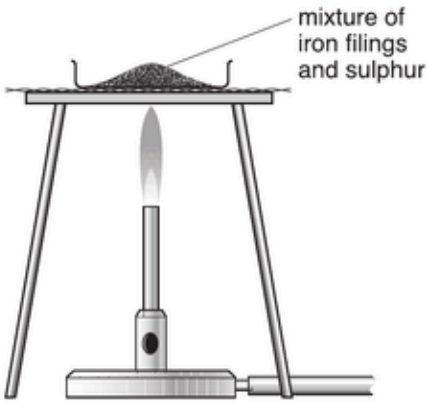
Chemical Reactions

From burning and rusting to the symbol equations that describe them, understanding chemical reactions is at the heart of KS3 chemistry and GCSE Science.

14. A teacher mixed iron filings with sulphur on a metal tray.
She heated the mixture in a fume cupboard.
Sulphur is yellow. Iron filings are grey.



The mixture glowed very brightly. The teacher turned off the bunsen burner.
The glow spread through the mixture.
When the mixture cooled, a black solid called iron sulphide was left.

(a) From this information, give **one** way you can tell that a chemical reaction took place.

_____

_____

14a
1 mark

(b) What type of substance is each of the chemicals involved in this reaction?
Choose from:

metallic element	mixture	non-metallic element	compound

iron _____

14b
1 mark

sulphur _____

14b
1 mark

iron sulphide _____

KS3 Science SATs, Tier 3-6, Paper 2 (2007) - Q14(a)(b)

(b) Three pairs of chemicals are listed below.
A reaction only takes place with two of the pairs.

Draw a line from each reaction to the correct result.
Draw only **three** lines.

pair of chemicals	result
calcium carbonate + hydrochloric acid	no reaction
magnesium + hydrochloric acid	a chloride, carbon dioxide and water are formed
copper + hydrochloric acid	a chloride and hydrogen are formed

12b
1 mark

12b
1 mark

KS3 Science SATs, Tier 5-7, Paper 1 (2006) - Q12(b)

(ii) Snow that falls on the ground melts slowly.
Snow that falls on Stefan's nose melts **very quickly**.
Give a reason for this.

_____

1aii
1 mark

(iii) In his hotel, Stefan sees some changes.
Are the changes below reversible?
Write **yes** or **no**.

ice melting _____

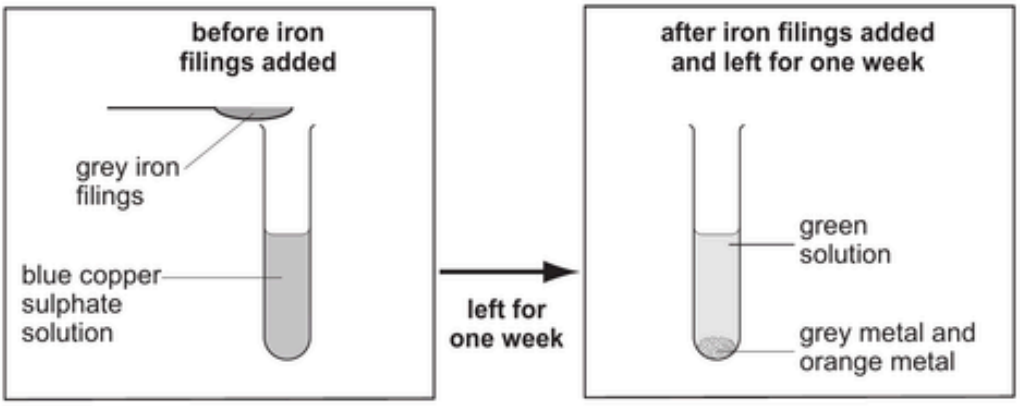
wood burning _____

toasting bread _____

1aiii
1 mark

KS3 Science SATs, Tier 3-6, Paper 1 (2009) - Q1(a)(iii)

13. Joanne added iron filings to copper sulphate solution.
She observed the reaction after one week.



(a) What evidence in the diagrams shows that a chemical reaction has taken place?

13a
1 mark

_____

(b) The reaction between iron and copper sulphate is a **displacement** reaction.

(i) Give the name of the orange metal visible after one week.

13bi
1 mark

_____

(ii) What is the name of the compound formed in this reaction?

13bii
1 mark

_____

(iii) Joanne poured the green solution into another test tube. She added some copper pieces to the solution.

Will a displacement reaction occur?

yes ☐ no ☐

Explain your answer.

13biii
1 mark

_____

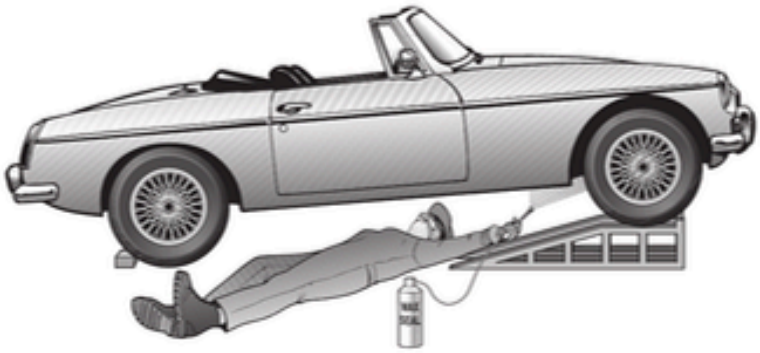
_____

Modern Tuition

12. Jill bought a can of Wax Seal to spray the parts underneath her car.



Wax Seal helps to prevent these parts rusting.
It is a mixture of wax and a liquid called white spirit.



(a) (i) The body of Jill's car is made from steel. Steel contains iron.

Give **two** substances that are needed for iron to rust.

12ai
1 mark

1. _____

12ai
1 mark

2. _____

(ii) How does Wax Seal help to protect the car from rusting?

12aii
1 mark

_____

_____

(iii) Wax Seal can also be used on the upper parts of a car.
What else protects parts such as the doors from rusting?

12aiii
1 mark

_____

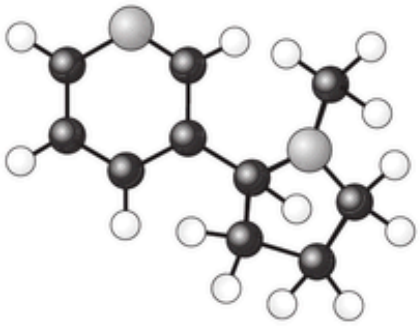
(b) The metal parts of a car may corrode.
What type of air pollution could cause corrosion?

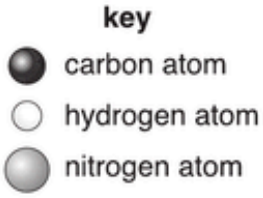
12b

_____

Modern Tuition

(c) The diagram below shows a nicotine molecule.
It contains atoms of three elements.





(i) Nicotine is a compound. How does the diagram show this?

_____

_____

10ci
1 mark

(ii) When nicotine in a cigarette is burned in air, nitric oxide is formed from the nitrogen in the nicotine.

Look at the elements in nicotine.

Give the names of **two** other compounds formed when nicotine burns in air.

1. _____

2. _____

10cii
1 mark

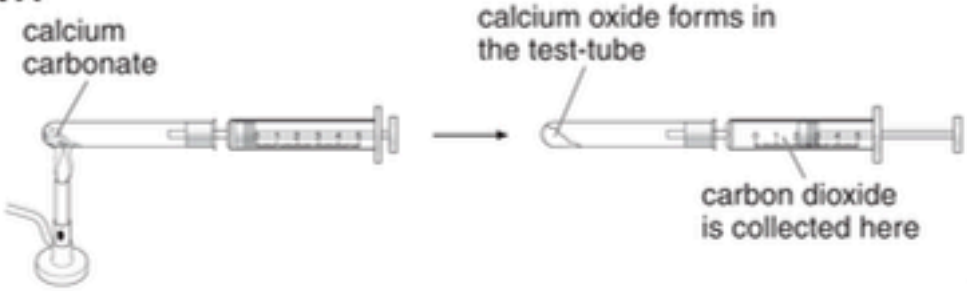
10cii
1 mark

maximum 7 marks

Modern Tuition

12. A science teacher showed her class three experiments, A, B and C.
The experiments and the word equations for the reactions that took place are shown below.
All the experiments were done in a fume cupboard.

experiment A



word equation calcium carbonate → calcium oxide + carbon dioxide

experiment B

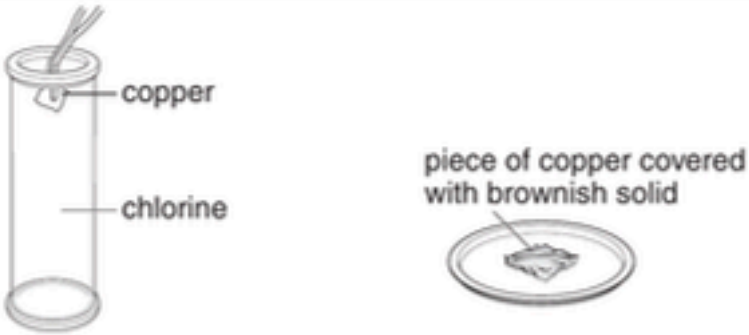
iron filings and sulphur are heated together



word equation iron + sulphur → iron sulphide

experiment C

hot copper is added to chlorine



word equation copper + chlorine → _____

KS3 Science SATs, Tier 3-6, Paper 2 (2006) - Q12 (Experiments A-C)

(a) From the substances in experiments A, B and C, opposite, give the name of:

(i) **one** metallic element;

_____ 12ai 1 mark

(ii) **one** non-metallic element;

_____ 12aii 1 mark

(iii) **two** compounds.

_____ and _____ 12aiii 1 mark

(b) In experiment B, the iron filings weighed 2.0 g at the beginning of the experiment and the iron sulphide produced weighed 2.8 g.

Explain this increase in mass.

_____

_____ 12b 1 mark

(c) Complete the word equation for the chemical reaction in experiment C.

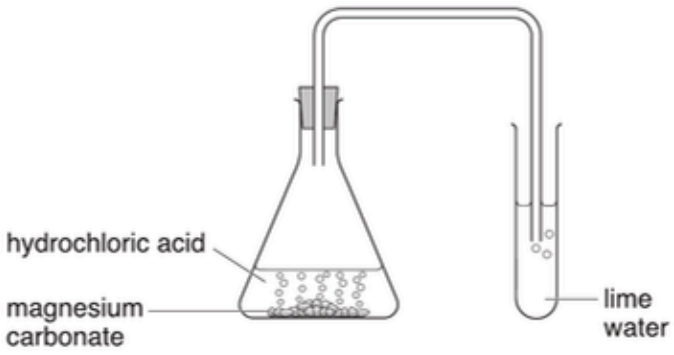
copper + chlorine → _____ 12c 1 mark

Modern Tuition

12. The word equation for the reaction between magnesium carbonate and hydrochloric acid is shown below.

magnesium carbonate + hydrochloric acid → magnesium chloride + carbon dioxide + water

(a) Sadiq added hydrochloric acid to magnesium carbonate in a flask.



(i) Suggest the pH of hydrochloric acid.

12ai
1 mark

_____

(ii) The carbon dioxide produced was bubbled through lime water.

How would the lime water change?

12aii
1 mark

_____

(b) Sadiq repeated the experiment by adding **sulphuric acid** to magnesium carbonate.

Complete the word equation for the reaction that took place.

12b
1 mark

magnesium carbonate + sulphuric acid → _____ + carbon dioxide + water

Modern Tuition

(b) Ramy dissolved some bicarbonate of soda in distilled water.
This produced an alkaline solution.

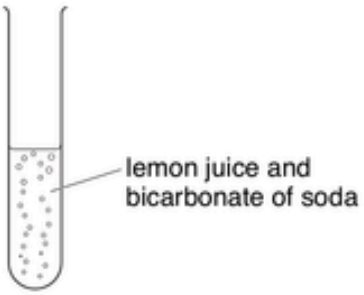
(i) Ramy added the indicator to the alkaline solution.

Suggest what colour the indicator became.
Use **table 1**, on the opposite page, to help you.

_____

4bi
1 mark

(ii) Ramy added lemon juice to the solution of bicarbonate of soda.



How could he tell that a gas was produced?

_____

4bii
1 mark

(c) Ramy mixed an acid with an alkali and tested the mixture with the indicator solution.
The indicator solution turned green.

What is the name of the reaction between an acid and an alkali?
Tick the correct box.

condensation ☐

crystallisation ☐

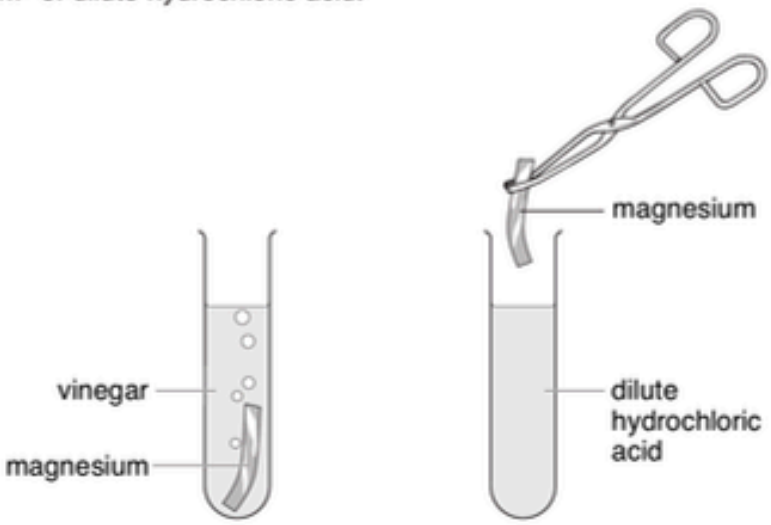
evaporation ☐

neutralisation ☐

4c
1 mark

Modern Tuition

(c) Molly put a piece of magnesium into a test-tube containing 20 cm^3 of vinegar. She put another piece of magnesium into a test-tube containing 20 cm^3 of dilute hydrochloric acid.



(i) Molly thought that magnesium would react more vigorously with hydrochloric acid than with vinegar.
What information in the table made Molly think this?

_____

_____

11ci
1 mark

(ii) How would Molly be able to tell if a more vigorous reaction took place with hydrochloric acid than with vinegar?

_____

_____

11cii
1 mark

(d) (i) Complete the word equation for the reaction between magnesium and hydrochloric acid.

11di
1 mark

magnesium + hydrochloric acid → _____ + _____

11di
1 mark

(ii) After some time this reaction stopped. Why did the reaction stop?

_____

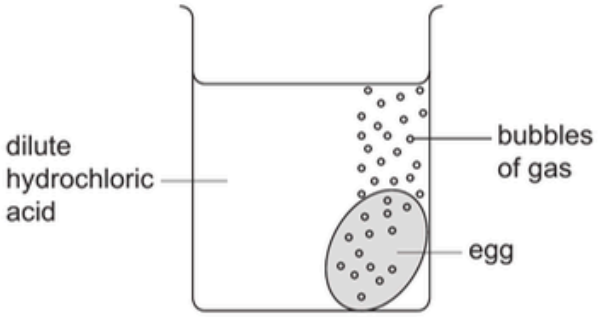
_____

11dii
1 mark

maximum 9 marks

Modern Tuition

(b) Emilio cooked an egg until it was hard-boiled.
He put the egg in a beaker of dilute hydrochloric acid as shown.



(i) The egg shell reacted completely with the acid.
After two days the pH of the liquid in the beaker was 2.5.

How did the **acidity** of the liquid in the beaker change?
Use the table above to help you.

_____

9bi
1 mark

(ii) Emilio put another hard-boiled egg in some ethanoic acid.
It took longer for the shell to react completely.

Use the table opposite to suggest a reason for this.

_____

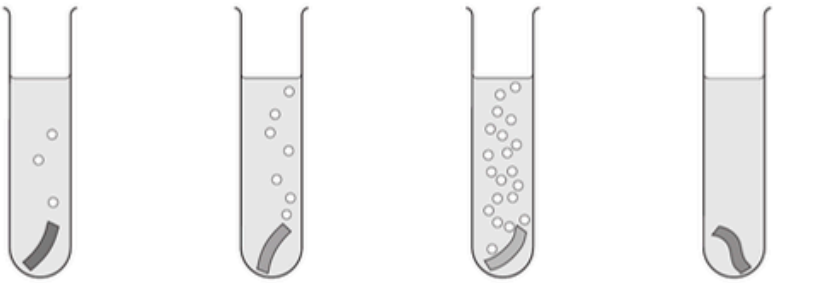
_____

9bii
1 mark

Modern Tuition

4. (a) Ruth put a piece of a different metal in each of four test tubes.

She poured 10 cm^3 of hydrochloric acid onto each metal.



iron + hydrochloric acid | **zinc** + hydrochloric acid | **magnesium** + hydrochloric acid | **copper** + hydrochloric acid

Look at the diagrams above.

(i) How do these show if a metal reacts with the acid?

_____ 4ai

1 mark

(ii) **On the lines below**, put the **four** metals in the order of how strongly they react with the acid.

most reactive _____

_____

_____

least reactive _____ 4aii

1 mark

Modern Tuition

(d) (i) The gemstone in the drawing is set into a gold ring.
Gold is an element that is found in rocks.
Gold is never found combined with other elements.

Part of the reactivity series of metals is shown below.

more reactive	aluminium
	zinc
	lead
less reactive	copper

Where should gold be placed in this reactivity series?

_____

12di

1 mark

(ii) The more reactive metals react with acids.

Complete the word equation for the reaction of zinc with hydrochloric acid.

zinc + hydrochloric acid ⟶ _____ + _____

12dii

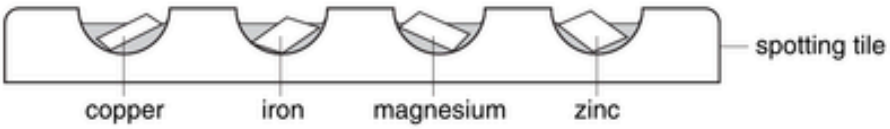
1 mark

12dii

1 mark

Modern Tuition

12. (a) Sasha placed small samples of four different metals on a spotting tile. She added drops of calcium nitrate solution to each metal.



Sasha repeated the experiment with:

- fresh samples of the four metals and copper nitrate solution
- fresh samples of the four metals and iron nitrate solution.

Will a reaction take place when each of the metals is added to each of the solutions?
Use the reactivity series below to help you.

most reactive	calcium
	magnesium
	aluminium
	zinc
	iron
	lead
least reactive	copper

In the table below:

- place a tick, ✓, to show that a reaction took place
- place a cross, X, to show that **no** reaction took place.

Two have been done for you.

salt solution	**metal**			
	copper	**iron**	**magnesium**	**zinc**
calcium nitrate				
copper nitrate	X			
iron nitrate		X		

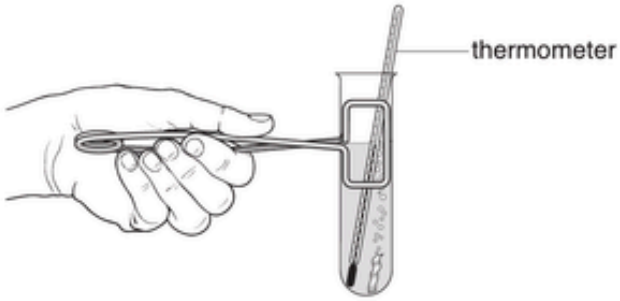
12a 1 mark

12a 1 mark

12a 1 mark

Modern Tuition

12. Harry mixed zinc with copper sulphate solution in a test-tube.
A displacement reaction took place and the temperature increased.



(a) The word equation for the reaction is shown below.

zinc + copper sulphate → zinc sulphate + copper

Why is this reaction called a displacement reaction?

12a

1 mark

(b) Harry repeated the experiment with two other metals.
He wanted to calculate the temperature rise each time.
His results are shown below.

metal added to copper sulphate	temperature at the start (°C)	highest temperature reached (°C)	rise in temperature (°C)
zinc	20.0	36.5	16.5
iron	25.5	38.5	13.0
magnesium	19.5	87.5	68.0

Harry used different starting temperatures.
Explain why this did **not** affect his results.

12b

1 mark

Modern Tuition

(c) Part of the reactivity series of metals is shown below.

most reactive	sodium
	calcium
	magnesium
	aluminium
	zinc
	iron
	lead
least reactive	copper

Use the reactivity series above to answer all the questions below.

(i) Why was the highest rise in temperature obtained with magnesium and copper sulphate?

_____

_____

12ci
1 mark

(ii) Why was the rise in temperature obtained with zinc and copper sulphate **not** much higher than the rise in temperature obtained with iron and copper sulphate?

_____

_____

12cii
1 mark

(iii) In which of the following mixtures would there be a rise in temperature? Write **yes** or **no** in each blank box.

mixture	Would there be a rise in temperature?
aluminium + sodium chloride	
calcium + zinc sulphate	
lead + zinc chloride	
magnesium + iron chloride	

12ciii
1 mark

12ciii
1 mark

Modern Tuition

12. (a) The chemical formula for hydrochloric acid is HCl.
The chemical formula for sodium hydroxide is NaOH.

When they react together, two products are formed.
The chemical formula for one product is NaCl.

12ai 1 mark

(i) Complete the word equation below with the **names** of both products.

12ai 1 mark

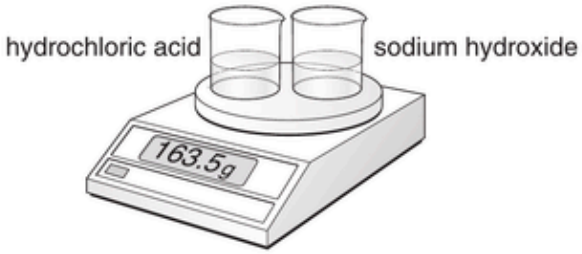
(ii) **On the dotted line**, give the chemical formula of the other product.

sodium hydroxide + hydrochloric acid → _____ + _____

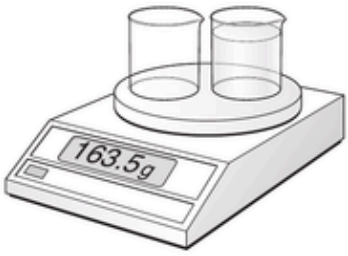
NaOH HCl NaCl ______

12aii 1 mark

(b) In experiment 1, Molly put two beakers on a balance.
One contained 20 cm^3 of hydrochloric acid.
The other contained 20 cm^3 of sodium hydroxide solution.
The total mass was 163.5 g.



She poured the acid onto the sodium hydroxide. They reacted.



Why did the reading on the balance **not** change?

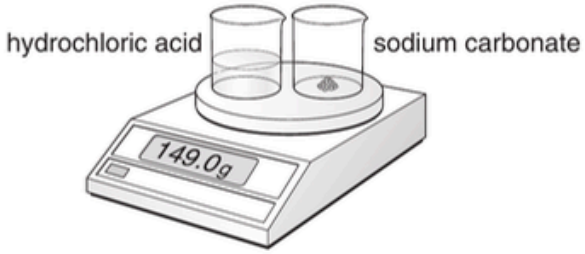
_____

_____

12b 1 mark

Modern Tuition

(c) In experiment 2, Molly put two beakers on a balance.
One contained 20 cm^3 of hydrochloric acid.
The other contained 5 g of sodium carbonate.



She poured the acid onto the sodium carbonate. They reacted.
Two of the products are the same as in experiment 1.

(i) Complete the word equation with the names of the **three** products.

sodium carbonate + hydrochloric acid → _____ + _____ + _____

12ci
1 mark

(ii) The total mass at the start was 149.0 g.
When the reaction stopped, the reading on the balance was 147.0 g.

Why was there a loss of mass in this reaction?

_____

_____

12cii
1 mark

Modern Tuition

13. Burning fossil fuels causes air pollution.

(a) (i) Give the names of **two** fossil fuels.

13ai

1 mark

_____ and _____

(ii) Some fossil fuels contain sulphur.

Complete the word equation for the reaction between sulphur and oxygen in the air.

13aii

1 mark

sulphur + oxygen → _____

KS3 Science SATs, Tier 3-6, Paper 1 (2005) - Q13(a)

(c) (i) A gas in the air reacts with iron to make it rusty.
Give the name of this gas.

5ci

1 mark

_____

(ii) What could you do to an iron gate to protect it from this gas in the air?

5cii

1 mark

_____

KS3 Science SATs, Tier 3-6, Paper 1 (2009) - Q5(c)

(ii) The reactants in a bath bomb were 176 g at the start.
129 g of sodium citrate and 14 g of water are produced in the reaction.
Calculate the mass of gas produced in the reaction.

12cii

_____

_____ g

KS3 Science SATs, Tier 5-7, Paper 2 (2009) - Q12(c)(ii)

11. (a) The fire extinguisher below contains a compound called sodium hydrogencarbonate.



contains sodium hydrogencarbonate powder

The formula for sodium hydrogencarbonate is $NaHCO_3$.

When sodium hydrogencarbonate is heated it breaks down to produce carbon dioxide, water and a compound with the formula Na_2CO_3.

This is shown in the equation below.

(i) Complete the word equation below.

11ai
1 mark

sodium hydrogencarbonate → carbon dioxide + water + _____ (Na_2CO_3)

(ii) Complete the table below to show the mass of water produced when 168 g of sodium hydrogencarbonate breaks down completely.

11aii
1 mark

compound	reactant or product	mass (g)
sodium hydrogencarbonate	reactant	168
carbon dioxide	product	44
water	product	
Na_2CO_3	product	106

(iii) How much carbon dioxide is produced when 336 g of sodium hydrogencarbonate breaks down completely?

11aiii
1 mark

_____ g

Modern Tuition