OCR GCSE GATEWAY CHEMISTRY A · J248

CHEMISTRY



EXAM QUESTION PACK

C3.1 INTRODUCING CHEMICAL REACTIONS

SCORE	PERCENTAGE
/251	%

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Gateway Chemistry A (9-1)

Introducing chemical reactions

Please note that you may see slight differences between this paper and the original.

Candidates answer on the Question paper.

OCR supplied materials:
Additional resources may be supplied with this paper.

Other materials required:
- Pencil
- Ruler (cm/mm)

Duration: Not set

Candidate forename		Candidate surname	

Centre number						Candidate number				

INSTRUCTIONS TO CANDIDATES

- Write your name, centre number and candidate number in the boxes above. Please write clearly and in capital letters.
- Use black ink. HB pencil may be used for graphs and diagrams only.
- Answer **all** the questions, unless your teacher tells you otherwise.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- Where space is provided below the question, please write your answer there.
- You may use additional paper, or a specific Answer sheet if one is provided, but you must clearly show your candidate number, centre number and question number(s).

INFORMATION FOR CANDIDATES

- The quality of written communication is assessed in questions marked with either a pencil or an asterisk. In History and Geography a *Quality of extended response* question is marked with an asterisk, while a pencil is used for questions in which *Spelling, punctuation and grammar and the use of specialist terminology* is assessed.
- The number of marks is given in brackets **[ ]** at the end of each question or part question.
- The total number of marks for this paper is **251**.
- The total number of marks may take into account some 'either/or' question choices.

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1 The alkane, $C_{15}H_{32}$, is cracked to make an alkene, C_6H_{12} and an alkane, C_3H_8.

Construct the **balanced symbol** equation for this reaction.

[1]

2(a) Ammonium sulfate, $(NH_4)_2SO_4$, is a fertiliser.

Ammonium sulfate can be manufactured from ammonia and sulfuric acid.

Sulfuric acid is manufactured in a series of steps.

Step 1:
Sulfur is burnt in oxygen to produce sulfur dioxide.

Step 2, The Contact Process:
Sulfur dioxide is reacted with oxygen to produce sulfur trioxide. This takes place in the presence of vanadium(V) oxide at a pressure of 2 atmospheres and at about 450°C.

Step 3:
Sulfur trioxide is reacted with water to produce sulfuric acid.

Write balanced symbol equations for each stage of this process.

[4]

(b) A sample containing 17.0 g of ammonia completely reacts with sulfuric acid.

A mass of 66.0 g of ammonium sulfate is made.

Show that the maximum mass of ammonium sulfate that can be made from 51.0 g of ammonia is 198.0 g.

[1]

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3 The Group 7 elements are known as the halogens.

The halogens have similar chemical properties.

Their physical properties vary with increasing atomic number.

All halogens react with alkali metals to make a salt.

(i) All halogens have similar chemical reactions.

Explain why in terms of electronic structure.

---

[1]

(ii) Sodium reacts with bromine to make sodium bromide, NaBr.

Construct the **balanced symbol** equation for this reaction.

---

[2]

(iii) What is the formula of the product of the reaction between astatine and potassium?

---

[1]

4 Which of these shows the balanced symbol equation for the reaction between potassium and chlorine to make potassium chloride?

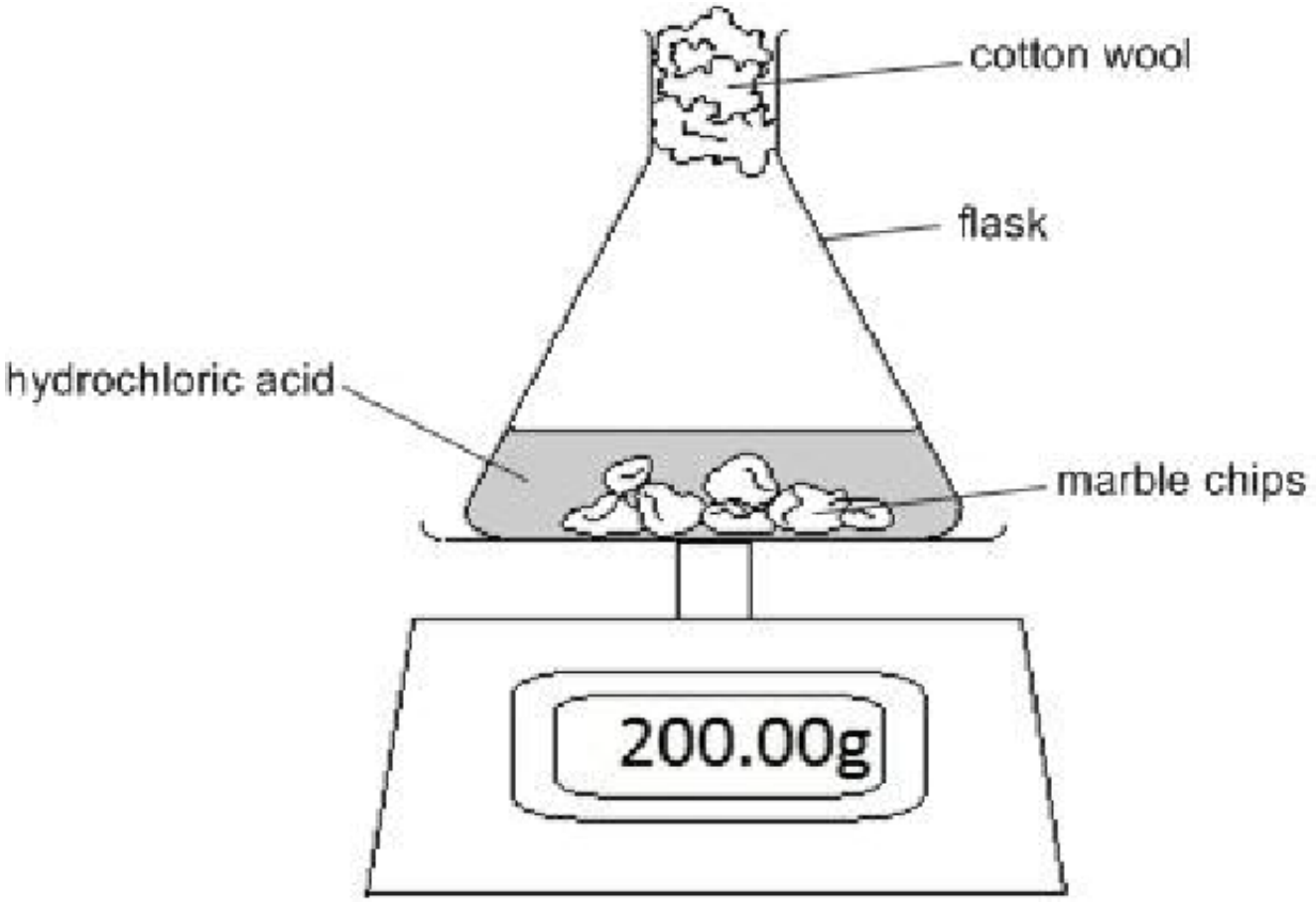
A $K + Cl_2 \rightarrow KCl_2$
B $P + Cl_2 \rightarrow PCl_2$
C $2K + Cl_2 \rightarrow 2KCl$
D $2P + Cl_2 \rightarrow 2PCl$

Your answer ☐

[1]

5 Look at the diagram.

It shows how the reaction between hydrochloric acid and marble chips (calcium carbonate) can be monitored.



The reading on the balance **decreases** during the reaction.

Which of these statements is the **best** explanation?

A Acid escapes from the flask.
B A gas called hydrogen is made which leaves the flask.
C A gas called carbon dioxide is made which leaves the flask.
D The temperature in the laboratory changes.

Your answer ☐

[1]

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6(a) Irenka reacts an element, **X**, with oxygen, O_2.

There is one product. It is the oxide of **X** i.e. **X** oxide.

4.86 g of **X** reacts with 3.20 g of oxygen to make 8.06 g of **X** oxide.

(i) Calculate the number of moles of **X**, oxygen and **X** oxide involved in the reaction.

(The relative atomic mass of **X** is 24.3 and the relative formula mass of oxygen, O_2, is 32.0 and of **X** oxide is 40.3.)

Number of moles of **X** = _____

Number of moles of O_2 = _____

Number of moles of **X** oxide = _____ **[3]**

(ii) Use your answers to write the **balanced symbol** equation for the reaction between **X** and oxygen to make **X** oxide.

_____ **[2]**

(b) Look at the equation.

It shows the reaction between sodium hydroxide and dilute sulfuric acid.

$$2NaOH + H_2SO_4 \longrightarrow Na_2SO_4 + 2H_2O$$

sodium hydroxide + sulfuric acid ⟶ sodium sulfate + water

Calculate the mass of sodium hydroxide needed to make 30.0 g of sodium sulfate.

Give your answer to three significant figures.

Mass of sodium hydroxide = _____ g [3]

7 Zinc nitrate can be made by reacting zinc oxide with nitric acid, HNO_3.

Write a **balanced symbol** equation for this reaction.

_____ [2]

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8 Magnesium has an atomic number of 12.

Calculate the mean mass of an atom of magnesium. Quote your answer to **three** significant figures.

(Avogadro constant = 6.022×10^{23} atoms per mole)

Mean mass _____ g **[2]**

9 A student adds calcium to dilute hydrochloric acid. The mixture begins to fizz.

Write a balanced symbol equation for this reaction.

_____ **[2]**

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10 The Group 7 elements are known as the halogens.

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All halogens react with alkali metals to make a salt.

(i) All halogens have similar chemical reactions.

Explain why in terms of electronic structure.

---

[1]

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Construct the **balanced symbol** equation for this reaction.

---

[2]

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---

[1]

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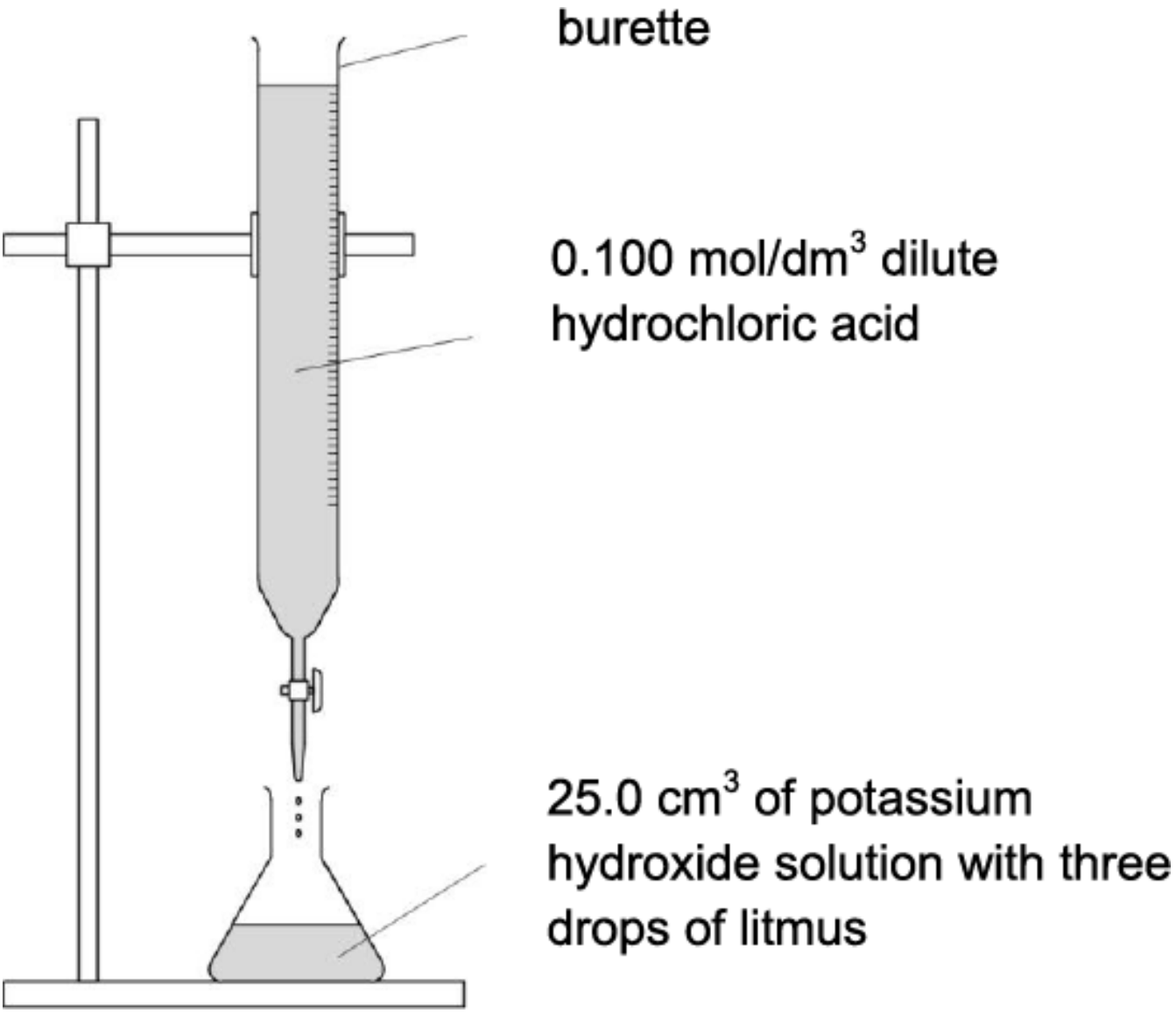
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11(a) Sarah does three titrations with dilute hydrochloric acid and potassium hydroxide solution.

Hydrochloric acid neutralises the alkali potassium hydroxide.

$$HCl(aq) + KOH(aq) \rightarrow KCl(aq) + H_2O(l)$$

Look at the apparatus she uses.



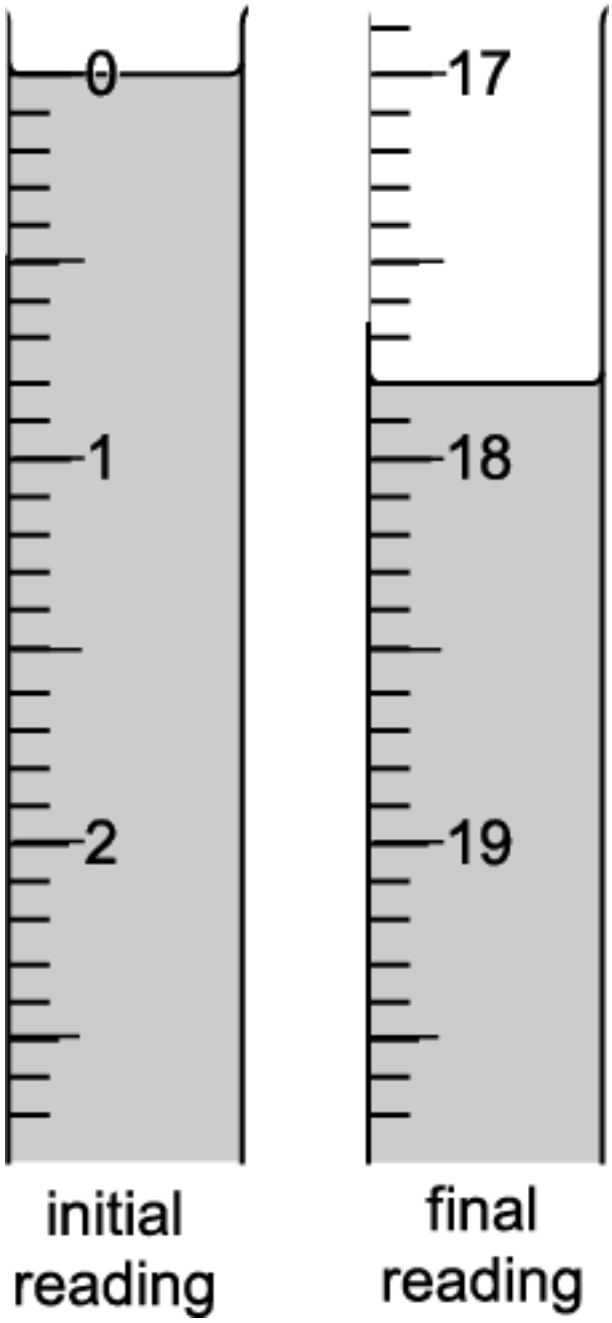
Look at the diagrams. They show parts of the burette during the first titration.

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First titration



Here is Sarah's results table:

Titration number	1	2	3
final reading (cm^3)		37.5	32.1

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initial reading (cm^3)		20.4	15.0
titre (volume of acid added) (cm_3)		17.1	17.1

Use the diagrams and table to help you calculate the mean titre.

Explain your answer.

Mean titre = _____ cm^3 **[2]**

(b) Sarah uses 25.0 cm^3 of potassium hydroxide solution, KOH.

She also uses hydrochloric acid with a concentration of 0.100 mol/dm^3.

Calculate the concentration, in mol/dm^3, of the KOH(aq).

Concentration of KOH(aq) = _____ mol/dm^3 **[2]**

(c) Use your answer to **(b)** to calculate the concentration of the KOH(aq) in g/dm^3.

Concentration of KOH(aq) = _____ g/dm^3 **[2]**

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12 The size of a nanoparticle is similar to the size of a molecule.

Which of these best describes the size of a nanoparticle?

A 0.01 nm
B 50 nm
C 1000 nm
D 10,000 nm

Your answer ☐

[1]

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13 * A student is separating a mixture of three solid substances, **A**, **B** and **C**.

Look at the table. It gives information about these substances.

Substance	Colour	Is it magnetic?	Melting point (°C)	Is it soluble in water?
A	grey	yes	1535	no
B	white	no	801	yes
C	yellow	no	1427	no

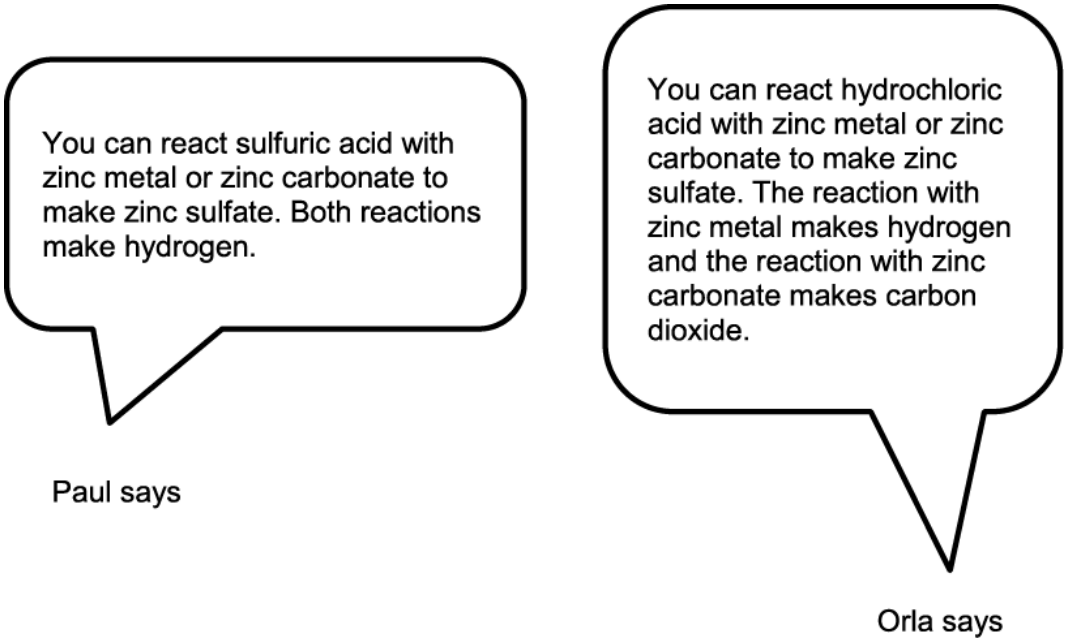
Suggest how the student can separate the mixture to get pure, dry samples of substances **A**, **B** and **C**.

Explain why your methods work.

[6]

14 Paul and Orla want to make some solid zinc sulfate.

They make some predictions.



Comment on how correct **both** statements are.

---

[4]

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15(a) Look at the data about some hydrocarbons.

Name	Number of carbon atoms in molecule	Molecular formula	Boiling point (°C)
ethane	2	C_2H_6	–88
propane	3	C_3H_8	–42
pentane	5	C_5H_{12}	36
hexane	6	C_6H_{14}	69

The data for ethane and propane have been plotted on the grid.

(i) Plot the data for pentane and hexane on the grid.

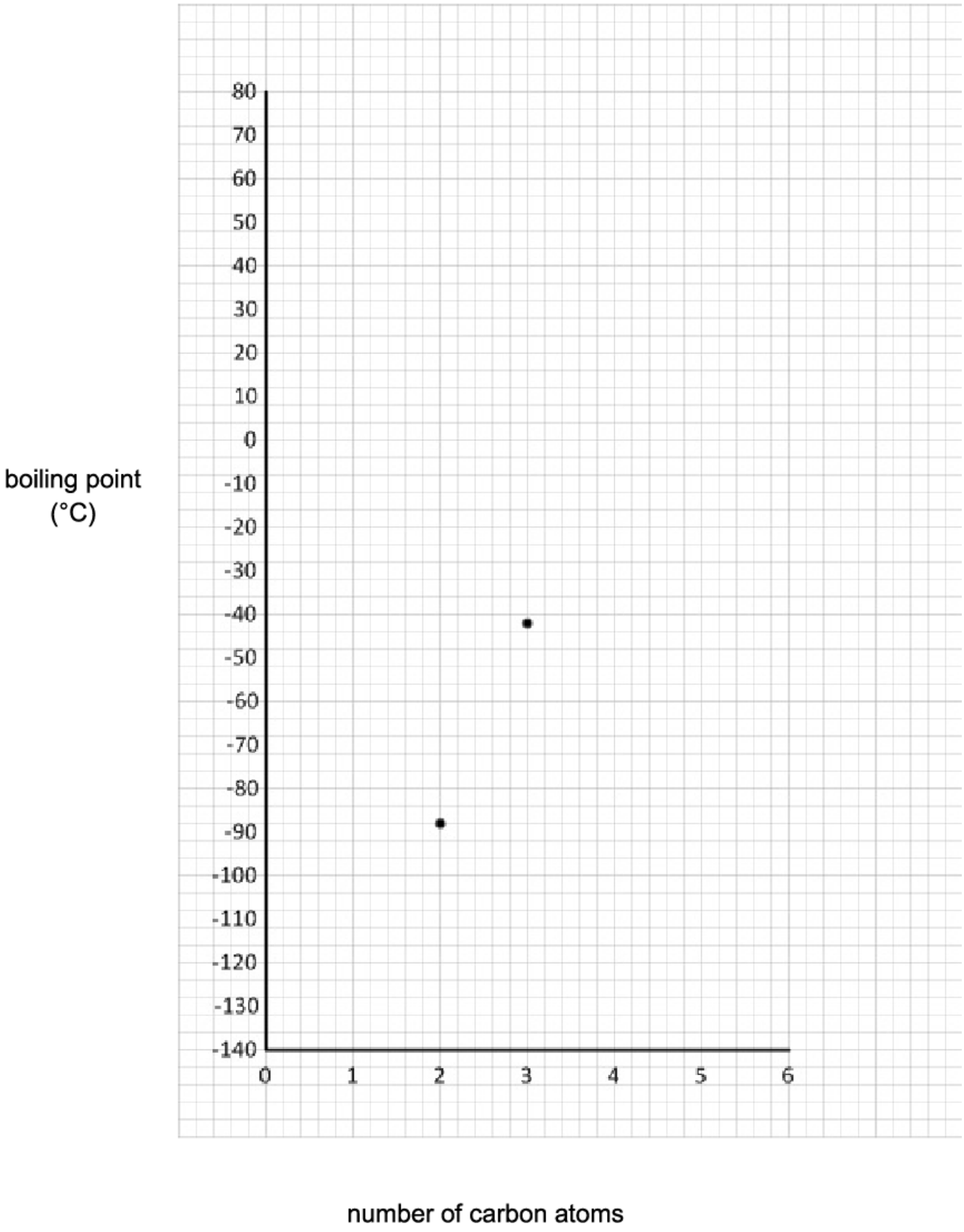
[2]

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Draw the line of best fit.



(ii) Use your graph to estimate the boiling point of butane.

answer:_____ °C [1]

(iii) Describe the relationship between the number of carbon atoms in the molecule and its boiling point.

Use ideas about forces between molecules to explain your answer.

---[2]

(b) **Propane** burns in oxygen, O_2.

Carbon dioxide and water are made.

Write a **balanced symbol** equation for this reaction.

---[2]

16

(a) Nanoparticles are used as catalysts.

Describe a property of nanoparticles that make them useful as catalysts.

---[2]

(b) David is synthesising a new titanium dioxide nanoparticle for use as a catalyst.

One TiO_2 nanoparticle has a mass of 5.0×10^{-3} mg.

Calculate how many TiO_2 nanoparticles are in 80.0 mg of TiO_2.

---[2]

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17 Look at the equation for the reaction.

magnesium + sulfuric acid → magnesium sulfate + hydrogen

Hayley and Andy investigate this reaction with different masses of magnesium.

They calculate the mass of sulfuric acid used and the masses of magnesium sulfate and hydrogen made.

Mass of magnesium in g	Mass of sulfuric acid in g	Mass of magnesium sulfate in g	Mass of hydrogen in g
0.50	2.04	2.50	0.04
1.00	4.08	5.00	0.08
1.50	_____	7.50	0.12
2.00	8.16	10.00	_____

(i) Complete the table.

[2]

(ii) Calculate the mass of magnesium sulfate made if 10 g of magnesium completely reacts with sulfuric acid.

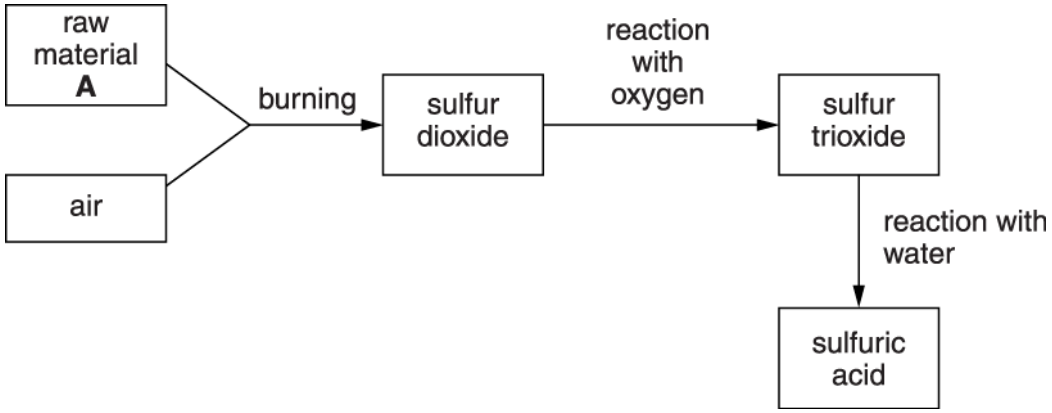
Explain how you worked out your answer.

---

[2]

18 This question is about the Contact Process used for the manufacture of sulfuric acid.

Look at the flow chart for the process.



In the process, sulfur dioxide, SO_2, reacts with oxygen, O_2, to make sulfur trioxide, SO_3.

Write the **balanced symbol** equation for this reaction.

[2]

19 Orange juice contains vitamin C.

The formula for vitamin C is $C_6H_8O_6$.

A sample of 176 g of vitamin C contains 72 g of carbon and 8 g of hydrogen.

How many grams of oxygen does it contain?

answer _____ g

[1]

20 Jed is testing potassium chloride and some unknown compounds.

He does some tests.

These are the tests that Jed does on solutions of the compounds:

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- a flame test
- adding sodium hydroxide solution
- adding silver nitrate solution.

Look at his results.

Compound	Flame colour	Adding sodium hydroxide solution	Adding silver nitrate solution
potassium chloride	lilac	no reaction	white solid made
A	yellow	no reaction	white solid made
B	no colour	green solid made	cream solid made

Potassium chloride reacts with silver nitrate to make silver chloride and potassium nitrate.

Write a **word** equation for this reaction.

Identify the unknown compounds **A** and **B** and explain your answers.



The quality of written communication will be assessed in your answer to this question.

[6]

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21 This question is about two Group 1 elements, sodium and potassium.

Potassium reacts with water.

One of the substances made is an alkali.

The other substance made burns with a 'pop'.

Complete the **word** equation for this reaction.

potassium + water → ..... + ...

[2]

22 Hydrochloric acid is a **strong** acid.

Ethanoic acid is a **weak** acid.

Both acids can either be concentrated or dilute.

Explain the difference between acid **strength** and acid **concentration**.

---

[2]

23 Kate and Steve are testing some water samples.

They use lead nitrate solution and barium chloride solution.

They add each solution to different samples of water.

Look at the table. It shows their results.

Water sample	Effect of adding lead nitrate solution	Effect of adding barium chloride solution
A	white precipitate	no reaction
B	yellow precipitate	white precipitate
C	no reaction	white precipitate

Which negative ions are in each water sample?

Explain your answers.

---

[3]

24 Look at the table.

It shows information about the Group 7 elements.

Element	Appearance	Melting point in °C	Boiling point in °C	Order of reactivity
fluorine	yellow gas	– 220	_____	most reactive 
chlorine	green gas	– 101	– 34	
bromine	red / brown liquid	– 7	59	
iodine	_____	114	184	
astatine	black solid	_____	337	least reactive

Fluorine is more reactive than astatine.

Explain the trend in the reactivity of the Group 7 elements.

---

[2]

25 Zinc reacts with hydrochloric acid.

Hydrogen gas and zinc chloride are made.

Write the **word** equation for this reaction.

---

[1]

26 Sodium hydrogencarbonate decomposes when it is heated.

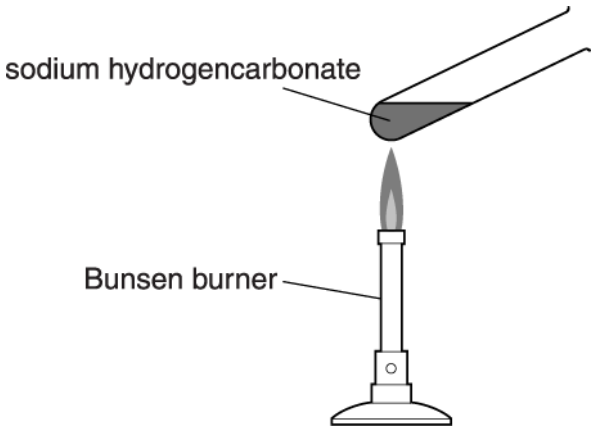
sodium hydrogencarbonate	→	sodium carbonate	+	carbon dioxide	+	water
$2NaHCO_3$	→	Na_2CO_3	+	CO_2	+	H_2O

The table shows the relative formula masses, M_r, of the substances in the equation.

Substance	Relative formula mass
$NaHCO_3$	84
Na_2CO_3	106
CO_2	44
H_2O	18

Zakia heats some sodium hydrogencarbonate.

Look at the apparatus she uses.



Zakia heats 0.84 g of solid sodium hydrogencarbonate.

When the reaction is complete the test tube contains 0.53 g of solid sodium carbonate.

(i) The mass of the solid in the test tube **decreases** when it is heated.

Explain why.

---

[1]

(ii) Zakia does another experiment.

This time she heats 8.4 g of solid sodium hydrogencarbonate.

Predict the mass of solid sodium carbonate made when the reaction is complete.

---

mass = _____ g

[1]

(iii) Zakia makes **less** solid sodium carbonate than she predicts.

Suggest **two** reasons why she makes less solid.

---**[2]**

27(a) Potassium sulfate, K_2SO_4, is a fertiliser.

Potassium sulfate contains the **essential** element potassium, K.

Ammonium phosphate, $(NH_4)_3PO_4$, is another fertiliser.

Write down the names of the **two essential** elements in ammonium phosphate.

---**[2]**

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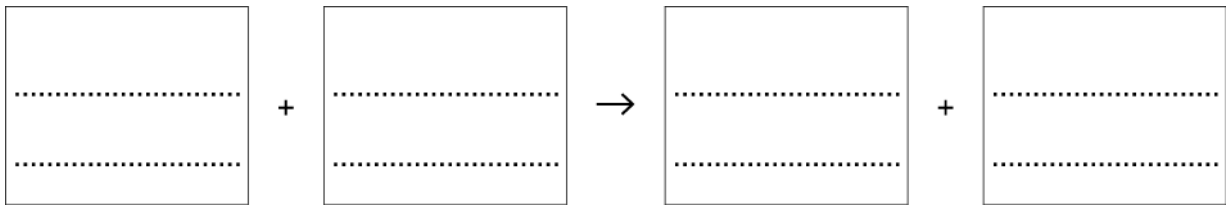
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(b) Fertilisers are made by reacting an acid with an alkali.

This is a neutralisation reaction.

(i) Potassium hydroxide reacts with nitric acid.

Write a **word equation** for this reaction.



[2]

(ii) One way to find out the pH of a solution of fertiliser is by using a pH meter.

Write about one **other** way to find the pH.

---

[2]

28 This question is about making ammonia by the Haber process.

Nitrogen and hydrogen react to make ammonia.

(i) The hydrogen gas used to make ammonia comes from natural gas.

Where does the **nitrogen gas** come from?

Choose from the list.

air

limestone

salt

water

---------- [1]

(ii) Nitrogen and hydrogen react to make ammonia.

Not all of the nitrogen and hydrogen reacts.

What happens to the unreacted nitrogen and hydrogen?

---------- [1]

29(a) Zinc, Zn, reacts with hydrochloric acid, HCl.

Hydrogen gas, H_2, and zinc chloride, $ZnCl_2$, are made.

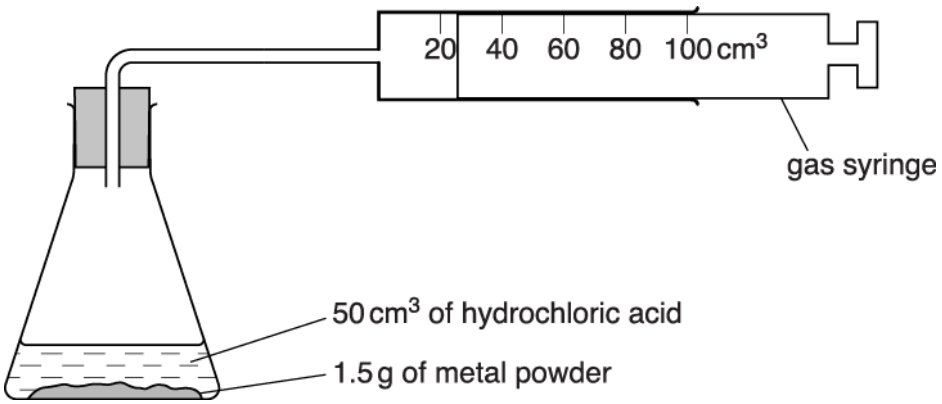
Construct the **balanced symbol** equation for this reaction.

---------- [1]

(b) Fatimah and Sam investigate the reaction between acid and metals.

They react dilute hydrochloric acid with zinc powder and with iron powder.

Look at the apparatus they use.



Every 10 seconds they measure the volume of gas in the gas syringe.

Fatimah and Sam do three different experiments.

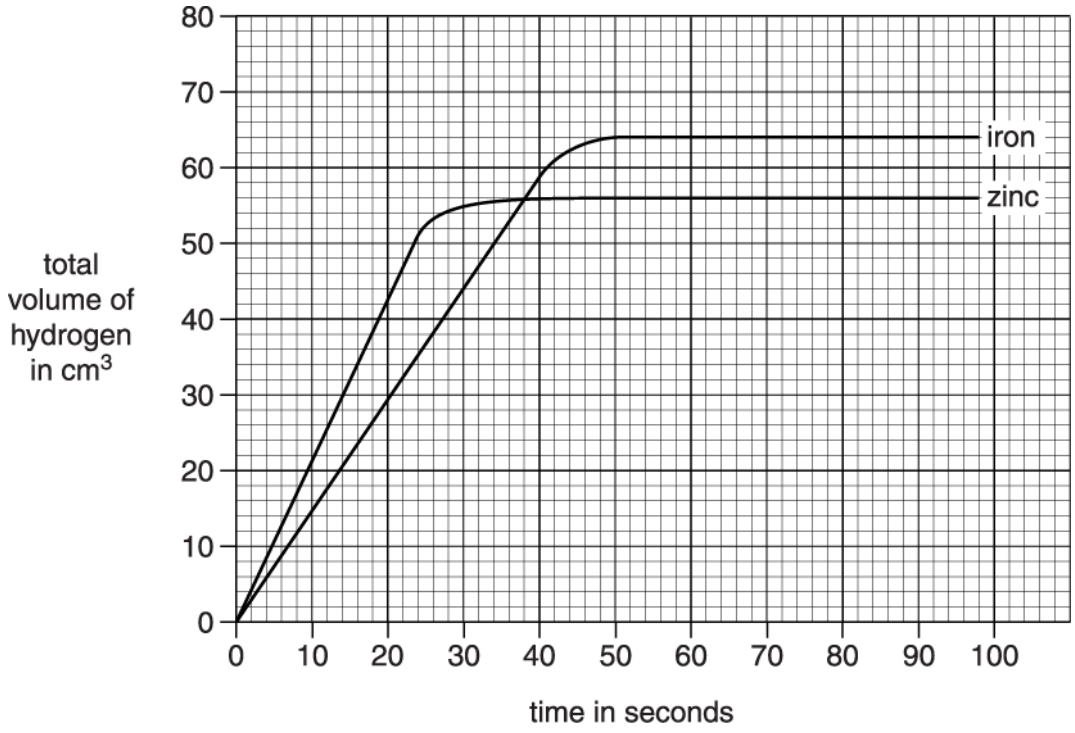
- 50 cm^3 hydrochloric acid and 0.15 g of zinc
- 50 cm^3 hydrochloric acid and 0.15 g of iron
- 50 cm^3 hydrochloric acid and 0.075 g of iron mixed with 0.075 g of zinc.

Look at the graph of the results for the first two experiments.

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(i) Calculate the rate of reaction of **iron** during the **first 30 seconds**.

---

rate of reaction = _____ cm^3 / s

[1]

(ii) Predict the total volume of hydrogen formed when the **mixture** of zinc and iron powder is used.

_____ cm^3

[1]

(c) Increasing the concentration of a reactant in solution will increase the rate of reaction.

Use the reacting particle model to explain why.

---

[2]

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30 Sodium hydrogencarbonate decomposes when it is heated.

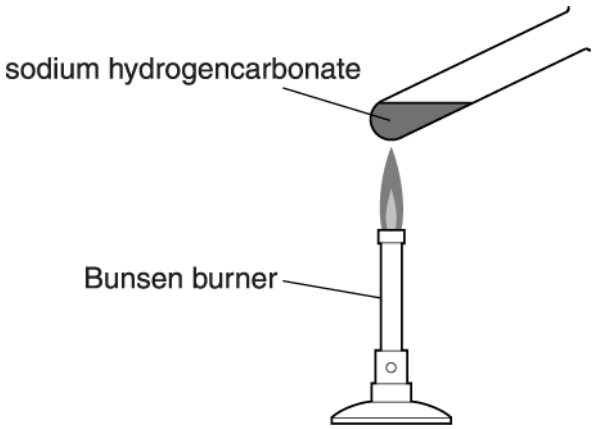
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$NaHCO_3$	84
Na_2CO_3	106
CO_2	44
H_2O	18

Zakia heats some sodium hydrogencarbonate.

Look at the apparatus she uses.



Zakia heats 1.000 g of solid sodium hydrogencarbonate.

After heating for ten minutes the test tube contains 0.631 g of solid sodium carbonate.

Zakia does the experiment again.

This time she uses 2.500 g of solid sodium hydrogencarbonate.

(i) Show that the predicted mass of solid sodium carbonate that she should make is 1.578 g.

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[1]

(ii) Zakia actually makes 1.124 g of solid sodium carbonate.

Calculate the percentage yield.

Give your answer to **three significant figures**.

percentage yield = _____ %

[2]

31

(i) Iron rusts in damp air.

Rust is hydrated iron(III) oxide.

Write the **word** equation for the rusting of iron.

[1]

(ii) The rusting of iron is an **oxidation** reaction.

Explain why.

[1]

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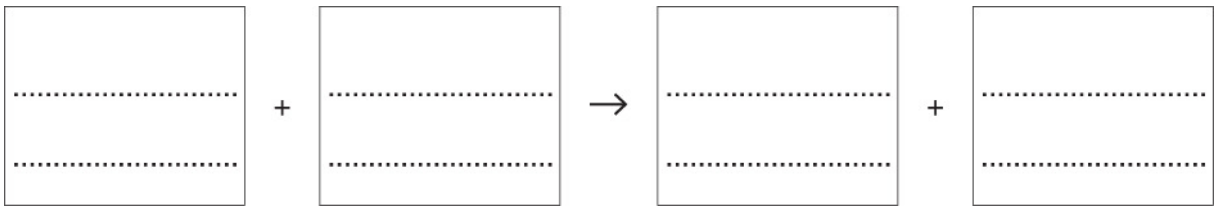
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32 Fertilisers are made by reacting an acid with an alkali.

This is a neutralisation reaction.

Potassium hydroxide reacts with nitric acid.

Write a **word** equation for this reaction.



[2]

33 The alloy duralumin contains aluminium.

Aluminium reacts with oxygen, O_2.

Aluminium oxide, Al_2O_3, is made.

Write a **balanced symbol** equation for this reaction.

[2]

34 Acids contain hydrogen ions, H^+. Alkalis contain hydroxide ions, OH^-.

Write the **ionic** equation for neutralisation.

[1]

35 Nitrogen molecules react with oxygen molecules.

Nitrogen monoxide molecules are made.

Write down the **word** equation for the reaction between nitrogen and oxygen.

[1]

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36(a) Methane is a fuel that can be made by the reaction between carbon dioxide and hydrogen.

$$CO_2(g) + 4H_2(g) \; ? \; CH_4(g) + 2H_2O(g)$$

What is the meaning of (g) in the equation?

---

[1]

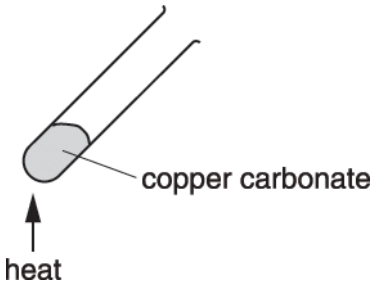
(b) What is the meaning of the symbol ? ?

---

[1]

37 Lindsay is heating some copper carbonate, $CuCO_3$.

Look at the diagram. It shows the apparatus Lindsay uses to heat the copper carbonate.



Copper carbonate changes into carbon dioxide and a solid. This is called **thermal decomposition.**

(i) Write a **word** equation for this reaction.

---

[1]

(ii) What is meant by thermal decomposition?

---

[1]

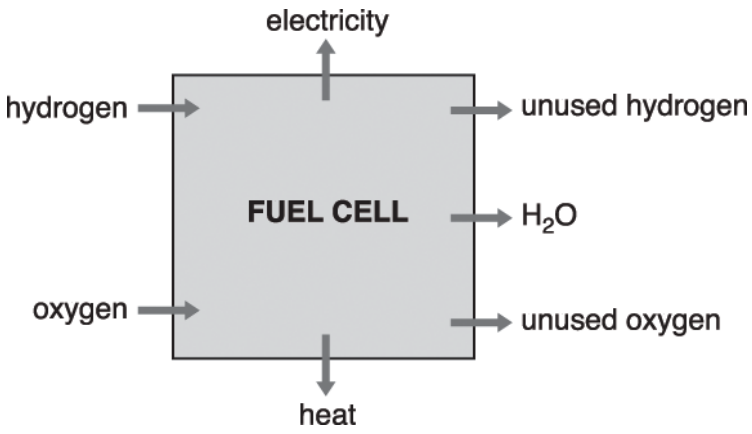
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38 Fuel cells are used to make electricity.

Look at the diagram. It shows what happens in a fuel cell.



In this fuel cell, hydrogen, H_2, reacts with oxygen, O_2.

Water, H_2O, is made.

Write a **balanced symbol** equation for this reaction.

[2]

39(a) In this reaction the $K^+(aq)$ and the $NO_3^?(aq)$ are called **spectator ions**.

What is meant by a spectator ion?

[1]

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(b) Sam researches different ways of making insoluble salts such as lead iodide.

In one reaction she adds potassium iodide solution to lead nitrate solution.

Potassium iodide solution contains $K^+(aq)$ and $I^?(aq)$.

Lead nitrate solution contains $Pb^{2+}(aq)$ and $NO_3^?(aq)$.

Look at the balanced ionic equation for the precipitation reaction.

$$Pb^{2+}(aq) + 2I^?(aq) \; ? \; PbI_2(s)$$

Explain why this precipitation reaction is extremely fast.

---

[1]

40 A compound with the formula K_2FeO_4 has been discovered on Mars.

A sample of K_2FeO_4 is analysed.

The 1.00 g sample contains 0.39 g of potassium and 0.28 g of iron.

Calculate the percentage by mass of oxygen in this sample of K_2FeO_4.

percentage by mass = _____ %

[2]

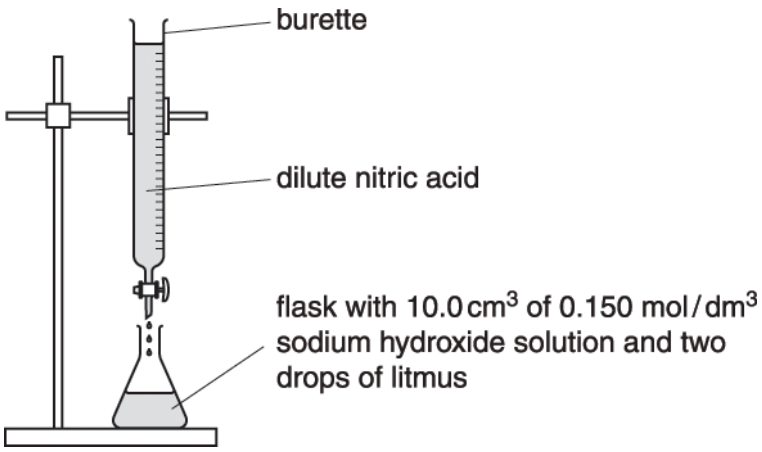
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41 Cristina titrates dilute nitric acid with sodium hydroxide solution.

Look at the diagram of her apparatus.



Cristina slowly adds dilute nitric acid into the flask until the end point is reached.

Cristina does four titrations.

Look at her results table.

Titration number	1	2	3	4
Final burette reading in cm^3	26.5	49.2	26.4	40.3
Initial burette reading in cm^3	0.0	24.1	1.2	15.0
Titre (volume of acid added) in cm^3	26.5	25.1	25.2	25.3

(i) Cristina calculates the mean titre to be 25.2 cm^3.

Explain why this is the **best** mean value from these results.

---

[2]

(ii) Cristina uses 10.0 cm^3 of sodium hydroxide solution.

The concentration of the sodium hydroxide solution is 0.150 mol / dm^3.

Calculate the number of moles of sodium hydroxide in 10.0 cm^3 of this solution.

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---

number of moles = _____

[1]

(iii) Look at the equation for the reaction between nitric acid and sodium hydroxide.

$$HNO_3 + NaOH \rightarrow NaNO_3 + H_2O$$

Use the information from parts **(i)** and **(ii)** to calculate the concentration of the nitric acid.

Give your answer to **three** significant figures.

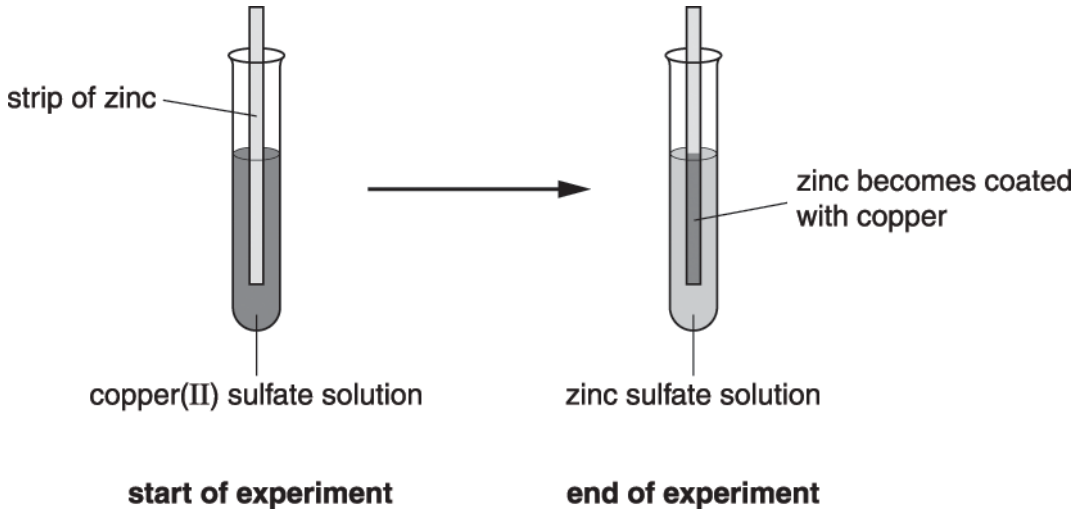
---

concentration of nitric acid = _____ mol / dm^3

[2]

42 Jill investigates the reactivity of some metals.

Look at the diagram. It shows what happens when she puts a strip of zinc into copper(II) sulfate solution.



Write the **word** equation for the reaction between zinc and copper(II) sulfate solution.

..... + ... → ..... + ...

....

....

[1]

43(a) Chlorine reacts with sodium bromide solution.

Look at the **ionic** equation for this reaction.

$$Cl_2 + 2Br^- \rightarrow Br_2 + 2Cl^-$$

Explain why chlorine is **reduced** in this reaction.

---

[1]

(b) Chlorine also reacts with potassium iodide solution, KI.

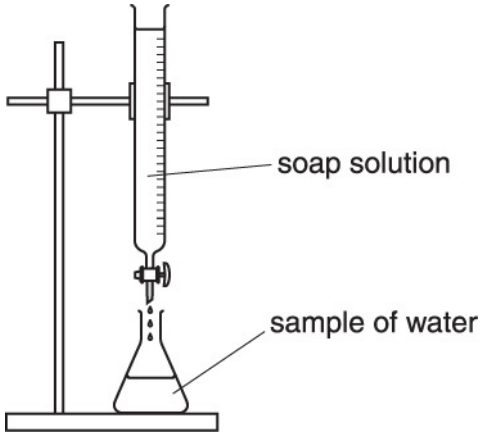
Iodine and potassium chloride are made.

Construct a **balanced symbol** equation for this reaction.

[2]

44 Sunita and Carl are investigating 3 samples of water, **A**, **B** and **C**.

Look at the diagram. It shows the apparatus they use.



They add soap solution to samples of water and shake them.

They keep adding more soap solution until a lather remains.

Look at the table. It shows their results.

Sample		Volume of soap solution added in cm^3
distilled water		2.0
sample **A**	before boiling	10.0
	after boiling	10.0
sample **B**	before boiling	12.0
	after boiling	6.0
sample **C**	before boiling	7.0
	after boiling	2.0

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Place the water samples, **A**, **B** and **C**, in order of their hardness (hardest first).

Write about the different types of hardness in each of the samples **A**, **B** and **C**.

Explain your answers.

The quality of written communication will be assessed in your answer to this question.

[6]

45 Glucose reacts to make carbon dioxide and ethanol.

Look at the formulas.

Substance	Formula
glucose	$C_6H_{12}O_6$
carbon dioxide	CO_2
ethanol	C_2H_5OH

Write down the **balanced symbol** equation for this reaction.

[2]

46 CFCs have now been replaced by HFCs.

The formula of one HFC is $C_2H_2F_4$.

(i) Write down the names of the three **elements** in $C_2H_2F_4$.

---

[1]

(ii) Write down the **total number of atoms** in one molecule of $C_2H_2F_4$.

answer _____

[1]

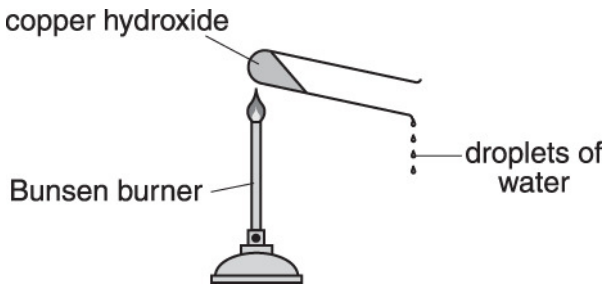
47(a) Copper hydroxide decomposes when heated. Copper oxide and water are made.

Write down the **word** equation for this reaction.

---

[1]

(b) Jess heats some copper hydroxide. Look at the apparatus she uses.



She measures the mass of copper hydroxide at the start.

She then heats the copper hydroxide for 5 minutes. Jess lets the apparatus cool down.

She then measures the mass of copper oxide made.

Jess does the experiment three more times. Look at her results.

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Experiment number	Mass of copper hydroxide in g	Mass of copper oxide made in g	Mass of water made in g
1	0.50	0.41	0.09
2	1.00	0.82	0.18
3	1.50	1.22	_____
4	2.00	1.63	_____

Jess predicts that the mass of water made depends on the mass of copper hydroxide heated.

Complete the results table.

Is Jess's prediction supported by her results?

Explain your answer.

---

[3]

48(a) Look at the table. It shows information about the halogens.

Halogen	Formula	Colour	State at room temperature	Use
fluorine	F_2	pale yellow	gas	making sodium fluoride
chlorine	Cl_2	_____	gas	making plastics
bromine	Br_2	brown	_____	making medicines
iodine	I_2	grey	solid	_____ _____

[3]

Complete the table.

(b) Bromine reacts with sodium. Sodium bromide is made.

Write the **word** equation for this reaction.

---

[1]

49 Hilary investigates the reaction between magnesium, Mg, and hydrochloric acid, HCl.

Magnesium chloride, $MgCl_2$, and hydrogen, H_2, are made.

Construct the **balanced symbol** equation for this reaction.

---

[2]

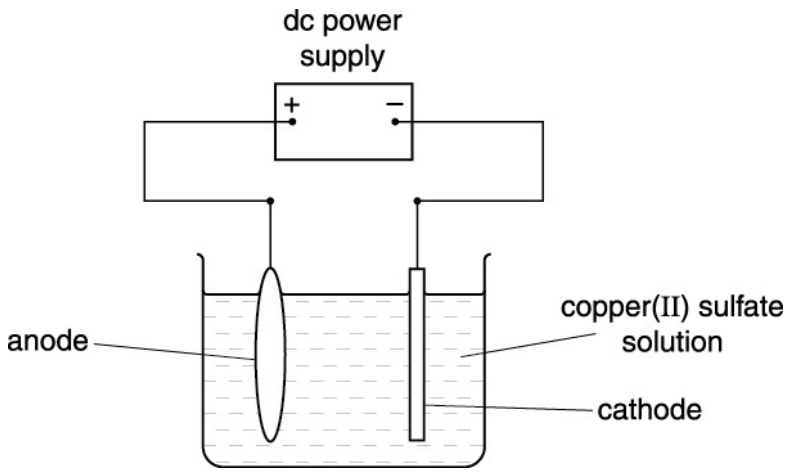
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50

Look at the diagram. It shows apparatus used to purify copper.



Look at the equations below for the electrode reactions.

The anode: $Cu - 2e^- \rightarrow Cu^{2+}$

The cathode: $Cu^{2+} + 2e^- \rightarrow Cu$

(i) Which reaction is oxidation and which is reduction?

Explain why.

---

[2]

(ii) Use the electrode reactions to explain why the anode **loses** mass and the cathode **gains** mass.

---

[2]

51 The LPG fraction of crude oil contains propane gas, C_3H_8.

Write a **balanced symbol** equation for the **incomplete** combustion of propane in oxygen, O_2.

Only carbon monoxide, CO, and water are made.

---

[2]

52 Hydrogen peroxide, H_2O_2, can be made from hydrogen, H_2, and oxygen, O_2.

hydrogen + oxygen → hydrogen peroxide

(i) Write the **balanced symbol** equation for this reaction.

---

[1]

(ii) This reaction has a 100% atom economy.

What does this mean?

---

[1]

(iii) Oskar finds out that 5 g of hydrogen should make 85 g of hydrogen peroxide.

Show that 100 g of hydrogen should make 1700 g of hydrogen peroxide.

---

[2]

(iv) Oskar uses 100 g of hydrogen to make hydrogen peroxide.

He predicts he should make 1700 g of hydrogen peroxide.

He actually makes 1530 g of hydrogen peroxide.

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Calculate Oskar's percentage yield of hydrogen peroxide.

percentage yield = _____ %

[2]

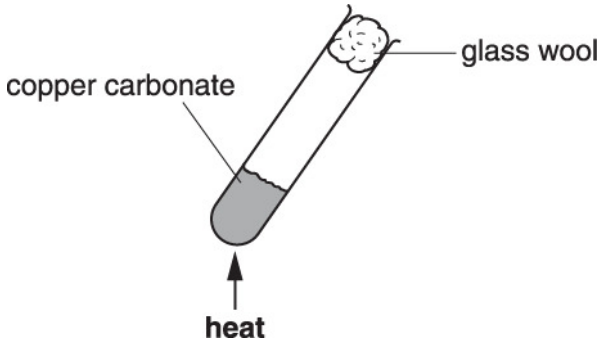
53(a) John and Sue investigate the decomposition of copper carbonate.

Copper carbonate, $CuCO_3$, breaks down into copper oxide, CuO, and carbon dioxide, CO_2.

Write the **balanced symbol** equation for this reaction.

[1]

(b) Look at the diagram. It shows the apparatus they use.



They measure the contents of the test tube before and after heating.

Look at their results.

	Mass in g
mass of contents before heating	12.40
mass of contents after heating	8.00

(i) Calculate the mass of **carbon dioxide** made.

---

answer _____ g

[1]

(ii) John and Sue repeat the experiment.

This time they use **24.80 g** of copper carbonate.

Calculate the mass of **carbon dioxide** they make this time.

answer _____ g

[1]

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54 Sam makes some copper.

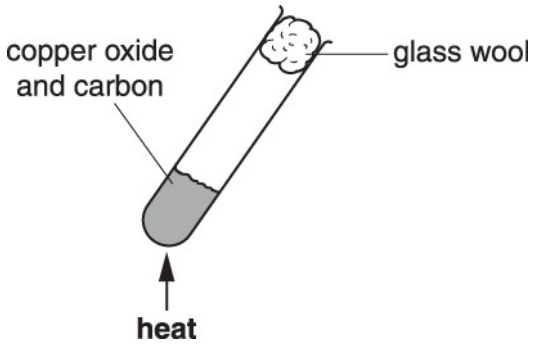
(i) Sam heats copper oxide, CuO, with carbon, C.

Copper, Cu, and carbon dioxide, CO_2, are made.

Write a **balanced symbol** equation for this reaction.

[2]

(ii) Look at the diagram. It shows the apparatus he uses.



Sam measures the mass of the test tube and its contents before and after heating.

The mass of the test tube and its contents **decreases**.

Suggest why.

[1]

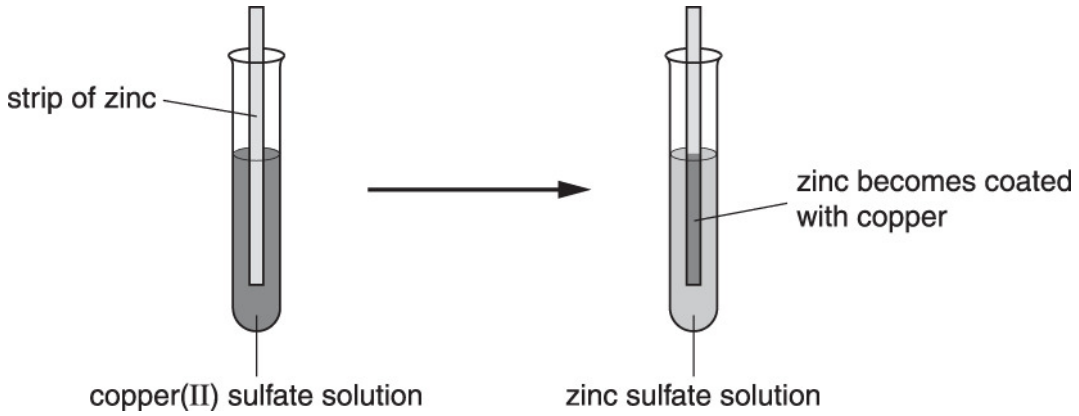
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55 Jill investigates the reactivity of some metals.

Look at the diagram. It shows what happens when she puts a strip of zinc into copper(II) sulfate solution.



Write the **word** equation for the reaction between zinc and copper(II) sulfate solution.

....	+	....	→	....	+	....	

[1]

56 Hexane is one of the hydrocarbons found in petrol.

Hexane completely burns in excess air.

Look at the symbol equation for this reaction.

Balance the equation by putting numbers in the boxes.

2	C_6H_{14}	+	.....	O_2	→	.....	CO_2	+	..... H_2O

[2]

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57 Ethanoic acid, $C_2H_4O_2$, can be made by several different processes.

Ethanol can be oxidised using oxygen.

$$C_2H_6O + O_2 \rightarrow C_2H_4O_2 + H_2O$$

Mike knows that 46 tonnes of ethanol should make 60 tonnes of ethanoic acid.

A factory uses 4.6 tonnes of ethanol.

Predict the mass of ethanoic acid that should be made.

predicted mass of ethanoic acid = _____ tonnes

[1]

58 Sodium chloride (salt) is an important raw material in the chemical industry.

Sodium, Na, reacts with chlorine, Cl_2.

Sodium chloride, NaCl, is made.

Write a **balanced symbol** equation for this reaction.

[2]

59 Bornite is a mineral extracted from the Earth.

Bornite has the chemical formula Cu_5FeS_4.

How many different **elements** are in Cu_5FeS_4?

[1]

60(a) Some power stations burn coal.

Coal often contains **sulfur** as an impurity.

The sulfur reacts with oxygen to make sulfur dioxide.

Write down the **word equation** for this reaction.

[1]

(b) Nitrogen dioxide is also made in a power station.

To stop the nitrogen dioxide going into the atmosphere it is reacted with water.

Nitrogen dioxide reacts with water to make two acids.

Copy out and **balance** the **symbol equation** for this reaction.

$$NO_2 + H_2O \rightarrow HNO_2 + HNO_3$$

[1]

61 Look at the formulas.

CO_2 Na Mg^{2+} Zn F^-

Use the formulas to write down the formula of magnesium fluoride.

[1]

62 Pentane, C_5H_{12}, is an alkane found in petrol.

Pentane undergoes **complete combustion** in excess oxygen, O_2.

Carbon dioxide and water are made.

Write the **balanced symbol** equation for the complete combustion of pentane.

[2]

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63 Avogadro's constant has a value of 6.02×10^{23}.

How many **oxygen atoms** are in 0.25 moles of oxygen molecules?

A 1.204×10^{24}
B 1.505×10^{23}
C 3.010×10^{23}
D 6.020×10^{23}

Your answer [ ] **[1]**

64 Methane burns in oxygen to form carbon dioxide and water.

$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$

Calculate the amount of carbon dioxide made when 6.4 g of methane is burnt.

A 2.8 g
B 4.4 g
C 14.4 g
D 17.6 g

Your answer [ ] **[1]**

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65

(i) Solid lead reacts with nitric acid, HNO_3.

Lead nitrate, $Pb(NO_3)_2$, nitrogen oxide, NO, and water are made.

Write a **balanced symbol** equation for this reaction.

[2]

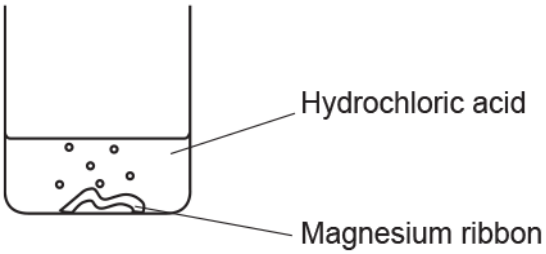
(ii) How many moles of lead nitrate would be produced if 20.7 g of lead reacts with nitric acid?

Give your answer to **2** significant figures.

Moles of lead nitrate = ... **[4]**

66 A student investigates the reaction between magnesium and dilute hydrochloric acid, HCl.

The student adds magnesium ribbon to hydrochloric acid in a beaker, as shown in the diagram.



Write the **balanced symbol** equation for this reaction.

[2]

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67 A student reacts calcium carbonate with hydrochloric acid.

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

What physical state does **(g)** represent in the balanced symbol equation?

A Aqueous

B Gas

C Liquid

D Solid

Your answer [1]

68 The formula of a magnesium ion is Mg^{2+}.

The formula of a nitrate ion is NO_3^-.

What is the formula of **magnesium nitrate**?

A $MgNO_3$

B Mg_2NO_3

C $Mg(NO_3)_2$

D $Mg_2(NO_3)_3$

Your answer [1]

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69 In the Haber process nitrogen gas, N_2, reacts with hydrogen gas.

Ammonia, NH_3, is made. The reaction is a reversible reaction.

Write the **balanced symbol** equation for the reaction.

[2]

70 Look at the balanced symbol equation.

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

What does the symbol **(s)** represent in the balanced symbol equation?

A Solid
B Solute
C Solution
D Substance

Your answer ☐ [1]

71 Ethanol, C_2H_5OH, burns in oxygen. Carbon dioxide and water are made.

Which equation for this reaction is correctly balanced?

A $C_2H_5OH + O_2 \rightarrow CO_2 + H_2O$
B $C_2H_5OH + 3O_2 \rightarrow 2CO_2 + 3H_2O$
C $C_2H_5OH + 2O_2 \rightarrow 3CO_2 + 2H_2O$
D $2C_2H_5OH + 7O_2 \rightarrow 4CO_2 + 6H_2O$

Your answer ☐ [1]

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72 Oxygen reacts with 1.20 g of carbon. 4.40 g of carbon dioxide forms.

$C + O_2 \rightarrow CO_2$

What mass of oxygen is used in this reaction?

A 0.80 g
B 1.60 g
C 3.20 g
D 5.60 g

Your answer ☐ [1]

73 The symbol of an aluminium ion is Al^{3+}.

The symbol of an oxide ion is O^{2-}.

What is the formula of aluminium oxide?

A AlO
B Al_2O
C Al_3O_2
D Al_2O_3

Your answer ☐ [1]

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74 Acids are substances that turn universal indicator paper red.

(i) What makes a substance acidic?

[1]

(ii) Sodium hydroxide, NaOH, is an alkali.

Sodium hydroxide neutralises sulfuric acid, H_2SO_4. The reaction makes a salt called sodium sulfate, Na_2SO_4. Water is also made.

Complete the **balanced symbol equation** for this reaction.

..... $NaOH + H_2SO_4 \rightarrow Na_2SO_4$ + ... H_2O

[2]

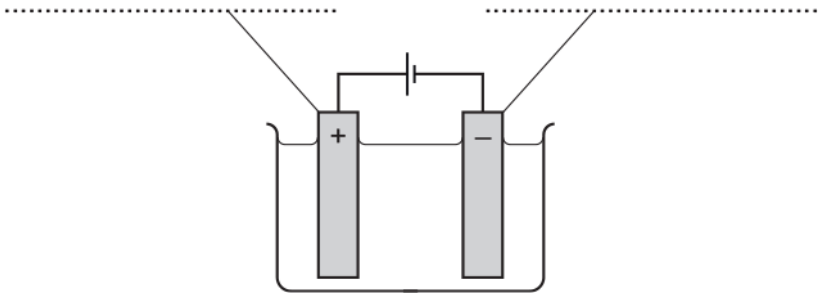
75(a) Electrolysis can be used to separate the elements in some compounds using electricity.

(i) Look at the diagram of an electrolysis experiment.

Complete the diagram using the words in the list.

You may use each word once, more than once or not at all.

cathode **anode** **battery**



[2]

(ii) A teacher demonstrates the electrolysis of molten lead bromide.

Predict the products made at each electrode.

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Positive electrode _____

Negative electrode _____

[2]

(iii) Molten lead bromide contains lead ions, Pb^{2+}, and bromide ions, Br^-.

What is the formula for lead bromide?

Tick (✓) **one** box.

PbBr ☐

$PbBr_2$ ☐

Pb_2Br ☐

Pb_2Br_2 ☐

[1]

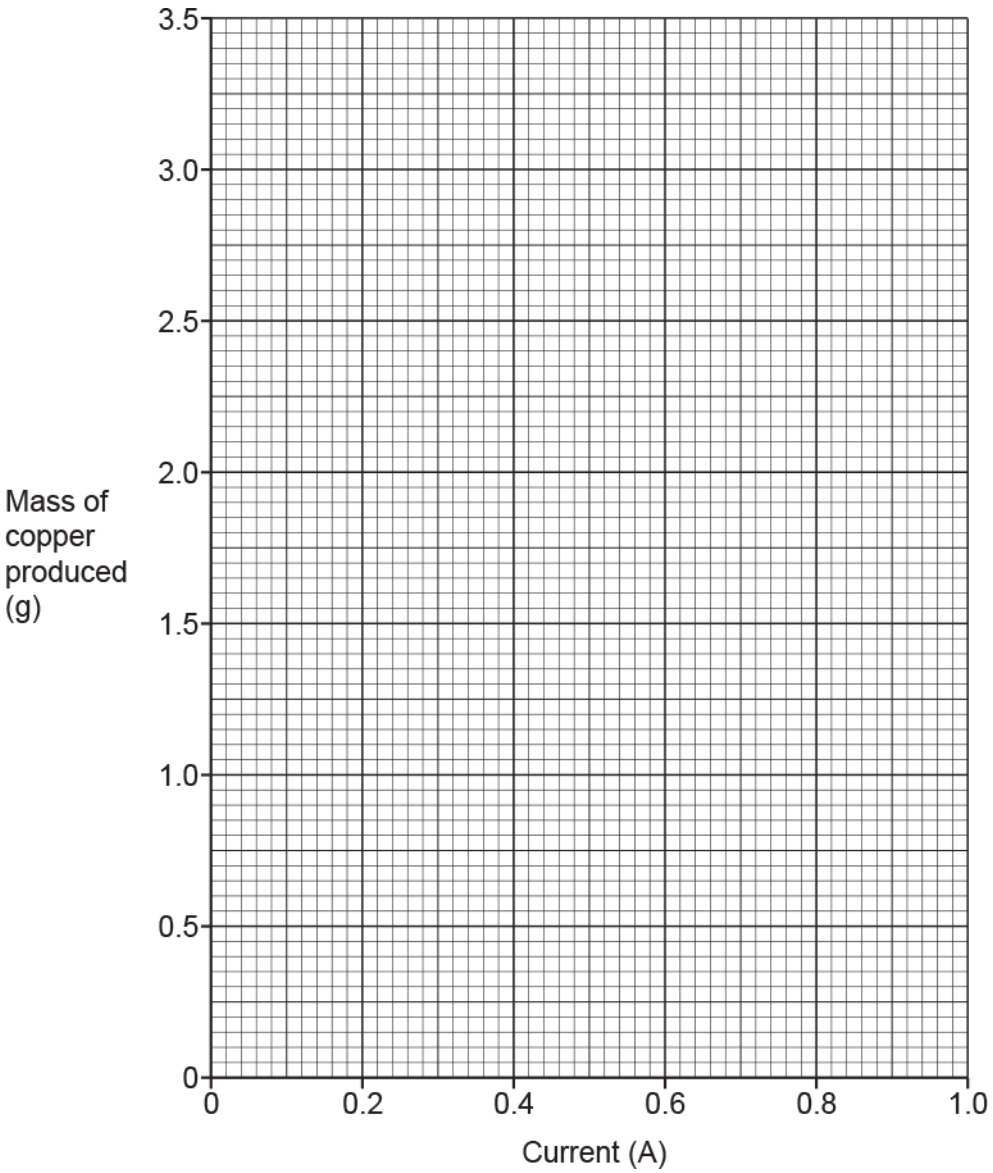
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(b) The student investigates the mass of copper made during the electrolysis of aqueous copper chloride.

The student varies the electric current and passes the current for the same time in each experiment. Here is a table of their results.

Current (A)	Mass of copper produced (g)
0.2	0.6
0.4	1.3
0.6	1.8
0.8	2.5
1.0	3.1

(i) Plot a graph of the student's results and draw a line of best fit.



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[3]

(ii) Use your graph to **estimate** the current needed to make 2.25 g of copper.

Current = ... A **[1]**

(iii) Use your graph, and a calculation, to find the mass of copper that would be produced using 15 A.

Give your answer to **2** significant figures.

Mass of copper produced = ... g **[2]**

76 The burning of methane gas is an exothermic reaction.

When methane, CH_4, burns in oxygen, O_2, carbon dioxide, CO_2, and water, H_2O, are made.

Write the **balanced symbol equation** for this reaction.

[2]

77 Magnesium reacts with chlorine. Magnesium chloride is made.

What is the balanced symbol equation for this reaction?

A $Mg + Cl \rightarrow MgCl$

B $Mg + Cl_2 \rightarrow MgCl_2$

C $2Mg + Cl_2 \rightarrow 2MgCl$

D $2Mg + Cl_2 \rightarrow Mg_2Cl_2$

Your answer [1]

78 Avogadro's constant has a value of 6.02×10^{23}.

What is the number of atoms in 0.5 mol of water?

A 2.00×10^{23}

B 3.01×10^{23}

C 6.02×10^{23}

D 9.03×10^{23}

Your answer [1]

79 Sodium hydroxide reacts with hydrochloric acid. Sodium chloride and water are made.

$NaOH + HCl \rightarrow NaCl + H_2O$

What mass of sodium hydroxide would be needed to make 46.8 g of sodium chloride?

A 16 g

B 32 g

C 50 g

D 64 g

Your answer [1]

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80 Which equation shows the formation of a Group 2 metal ion?

M represents a Group 2 metal and e^- represents an electron.

A $M + e^- \rightarrow M^+$

B $M + 2e^- \rightarrow M^{2+}$

C $M \rightarrow M^+ + e^-$

D $M \rightarrow M^{2+} + 2e^-$

Your answer [1]

81 Phosphoric acid contains phosphate ions, PO_4^{3-}.

Phosphoric acid is completely neutralised by sodium hydroxide.

What is the formula of the salt that is made?

A Na_2PO_4

B Na_3PO_4

C $Na(PO_4)_3$

D $Na_2(PO_4)_3$

Your answer [1]

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82(a) A student is investigating chemical reactions that produce heat.

She adds zinc to hydrochloric acid, HCl.

Zinc chloride, $ZnCl_2$, and hydrogen gas are made.

(i) Write the **balanced symbol** equation for this reaction.

[2]

(ii) What term is used to describe a reaction that produces heat?

[1]

(b) The student draws the reaction profile for this reaction, as shown in **Fig. 18.1**.

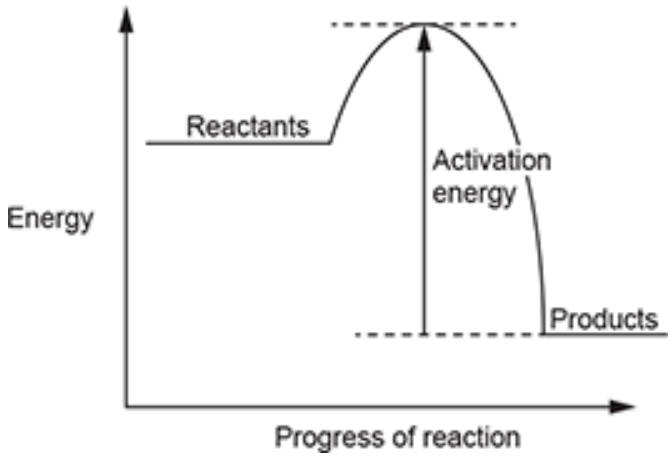


Fig. 18.1

Explain what is meant by the term **activation energy**.

[1]

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83 After testing some soil samples, a farmer finds that the soil in one of his fields is acidic.

Acidic soil can be neutralised by spreading magnesium carbonate, $MgCO_3$, onto the soil.

The farmer uses 25.0 kg of magnesium carbonate.

Calculate the number of moles of magnesium carbonate the farmer uses.
(A_r: C = 12.0; Mg = 24.3; O = 16.0)

Give your answer to **3** significant figures.

Number of moles of magnesium carbonate = ... **[3]**

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(i) Sodium oxide reacts with water.

An aqueous solution of sodium hydroxide is made.

Write the **balanced symbol equation** for this reaction, including **state symbols**.

[3]

(ii) Sodium hydroxide neutralises acids. It is an alkali.

Which ion do solutions of alkalis contain?

[1]

(iii) A salt is made when sodium hydroxide neutralises sulfuric acid.

Name this salt.

[1]

(iv) A sample of hydrochloric acid has a pH of 1.04.

A student adds water to the hydrochloric acid until the pH is 3.04.

The concentration of hydrogen ions decreases.

Calculate the factor by which the hydrogen ion concentration has decreased.

Decrease in hydrogen ion concentration = ... **[2]**

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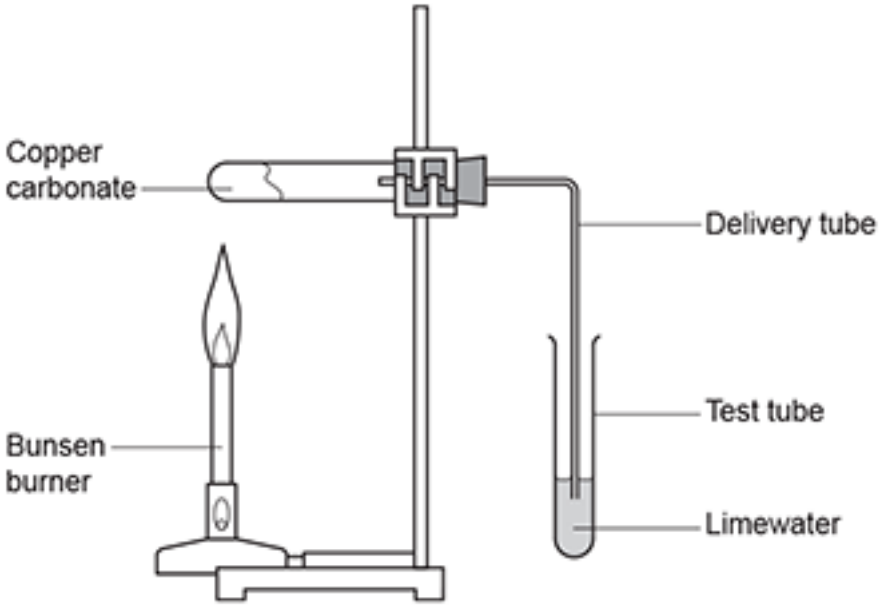
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85(a) A student investigates the thermal decomposition of copper carbonate.

copper carbonate → copper oxide + carbon dioxide

Here is the set-up of the apparatus she uses.



The student measures the mass of copper carbonate at the start of the experiment. She then measures the mass of copper oxide made.

She does the experiment five times using a different mass of copper carbonate each time.

Look at her results.

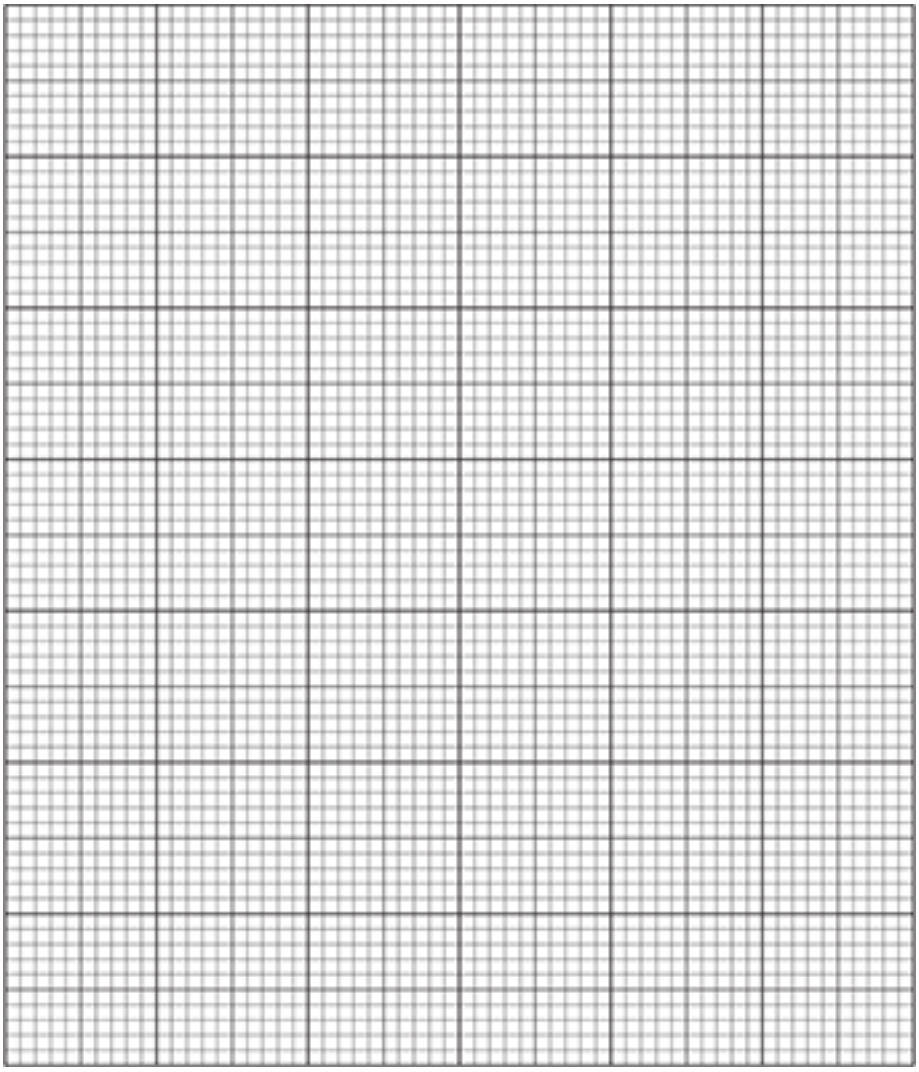
Mass of copper carbonate (g)	Mass of copper oxide (g)
1.00	0.70
2.00	1.35
3.00	1.95
4.00	2.65
5.00	3.30

(i) Plot a graph of the student's results and draw a line of best fit.

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[4]

(ii) What is the mass of copper carbonate that needs to be heated to produce 2.50 g of copper oxide?

Use your graph in your answer.

Mass of copper carbonate = ... g **[1]**

(iii) The mass of copper oxide made in the reaction is less than the mass of the copper carbonate heated.

Suggest why.

---

[1]

(b) Calcium carbonate thermally decomposes to make calcium oxide and carbon dioxide.

$CaCO_3 \rightarrow CaO + CO_2$

Calculate the mass of calcium carbonate needed to make 209g of calcium oxide.

(A_r: Ca = 40.1, C = 12.0, O = 16.0)

Give your answer to **3** significant figures.

Mass of calcium carbonate = ... g **[4]**

86 This question is about elements in the Periodic Table.

Look at the table. It shows some properties of Group 7 elements.

Element	Molecular formula	State at room temperature	Radius of an atom (nm)	Order of reactivity
Fluorine	F_2	.....	0.072	most reactive ↕ least reactive
Chlorine	Cl_2	gas	0.099	
Bromine	Br_2	liquid	0.114	
Iodine	I_2	solid	0.133	
Astatine	At_2	solid	.....	

In the table, the Group 7 elements are listed in order of reactivity.

The equations show a displacement reaction of Group 7 elements.

chlorine + sodium bromide → sodium chloride + bromine

Cl_2 + 2NaBr → 2NaCl + Br_2

(i) Complete the word equation.

bromine + sodium iodide → _____ + _____ [1]

(ii) There is no reaction between iodine and sodium bromide.

Explain why.

_____

_____ [1]

(iii) Chlorine reacts with sodium iodide. Sodium chloride and iodine are made.

Write the **balanced symbol** equation for this reaction.

_____ [2]

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87 A student reacts some metals with different salt solutions.

Table 17.2 shows her results.

	Magnesium	**Zinc**	**Iron**	**Copper**
Copper sulfate	blue solution becomes colourless	blue solution becomes colourless	blue solution becomes green	no reaction
Iron sulfate	green solution becomes colourless	green solution becomes colourless	no reaction	no reaction
Magnesium sulfate	no reaction	no reaction	no reaction	no reaction
Zinc sulfate	black coating on magnesium	no reaction	no reaction	no reaction

Table 17.2

(i) What colour is **iron sulfate** solution?

[1]

(ii) Write down the order of reactivity of the four metals copper, iron, magnesium and zinc.
Use **Table 17.2** to help you.

..... **most reactive**

.....

.....

..... **least reactive** **[2]**

(iii) Magnesium reacts with copper sulfate, $CuSO_4$.

Magnesium sulfate, $MgSO_4$, and copper are made.

Write the **balanced symbol** equation for this reaction.

[1]

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88 Sodium is in Group 1 of the Periodic Table.

Sodium reacts with water to make sodium hydroxide, NaOH, and hydrogen.

Write the **balanced symbol** equation for the reaction between sodium and water.

[2]

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89(a) A student investigates the reactivity of four metals, **A**, **B**, **C** and **D**.

He adds a small piece of each metal to cold water.

He then adds a small piece of each metal to dilute hydrochloric acid.

Look at his results.

"

Metal	Observations in water	Observations in dilute hydrochloric acid
A	slow bubbling	very fast bubbling
B	no reaction	no reaction
C	fast bubbling	very fast bubbling
D	no change	slow bubbling

The piece of metal **C** used by the student produces 30 cm^3 of hydrogen gas when it reacts with the dilute hydrochloric acid at room temperature and pressure.

(i) Calculate the number of **moles** of hydrogen gas produced.

One mole of any gas occupies 24 dm^3 at room temperature and pressure.

Moles of hydrogen gas = ... **[2]**

(ii) Use your answer from **(i)** to calculate the **mass** of hydrogen gas produced.

Mass of hydrogen gas = ... g **[1]**

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(b) Chromium metal, Cr, reacts with nickel sulfate solution, $NiSO_4$. Solid nickel is made.

Two possible equations for this reaction are:

Equation 1 $Cr + NiSO_4 \rightarrow CrSO_4 + Ni$

Equation 2 $2Cr + 3NiSO_4 \rightarrow Cr_2(SO_4)_3 + 3Ni$

10.40 g of chromium metal reacts with excess nickel sulfate solution to make 17.61 g of nickel.

Deduce which equation, **1** or **2**, represents the reaction which takes place.

A_r: Cr = 52.0, Ni = 58.7

---

[3]

END OF QUESTION PAPER