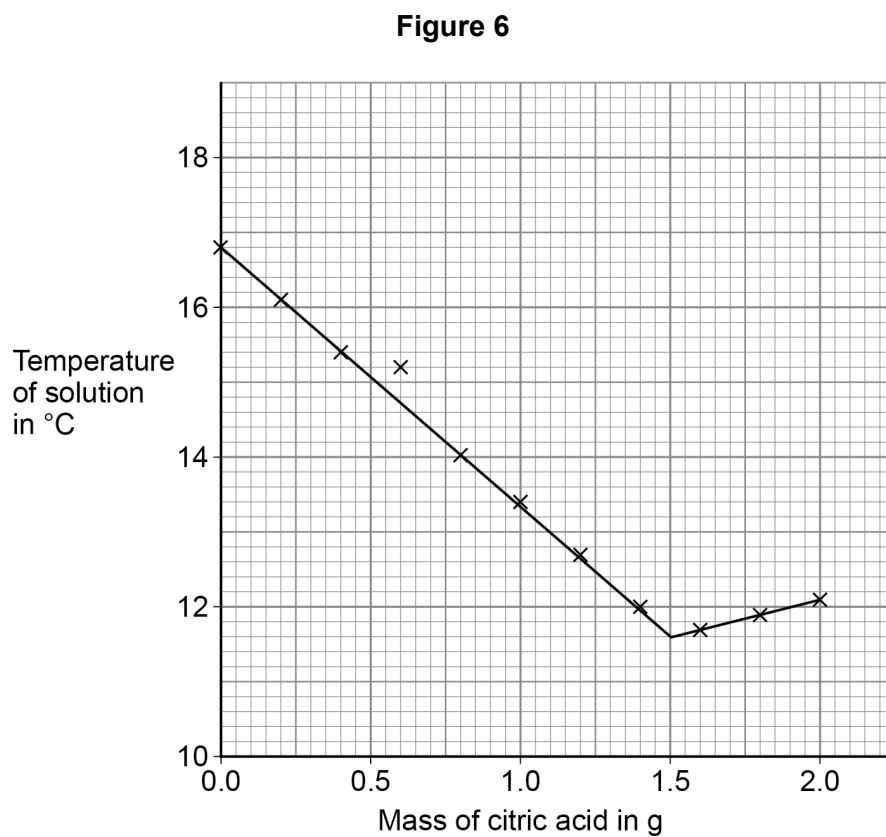
Equation for the reaction _____

Turn over ►

6. Repeat steps 3 to 5 until a total of 2.00 g of citric acid has been added.

The student plotted the results on a graph.

Figure 6 shows the student's graph.



[34.1]

Figure 6 shows an anomalous point when 0.60 g of citric acid was added. This was caused by the student making an error.

The student correctly:

- measured the mass of the citric acid
- read the thermometer
- plotted the point.

Suggest **one** reason for the anomalous point.

[1 mark]

out

[35.1] Draw **one** line from each hydrocarbon to the formula of that hydrocarbon.

[2 marks]

Hydrocarbon	Formula
	C₆H₈
Hexane	C₆H₁₀
	C₆H₁₂
Hexene	C₆H₁₄
	C₆H₁₆

- [36.1] A student adds a solution of ethanoic acid to zinc carbonate in an open flask on a balance.

Explain what happens to the mass of the flask and its contents during the reaction.

[3 marks]

22
04

[_{37.1}] What is meant by 'isotopes'?

You should refer to subatomic particles.

[2 marks]

[37.2]

Table 1 shows the mass numbers and the percentage abundance of two isotopes of potassium.

Table 1

Mass number	Percentage abundance
39	93.1
41	6.9

Calculate the relative atomic mass (A_r) of potassium.

Give your answer to 1 decimal place.

[3 marks]

Relative atomic mass (1 decimal place) = _____

[-]

[38.1] The formula of the zinc ion is Zn^{2+}

The formula of the nitrate ion is NO_3^-

What is the formula for zinc nitrate?

[1 mark]

Tick (✓) **one** box.

ZnNO_3

☐

$\text{Zn}(\text{NO}_3)_2$

☐

Zn_2NO_3

☐

$\text{Zn}_2(\text{NO}_3)_2$

☐

Question 2 continues on the next page

Turn over ►

[_{39.1}] 0.12 g of magnesium reacted to produce 0.20 g of magnesium oxide.

Calculate the number of moles of oxygen gas (O₂) that reacted.

Relative atomic mass (A_r): O = 16

[3 marks]

Moles of oxygen gas = _____

[39.2] Iron reacts with oxygen to produce an oxide of iron.

0.015 moles of iron reacts with 0.010 moles of oxygen gas (O_2).

Determine:

- the formula of the iron oxide produced
- the balanced symbol equation for the reaction.

[4 marks]

Formula of iron oxide = _____

Balanced symbol equation

ou

[
-
.]

Table 3 shows the concentration of nitrogen dioxide in the air in three different areas for 1 week.

Table 3

Concentration of nitrogen dioxide in the air in micrograms per m ³			
Day	City centre	Countryside	Motorway
Monday	35	8	22
Tuesday	37	8	23
Wednesday	37	8	23
Thursday	34	8	23
Friday	37	8	23
Saturday	29	7	20
Sunday	X	6	17

[40.1] The mean value for nitrogen dioxide in the air for the whole week in the city centre is 33 micrograms per m³.

Calculate the value (**X**) for the concentration of nitrogen dioxide in the air in the city centre on Sunday.

[2 marks]

X = _____ micrograms per m³

[40.2] In a catalytic converter nitrogen dioxide (NO_2) reacts to produce nitrogen and oxygen.

Complete the equation for the reaction.

You should balance the equation.

[2 marks]



[_{41.1}] Give the meaning of 'isotopes'.

You should answer in terms of subatomic particles.

[2 marks]

[41.2]

Table 1 shows the mass numbers and percentage abundances of the isotopes of gallium.

Table 1

Mass number	Percentage abundance (%)
69	60
71	40

Calculate the relative atomic mass (A_r) of gallium.

Give your answer to 1 decimal place.

[2 marks]

Relative atomic mass (1 decimal place) = _____

[41.3] Give the numbers of electrons and neutrons in an atom of the isotope $^{69}_{31}\text{Ga}$ [2 marks]

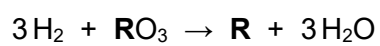
Number of electrons _____

Number of neutrons _____

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:



[42.1] 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

[2 marks]

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

[43.1] Complete the equation for the reaction of potassium with water.

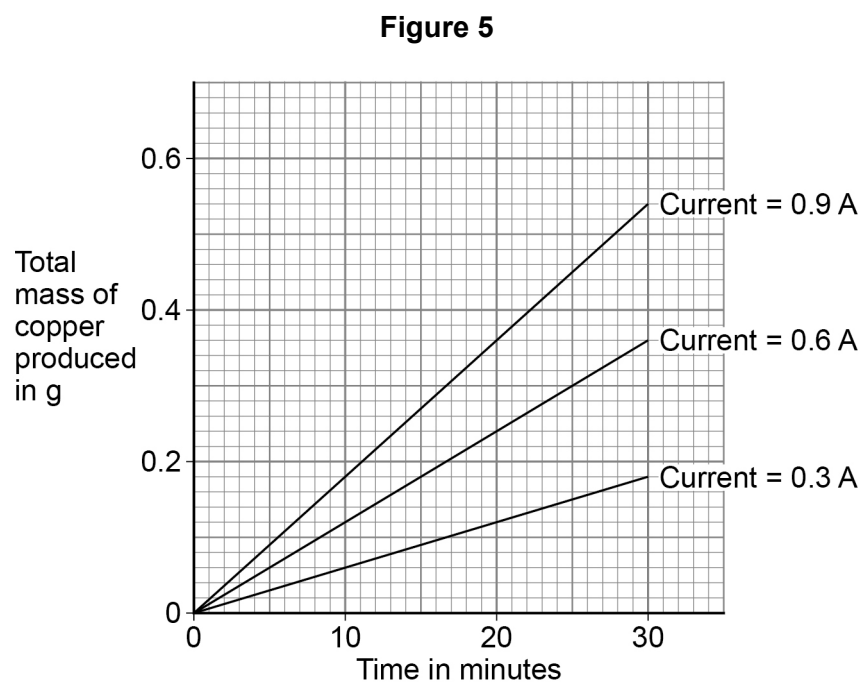
You should balance the equation.

[2 marks]



The students plotted their results on a graph.

Figure 5 shows the graph.



[44.1]

] Determine the number of atoms of copper produced when copper nitrate solution is electrolysed for 20 minutes at a current of 0.6 A

Give your answer to 3 significant figures.

Use **Figure 5**.

Relative atomic mass (A_r): Cu = 63.5

The Avogadro constant = 6.02×10^{23} per mole

[3 marks]

Number of atoms (3 significant figures) = _____

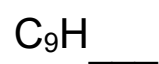
[-]

Turn over for the next question

Turn over ►

[45.1] Complete the formula of nonane.

[1 mark]



[46.1] Potassium sulfate contains K^+ and SO_4^{2-} ions.

What is the formula of potassium sulfate?

[1 mark]

Tick (✓) **one** box.

KSO_4

☐

K_2SO_4

☐

$\text{K}(\text{SO}_4)_2$

☐

$\text{K}_2(\text{SO}_4)_2$

☐

[46.2] The experiment is repeated 4 times.

The volumes of oxygen collected in the 4 experiments are:

6 cm³ 9 cm³ 10 cm³ 11 cm³

The mean volume of oxygen collected in the 4 experiments is 9 cm³

The measure of uncertainty is the range of a set of measurements about the mean.

What is the measure of uncertainty in the 4 experiments?

[1 mark]

Tick (✓) **one** box.

9 ± 1 cm³

☐

9 ± 2 cm³

☐

9 ± 3 cm³

☐

[_{47.1}] Complete the equation.

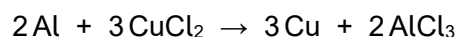
You should balance the equation.

[2 marks]



$$[47.2$$

The equation for the reaction is:



Calculate the maximum mass of copper produced in grams (g).

You should determine the limiting reactant.

Relative atomic masses (A_r): Al = 27 Cu = 63.5

Relative formula masses (M_r): $\text{CuCl}_2 = 134.5$ $\text{AlCl}_3 = 133.5$

[6 marks]

[illegible]

Limiting reactant is _____

Mass of copper = _____ g

Question 7 continues on the next page

Turn over ►

[48.1] The salty water contains sodium chloride.

The scientist collected 2.40 g of sodium chloride from 150 cm³ of salty water.

Calculate the concentration of sodium chloride in grams per dm³

[3 marks]

Concentration of sodium chloride = _____ g/dm³

[]

[49.1]

Calculate the number of C_{70} molecules that can be made from one mole of carbon atoms.

The Avogadro constant = 6.02×10^{23} per mole

[3 marks]

Number of molecules = _____

out:

[-]

[50.1] Complete the equation for the reaction of rubidium with water.

You should balance the equation.

[3 marks]



[50.2]

Table 1 shows information about the three isotopes of neon.**Table 1**

Mass number	Percentage abundance (%)
20	90.48
21	0.27
22	9.25

Calculate the relative atomic mass (A_r) of neon.

Give your answer to 3 significant figures.

[3 marks]

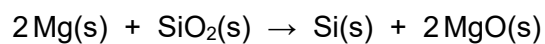
Relative atomic mass (3 significant figures) = _____

[-]

Turn over ►

Magnesium also reduces silicon dioxide.

The equation for the reaction is:



- [51.1] Calculate the minimum mass in grams of magnesium needed to completely reduce 1.2 kg of silicon dioxide.

Relative atomic masses (A_r): O = 16 Mg = 24 Si = 28

[5 marks]

Minimum mass of magnesium = _____ g

[52.1] Petrol contains a hydrocarbon with the formula C_9H_{20}

Complete the equation for the complete combustion of C_9H_{20}

You should balance the equation.

[2 marks]



[_{53.1}] Calculate the relative formula mass (M_r) of sulfuric acid (H_2SO_4).

Relative atomic masses (A_r): $\text{H} = 1$ $\text{O} = 16$ $\text{S} = 32$

[2 marks]

Relative formula mass (M_r) = _____

[53.2]

] A solution of lithium sulfate contains 0.30 g of lithium sulfate in 25 cm³.

Calculate the concentration of lithium sulfate in g/dm³.

[3 marks]

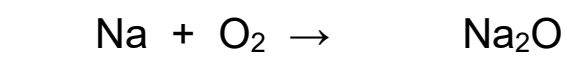
Concentration = _____ g/dm³

[-]

Turn over ►

[54.1] Balance the equation for the reaction.

[1 mark]



[55.1] What is the number of neutrons in this bromine atom?

[1 mark]

[55.2] Chlorine has two isotopes.

Table 2 shows the percentage abundance of the two isotopes of chlorine.

Table 2

Isotope	Percentage (%) abundance
$^{35}_{17}\text{Cl}$	75.77
$^{37}_{17}\text{Cl}$	24.23

Calculate the relative atomic mass (A_r) of chlorine.

Give your answer to 2 decimal places.

[3 marks]

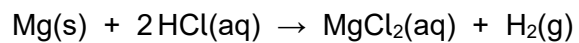
Relative atomic mass (2 decimal places) = _____

Turn over ►

Acids react with some metals to produce soluble salts.

A student adds magnesium to hydrochloric acid until no more acid reacts and excess magnesium remains.

The equation for the reaction is:



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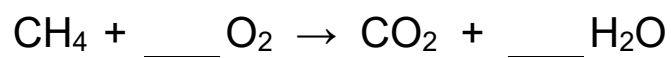
$$\left[\begin{array}{c} \text{---} \end{array} \right]$$

Turn over ►

[57.1] Methane is a fuel.

Balance the equation for the combustion of methane.

[1 mark]



[58.1] **Table 2** shows the results.

Table 2				
Type of water	Mass of dissolved solids in grams			
	Test 1	Test 2	Test 3	Mean
Distilled water	0.00	0.00	0.00	0.00
Sea water	0.30	X	0.26	0.29

Calculate the value **X** for the mass of dissolved solids in sea water in **Test 2**.
[2 marks]

Mass **X** = _____ g

[59.1]

The discovery of isotopes explained why some relative atomic masses are not whole numbers.

Element **R** has two isotopes.

Table 1 shows the mass numbers and percentage abundances of the isotopes of element **R**.

Table 1

Mass number	Percentage abundance (%)
6	7.6
7	92.4

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

Give your answer to 1 decimal place.

[3 marks]

Relative atomic mass (1 decimal place) = _____

out

[.

- [60.1] The student recorded the mean lowest temperature of the solution for 8.0 g of ammonium nitrate as 16.5 ± 0.3 °C.

Explain why the student included ± 0.3 °C after the mean lowest temperature.

[2 marks]

[61.1] The concentration of an acid can be measured in mol/dm^3 .

Which combination of changes **increases** the concentration of an acid?

[1 mark]

Tick (✓) **one** box.

The mass of acid dissolved is halved and the volume of the solution is halved.

☐

The mass of acid dissolved is halved and the volume of the solution is doubled.

☐

The mass of acid dissolved is doubled and the volume of the solution is halved.

☐

The mass of acid dissolved is doubled and the volume of the solution is doubled.

☐

[62.1]

Write a balanced symbol equation for the reaction between barium and hydrochloric acid.

[3 marks]

_____ + _____ → _____ + _____

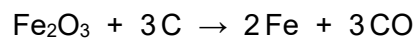
Turn over for the next question

Turn over ►

This question is about displacement reactions.

Iron is extracted from iron oxide by a displacement reaction with carbon.

The equation for the reaction is:



- [63.1] Which expression shows how to calculate the mass of carbon needed to produce 1 mole of iron from iron oxide?

Relative atomic mass (A_r): C = 12

[1 mark]

Tick (✓) **one** box.

$$\frac{1}{3} \times 12 \text{ g}$$

☐

$$\frac{3}{2} \times 12 \text{ g}$$

☐

$$1 \times 12 \text{ g}$$

☐

$$3 \times 12 \text{ g}$$

☐

Question 9 continues on the next page

Turn over ►

[64.1] The student calculated the rate of the reaction for each trial.

Table 1 shows the results of the calculations.

Table 1

	Trial 1	Trial 2	Trial 3	Trial 4
Rate of reaction in cm³/s	0.78	0.81	0.68	0.81

Determine the mean time taken to collect 20 cm³ of gas.

Do **not** include any anomalous results.

Use the equation:

$$\text{mean rate of reaction} = \frac{\text{volume of gas collected}}{\text{mean time taken}}$$

[5 marks]

Mean time taken = _____ s

Question 1 continues on the next page

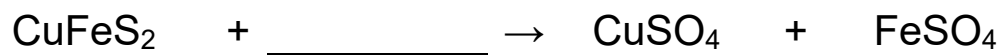
Turn over ►

[65.1] CuFeS₂ reacts with oxygen to produce copper(II) sulfate and iron(II) sulfate.

Complete the equation for this reaction.

You should balance the equation.

[2 marks]



[66.1] An amino acid can be represented as:



The relative formula mass (M_r) of this amino acid is 75

Calculate the relative formula mass of the section of this amino acid molecule represented by



Relative atomic masses (A_r): H = 1 C = 12 N = 14 O = 16

[2 marks]

Relative formula mass = _____