Chemistry Revision - TYPES OF EQUATION (Higher)

As part of your revision you should learn the general equations for the reactions studied across all topics, which you can apply to the examples. Note, Salts are named from the acids that form them, hydroCHLORIC acid makes CHLORIDES, Sulfuric acid makes Sulfates, **nitric** acids make **nitrates,** phosphoric acid makes phosphates. The reactions you should learn are:

1. Metal and acid

Metal + Acid → Salt + Hydrogen

2. Metal and water

Metal + Water → Metal Hydroxide + Hydrogen

3. Metal carbonate and acid

Metal Carbonate + Acid → Salt + Water + Carbon Dioxide

4. Metal hydroxide and acid

Metal Hydroxide + Acid → Salt + Water

5. Metal oxide and acid

Metal Oxide + Acid → Salt + Water

6. Metal and halogen

Metal + Halogen → Metal Halide

7. Hydrogen and Halogen

Hydrogen + Halogen → Hydrogen Halide

8. Displacement reactions of a (more reactive) metal and metal compound (salt)

E.g Magnesium + Copper Sulfate → Magnesium Sulfate + Copper

9. Displacement reactions of (more reactive) halogen with metal halide

E.g Fluorine + Sodium Iodide → Sodium Fluoride + Iodine

10. Complete combustion of a fuel

Fuel + Oxygen → Carbon Dioxide + Water

11. Incomplete combustion

Fuel + Oxygen → Carbon Monoxide + Carbon + Water

12. Heating a metal oxide with carbon (extraction)

Metal Oxide + Carbon → Carbon Dioxide + Metal

13. Precipitation –when 2 soluble salts react together to form an insoluble salt (solid) which is a precipitate, the ions swap places

Sodium Chloride(aq) + Silver nitrate (aq) → Silver Chloride (s) + Sodium Nitrate (aq)

TASK: Produce a summary / cue cards of these 13 reactions with 2 of your own examples, including word equations and full balanced equations. Do this and show your teacher before attempting any of the exam questions

How am I expected to know all the chemical formulae?

Some you just have to learn:

Ionic substances

Magnesium chloride	$MgCl_2$
Calcium chloride	$CaCl_2$
Magnesium oxide	MgO
Copper sulfate	$CuSO_4$
Sodium chloride	$NaCl$
Potassium chloride	KCl

Simple molecular covalent / Simple molecules

Water	H_2O
Carbon dioxide	CO_2
Carbon monoxide	CO
Oxygen	O_2
Hydrogen	H_2
Methane	CH_4
Ethane	C_2H_6
Propane	C_3H_8
Butane	C_4H_{10}

Acids (ionic when aqueous)

Nitric acid	HNO_3
Sulfuric acid	H_2SO_4
Hydrochloric acid	HCl

Alkalis (ionic)

Sodium hydroxide	$NaOH$
Calcium hydroxide	$Ca(OH)_2$

Bases (ionic)

Copper oxide	CuO
Calcium carbonate	$CaCO_3$
Copper carbonate	$CuCO_3$

Cont.

Other substances you can figure out

Hydrocarbons / organic substances. Learn the general formula of the homologous series and use the number of carbons to figure it out

Alkanes	C_nH_{2n+2}	e.g CH_4 C_2H_6 C_4H_{10} $C_{22}H_{46}$
Alkenes	C_nH_{2n}	e.g C_2H_4 C_4H_8 $C_{22}H_{44}$
(Triple) Alcohols	$C_nH_{2n+1}OH$	e.g CH_3OH C_2H_5OH C_4H_9OH $C_{22}H_{45}OH$
(Triple) Carboxylic acids	$C_nH_{2n+1}COOH$	e.g CH_3COOH C_2H_5COOH C_4H_9COOH

Ionic substances

Learn the **charges on the ions,** choose the correct ratio to cancel out and then have the correct formula. Learn these

Positive Ions		Negative Ions	
Hydrogen	H^+	Fluoride	F^-
Lithium	Li^+	Chloride	Cl^-
Sodium	Na^+	Bromide	Br^-
Potassium	K^+	Iodide	I^-
Magnesium	Mg^{2+}	Oxide	O^{2-}
Calcium	Ca^{2+}	Hydroxide	OH^-
Aluminium	Al^{3+}	Nitrate	NO_3^-
Silver	Ag^+	Sulphate	SO_4^{2-}
Copper	Cu^{2+}	Phosphate	PO_4^{3-}
Ammonium	NH_4^+	Carbonate	CO_3^{2-}
Iron	Fe^{2+} & Fe^{3+}		

Work out the formula of

Copper nitrate

Lithium Oxide

Sodium sulfate

Calcium carbonate

All the different types of equation - explained

Type 1 – Full balanced equation

When a more reactive halogen displaces a less reactive halogen

E.g $2NaBr(aq) + Cl_2(g) \rightarrow 2NaCl(aq) + Br_2(l)$

The numbers in front are called big balancing numbers and are there because of conservation of mass, the same number of atoms should be the same on the left (reactants) as there are on the right (products). They are not part of the chemical formula.

Type 2 – Ionic equation

These only include the ions that change in the reaction and ignore the spectator ions. Use the state symbols to help. In the equation above Na^+ is (aq) at the start and the end so we leave this out. We need to recall that NaBr is in fact an ionic compound made of Na^+ and Br^- ions so we must include charge!

The ionic equation would become:

$2Br^-(aq) + Cl_2(g) \rightarrow 2Cl^-(aq) + Br_2(l)$

Another example would be a precipitation reaction between 2 soluble salts to make an insoluble salt- ions swap places!

Full equation: $AgNO_3(aq) + NaCl(aq) \rightarrow AgCl(s) + NaNO_3(aq)$

To turn this into an ionic equation we need to spot that Na^+ and NO_3^- are (aq) at the start and end, so we only focus on the ions that change from (aq) to (s). These are Ag^+ and Cl^-. So the ionic equation would be:

$Ag^+(aq) + Cl^-(aq) \rightarrow AgCl(s)$

Another example of a precipitation

Full : $2NaOH(aq) + CuSO_4(aq) \rightarrow Cu(OH)_2(s) + Na_2SO_4(aq)$
Ionic: $2OH^-(aq) + Cu^{2+}(aq) \rightarrow Cu(OH)_2(s)$

You may be asked to show **neutralisation** by ionic equations.

E.g Metal hydroxide and acid:	$H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$
E.g. Metal carbonate and acid:	$2H^+(aq) + CO_3^{2-}(aq) \rightarrow H_2O(l) + CO_2(g)$
Or Metal and acid	$2H^+(aq) + M(aq) \rightarrow M^{2+} + H_2$

The ionic equations for neutralisation are the same no matter which combination of

acid or base you use. Note M can represent any metal ion with a 2+ charge, e.g Mg^{2+}

Type 3 – Half equations

These are used to show oxidation and reduction (OIL RIG), when one atom or ion loses electrons, while another gains electrons. We split an ionic equation into 2 half equations; one for oxidation, the other for reduction.

Ionic equation:	$2Br^-$ (aq)	+	Cl_2 (g)	→	2Cl - (aq)	+	Br_2 (l)
Reduction half equation:	Cl_2 (g)	+	2e-	→	2Cl - (aq)		
Oxidation half equation:	$2Br^-$ (aq)			→	Br_2 (l)	+	2e-

Tip: When Reduction happens, electrons are Gained so electrons go on the left. When Oxidation happens electrons are Lost and go on the right. The total charge on the left should be equal to the total charge on the right for both ionic and half equations.

Electrolysis involves reduction and oxidation at the anode and cathode so you might be asked about half equations here too. Common examples:

Reduction of aluminium oxide by electrolysis Al^{3+} + 3e- → Al (s)
Reduction of copper sulfate solution by electrolysis Cu^{2+} + 2e- → Cu (s)

Make sure you revise the other examples of redox reactions

1) Displacement reactions of metals

Magnesium + Copper Sulfate → Copper + Magnesium Sulfate

Reduction half equation:	Cu^{2+}	+ 2e-	→	Cu (s)	
Oxidation half equation:	Mg		→	Mg^{2+}	+ 2e-

2) Group 1 metals with water:

Potassium atoms lose electrons easily when they react to become K+ ions:

K (s) → K^+ (aq) + e^-

3) Halogen displacement reactions. When IodIDE I^- becomes a brown solution of IodiNE, I_2 when it reacts with ChlorINE Cl_2

Reduction half equation:	Cl_2 (g)	+ 2e-	→	2Cl - (aq)	
Oxidation half equation:	2 I^- (aq)		→	I_2 (aq)	+ 2e-

Exam Questions- Do NOT complete until you have made flash / cards/ summary / mindmap. Use these to self –test yourself,

Tip: Look at the types of equation they are asking for. If you don't know the substances formed, use your summary of general equations to write a word equation *first* to figure out the products.

Q1a

When decane undergoes complete combustion, a mixture of carbon dioxide and water is formed.

Complete the balanced equation for this reaction.

(2)

$2C_{10}H_{22}$ + ... O_2 → ..... CO_2 + ... H_2O

Q1b

When magnesium reacts with hydrochloric acid, salt and a gas are formed.

Complete the balanced equation for this reaction.

What is the ionic equation for this reaction?

Q1c

When copper carbonate reacts with 3 products form including one gas.

Complete the balanced equation for this reaction.

What is the ionic equation for this reaction?

Q2.

A student investigated the rate of reaction between dilute hydrochloric acid and marble chips (calcium carbonate).

Calcium chloride, carbon dioxide and water are formed.

Complete and balance the equation for the reaction.

(2)

$CaCO_3$ + HCl → ..... + ... + ...

Q3.

Iron(III) ions, Fe^{3+}, react with hydroxide ions in solution to form insoluble iron(III) hydroxide.

Complete the ionic equation for this reaction.

(1)

$Fe^{3+} + 3OH^- \rightarrow$ .....

Q4.

(b) Aluminium ions, Al^{3+}, react with hydroxide ions in solution to give a white precipitate of aluminium hydroxide.

Write the ionic equation for this reaction.

(3)

Q5.

Metals

There are many metallic elements in the periodic table.

(a) Which row of the table correctly shows two metals that are in group 1 and two metals that are transition metals?

Put a cross (☒) in the box next to your answer.

(1)

	group 1	transition metals
☐ **A**	lithium and zinc	calcium and copper
☐ **B**	potassium and caesium	copper and iron
☐ **C**	sodium and potassium	copper and magnesium
☐ **D**	sodium and magnesium	manganese and nickel

(ii) Write the balanced equation for the reaction of sodium with water to form sodium hydroxide and hydrogen.

(3)

.....

Q2.

(a) Sodium chloride is a metal chloride which is soluble in cold water.

(i) Give the name of a metal chloride which is insoluble in cold water.

Put a cross (☒) in the box next to your answer.

(1)

- ☒ **A** copper chloride
- ☒ **B** lead chloride
- ☒ **C** magnesium chloride
- ☒ **D** potassium chloride

Q3.

Salts

(a) Which of the following pairs of substances contains one substance that is soluble in water and one that is insoluble in water?

Put a cross (☒) in the box next to your answer.

(1)

- ☒ **A** aluminium nitrate and lead sulfate
- ☒ **B** ammonium chloride and copper sulfate
- ☒ **C** copper hydroxide and lead sulfate
- ☒ **D** sodium hydroxide and potassium nitrate

(ii) Complete the balanced equation for the precipation reaction between barium chloride and potassium sulfate.

(2)

$BaCl_2$ (aq) + K_2SO_4 (aq) → .....

(iii) Write an ionic equation for the reaction above:

Q1.

Astatine, bromine, chlorine, fluorine and iodine are all halogens.
They are found in Group 7 of the Periodic Table.

(b) Name a halogen that is a solid at room temperature.

(1)

.....

(c) Bromine can be obtained from the bromide ions in sea water.

Chlorine is bubbled into sea water.
The chlorine oxidises the bromide ions to bromine atoms.
The bromine atoms then form bromine molecules.

(i) Complete the **ionic equation** to show how bromine **atoms** are formed from bromide ions.

(1)

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

(ii) State, in terms of electrons, why this reaction is described as the oxidation of bromide ions.

(1)

.....

.....

(iii) Write a **half equation** to show how bromine atoms form bromine molecules.

(1)

.....

(iv) Write a **half equation** to show how chlorine molecules become chloride ions

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