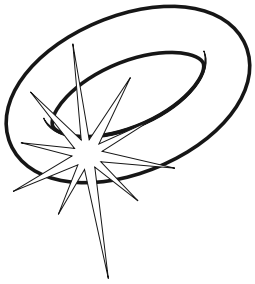
9Fa(1) Shine on

Name _____ Class _____ Date _____

1 Use the names of the four metals in the box to answer these questions.

copper	gold	iron	silver



a Which metal reacts least?

_____

b Which metal reacts with oxygen to form copper oxide?

_____

c Which metal will turn into rust if you leave it in the air?

_____

d Which metal keeps its shiny appearance for the longest time?

_____

e Which metal is in bronze?

_____

f Which two metals are often used for jewellery?

_____

g Which metal does not react with oxygen in the air?

_____

h Which metal reacts the quickest?

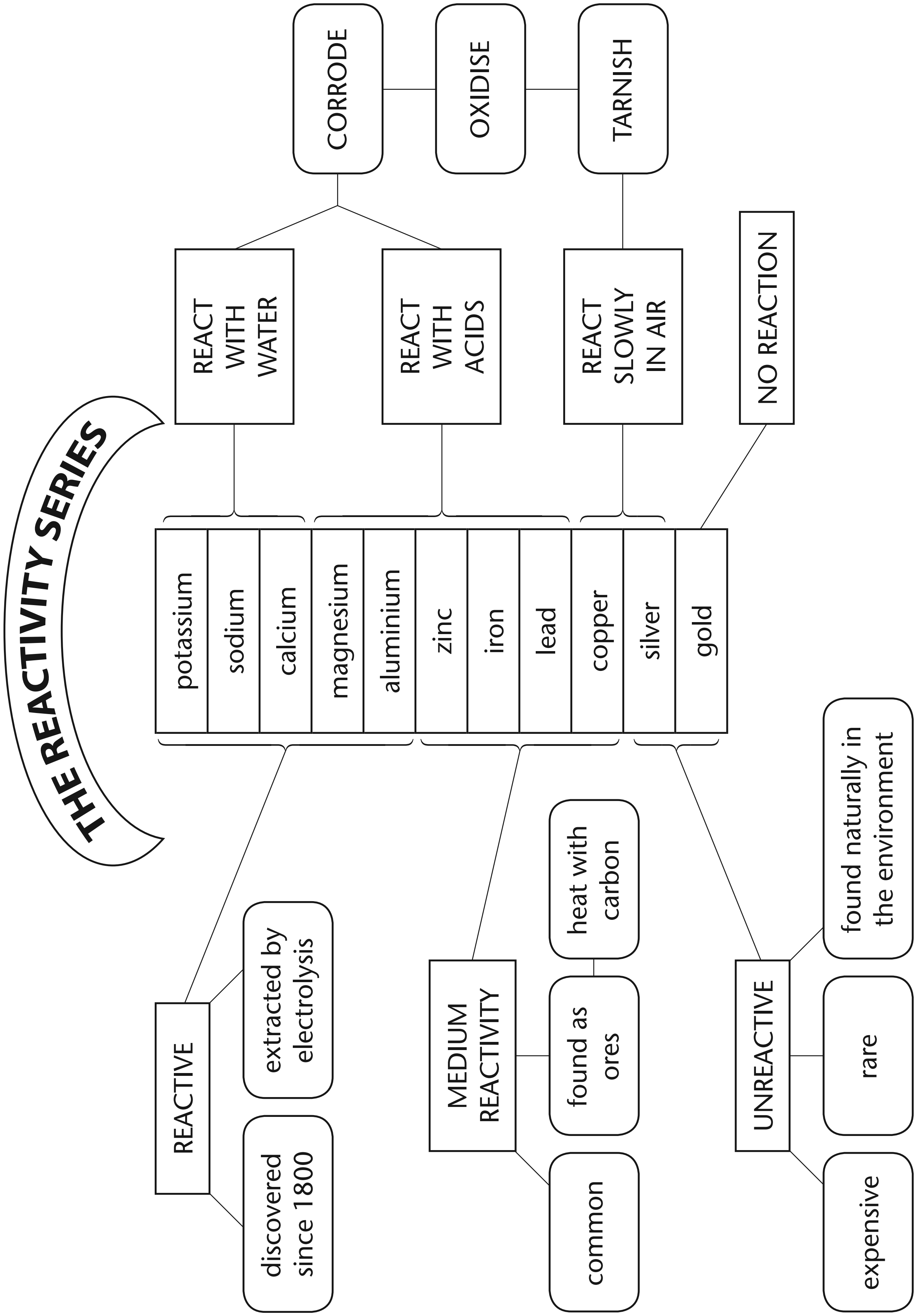
_____

2 Draw lines to match the words with their meanings.

Word	Meaning
unreactive	doesn't react easily
tarnish	when a substance reacts and wears away
corrodes	when a shiny metal turns dull

I CAN... • describe how metals tarnish and corrode • compare how quickly metals react.

The big picture



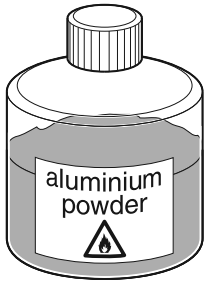
Reactions of metals with oxygen

I CAN...
- describe trends and patterns in chemical reactions
- draw conclusions from secondary data sources.

aluminium

Al

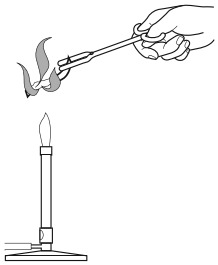
No reaction when in block form unless heated very strongly indeed. Burns readily in powder form.



magnesium

Mg

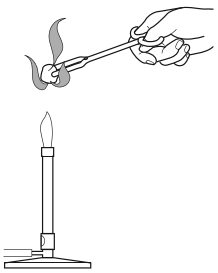
Magnesium ribbon burns brightly when heated in a flame. Magnesium powder burns very rapidly with a white flash.



calcium

Ca

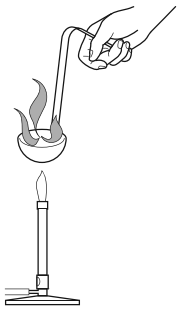
Calcium pieces burn strongly if heated in a flame for several minutes.



potassium

K

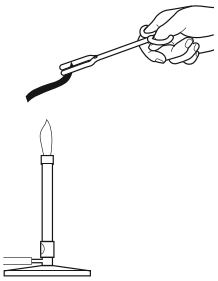
Melts very easily and then catches fire. Burns very rapidly with a lilac coloured flame.



copper

Cu

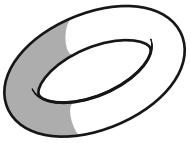
Metal glows red when heated in a strong flame but does not burn. There is a black coating on the metal at the end.



silver

Ag

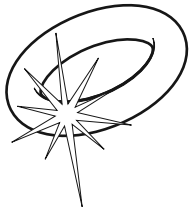
No reaction in a flame. Silver will melt if heated to a high temperature but will not burn. Will react very slowly with air to form silver oxide.



gold

Au

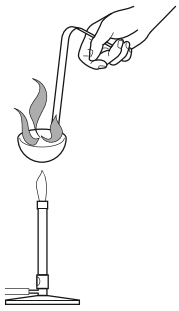
No reaction. Gold will melt if heated to a high temperature but will not burn. Does not oxidise in the air.



sodium

Na

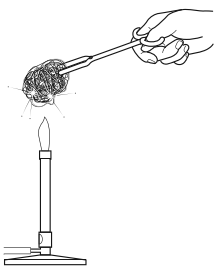
Melts easily and then sets on fire. Burns rapidly with a yellow/orange flame.



iron

Fe

No reaction in block form. Fine wire or filings will sparkle when put in a flame. Iron will rust slowly in moist air.



zinc

Zn

No reaction when in block form. Burns in powder form.

Metal oxides: Looking for patterns 1

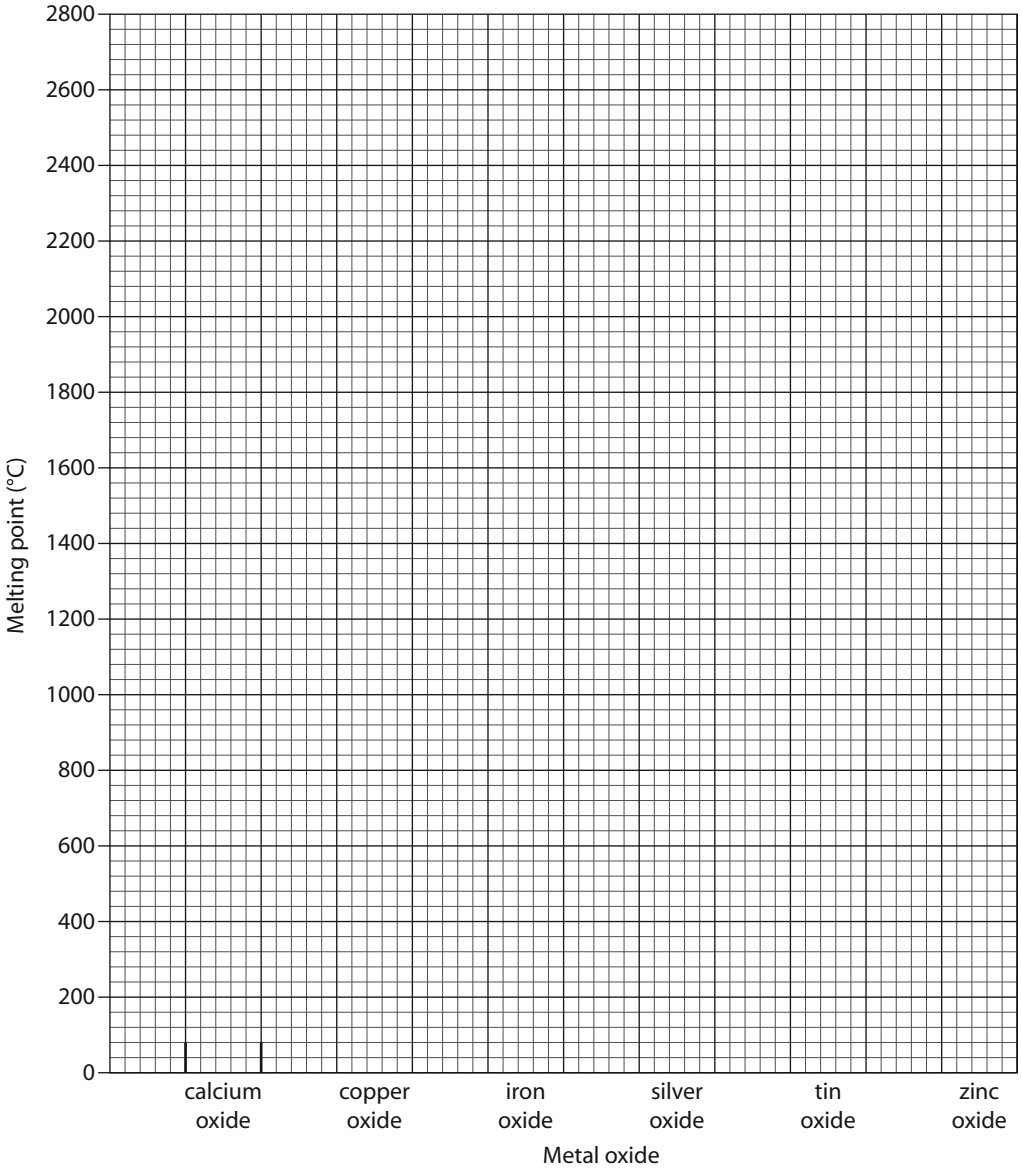
H S W

Name _____ Class _____ Date _____

This table shows the melting points of six metal oxides in degrees Celsius.

Metal oxide	Melting point (°C)	When was the metal discovered?
calcium oxide	2614	1808
copper oxide	1326	over 5000 years ago
iron oxide	1369	about 3000 years ago
silver oxide	230	about 7000 years ago
tin oxide	886	over 5000 years ago
zinc oxide	1975	before 1500

1 Put the melting point data into the bar chart below.



Metal oxides: Looking for patterns 1 (continued)

2 Which metal oxide has the highest melting point? _____

3 Which gas in the air reacts with metals to make a metal oxide? _____

4 a Which *three* metal oxides have the lowest melting points?

- _____
- _____
- _____

b What can you say about when these three metals were discovered?

_____

5 a Which two metals were discovered most recently?

- _____
- _____

b What can you say about the melting points of the oxides of these two metals?

_____

6 Does the data for iron oxide fit this pattern? _____

Explain your answer.

_____

_____

7 Carly said, 'The higher the melting point, the more recently the metal was discovered.'

Tick the box that you think that describes the evidence best.

- ☐ Carly's statement is definitely true.
- ☐ Carly's statement is definitely false.
- ☐ Carly might be right but we don't have enough evidence.
- ☐ Carly is probably wrong but we need some more evidence.

I CAN...

- present data as a bar chart
- use data from tables and bar charts to draw conclusions
- evaluate conclusions drawn from secondary evidence.

9Fb(1) Stinging in the rain

Name _____ Class _____ Date _____

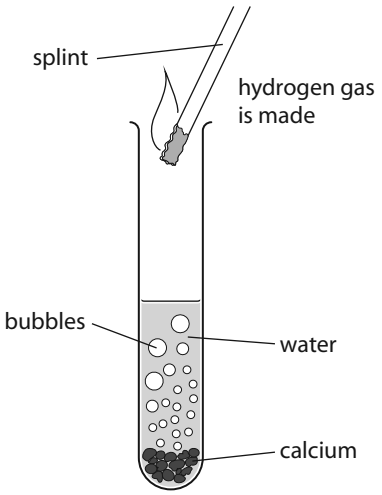
1 Some metals react with water.

Look at the diagram and complete the sentences.

a The metal is called _____.

b It reacts with _____.

c A gas is made. It is called _____.



2 Look at the word equation.

calcium + water → calcium hydroxide + hydrogen

Draw lines to match up the sentence halves below. One has been done for you.

Calcium is an …	
Water is a …	element.
Calcium hydroxide is a …	compound.
Hydrogen is an …	

3 Some metals react very fast with water. Draw lines to match the correct boxes and safety symbols.

Metal	What happens when it is put in water	Symbol
potassium	explodes	
caesium	catches fire	

Stinging in the rain (continued)

4 Some metals react with water and others do not. Unscramble the letters to get the correct metal.

a *Claimuc* is a reactive metal which forms an alkali when it reacts with water.

_____

b *Precop* is a less reactive metal that is used in bronze statues and water pipes.

_____

c *Megaminus* burns with a bright white flame and reacts slowly with water. You need electricity to get it from its compounds. _____

d *Idosum* floats on water and reacts quickly with water to make an alkali.

_____

e *Mustisoap* sets on fire when you put it in water. _____

5 Put the five metals from question **4** in order of their reactions with water, with the one that reacts the most first.

1 _____

2 _____

3 _____

4 _____

5 _____

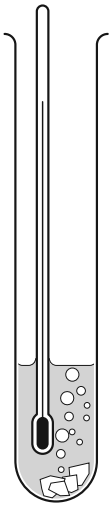
I CAN...
- describe what happens when metals react with water
- use evidence to place metals in order of reactivity.

Hotting up 1

Name _____ Class _____ Date _____

What affects the amount of heat given off in a reaction?

When calcium reacts with water the tube gets hot. In these experiments you will investigate the variables that affect the heat produced.



Test 1 Changing the amount of calcium

Apparatus

- boiling tube
- tube rack
- measuring cylinder
- thermometer
- calcium granules (from your teacher)
- eye protection

⚠ Do not touch the pieces of calcium. Your teacher will handle the calcium using forceps. Calcium is highly flammable.

Method

A Measure out 10 cm^3 of water in the measuring cylinder.

B Pour it into the boiling tube.

C Measure the temperature of the water and write it in the table.

D Ask your teacher for a piece of calcium. Your teacher will drop it into the water.

E As soon as the reaction is finished, measure the temperature of the liquid.

F Wash out your tube.

G Repeat the experiment with two pieces of calcium, and then three pieces.

Recording your results

Pieces of calcium	Water temperature at the start (°C)	Water temperature at the end (°C)	Temperature rise (°C)
1			
2			
3			

Hotting up 1 (continued)

Considering your results/conclusions

1 The more pieces of calcium we used _____

_____.

2 The variables that were the same each time were _____

_____.

3 It was a fair test because _____

_____.

Test 2 Changing the volume of water

Method

A Measure out 5 cm^3 of water in the measuring cylinder.

B Pour it into the boiling tube.

C Measure the temperature of the water and write it in the table.

⚠ Do not touch the pieces of calcium. Your teacher will handle the calcium using forceps. Calcium is highly flammable.

D Ask your teacher for a piece of calcium. Your teacher will drop it into the water.

E As soon as the reaction is finished, measure the temperature of the liquid.

F Wash out your tube.

G If you have done Test **1**, write the result for 10 cm^3 of water into your table. If you have not done this experiment already, do it now.

H Repeat the experiment with 15 cm^3 of water.

Recording your results

Volume of water (cm^3)	Water temperature at the start (°C)	Water temperature at the end (°C)	Temperature rise (°C)
5			
10			
15			

Considering your results/conclusions

1 The more water we used _____

_____.

2 The variables that were the same each time were _____

_____.

3 It was a fair test because _____

_____.

I CAN...
- carry out a safe experiment
- explain why my test was fair
- make careful observations and draw a conclusion.

9Fb(5) Reactions with water

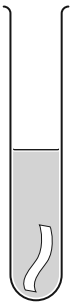
I CAN...
- describe trends and patterns in chemical reactions
- use secondary data sources to draw a conclusion.

9 F b

aluminium

Al

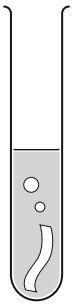
No reaction with cold or hot water. Will react with steam to produce aluminium oxide and hydrogen.



magnesium

Mg

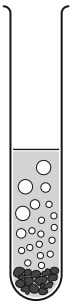
Very slow reaction with cold water. Slow reaction with hot water. Reacts readily with steam to form magnesium oxide and hydrogen.



calcium

Ca

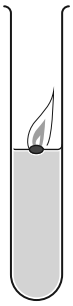
Reacts rapidly with cold water. Hydrogen gas is given off. The water turns milky white.



potassium

K

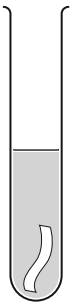
Violent reaction. Potassium floats on the surface of the water, melts and then catches fire. Burns with a lilac coloured flame. Hydrogen gas given off.



copper

Cu

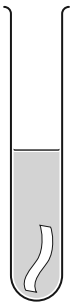
No reaction with cold or hot water. No reaction with steam.



silver

Ag

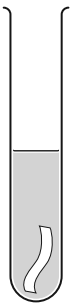
No reaction with cold or hot water. No reaction with steam.



gold

Au

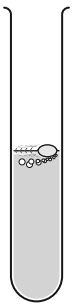
No reaction with cold or hot water. No reaction with steam.



sodium

Na

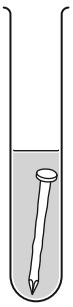
Rapid reaction. Sodium floats on water and moves around rapidly. Heat from the reaction melts the sodium. Hydrogen gas given off.



iron

Fe

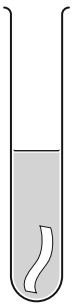
Iron will rust slowly in cold water.



zinc

Zn

No reaction with cold or hot water. Will react slowly with steam to produce zinc oxide and hydrogen.



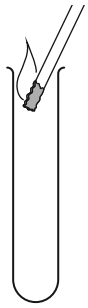
9Fc(1) Acid attack

Name _____ Class _____ Date _____

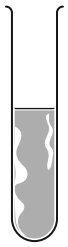
1 When metals react with acids, which gas is given off? Circle the right answer.

hydrogen oxygen helium carbon dioxide

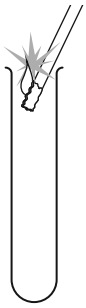
2 How do we test for this gas? Tick the correct box.



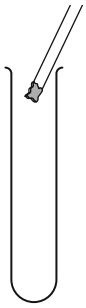
A relights a glowing splint ☐



B turns lime water milky ☐



C burns with a squeaky pop ☐



D puts out a burning splint ☐

3 When iron is corroded by sulphuric acid, what is the name of the substance formed? Tick the correct box.

☐ iron chloride ☐ iron sulphate ☐ iron oxide ☐ hydroxide

4 What *type* of substance is this? Tick the correct box.

☐ acid ☐ alkali ☐ salt ☐ metal

5 Draw lines to link the correct metal to each description.

Description	Metal
corrodes steadily in acids if you don't paint it and goes rusty	aluminium
can be left unpainted because it protects itself	zinc
can be used to protect iron and steel by galvanising	iron
reacts quickly with acids but reacts very slowly with water	tin
is used to coat steel cans	magnesium

I CAN...
- describe the reactions of metals with acids
- describe ways in which metals can be protected against corrosion.

Now you see it ... 1

Name _____ Class _____ Date _____

What happens when magnesium reacts with acid?

Apparatus

- boiling tube
- test tube rack
- measuring cylinder (10 or 25 cm^3)
- stopclock
- thermometer
- piece of magnesium (1 cm long)
- dilute hydrochloric acid
- eye protection

Method

A Measure out 10 cm^3 of hydrochloric acid and pour it into the boiling tube.

B Measure the temperature of the acid and write it down.

C Take the piece of magnesium. Drop it into the boiling tube and start timing.

D Watch what happens to the magnesium and the acid.

E When the reaction is finished, stop the clock. Note the time.

F Measure the temperature of the liquid in the tube.

Recording results

Temperature of acid at the start	
Temperature of the liquid at the end	
Time taken for the reaction to finish	

Considering your results/conclusions

1 What are the names of the two reactants in this experiment?

_____ _____

2 Which one is:

a an element _____

b a compound? _____

3 How could you tell that a reaction was taking place? _____

4 What was the temperature change? _____

5 How did you know when the reaction had finished? _____

Now you see it ... 1 (continued)

6 Why do you think the reaction finished? Tick the box you think is right.

- ☐ The acid had all been used up.
- ☐ The magnesium had all been used up.
- ☐ Both the acid and the magnesium had been used up.

Explain your answer using evidence from the experiment.

_____

_____

7 If your idea is correct, what would happen when you added universal indicator?

- ☐ The indicator will turn orange or red.
- ☐ The indicator will stay green.
- ☐ The indicator will turn blue or purple.

Explain why.

_____

8 What would happen if you added another piece of magnesium?

- ☐ The magnesium would start fizzing.
- ☐ There would be no reaction.

Explain why.

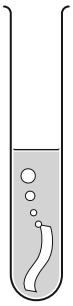
_____

I CAN...
- make careful observations
- think up theories
- describe how my ideas can be used to make predictions.

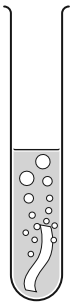
Reactions of metals with acids

I CAN...
- describe trends and patterns in chemical reactions
- use secondary data sources to draw a conclusion.

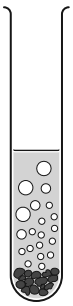
aluminium
Al
Steady reaction with acids giving off hydrogen gas, once the protective layer has been 'stripped off' by the acid.



magnesium
Mg
Rapid reaction with acids giving off hydrogen gas. Heat from the reaction means that the tube will get warm.

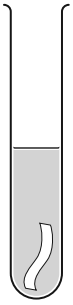


calcium
Ca
Very rapid reaction with acids. Hydrogen gas is given off. Heat from the reaction means that the liquid in the tube gets hot.

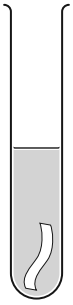


potassium
K
Violently explosive reaction with acids. Potassium reacts with the acid forming hydrogen gas. This reaction should not be attempted in the laboratory.

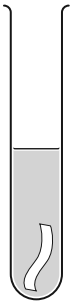
copper
Cu
No reaction with most dilute acids. Copper will react with concentrated acids.



silver
Ag
No reaction with most dilute acids. Silver will react with some concentrated acids.

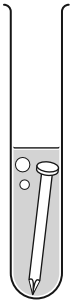


gold
Au
No reaction with any dilute acids. Only the strongest mixtures of concentrated acids will attack gold.

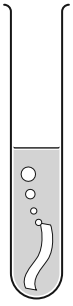


sodium
Na
Very violent reaction with acids. Possibly explosive. Sodium reacts with the acid forming hydrogen gas. This reaction should not be attempted in the laboratory.

iron
Fe
Slow reaction with dilute acids to produce hydrogen



zinc
Zn
Steady reaction with dilute acids to produce hydrogen.



9Fd(1) The reactivity league

Name _____ Class _____ Date _____

1 Use the reactivity series on page 75 of the Pupil's Book to answer the questions.

a Write down the name of the most reactive metal.

_____

b What is the least reactive metal? _____

c Is zinc more or less reactive than iron? _____

d Which two metals can explode when you mix them with acids?

_____ _____

e Name a metal that will react with oxygen but does not react with water. _____

f Which metal burns in air but only reacts very slowly with water?

_____

2 In the table, tick the column to show whether the substances will react or not. The first one has been done for you as an example.

Chemicals	Reaction	No Reaction
gold + sulphuric acid		✓
copper + oxygen		
zinc + water		
sodium + water		
magnesium + hydrochloric acid		

I CAN...
- describe the reactivity of different metals
- interpret data from a table.

9Fd(2) Competition between metals

Say if each of these statements are true or false.

A Aluminium will react with iron oxide. _____

B Aluminium oxide is an element. _____

C In a displacement reaction, one metal swaps for another.

_____

D The bonds between iron and oxygen are stronger than the bonds between aluminium and oxygen. _____

E Copper will not displace the iron from iron oxide.

_____

F Magnesium will not displace the iron from iron oxide.

_____

G The melting point of aluminium oxide is likely to be below 1000 °C.

_____

H Iron will react with copper sulphate because copper is lower in the reactivity series than iron. _____

I Reactive metals like aluminium are extracted by heating their oxides with carbon. _____

J Iron will not react with calcium oxide. _____

Quick Quiz answer sheet

Name _____ Class _____ Date _____

The Quick Quiz is to see how much you already know about a subject. It also gives you some idea of the things you will soon be learning about. Record your answers in the answers column. Shade in or tick the ones you get right.

Topic		Answers		I can already…
9Fa	1			Recall the name of the gas in the air that reacts with metals most easily.
	2			Name some metals that are unreactive in air.
	3			Write word equations for the reactions of metals in the air.
	4			Explain the meanings of the words tarnish, oxidise and corrode.
9Fb	1			Describe the reactions of metals with water.
	2			Write word equations for the reactions of metals with water.
	3			Place metals in order of reactivity based on their chemical properties.
	4			Describe and explain the method used to extract reactive metals from their compounds.
9Fc	1			Describe what happens when iron corrodes.
	2			Explain how some metals are naturally protected against corrosion.
	3			Write word equations for the reactions of metals with acids.
	4			Describe ways in which metals can be protected against corrosion.
9Fd	1			Compare the reactivity of some familiar metals.
	2			Describe the criteria used to sort metals into order of reactivity.
	3			Explain how to use the reactivity series to predict if a reaction will take place.
	4			Write word equations for reactions of metals that do take place with water, air and acids.

Quick Quiz:	/16	At the start: 0–4 = I didn't know much; 5–9 = I knew something 10–12 = I knew a fair bit; 13–16 = I already knew a lot

Sculpture park

Different metals are used for different purposes and the way that they are used depends on their properties. One aspect of this is how they **react** with other substances in the environment around them, such as air, water and acids. Most metals are shiny and this is one simple way in which they can be identified.

Some metals react very easily or quickly. They are **reactive**. Examples of reactive metals are sodium, calcium and magnesium.

Other metals do not react very easily and are described as **unreactive**. Gold is a very unreactive metal. Because they are less easily corroded, unreactive metals are often used for jewellery and decoration. But they tend to be more expensive because they are very rare and only small quantities exist.

Metals such as copper and silver are fairly unreactive, but they do react slowly with the oxygen in the air. They **tarnish** when they lose their shiny appearance.

The most reactive metals are found on the left-hand side of the periodic table. Less reactive metals are found in the centre of the periodic table.

Many low reactivity metals have been known for thousands of years. The least reactive metals are found on their own (uncombined) in the environment. Others, such as copper and iron, can be extracted by heating their compounds in a fire. This process is called **reduction** because the amount of metal you get is always less than the compound that you started with.

The more reactive metals are extracted by **electrolysis.** This means that they have only been discovered in the last two hundred years, since the invention of the electric battery.

Some gases are more reactive than others. In the air, **oxygen** is the most reactive gas. **Nitrogen** is not very reactive. When metals react with the oxygen in the air they form **oxides**. This reaction is called **oxidation**.

$$\text{metal} + \text{oxygen} \longrightarrow \text{metal oxide}$$

Summary Sheets (continued)

The metals that react quickly with air also tend to react with water. When metals react with water they form **hydrogen** gas and a metal **hydroxide**.

metal + water ⟶ metal hydroxide + hydrogen

Natural rainwater is slightly acidic. Rain may also be polluted with acidic gases such as sulphur dioxide and nitrogen dioxide. This polluted rainwater is known as **acid rain**.

The metals that react with water also react very quickly with acids. Some metals that don't react with water do react with acids. When metals react with acids, they produce hydrogen and a **salt**.

metal + acid ⟶ salt + hydrogen

The name of the salt formed depends on the name of the acid:

- **sulphuric** acid makes **sulphates**
- **nitric** acid makes **nitrates**
- **hydrochloric** acid makes **chlorides**.

Reactions of metals with acids leads to **corrosion** – the metal gets worn away when the compounds formed dissolve in the water. Reactions with oxygen may also lead to corrosion, especially with iron where the rust (iron oxide) flakes off the surface of the metal. In other cases (e.g. aluminium), oxidation does not lead to corrosion, because the oxide layer sticks tightly to the metal forming a protective coating.

The reactivity of metals can be linked to their uses. Metals used for construction need to have a low reactivity, otherwise they will corrode away. Metals such as iron have to be protected from corrosion by painting or **plating** with a less reactive metal. Other methods of corrosion protection include **galvanising** (using zinc to form a protective layer) and **sacrificial protection** (using a more reactive metal to protect a less reactive metal by corroding first).

Metals can be arranged in a **reactivity series**. The metals are arranged in terms of their reactions with water, oxygen and acids, with the most reactive metals being placed at the top of the table. Metals higher in the table will react or corrode more quickly than those lower down.

The reactivity series can also be used to predict whether reactions will occur.

9F Assess yourself!

Name _____ Class _____ Date _____

9 F

You should prepare a presentation or leaflet on using metals and preventing corrosion. You should choose of these areas: artwork and sculture; transport; jewellery and fashion; or building and the home. You should link your work to ideas about metal reactivity.

Level	I have...	Yes
Working towards level 4	named a metal and said what it is used for.	
Level 4	named at least two different metals and described accurately examples of how they are used.	
	described what corrosion is.	
	described one simple method of preventing corrosion, e.g. painting.	
	stated whether the metals I have named are reactive or unreactive.	
Level 5	used scientific words or ideas to explain how metals corrode.	
	explained how a more complex method of preventing corrosion works, e.g. galvanising.	
	named and described the uses of at least three common metals.	
	explained why we use at least one metal for a particular purpose because of its properties.	
Level 6	explained several reasons why metals are used for a particular purpose.	
	explained why a metal is used for a particular job and the criteria used when choosing metals, e.g. cost, strength and resistance to corrosion.	
	found out about a metal that I had not heard of before, or found out about an unusual use of a more common metal.	
	used word equations to describe reactions.	
	described evidence for patterns in the reactions of acids and oxygen with metals.	
	described how new materials are designed to have specific properties.	
Level 7	explained what the reactivity series of metals is.	
	explained how methods of corrosion prevention link to the reactivity series of metals.	
	used symbol and chemical formulae correctly.	
	explained the evidence for the reactivity series of metals.	
	explained how factors such as cost or environmental impact may be important when selecting a metal and why preventing corrosion helps to use fewer resources.	
Level 8	used numerical data to compare different materials and explained why they are particularly suited for the purpose described.	
	explained how the position of a metal in the reactivity series determines the method used to extract it from its ore.	
	used my knowledge of the reactivity series to predict when a chemical reaction will take place and when it will not.	
	used balanced symbol equations to describe chemical reactions. explained that different methods of extracting metals use different amounts of energy and linked this to the importance of recycling metals.	