Year 10 Science 2026
Chemistry
Reactivity
Student Booklet 3

Name:_____

	2026 Term 1 Yr10 Chemistry Course Objectives	Bold = ext only **keywords**
	During this unit represent reactions using word and balanced formula equations, including state symbols.	
Atomic Structure (revision)	Draw and describe the model of an atom using a labelled diagram. Include the terms: protons, neutrons, electrons, nucleus, energy levels (shells) and cloud of electrons.	atom, proton, neutron, electron, shell
	Recall the properties of charge and mass to the atomic structure.	positive, neutral, negative
	Draw an energy level diagram and the electron configuration for the first 20 elements.	electron configuration, orbit (shell)
	Understand how the electron configuration of an atom determines its position in the Periodic Table and its valency.	
	Describe an isotope and why elements on the Periodic table do not have whole mass numbers.	isotope, mass number, relative atomic mass
Bonding	Understand the difference between an ionic bond and a covalent bond.	ionic bond, covalent bond, ionic compound, molecules
Combustion and Fuels	State the definition of a fuel.	fuel
	Name, write the formulae and draw the structure for the first five alkanes and alkenes,	alkane, alkene, hydrocarbon, saturated, unsaturated, single bond, double bond, structural formula,
	Write chemical equations for the complete combustion of a hydrocarbon. Including the use of the appropriate state symbol for water.	Incomplete/complete combustion
	State the products of incomplete combustion.	
	Explain why incomplete combustion produces carbon monoxide and carbon.	
	Describe how carbon monoxide behaves as a toxic gas.	toxic, haemoglobin
	Complete a practical to determine the energy content of fuels.	fuel, combustion, ignition, energy.
		exothermic, endothermic
Climate Change	Explain how greenhouse gases (e.g. carbon dioxide, methane, water, nitrous oxide) can lead to climate change.	emit, reflect, absorb, thermal energy,
	Briefly describe the processes of carbon dioxide sequestration (removal and storage) and understand this as a method to slow down the increase of atmospheric carbon dioxide.	carbon dioxide sequestration – biomass, ocean acidification
Alternative fuels	Describe some of the advantages and disadvantages of biofuels (bioethanol and biodiesel) as an alternative to crude oil.	

	Describe the advantages and disadvantages of using hydrogen gas as a fuel.	
Reactivity of Metals	Understand that metals can be arranged in their order of reactivity.	
	Use chemical equations, including state symbols, to describe the reactions of metals with a) oxygen b) dilute acids (hydrochloric, sulfuric, nitric)	
	Understand how less reactive metals can be displaced from their ore by more reactive ones. Use chemical equations to describe these reactions.	
	Explain that unreactive metals form 'weak' compounds that decompose when heated. Use chemical equations to describe the reactions of metal carbonates when heated.	
	Use the reactivity series to predict displacement reactions. Use word and balanced equations to describe the reactions of metal displacement reactions.	
	Write ionic equations for displacement reactions.	
	Use the atomic structure to explain why some metals are more reactive than others.	
Rates of Reactions (Term 4 – not tested in S2 exam)	State the kinetic theory of matter and the collision theory.	kinetic theory of matter, collision theory
	List the factors that can control the rate of a chemical reaction: surface area, concentration, temperature, mixing/stirring, **catalyst.**	concentration, **catalyst enzyme**
	Explain how the different factors (listed above) can affect the rate of reaction and how these are related to the collision theory.	

1. Periodic table of the elements

1 **H** 1.0 hydrogen																	**2** **He** 4.0 helium
3 **Li** 6.9 lithium	**4** **Be** 9.0 beryllium											**5** **B** 10.8 boron	**6** **C** 12.0 carbon	**7** **N** 14.0 nitrogen	**8** **O** 16.0 oxygen	**9** **F** 19.0 fluorine	**10** **Ne** 20.2 neon
11 **Na** 23.0 sodium	**12** **Mg** 24.3 magnesium											**13** **Al** 27.0 aluminium	**14** **Si** 28.1 silicon	**15** **P** 31.0 phosphorus	**16** **S** 32.1 sulfur	**17** **Cl** 35.5 chlorine	**18** **Ar** 39.9 argon
19 **K** 39.1 potassium	**20** **Ca** 40.1 calcium	**21** **Sc** 45.0 scandium	**22** **Ti** 47.9 titanium	**23** **V** 50.9 vanadium	**24** **Cr** 52.0 chromium	**25** **Mn** 54.9 manganese	**26** **Fe** 55.8 iron	**27** **Co** 58.9 cobalt	**28** **Ni** 58.7 nickel	**29** **Cu** 63.5 copper	**30** **Zn** 65.4 zinc	**31** **Ga** 69.7 gallium	**32** **Ge** 72.6 germanium	**33** **As** 74.9 arsenic	**34** **Se** 79.0 selenium	**35** **Br** 79.9 bromine	**36** **Kr** 83.8 krypton
37 **Rb** 85.5 rubidium	**38** **Sr** 87.6 strontium	**39** **Y** 88.9 yttrium	**40** **Zr** 91.2 zirconium	**41** **Nb** 92.9 niobium	**42** **Mo** 96.0 molybdenum	**43** **Tc** (98) technetium	**44** **Ru** 101.1 ruthenium	**45** **Rh** 102.9 rhodium	**46** **Pd** 106.4 palladium	**47** **Ag** 107.9 silver	**48** **Cd** 112.4 cadmium	**49** **In** 114.8 indium	**50** **Sn** 118.7 tin	**51** **Sb** 121.8 antimony	**52** **Te** 127.6 tellurium	**53** **I** 126.9 iodine	**54** **Xe** 131.3 xenon
55 **Cs** 132.9 caesium	**56** **Ba** 137.3 barium	**57–71** lanthanoids	**72** **Hf** 178.5 hafnium	**73** **Ta** 180.9 tantalum	**74** **W** 183.8 tungsten	**75** **Re** 186.2 rhenium	**76** **Os** 190.2 osmium	**77** **Ir** 192.2 iridium	**78** **Pt** 195.1 platinum	**79** **Au** 197.0 gold	**80** **Hg** 200.6 mercury	**81** **Tl** 204.4 thallium	**82** **Pb** 207.2 lead	**83** **Bi** 209.0 bismuth	**84** **Po** (210) polonium	**85** **At** (210) astatine	**86** **Rn** (222) radon
87 **Fr** (223) francium	**88** **Ra** (226) radium	**89–103** actinoids	**104** **Rf** (261) rutherfordium	**105** **Db** (262) dubnium	**106** **Sg** (266) seaborgium	**107** **Bh** (264) bohrium	**108** **Hs** (267) hassium	**109** **Mt** (268) meitnerium	**110** **Ds** (271) darmstadtium	**111** **Rg** (272) roentgenium	**112** **Cn** (285) copernicium		**114** **Fl** (289) flerovium		**116** **Lv** (292) livermorium		

atomic number **79** symbol of element
relative atomic mass 197.0 Au name of element
gold

57 **La** 138.9 lanthanum	**58** **Ce** 140.1 cerium	**59** **Pr** 140.9 praseodymium	**60** **Nd** 144.2 neodymium	**61** **Pm** (145) promethium	**62** **Sm** 150.4 samarium	**63** **Eu** 152.0 europium	**64** **Gd** 157.3 gadolinium	**65** **Tb** 158.9 terbium	**66** **Dy** 162.5 dysprosium	**67** **Ho** 164.9 holmium	**68** **Er** 167.3 erbium	**69** **Tm** 168.9 thulium	**70** **Yb** 173.1 ytterbium	**71** **Lu** 175.0 lutetium

89 **Ac** (227) actinium	**90** **Th** 232.0 thorium	**91** **Pa** 231.0 protactinium	**92** **U** 238.0 uranium	**93** **Np** (237) neptunium	**94** **Pu** (244) plutonium	**95** **Am** (243) americium	**96** **Cm** (247) curium	**97** **Bk** (247) berkelium	**98** **Cf** (251) californium	**99** **Es** (252) einsteinium	**100** **Fm** (257) fermium	**101** **Md** (258) mendelevium	**102** **No** (259) nobelium	**103** **Lr** (262) lawrencium

The value in brackets indicates the mass number of the longest-lived isotope.

TURN OVER

Formulas and charges for selected ions

Cations

1+		2+		3+	
Name	**Formula**	**Name**	**Formula**	**Name**	**Formula**
ammonium	NH_4^+	barium	Ba^{2+}	aluminium	Al^{3+}
copper(I)	Cu^+	calcium	Ca^{2+}	chromium(III)	Cr^{3+}
hydronium	H_3O^+	copper(II)	Cu^{2+}	iron(III)	Fe^{3+}
lithium	Li^+	iron(II)	Fe^{2+}	**4+**	
potassium	K^+	lead(II)	Pb^{2+}	titanium(IV)	Ti^{4+}
silver	Ag^+	magnesium	Mg^{2+}		
sodium	Na^+	mercury(II)	Hg^{2+}		
		nickel(II)	Ni^{2+}		
		tin(II)	Sn^{2+}		
		zinc	Zn^{2+}		

Anions

1−		2−		3−	
Name	**Formula**	**Name**	**Formula**	**Name**	**Formula**
bromide	Br^-	carbonate	CO_3^{2-}	citrate	$C_6H_5O_7^{3-}$
chlorate	ClO_3^-	chromate	CrO_4^{2-}	nitride	N^{3-}
chloride	Cl^-	dichromate	$Cr_2O_7^{2-}$	phosphate	PO_4^{3-}
chlorite	ClO_2^-	monohydrogen phosphate	HPO_4^{2-}		
cyanide	CN^-	oxide	O^{2-}		
dihydrogen phosphate	$H_2PO_4^-$	peroxide	O_2^{2-}		
ethanoate	CH_3COO^-	sulfate	SO_4^{2-}		
fluoride	F^-	sulfide	S^{2-}		
hydrogen carbonate	HCO_3^-	sulfite	SO_3^{2-}		
hydrogen sulfate	HSO_4^-	thiosulfate	$S_2O_3^{2-}$		
hydrogen sulfide	HS^-				
hydrogen sulfite	HSO_3^-				
hydroxide	OH^-				
hypochlorite	ClO^-				
iodide	I^-				
nitrate	NO_3^-				
nitrite	NO_2^-				
perchlorate	ClO_4^-				
permanganate	MnO_4^-				

Reactivity and Displacing Metals

Learning Objective: Understand that metals can be arranged in their order of reactivity. Use chemical equations to describe the reactions of metals with a) oxygen b) an acid (hydrochloric, sulfuric, nitric)

Prac: Reacting metals with oxygen: iron, copper, magnesium

In the space below,
For each metal:
1. Write down your *observations*.
2. a) Write a *word equation* for the reaction of the metal with oxygen.
   b) Write a *balanced equation* to show the reaction of the metal with oxygen.
3. Write an *order of reactivity* starting with the most reactive to the least reactive.

Metal	Symbol	Observations when heated

Word and Balanced equations:

Order of Reactivity: Most reactive 1.

2.

Least reactive 3.

When a metal reacts with oxygen it produces an oxide:

General Equation: metal + oxygen → metal oxide

e.g. sodium + oxygen → sodium oxide

$Na_{(s)} + O_{2(g)} \rightarrow Na_2O_{(s)}$

magnesium + oxygen → magnesium oxide

$Mg_{(s)} + O_{2(g)} \rightarrow MgO_{(s)}$

When a metal reacts with an acid it produces a salt and hydrogen gas:

General Equation: metal + acid → salt + hydrogen

e.g. magnesium + hydrochloric acid → magnesium chloride + hydrogen

aluminium + sulfuric acid → aluminium sulfate + hydrogen

iron + nitric acid → iron nitrate + hydrogen

Naming the salt produced when an acid reacts with a metal:

Hydrochloric acid (HCl) produces *chloride* (Cl^-) salts e.g. sodium chloride (NaCl)

Sulfuric acid produces *sulfate* salts (SO_4^{2-}) e.g. sodium sulfate

Nitric acid produces *nitrate* salts (NO_3^-) e.g. sodium nitrate

Name the products and write the formula underneath). One box has been competed for you.

	Hydrochloric acid	Sulfuric Acid	Nitric Acid
Sodium			
Calcium			
Magnesium	magnesium chloride + hydrogen $MgCl_2 + H_2$		
Copper			
Iron			
Potassium			

Prac: Reacting metals with acids

Hydrochloric acid (HCl), sulfuric acid (H_2SO_4) and nitric acid (HNO_3)

In the space below,
For each metal:
1. Write down your *observations*.
2. a) Write a *word equation* for the reaction of the metal with sulfuric acid.
   b) Write a *balanced equation* to show the reaction of the metal with sulfuric acid.
3. Write an *order of reactivity* starting with the most reactive to the least reactive.
4. Compare this list with the list that you determined when heating metals.

Metal	Symbol	Observations when added to sulfuric acid

Word and Balanced equations:

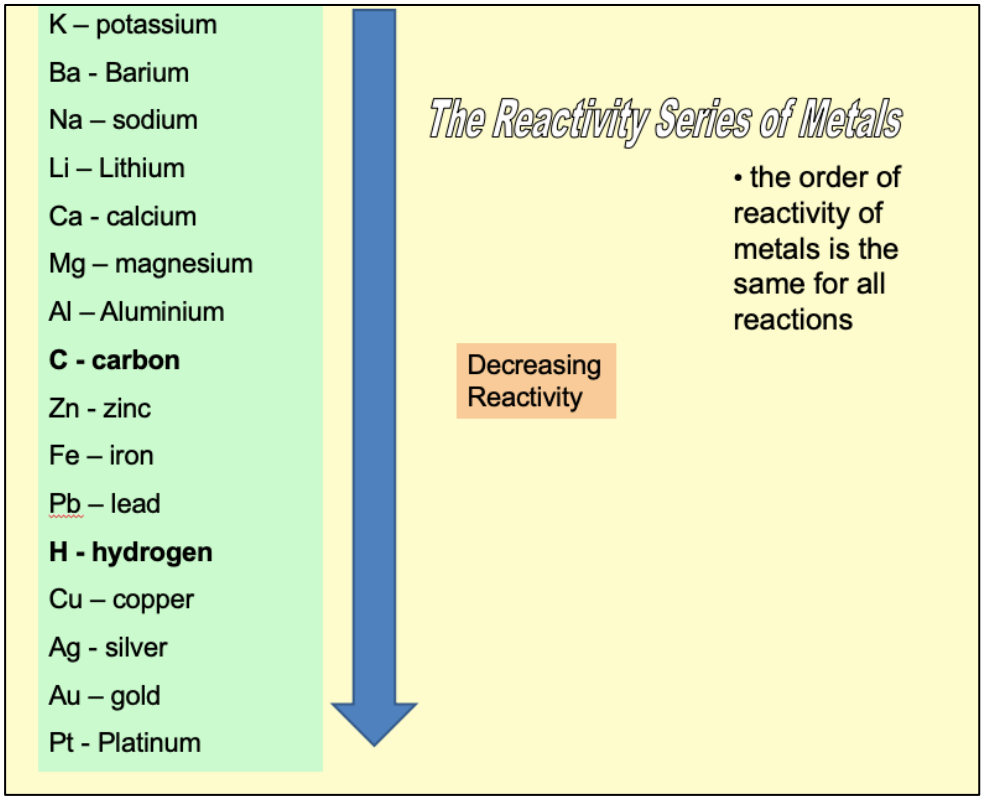
Order of Reactivity: Most reactive 1.

2.

3.

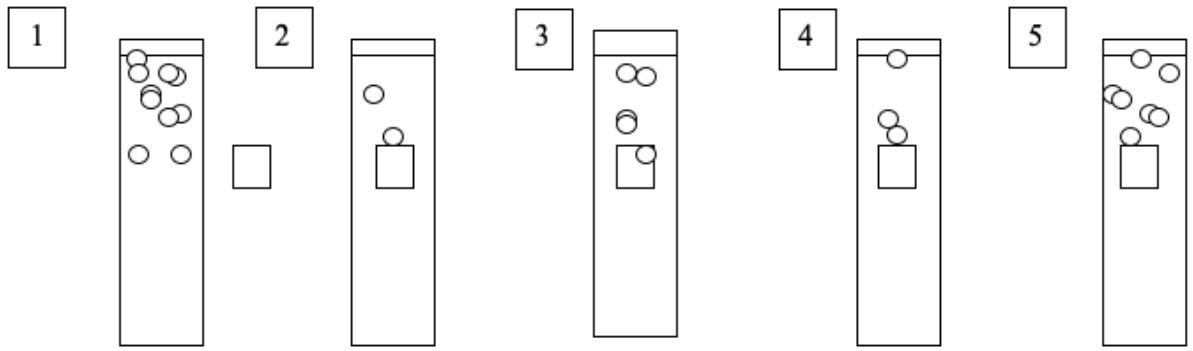
Least reactive 4.

How does this order compare with the last prac?



Reactivity Questions

A students set up a practical to determine the order of reactivity for some metals. They recorded the following observations:



Each container contains hydrochloric acid, along with a piece of metal:

1 – magnesium 2 – copper 3 – zinc 4 – iron 5 – aluminium

1. How do you know a reaction is occurring in the containers?

_____

2. According to the observations, which is the most reactive metal?

_____

3. For this prac:
   a) Name the independent variable.

---

   b) Name the dependent variable.

---

   c) Name **two** control variables.

---

4. State the gas produced.

---

5. Write a word equation for the reaction that occurred with aluminium.

---

6. Write a balanced equation for the reaction that occurred with aluminium.

---

7. Rank the containers in order or reactivity – highest first.

---

8. Complete the word equations and, underneath each, write a balanced equation.

a) lithium + nitric acid $\longrightarrow$

---

b) + $\longrightarrow$ hydrogen + lead chloride

---

c) + $\longrightarrow$ hydrogen + copper nitrate

---

d) tin + $\longrightarrow$ + tin sulphate

Learning Objective: Use the atomic structure to explain why some metals are more reactive than others.

Clickview video: Reaction of metals with oxygen
Watch the video and then answer the following questions:

1. Which product is formed when a metal reacts with oxygen?
a) a salt
b) an oxide
c) a hydroxide
d) a carbonate

2. Which two metals are highly reactive?
a) sodium and potassium
b) zinc and magnesium
c) copper and gold
d) silver and platinum

3. Which of the following statements is incorrect?
a) Metals lose their valence electrons readily.
b) Oxygen tends to accept electrons.
c) Oxygen gains electrons to become positively charged.
d) Metals form positively charged metal ions.

4. Which of these metals do not react with oxygen?
a) Mg
b) Na
c) Au
d) K

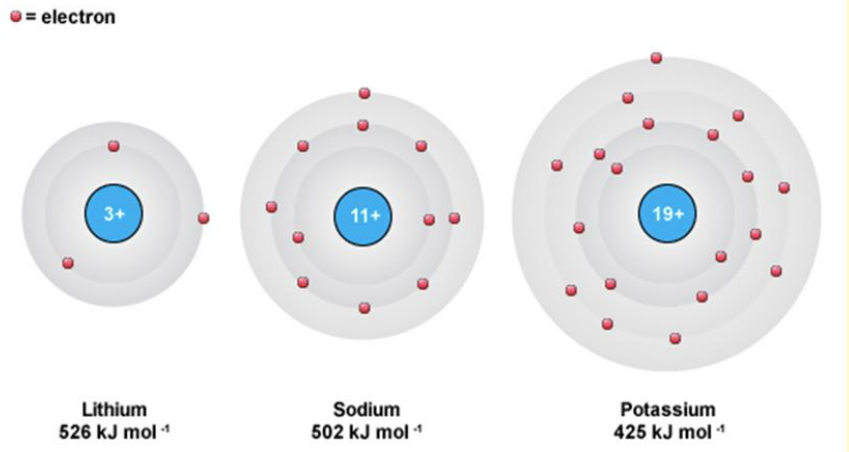
5. Which of the following metals form a black coating on its surface when heated at high temperature?
a) Mg
b) Na
c) Cu
d) K

6. The magnesium oxide dissolves in water to form ……..
a) magnesium
b) magnesium hydroxide
c) magnesium chloride
d) all of the above

7 Why does gold not corrode, even after several years?
a) It doesn't like air.
b) It is unreactive.
c) It is a metal.
d) It is shiny.

Reactivity of the Alkali Metals

What happens to the size of the atomic radius as you go down the group?
Why are the alkali metals more reactive than others?
Why does the reactivity increase as you go down the group?



Notes:

1. The negatively charged electrons are attracted to the positively charged nucleus.
2. Electrons in the valence shell use energy to escape the hold of the nucleus.
3. Alkali metals are very reactive as when they react they only need to lose 1 electron.
4. Reactivity increases down group 1 as the outer electron is further away from the nucleus and so needs less energy to escape the hold of the nucleus.
5. Reactivity of metals decreases across a period of the Periodic Table as the atoms need to lose more electrons and also the increased charge on the nucleus (more protons +) creates a stronger hold on the electrons in the atom. Therefore more energy is needed to react.

Use the information above to help answer the following, a diagram might help.

1. Explain why lithium is less reactive than potassium.

_____

_____

_____

_____

2. Explain why barium is more reactive than calcium.

_____

_____

_____

_____

Learning Objective: Understand how less reactive metals can be displaced from their ore by more reactive ones. Use chemical equations to describe these reactions. Use the reactivity series to predict displacement reactions. **Write ionic equations for displacement reactions**.

Metal Displacement

A metal can displace another metal from a salt.

First ask yourself which is the most reactive metal?

If the metal that is **not** as a salt is **more reactive**, then it will displace the less reactive metal from the salt.

e.g.

magnesium is more reactive than copper so magnesium will displace copper from the salt.

magnesium + copper sulphate → copper + magnesium sulphate

magnesium is less reactive than calcium so no reaction will take place.

magnesium + calcium nitrate → no reaction

Displacement of Metals Prac:

Predict if there will be a reaction by putting a tick or a cross in the box.

Carry out the prac to see if you were correct.

Work out the metal 'score' by adding up how many times it reacts.

	Copper Sulphate	Zinc Sulphate	Iron Sulphate	Magnesium Sulphate	Lead Nitrate	***Score***
Iron						
Zinc						
Copper						
Lead						
Magnesium						

Word and Balanced symbol equations for the displacement reactions

Learning Objective: Explain that unreactive metals form 'weak' compounds that decompose when heated. Use chemical equations to describe the reactions of metal carbonates when heated.

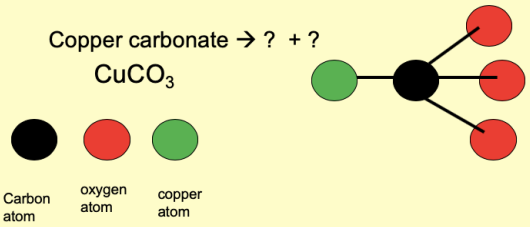
Thermal decomposition of Copper Carbonate

When heated copper carbonate breaks down from one chemical compound into two.

1. Write the word equation
2. Write a balanced equation, including state symbols.
3. **Balanced symbol equation**

Copper carbonate → ? + ?

$CuCO_3$

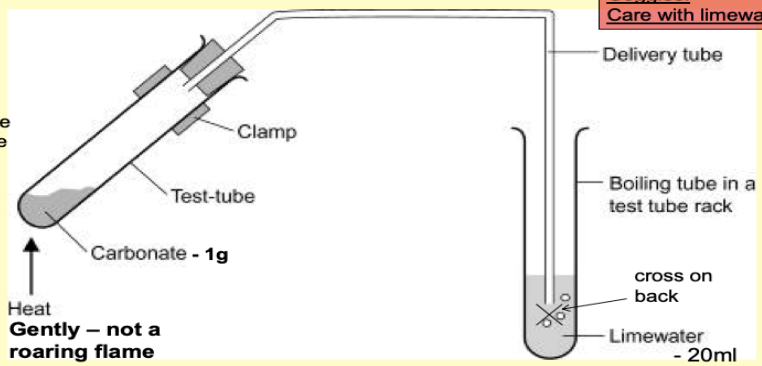


Ideas:

Which Carbonates Decompose the Easiest?

Goggles!
Care with limewater suck back!

zinc carbonate
sodium carbonate
copper carbonate



Time how long it takes for the cross to disappear – but no longer than 2 minutes!

Metal Carbonate	Time for lime water to turn cloudy (s)	Observations
copper carbonate		
calcium carbonate		
zinc carbonate		

Conclusion and equations for the reactions:

Extracting Copper from Malachite ore (copper carbonate)

There are three steps and chemical reactions to produce copper from malachite.

Reaction 1 – Thermal Decomposition Reaction

We use thermal energy to decompose the copper carbonate.

The gas produced in this reaction turns lime water cloudy. This indicates that we have produced _____ gas.

copper carbonate $\xrightarrow{\text{heat}}$ copper oxide + _____ gas

$CuCO_3$ ⟶ _____ + _____

Reaction 2 – Neutralisation Reaction

copper oxide + sulfuric acid ⟶ Copper sulfate + water

_____ + _____ ⟶ _____ + _____

Reaction 3 – Displacement reaction

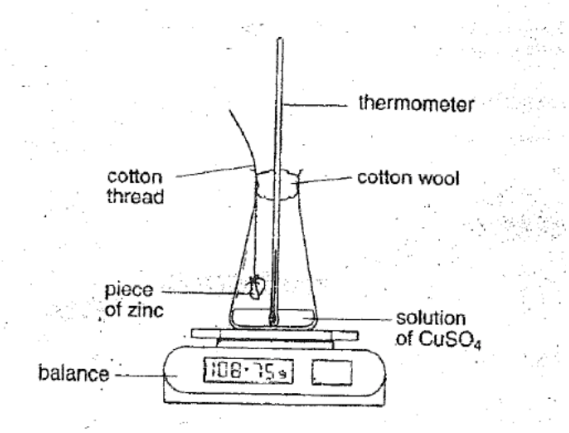
Why does zinc displace copper from the copper sulfate solution?

_____

Zinc + copper sulfate ⟶ Copper + zinc sulfate

_____ + _____ ⟶ _____ + _____

A Chemical Reaction Question



1. **State** the name of the compound $CuSO_4$ that is dissolved in water at the start of the reaction? (1)

_____

2. **State** the names and **give** the formula of the two products formed which occurs when the zinc is lowered into the solutions of $CUSO_4$. (4)

_____

_____

3. **Name** one other metallic element which would react in a similar way to zinc. (1)

_____

4. The flask and contents shown above were weighed. The zinc was lowered into the solution and the flask was swirled.

(a) **Explain what** change, if any, would there be in the mass of the flask and contents? (2)

_____

_____

(b) The reaction was repeated using a piece of silver instead of zinc. **Explain what** change, if any, would there be in the mass of the flask and contents? (2)

_____

_____

Predicting Using the Reactivity series of Metals

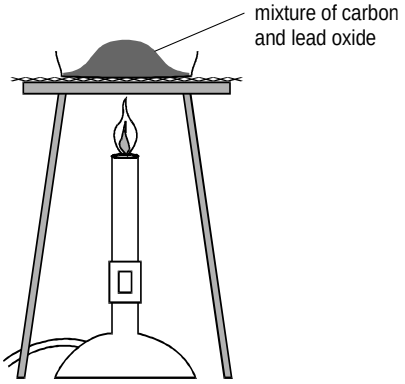
For each reaction predict if they will react.

For each that do react, write both a word and a balanced equation.

1. Zinc and Lead nitrate
2. Silver and Sodium chloride
3. Potassium and Copper carbonate
4. Aluminium and Zinc oxide
5. Iron and Tin nitrate
6. Calcium and Silver nitrate
7. Gold and Copper chloride
8. Iron and Iron oxide
9. Mercury and Lead oxide
10. Potassium and calcium carbonate

Questions

1. Marie mixed 5 g of carbon with 5 g of lead oxide. She heated the mixture strongly for 15 minutes in a fume cupboard.



After 15 minutes, Marie found some shiny beads in the mixture.

(a) Marie's performed a test that showed that the tiny beads were metal.
Name the metal that the beads were likely to be made from.

_____ 1 mark

(b) Marie also expected carbon dioxide to be formed in this experiment.

(i) In the molecule carbon dioxide, which element is combined with carbon?

_____ 1 mark

(ii) Where, apart from the air, did this element come from in this experiment?

_____ 1 mark

2. The table shows the observations made when four metals are added to cold water and to dilute hydrochloric acid.

metal	**observations with cold water**	**observations with dilute hydrochloric acid**
zinc	no reaction	bubbles of gas form and the metal slowly dissolves
platinum	no reaction	no reaction
potassium	the metal floats and then melts, a flame appears, and sometimes there is an explosion	(cannot be done safely)
nickel	no reaction	a few bubbles of gas form if the acid is warmed

(a) Write down the names of these **four** metals in the order of their reactivity.

most reactive _____

_____

_____

least reactive _____

1 mark

(b) (i) **Give** the name of another metal, **not** in the table, which reacts in a similar way to potassium.

_____ 1 mark

(ii) **Name** the gas formed when zinc reacts with dilute hydrochloric acid.

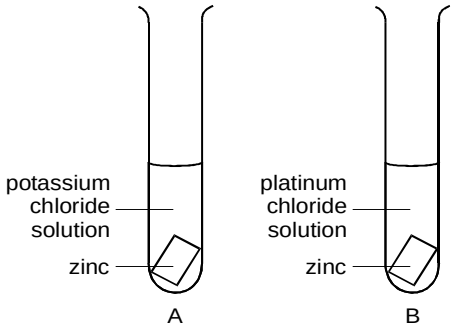
_____ 1 mark

(iii) The experiment with potassium and dilute hydrochloric acid should **not** be done in school laboratories. **Suggest why** it is dangerous.

_____

_____ 1 mark

(c) A scientist set up two test-tubes as shown below.



In test-tube B the zinc strip was slowly covered with a grey deposit.
Nothing happened in the other test-tube. **Explain** these observations.

_____

_____

_____

_____

_____

_____

4 marks

3. (a) Magnesium chloride is formed when magnesium reacts with an acid.

(i) Write the word and balanced equation for the reaction between magnesium and this acid. Include state symbols.

_____

_____

5 marks

(ii) **Suggest** why magnesium chloride can be made by adding magnesium to this acid, but copper chloride **cannot** be made by adding copper to this acid.

_____

_____

1 mark

(b) Copper sulphate is made by adding copper oxide to a different acid.
Give the name of the acid which is used.

.

_____

1 mark

(c) In the table below, **name** the compound represented by each formula.

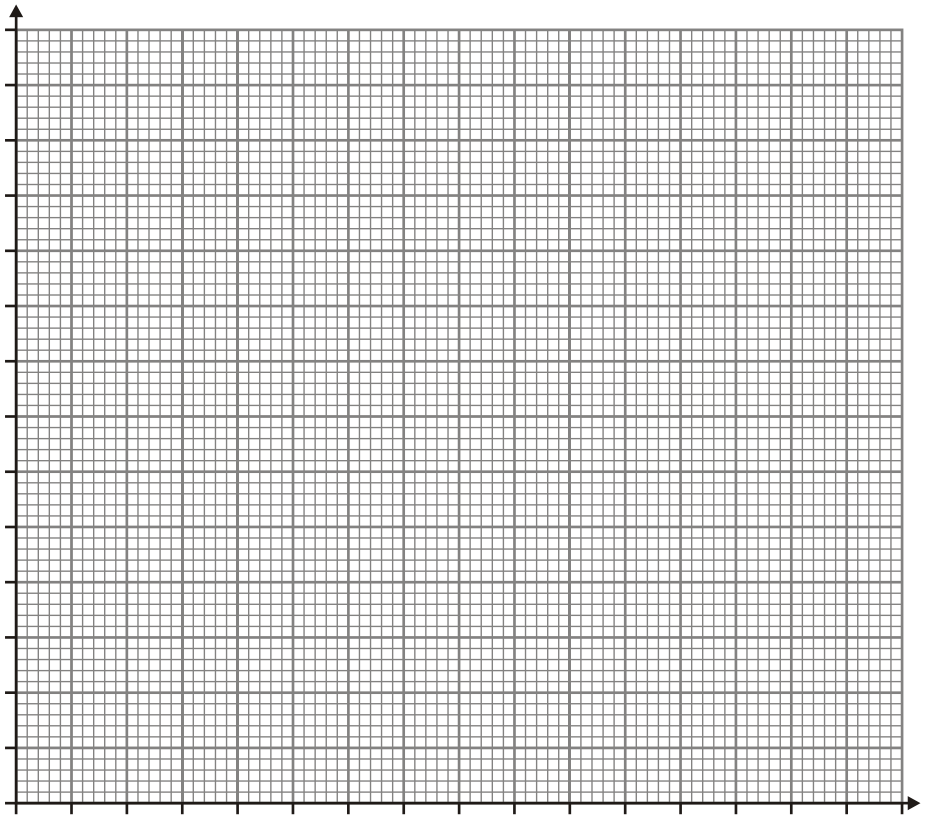
formula	name
$CuSO_4$	
$MgCl_2$	

2 marks

4. Six groups of pupils burned magnesium in air. The magnesium reacted with oxygen to form magnesium oxide.
They recorded the mass of magnesium used and the mass of magnesium oxide formed. Their results are shown in the table below.

group	mass of magnesium (g)	mass of magnesium oxide (g)
A	3.2	5.2
B	3.8	6.5
C	4.2	7.0
D	4.9	8.6
E	5.4	8.0
F	6.1	10.7

(a) Use their results to **draw** a suitable graph.



7 marks

(b) (i) Which group's results do **not** fit the general pattern?
Give the letter.

_____ 1 mark

(ii) How should the class deal with this outlier?

_____1 mark

(c) Use the graph to predict the mass of magnesium oxide that will be formed by burning 7.0 g of magnesium.

_____g 1 mark

(d) The results show the relationship between the mass of magnesium and the mass of magnesium oxide formed. What conclusion could you draw about this relationship?

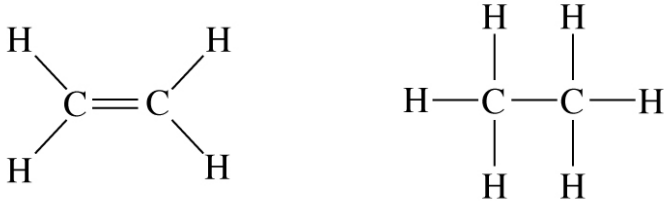
_____

_____

1 mark

Alkanes and Alkenes

The drawings show a molecule of ethane and a molecule of ethene.



1. Which molecule is ethane? Explain how you worked out your answer.

_____

_____

2. (a) Write down the formulae for propane and propene.

_____

_____

(b) Draw the structures of molecules of propane and propene.

propane *propene*

4. Write a balanced equation for the complete combustion of:

(a) propane

_____

(b) propene

_____

5. ‘pent-’ means five. Draw the structure of a molecule of pentane.

Boiling Points Data Analysis

The table below gives the boiling points of the compounds in three homologous series: the alkanes, the alkenes and the alcohols. Look at the table and then answer the questions.

Homologous series	Alcohols	Alkanes	Alkenes
Number of carbon atoms	Boiling point of the compound (°C)		
1	65	-164	n/a
2	79	-88	-104
3	97	-42	-47
4	117	0	-6
5	138	36	30

1. True or false? In each case, give a reason to support your answer using data from the table.

(a) Alkanes have a higher boiling point than alkenes.

_____

(b) The greater the number of carbon atoms, the lower the boiling point of the alcohols.

_____

(c) The alkane with four carbons (butane) has the same boiling point as water.

_____

2. Estimate the boiling point of the alcohol with six carbon atoms. Explain your reasoning.

_____

_____

_____

_____

3. Using the information from the graph, describe the relationship between the boiling point and the number of carbon atoms.

_____

_____

_____

_____

4. (a) On the graph paper, supplied. Plot all three sets of data on the same set of axes. Put the boiling point on the vertical axis (remember you will need positive and negative numbers) and the number of carbons on the horizontal axis. If you have coloured pencils, choose a different colour for each series.

(b) Why would it NOT be correct to join the points with a line of best fit in this case?

_____

_____

5. A student wrote: "The line on the alcohols graph goes up every time, so this shows the boiling point of the alcohols is directly proportional to the number of carbon atoms." Was the student correct? Give your reasons.

_____

_____

_____

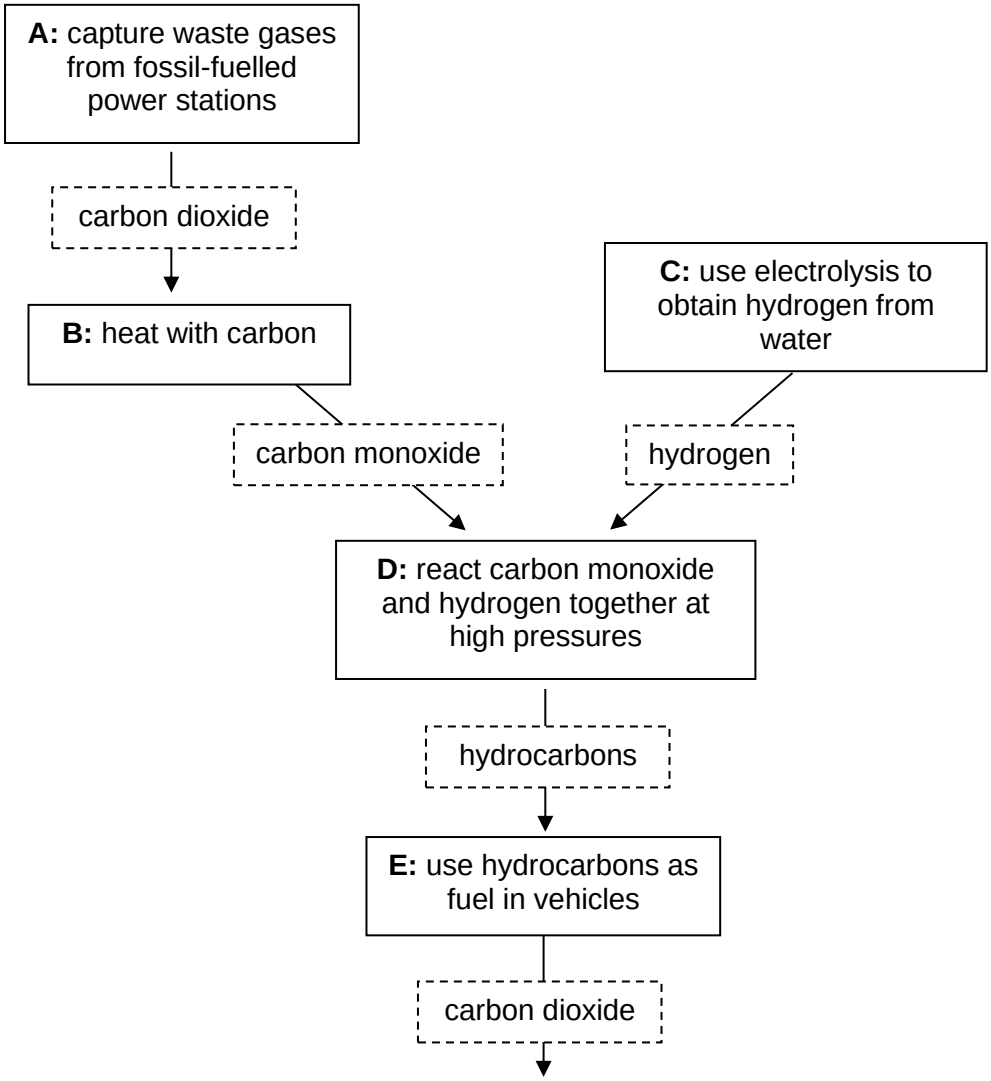
6. Explain why there is no data for the alkene with one carbon atom.

_____

_____

Making Hydrocarbons from Carbon Dioxide

The flowchart shows one way in which carbon dioxide might be converted into hydrocarbon molecules.



1. Which processes in the flow chart require energy?

_____

2. If you ignore the steps in the process that require energy, the process as shown in the flowchart produces as much carbon dioxide as it takes out of the air. Explain how it still reduces the amount of carbon dioxide added to the atmosphere overall.

_____

_____

_____

3. How will the overall carbon dioxide saving be affected if the energy you identified in question 1:

   a comes from a fossil-fuelled power station?

   _____

   b comes from renewable resources?

   _____

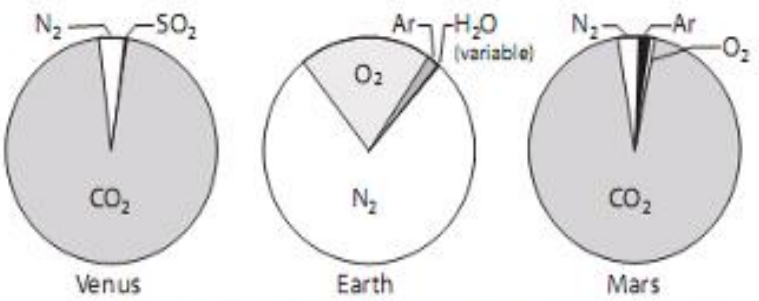
3. Suggest why step A collects carbon dioxide from power stations rather than from cars and lorries.

_____

_____

Planetary Heating

Venus, Earth and Mars are all rocky planets in our Solar System, but their atmospheres are very different. The pie charts show the gases in their atmospheres



The composition of the atmospheres on Mars, the Earth and Venus.

Planet	Mass of atmosphere above 1 m^2 of the planet (kg)	Calculated surface temperature (°C)
Venus	1×10^6	−46
Earth	1×10^4	−18
Mars	2×10^2	−56

Venus is closer to the Sun than the Earth, and Mars is further away from the Sun. Scientists can work out what the temperature on the surface of each planet *should be* based on the amount of radiation it receives from the Sun, and how much of this is reflected by clouds in the atmosphere.

These calculated values are shown in the table. The calculated value for Venus is lower than that for the Earth because Venus is covered in clouds, which reflect sunlight.

1. **Explain which** of the three planets you would expect to have the lowest surface temperature.

_____

_____

2 The mean surface temperature of the Earth is about 30 °C higher than the calculated value.

(a) **Explain why** this is so.

_____

_____

(b) **Name** three gases that contribute to this effect. (*Hint*: only one of these gases is shown on the pie chart.)

_____

(c) **Suggest why** the other gases are not shown on the pie chart.

_____

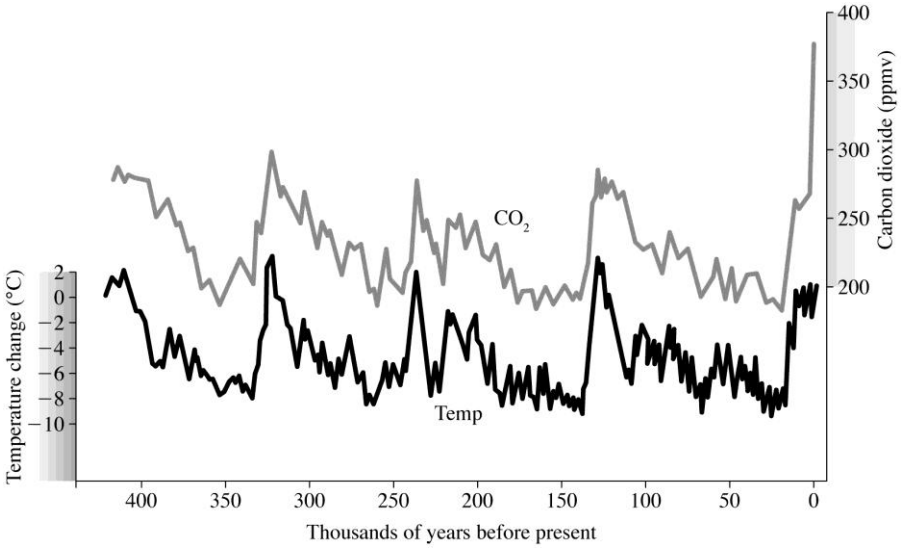
3. The actual surface temperature of Venus is about 500 °C higher than would be expected for the amount of solar radiation it receives. Use the data given above to **suggest why** this difference is much greater for Venus than it is for the Earth.

_____

4. The actual surface temperature of Mars is about the same as would be expected for the amount of solar radiation it receives. Using the data in the pie charts, why might you expect the measured surface temperature of Mars to be higher than the calculated one?

_____

5. Many scientists have concluded that human activity may influence the Earth's temperature. The graph shows one piece of evidence used to back up this idea.



Does this graph prove that increased levels of carbon dioxide affect the mean world temperature? Explain your answer.

_____

_____

7. Suggest two ways in which human activities could change the amount of carbon dioxide in the atmosphere.

_____

_____

Biofuels

1. What is a renewable fuel? Tick one box.

☐ a fuel that will run out one day

☐ a fuel that does not cause pollution when it burns

☐ a fuel that can be replaced, so it won't run out

2. Tick the correct boxes to show if each of these fuels is renewable or non-renewable.

	Fuel	Renewable	Non-renewable
a	petrol		
b	methane found with crude oil		
c	ethanol made from wheat		
d	wood		
e	methane made from animal droppings		
f	biodiesel		

3. Why does using biodiesel make our supplies of crude oil last longer?

_____

_____

_____

4. Jane and Sajid are talking about biodiesel:

Jane:
My car uses biodiesel. I'm not putting any extra carbon dioxide into the air because I use biodiesel.

Sajid:
You are adding carbon dioxide, but not as much as if you were using normal diesel.

(a) Explain why Jane thinks she is not adding carbon dioxide to the atmosphere overall.

_____

_____

(b) Explain why Sajid is correct.

_____

_____

Biofuel from Powerplant emissions

The text below is a shortened version of an article by Phil McKenna, published in New Scientist, 6 Oct 2006.

Two of the world's greatest energy users are electricity generation and transport. Both are responsible for huge quantities of greenhouse gas emissions, as most power plants and vehicles still rely on fossil fuels. Now Green Fuel and others are hoping to marry the two together with an emerging technology that uses a by-product of one to supply fuel to the other. Doing so could dramatically reduce their overall carbon dioxide emissions.

At the heart of the technology is a plastic cylinder full of algae, which literally sucks the CO_2 out of a power plant's exhaust. The algae can in turn be converted into biofuel, creating a cycle that takes the carbon from the smokestack to the gas tank before it enters the atmosphere. If successful, the technology could capture all of a power plant's CO_2 emissions.

To produce fuel from CO_2, the flue gases are fed into a series of transparent 'bioreactors', which are 2 metres high and filled with green microalgae suspended in nutrient-rich water. The algae produce sugars, which they then turn into fatty oils. As the algae grow and multiply, portions of the soup are continually withdrawn from each reactor and the oils are extracted. These can then be converted into biodiesel.

One key advantage of algae farms over other sources of biofuel such as corn and soybeans is that they need much less space (*New Scientist*, 23 September, p. 36). In Germany, where rapeseed is the primary crop used for biodiesel, it would take up to 33 times as much land as is needed by the algae bioreactors to produce the same amount of fuel. What's more, unlike other biofuel crops, algae do not require precious commodities like fresh water or fertile land. That makes the technology suitable for use in the deserts of the American south-west and China.

1. (a) Name the process in which algae use carbon dioxide.

_____

(b) What other reactant is needed for this process to take place?

_____

(c) What other substances are needed for the algae to grow?

_____

2. The new system is being developed in the Arizona desert in the USA. Suggest why this proposed method is more likely to work well in this location than it would in somewhere like the UK.

_____

3. Suggest why the plant needs to be located near to a power station.

_____

4. Explain the advantages of producing biodiesel from algae compared to producing it from rapeseed oil.

_____

_____

5. Is the fuel produced by this process 'carbon neutral'? Explain your answer

_____

_____

Metal and Oxygen

Word search: Find the missing words in the word search. They may appear forwards or backwards, up or down, or diagonally.

_____ is a highly reactive _____ and will oxidise most substances. Humans and other animals are protected from oxidation by their skin. _____ react with oxygen to form a metal _____. Different metals react at different _____ depending on their position on the reactivity scale. Metal oxides tend to be dull, which is why metals lose their _____ after they are exposed to oxygen in the air.

Lithium, _____ and potassium all _____ with oxygen quickly. _____ reacts more slowly, unless it is heated in which case it burns with a bright _____ light to form magnesium oxide. Magnesium is often used in _____ for this reason. _____ oxidises slowly from a pinky orange colour to a blue green.

_____ is a reactive metal but it is still used for soft drink cans which contain _____ acid made from _____ carbon dioxide. The reason for using it in this way is that aluminium reacts quickly to form a layer of _____ aluminium oxide which coats the surface of the can and stops it from reacting with the acid. If the oxide layer is scratched off, it exposes the metal _____ beneath to reaction. The dull oxide layer can be removed by _____ or sanding.

D	A	E	B	H	T	F	Z	W	M	X	H	T	C	E
I	N	L	A	T	I	B	U	G	O	N	H	N	O	V
S	U	E	U	O	E	Q	N	H	B	E	N	N	P	I
S	O	R	M	M	L	U	S	T	R	E	J	Y	P	T
O	T	D	T	F	I	R	E	W	O	R	K	S	E	C
L	Y	N	I	C	I	N	O	B	R	A	C	G	R	A
V	F	Z	E	U	A	J	I	M	V	P	M	S	O	E
E	N	Z	H	M	M	E	U	U	O	C	L	X	E	R
D	S	H	B	I	E	I	R	L	M	A	I	A	T	N
S	E	T	A	R	S	L	I	N	T	D	Q	J	I	U
L	P	M	O	E	S	S	E	E	E	A	T	O	H	Y
H	Y	K	N	M	H	M	M	G	S	S	D	K	W	Z
C	L	G	O	I	C	D	F	Y	X	M	U	A	M	H
B	A	T	N	J	F	X	E	X	N	I	D	W	M	N
M	A	G	Q	O	A	H	G	O	C	R	Z	R	Q	Z

The Reactivity Series

Word maze: Weave your way through the maze from Start to Finish to find all the missing words in the order in which they appear in the text. Words can change direction but each new word begins in one of the squares around the final letter of the previous word.

Some metals are less _____ than others. For example, _____ and gold stay shiny much longer than iron or _____ because they take longer to react with the oxygen in the air to form _____. Gold is so unreactive that it barely reacts with oxygen at all. Scientists have arranged the metals into a _____ series (also called the activity series) which shows how reactive they are. By _____, the most reactive metals are written on the _____ and the least reactive on the _____.

This is the reactivity series for common metals:

Sodium Calcium _____ Aluminium Zinc Iron _____ _____ Copper Silver Gold

_____ and calcium are reactive enough to react with _____ water but magnesium, aluminium, zinc and iron only react with _____. The _____ in the steam are moving fast enough – that is, they have enough _____ energy – to make the reaction happen. Tin, lead, copper, silver and gold do not react with water even in the gaseous state.

Where metals do react with water, they make _____ gas which is extremely _____. If the magnesium _____ is on fire and hot enough then it will react with water being used to put it out and create hydrogen gas, which can cause _____. This is why fires in scrap metal yards can be extremely dangerous.

_____ are more reactive than water so metals further down the reactivity series react with them. Magnesium reacts with dilute _____ acid rapidly and even zinc creates a few bubbles of hydrogen gas.

START

V	I	T	Y	C	O	N	V	E	N	T	I	O	N	L
I	P	O	C	R	E	V	L	M	A	E	T	S	D	E
T	P	E	R	O	X	I	I	M	T	I	C	H	L	F
C	A	E	R	S	E	D	S	O	E	K	S	Y	O	T
R	E	A	C	T	I	V	E	L	N	I	E	D	C	R
L	A	T	E	L	B	M	A	E	C	U	L	R	M	I
F	I	R	M	E	A	M	L	F	N	E	G	O	U	G
A	S	E	B	I	N	L	E	A	D	S	O	D	I	H
C	L	L	A	T	M	U	I	S	E	N	G	A	M	T
I	D	S	H	Y	D	R	O	C	H	L	O	R	I	C

FINISH

EXT ONLY

Ionic Equations

An **ionic equation** is a chemical **equation** where the electrolytes in aqueous solution are written as dissociated **ions**. Usually, this is a salt dissolved in water, where the **ionic** species are followed by (aq) in the **equation**, to indicate they are in aqueous solution.

Ionic equations for displacement reactions

An **ionic equation** shows only the atoms and **ions** that change during the **reaction** by losing or gaining electrons . They are useful for representing **displacement reactions** because they show what happens to the metal **ions**.
e.g.

Formula equation:

$Mg(s) + CuSO_4(aq) \rightarrow MgSO_4(aq) + Cu(s)$

Ionic equation:

$Mg(s) + Cu^{2+}(aq) \rightarrow Mg^{2+}(aq) + Cu(s)$

Writing Ionic equations

Write an ionic equation for the reaction between zinc and lead carbonate.

1. First write the balanced equation, including state symbols:

2. For the chemicals in solution (aq) write in the ions:

3. Now delete the ions that have not taken part in the reaction (not changed)

For the following that react, write an ionic equation:

1. iron and copper(II)sulfate
2. zinc and lead sulfate
3. potassium and copper(I)nitrate
4. lead and zinc bromide
5. sodium chloride and potassium
6. lithium and iron sulfate

7 magnesium and silver nitrate

8. aluminium and copper(II)sulfate