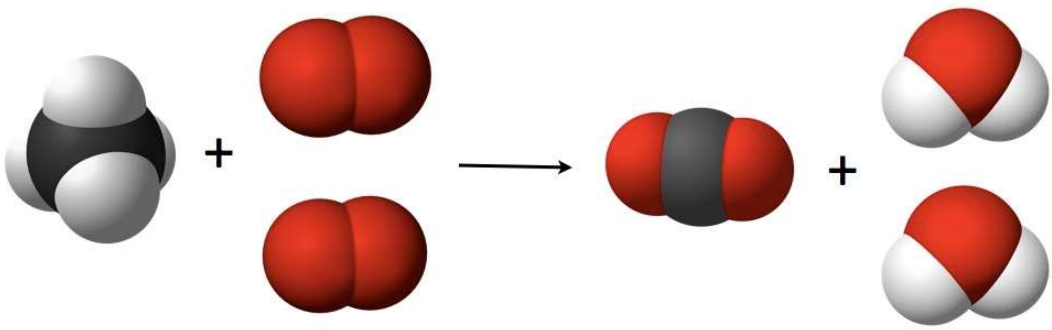
Master

Kirkcaldy High School



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

N4/5 Chemistry

Unit 1 - part 4

Formulae and Chemical Equations

Name: ______________________

Class: ______________________

Teacher: ______________________

Assessment Page

End of topic questions

Topic title	Date	Mark/Total Mark
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Homework

Homework title	Date	Mark/Total Mark
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Check tests

Test title	Date	Mark/Total Mark
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Teacher comments

Date: ________________

Chemical Formulae

Learning Intentions

- To learn about chemical formula and how it relates to valency.

Success Criteria

☐ I can describe the link between formulae and valency.

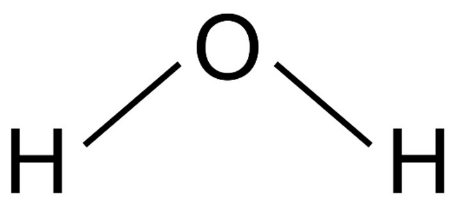
Introduction to Chemical Formulae*

Chemical formulae* are a way to describe what elements make up a compounds. They tell us which elements are involved and in what amounts.

For instance, the formula for water, H_2O, shows that each water molecule has **two** hydrogen atoms and **one** oxygen atom. This is a key part of chemistry because it helps us understand the composition (parts/makeup/ingredients).

In chemical formulae, the **subscript** number (smaller number at the bottom) next to an element's symbol indicates the **number** of **atoms** of that element present in the compound. For example, in H_2O, the subscript '2' next to hydrogen (H) tells us that there are **two** hydrogen atoms in each molecule of water.

If no subscript is present, as with the oxygen (O) in H_2O, it is understood to be **1**.



The **formula** of a compound is **directly related** to the **valency** of each element involved.

State the definition of valency below.

____

____

____

*Formulae is the plural of formula.
Formula = 1 formula
Formulae = multiple formula

Fill out the following table. For each compound, write the symbol of each element involved, the number of atoms (from the subscript – number below) and the valency.

Compound	Element 1 (Symbol)	Number of Atoms	Valency	Element 2 (Symbol)	Number of Atoms	Valency
Water (H_2O)						
Methane (CH_4)						
Sodium Chloride ($NaCl$)						
Calcium Oxide (CaO)						
Hydrogen Sulfide (H_2S)						
Carbon Dioxide (CO_2)						
Magnesium Chloride ($MgCl_2$)						
Aluminium Oxide (Al_2O_3)						

Do you notice a pattern with the number of atoms of each element in a compound and the valency? Use examples from the table to illustrate your answer.

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Date: ________________

Writing Formula – prefixes

Learning Intentions

- To learn how to write formula given prefixes

Success Criteria

☐ I can write the formula given the prefixes of each element

Writing the formula given prefixes

A prefix is a short word or letter set that is added at the **beginning** of **another word** to change its **meaning**.

In the context of chemistry, **prefixes** are used to **indicate** the **number of atoms** of each element in a compound.

- Common prefixes include "**mono-**" for **one**, "**di-**" for **two**, "**tri-**" for **three**, "**tetra-**" for **four**, "**penta-**" for **five**, and so on.

Complete the table below for the prefixes up to 6.

Prefix	Number of atoms

For example, if you have a compound named "**di**hydrogen **mon**oxide," the prefix "**di-**" before hydrogen tells you that there are **two** hydrogen atoms, and "**mono-**" before oxide indicates **one** oxygen atom. Therefore, the chemical formula would be **H_2O**.

Dihydrogen **mon**oxide = H_2O

Another example is "carbon tetrachloride." The prefix "**tetra-**" before chloride tells you that there are **four** chlorine atoms. Since there's **no prefix** before carbon, it's understood to be **one** carbon atom. The chemical formula would then be CCl_4.

Carbon **tetra**chloride = CCl_4

To write the formula:

1. Identify the element for each prefix.
2. Use the prefix to determine the number of atoms of that element.
3. Write the element symbol followed by the number of atoms as a subscript.

By following these steps, you can translate the name of a covalent compound into its corresponding chemical formula.

Complete the following table to find the formula of each compound. You will need to use your data booklet to find the symbols of each element.

Compound Name	**Element 1**	**Number of Atoms**	**Element 2**	**Number of Atoms**	**Chemical Formula**
Carbon dioxide					
Dihydrogen monoxide					
Sulfur hexafluoride					
Nitrogen triiodide					
Phosphorus pentachloride					
Carbon tetrachloride					
Dinitrogen tetroxide					
Silicon dioxide					
Dihydrogen sulfide					
Boron trifluoride					
Oxygen difluoride					
Phosphorus trichloride					

Complete the following table to write the name of each compound given the formula. You will need to use your data booklet to find the name of each element.

Chemical Formula	Compound Name
CO_2	
H_2O	
N_2O_3	
CCl_4	
PCl_3	
SO_3	
N_2O	
P_4O_2	
C_2H_2	
C_3H_8	
SiO_2	
H_2S	
BF_3	
NH_3	
CH_4	
SF_6	

Extension (more practice)

Complete the following table given either the formula or compound name.

Chemical Formula	Compound Name
CO	
	Dihydrogen monoxide
N_2O_4	
	Carbon tetrachloride
PCl_5	
SO_2	
	Dinitrogen monoxide
P_2O_5	
C_2H_4	
	Tricarbon octahydride
SiO_2	
	Dihydrogen sulfide
BCl_3	
NH_3	
	Carbon tetrahydride
SF_4	

Date: _______________

Chemical Formulae – swap and drop method

Learning Intentions

- To learn how to use the swap and drop method for writing formula.

Success Criteria

☐ I can use the swap and drop method to write chemical formulae.

☐ I can use the swap and drop method to write ionic formulae.

The swap and drop method

In chemistry, it's important to note that **prefixes** like "mono-", "di-", "tri-", etc., are not **always provided** in the names of compounds.

In such cases, understanding the **valency** of elements becomes **crucial** for **determining** the **formula** of the compound.

Define valency:

____

____

For example, sodium (Na) has a valency of 1 and chlorine (Cl) has a valency of 1; when they combine, they form sodium chloride (NaCl).

As a reminder, complete the table below for the valency of each group on the periodic table.

Group	Valency
1	
2	
3	
4	
5	
6	
7	
8/0	

The "swap and drop" method is a straightforward way to write the formula of a compound when you know the valency of each element.

This method involves **swapping** the **valencies** of the two atoms/ions and then dropping them to become the subscripts in the formula.

Here's how it works:

Step 1. **Symbol**: Write down the symbols of the ions involved. For example, for calcium (Ca) and chlorine (Cl).

S	Ca	Cl
V		
S		
D		
S		

Step 2. **Valency**: Next to each symbol, write down its valency. Calcium has a valency of 2, and chlorine has a valency of 1.

S	Ca	Cl
V	2	1
S		
D		
S		

Step 3. **Swap**: Swap the valencies of the ions. The valency of calcium becomes the subscript for chlorine, and the valency of chlorine becomes the subscript for calcium.

S	Ca	Cl
V	2	1
S	1	2
D	$CaCl_2$	
S		

Step 4. **Drop**: Drop the numbers to become subscripts. In our example, calcium with a valency of 2 will pair with two chlorines, each with a valency of 1.

S	Ca	Cl
V	2	1
S	1	2
D	$CaCl_2$	
S		

Step 5. **Simplify**: If the subscripts can be simplified, do so. For instance, if you end up with Ca_2O_2, it can be simplified to CaO.

S	Ca	Cl
V	2	1
S	1	2
D	$CaCl_2$	
S	$CaCl_2$	

Your teacher will guide you with some examples on the next page.

Demonstrated Examples by your teacher.

Compound Name	Swap and drop method:	Compound Name	Swap and drop method:
Sodium Chloride		Potassium Oxide	

Formula		**Formula**	

Compound Name	Swap and drop method:	Compound Name	Swap and drop method:
Magnesium Sulfide		Aluminium Oxide	

Formula		**Formula**	

Questions

Using the swap and drop method, write the formula for the following compounds. *Use a show-me-board/jotter to do your swap and drop methods before filling in the formula.*

Compound Name	Chemical Formula
Sodium chloride	
Calcium oxide	
Magnesium bromide	
Potassium iodide	
Barium chloride	
Strontium oxide	
Sodium fluoride	
Aluminium chloride	
Lithium oxide	
Calcium nitride	
Magnesium sulfide	
Potassium bromide	
Sodium phosphide	
Calcium hydride	
Magnesium iodide	

Ionic formulae – National 5 only

Simply put, the **ionic formula** of an ionic compound is just the formula found by doing the swap and drop method, and, the **charges** are **included** in the **formula** as a **superscript** (small number and charge above) for each ion.

For example, sodium (Na) has a charge of 1+ and chlorine (Cl) has a charge of 1-. When these ions combine to form sodium chloride, the charges are balanced, resulting in the formula $Na^{+}Cl^{-}$.

Just do the swap and drop method exactly as before, then, in the final step add the charges to make the ionic formula.

The formula without charges is called the chemical formula.

Demonstrated examples by your teacher.

Compound Name	**Swap and drop method:**	**Compound Name**	**Swap and drop method:**
Sodium Chloride		Magnesium Chloride	

Chemical Formula		**Chemical Formula**	
Ionic Formula		**Ionic Formula**	

Questions

Using the swap and drop method, write the chemical and ionic formula for the following compounds. Use a show-me-board/jotter to do your swap and drop methods before filling in the formula.

Compound Name	Chemical Formula	Ionic Formula
Sodium chloride		
Calcium oxide		
Magnesium bromide		
Potassium iodide		
Barium chloride		
Strontium oxide		
Sodium fluoride		
Aluminium chloride		
Lithium oxide		
Calcium nitride		
Magnesium sulfide		
Potassium bromide		
Sodium phosphide		
Calcium hydride		
Magnesium iodide		

Date: ________________

Chemical Formulae – Roman Numerals

Learning Intentions

- To learn how write formulae given roman numerals for transition metals.

Success Criteria

☐ I can write the formula for ionic compounds containing transition metals given roman numerals.

Formula with roman numerals

Roman numerals are used in the names of certain ionic compounds to indicate the charge on the **metal ion**, particularly for **transition metals** that can have **multiple** possible **charges**.

For example, iron can form ions with charges of **2+** or **3+**, leading to compounds named iron(**II**) chloride and iron(**III**) chloride, respectively. The Roman numeral indicates the **charge** on the **iron ion** in each compound.

Fill in the table for the first 6 roman numerals.

Number	Roman Numeral
1	I
2	II
	V

The **roman numerals** are therefore just the **valency** of the **metal**, with this information we can use the **swap and drop method**.

Demonstrated examples by your teacher.

Compound Name	Swap and drop method:	Compound Name	Swap and drop method:
Iron(II) Oxide		Iron(III) Oxide	

Chemical Formula		**Chemical Formula**	
Ionic Formula		**Ionic Formula**	

Compound Name	Swap and drop method:	Compound Name	Swap and drop method:
Zinc(II) Chloride		Vanadium(II) Oxide	

Chemical Formula		**Chemical Formula**	
Ionic Formula		**Ionic Formula**	

Questions

Using the swap and drop method, write the formula for the following compounds with roman numerals. Use a show-me-board/jotter to do your swap and drop methods before filling in the formula.

Compound Name	Chemical Formula	Ionic Formula
Iron(III) chloride		
Copper(II) oxide		
Tin(IV) sulfide		
Lead(II) iodide		
Iron(II) oxide		
Manganese(IV) fluoride		
Cobalt(III) nitride		
Nickel(II) bromide		
Chromium(III) phosphide		
Vanadium(V) oxide		
Copper(I) sulfide		
Zinc(II) fluoride		
Tin(II) oxide		
Iron(III) nitride		
Cobalt(II) chloride		
Manganese(II) iodide		
Chromium(VI) sulfide		
Nickel(III) oxide		

Date: ________________

Chemical Formulae – Group ions

Learning Intentions

- To learn how to write formulae with group ions.

Success Criteria

☐ I can write the formula of a compound that contains group ions.

Formula Group ions

A **group ion**, also known as a **polyatomic** ion, is an ion that consists of **two** or **more atoms** where one of them is **oxygen**, carrying a **net** charge.

- This is the origin of the -ate/-ite naming distinction we made at the beginning of this topic.

Unlike single-element ions, which consist of just one type of atom (e.g. Cl^-), group ions are made up of multiple types of atoms.

- For example, the sulfate ion (SO_4^{2-}) is a group ion consisting of one sulfur atom and four oxygen atoms, carrying a net charge of 2-.

<u>These group ions are found on page 8 of the data booklet</u>.

<u>Whenever you see a name end in -ate/-ite you will need to find the formula of the group ion on page 8. There are a few exceptions, e.g. ammonium, hydroxide, etc.</u>

Using page 8 of the data booklet, find the formula of each of these group ions. (remember – the charge is the same number as the valency)

Group Ion Name	Ionic Formula (from Data Booklet)	Charge (from Data Booklet)
Sulfate		
Sulfite		
Nitrate		
Phosphate		
Carbonate		
Hydroxide		
Dichromate		
Ammonium		

Finding the formula of compounds with group ions

Once we find the formula of the group ion, we just treat it like any other symbol when applying the swap and drop method. However, since there are multiple symbols we must put the group ions in **brackets** if there are more than one.

For example, the completed formula for aluminium sulfate is: **$Al_2(SO_4)_3$**

Show this through the swap and drop method:

S Al SO_4
V 3 2
S 2 3
D $Al_2(SO_4)_3$
S $Al_2(SO_4)_3$

The **ionic formula** can also be written: **$Al^{3+}{}_3(SO_4{}^{2-})_3$**

Notice that the charge of the group ion stays inside the bracket.

Your teacher will now demonstrate some more examples below.

Questions

Using the swap and drop method, write the formula for the following compounds with group ions. Use a show-me-board/jotter to do your swap and drop methods before filling in the formula.

Compound Name	Chemical Formula	Ionic Formula
Sodium sulfate		
Calcium nitrate		
Magnesium carbonate		
Potassium phosphate		
Aluminium hydroxide		
Sodium bicarbonate		
Calcium carbonate		
Ammonium chloride		
Lithium sulfate		
Barium nitrate		
Zinc Sulfate		
Magnesium Nitrate		
Potassium Sulfite		
Iron(III) phosphate		
Copper(II) hydroxide		
Iron(II) nitrate		

Challenge (Optional) – National 5 only

To find the charge of metal ions in a compound when the formula is given, especially for transition metals, you can reverse-engineer the formula. This is particularly useful when the periodic table alone doesn't provide the charge, and when Roman numerals are not included in the compound's name.

To find the charge of a metal ion in a compound when only the formula is given, you can follow these steps:

Step 1. **Identify the Ions**: Look at the formula and find the metal and non-metal. For example, in $FeCl_3$, iron is the metal and chlorine is the non-metal.

Step 2. **Determine the Number of Each Ion**: Check how many of each ion are in the formula. In $FeCl_3$, there's one iron and three chlorines.

Step 3. **Find the Charge of the Known Ion**: Use the periodic table to find the charge of the non-metal. Chlorine usually has a charge of 1-.

Step 4. **Calculate the Charge of the Metal Ion**: To find the charge of the metal, multiply the charge of the non-metal by how many of them are in the formula (there would be a total of 3- charge from the Cl's).

Then divide by the number of metal ions (1 in this case).

In $FeCl_3$, you'd divide 3 by 1, this number is the charge of the positive metal ion, this would be a charge of 3+.

So 3 total positives and 3 total negatives = neutral.

Step 5. **Confirm Electrical Neutrality**: Double-check that the charges balance out to make sure the compound is neutral. In $FeCl_3$, one iron with a 3+ charge balances with three chlorines each with a 1- charge.

We can then write the ionic formula: $\mathbf{Fe^{3+}Cl^{-}_3}$.

And the compound name with roman numerals, **Iron(III) chloride**.

Complete the following table to find the charge of the metal ions.

Formula	**Metal Ion**	**Non-Metal/ Group Ion**	**Charge on Non-Metal/ Group Ion**	**Total Negative Charge**	**Charge on Metal Ion**	**Ionic Formula**
NaCl	Na	Cl	-	-	+	$Na^{+}Cl^{-}$
MgO	Mg	O	2-	2-	2+	$Mg^{2+}O^{2-}$
Al_2O_3						
$FeCl_3$						
CuO						
ZnS						
$Ca(NO_3)_2$						
K_2SO_4						
$Al(OH)_3$						
$Fe_2(SO_4)_3$						
PbI_2						
MnO_2						
$NiCl_2$						
$Ba_3(PO_4)_2$						
Li_2CO_3						
Ag_2S						

Date: _______________

Writing Word Equations

Learning Intentions

- To learn how to write word equations of a described chemical reaction.

Success Criteria

☐ I can write word equations given the description of a chemical reaction.

Word equations

Word equations are a way to represent **chemical reactions** using the **names** of the **substances involved**, rather than their chemical symbols or formulas.

They provide a straightforward way to describe what happens in a chemical reaction, showing the **reactants** that are **used up** and the **products** that are **formed**.

In a word equation, the reactants are usually written on the left-hand side, the products on the right-hand side, and the two are separated by an arrow that signifies the direction of the reaction.

General Format:

Reactant ⟶ Product

For example:

When calcium carbonate is heated, it decomposes to form calcium oxide and carbon dioxide gas.

The word equation would be:

Calcium Carbonate ⟶ Calcium Oxide + Carbon Dioxide

Questions

Given the following description of a chemical reaction, write a word equation for each of the following:

1. **Write a Word Equation**: When hydrogen gas reacts with oxygen gas, water is formed.

→

2. **Write a Word Equation:** Sodium hydroxide solution is mixed with hydrochloric acid, resulting in the formation of sodium chloride and water.

→

3. **Write a Word Equation:** Magnesium metal reacts with hydrochloric acid to produce magnesium chloride and hydrogen gas.

→

4. **Write a Word Equation:** When carbon is burned in an excess of oxygen, carbon dioxide is produced.

→

5. **Write a Word Equation:** Zinc metal is added to a solution of copper sulfate, resulting in the formation of zinc sulfate and copper metal.

→

Date: _______________

Writing Chemical Equations

Learning Intentions

- To learn how write chemical equations.

Success Criteria

☐ I can write chemical equations given the word equation.

☐ I can write word equations given the chemical formula.

Chemical Equations

Unlike word equations, which use the names of the substances involved, chemical equations use the chemical **symbols** and **formulas**. This makes them much more informative and easier to work with for **calculations**.

If you are given the word equation, you can write the chemical equation by working out the formula for each compound involved.

You must remember which elements are **diatomic** to do this.

Step 1: Write the Word Equation
First, write down the word equation to describe the reaction:

Hydrogen + oxygen → water

Step 2: Replace each word with the formula
Next, replace the names of the reactants and products with their respective chemical symbols or formulas. (hydrogen and oxygen are diatomic)

$$H_2 + O_2 \rightarrow H_2O$$

Step 3: Add State Symbols (Optional)
You can add state symbols to indicate the physical state of each substance.

$$H_2(g) + O_2(g) \rightarrow H_2O(l)$$

Questions

For each of the following word equations, convert them into chemical equations. Remember to check if the element is diatomic, some compounds you may need to search for their formulae. *__There is no need to write the state symbols__*

1. Sodium + Chlorine → Sodium Chloride

										→										

2. Hydrogen + Nitrogen → Ammonia

										→										

3. Carbon + Oxygen → Carbon Dioxide

										→										

4. Methane + Oxygen → Carbon Dioxide + Water

										→										

5. Calcium Oxide + Water → Calcium Hydroxide

										→										

6. Iron + Oxygen → Iron(III) Oxide

										→										

7. Sulfur Dioxide + Oxygen → Sulfur Trioxide

										→										

8. Magnesium + Oxygen → Magnesium Oxide

										→										

9. Potassium + Water → Potassium Hydroxide + Hydrogen Gas

										→										

10. Copper + Silver Nitrate → Copper Nitrate + Silver

										→										

11. Calcium Carbonate → Calcium Oxide + Carbon Dioxide

										→										

Extension

Now make the word equation from the chemical equation.

1. $Na + Cl_2 \rightarrow NaCl$

										→										

2. $H_2 + O_2 \rightarrow H_2O$

										→										

3. $N_2 + H_2 \rightarrow NH_3$

										→										

4. $C + O_2 \rightarrow CO_2$

										→										

5. $Mg + O_2 \rightarrow Mg$

										→										

Date: ________________

Writing Chemical Equations – with state symbols

Learning Intentions

- To learn how to write chemical equations with state symbols.

Success Criteria

☐ I can write the chemical equation with state symbols.

☐ I can identify effervescence and precipitation reactions given state symbols.

State Symbols

State symbols are used in chemical equations to indicate the **physical state** of each **substance** involved in the reaction. These symbols are usually written as subscripts next to the chemical formula of the substance. Here are the most commonly used state symbols:

State Symbol	Meaning	Example Usage in a Chemical Equation
(*s*)	Solid	NaCl (*s*)
(*l*)	Liquid	H_2O (*l*)
(*g*)	Gas	O_2 (*g*)
(*aq*)	Aqueous (dissolved in water)*	NaCl (*aq*)

*If a substance is dissolved in water it is known as a **solution.**

Complete the table given the description and chemical name.

Description of Substance	***Chemical Formula with State Symbol***
Solid Sodium Chloride	
Sodium Chloride Solution	
Gaseous Water	
Liquid mercury	
Solid Iron(III) Oxide	
Aqueous hydrogen chloride	
Gaseous Oxygen	
Solid Zinc Sulfate	

Questions

Write the chemical equation for the following and include the state symbols.

1. Solid Sodium + Chlorine Gas → Solid Sodium Chloride

										→										

2. Liquid Water → Hydrogen Gas + Oxygen Gas

										→										

3. Solid Iron + Oxygen Gas → Solid Iron(III) Oxide

										→										

4. Solid Calcium Carbonate → Solid Calcium Oxide + Carbon Dioxide Gas

										→										

5. Solid Magnesium + Oxygen Gas → Solid Magnesium Oxide

										→										

6. Solid Sodium Carbonate + Liquid Water → Aqueous Sodium Hydroxide + Carbon Dioxide Gas

										→										

7. Solid Aluminium + Chlorine Gas → Solid Aluminium Chloride

										→										

8. Solid Potassium + Liquid Water → Aqueous Potassium Hydroxide + Hydrogen Gas

										→										

Remember back to the rates of reaction topic, we learned about effervescence and precipitation, now we can identify them using chemical equations with state symbols.

- **Effervescence**: The production of gas bubbles during a reaction, often observed as **fizzing** or **bubbling** in a liquid. This is a result of the formation of a **product** that is **gaseous (g)**

$$HCl(aq) + NaHCO_3(s) \rightarrow NaCl(aq) + \mathbf{CO_2(g)} + H_2O(l)$$

- **Precipitation**: The formation of a **precipitate** from a solution during a reaction. This occurs when two **soluble reactants**, they will we **aqueous** (**aq**), combine to form an **insoluble** product, this will be **solid** (**s**), that **settles** out of the solution.

$$AgNO_3(aq) + NaCl(aq) \rightarrow \mathbf{AgCl(s)} + NaNO_3(aq)$$

Identify the effervescence and precipitation reactions using the state symbols and list them below.

a. $AgNO_3(aq) + NaCl(aq) \rightarrow AgCl(s) + NaNO_3(aq)$

b. $H_2SO_4(aq) + NaOH(aq) \rightarrow Na_2SO_4(aq) + H_2O(l)$

c. $CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$

d. $2H_2(g) + O_2\ (g) \rightarrow 2H_2O(l)$

e. $Na(s) + H_2O(l) \rightarrow NaOH(aq) + H_2(g)$

f. $Ba(NO_3)_2(aq) + Na_2SO_4(aq) \rightarrow BaSO_4(s) + 2NaNO_3(aq)$

g. $C_6H_{12}O_6(aq) + 6O_2(g) \rightarrow 6CO_2(g) + 6H_2O(l)$

h. $Pb(NO_3)_2(aq) + 2KI(aq) \rightarrow PbI2(s) + 2KNO_3(aq)$

Effervescence reactions: ____

Precipitation reactions: ____

Using state symbols to visualise reactions

Using states symbols helps us visualise how the reaction occurs. Using the reaction below:

$$HCl(aq) + NaHCO_3(s) \rightarrow NaCl(aq) + CO_2(g) + H_2O(l)$$

In this equation, hydrochloric acid (HCl) is aqueous, sodium bicarbonate ($NaHCO_3$) is solid, sodium chloride (NaCl) is aqueous, carbon dioxide (CO_2) is gaseous, and water (H_2O) is liquid.

This means a solution of HCl (hydrochloric acid) was reacted with $NaHCO_3$ (sodium hydrogencarbonate. The products were an NaCl (sodium chloride) solution and CO_2 (carbon dioxide) gas and liquid water (H_2O).

- To visualize the reaction, imagine adding a solid lump or powder of sodium hydrogencarbonate to the acid. The mixture would effervesce, producing bubbles of carbon dioxide gas. Instead of an acid solution it is now a sodium chloride (salt) solution.

Sketch an image of this reaction below.

→

Date: _______________

Writing Balanced Chemical Equations

Learning Intentions

- To learn how to balance chemical equations.

Success Criteria

☐ I can balance chemical equations with simple compounds.

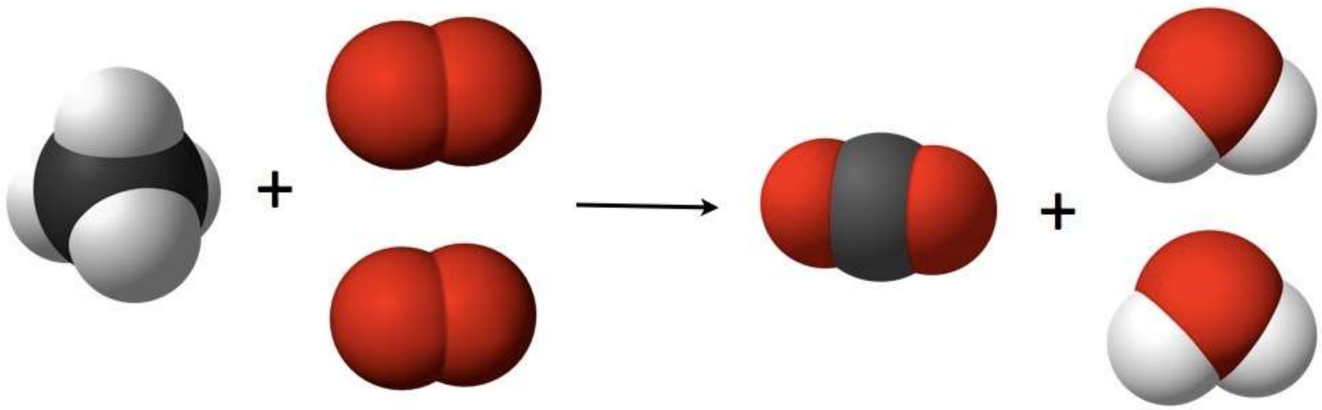
☐ I can balance chemical equations with compounds containing group ions.

Balanced Chemical Equations

When you write a **chemical** equation to use in **calculations** for the **quantities** of chemicals needed, you need to make sure you have the **same number** of each type of **atom** before and after the reaction happens. This is because atoms don't just **disappear** or get **created** from nowhere; they **rearrange** to form new substances.

Getting this right helps you understand how different chemicals react together. It's a fundamental skill you will need to practice.

Your teacher will show you how to balance chemical equations and a detailed step-by-step guide is shown on the following page.



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

Example Equation: **$H_2 + O_2 \rightarrow H_2O$**

Step 1: Write Down the Unbalanced Equation

$$H_2 + O_2 \rightarrow H_2O$$

Step 2: List and Count the Atoms

$$H_2 + O_2 \rightarrow H_2O$$

Element	Left Side	Right Side
H	2	2
O	2	1

Step 3: Balance the Atoms

Start with the element that is unbalanced and appears the least number of times in the equation. In this case, it's oxygen (O).

To balance the oxygen atoms, place a coefficient in front of H_2O:

$$H_2 + O_2 \rightarrow \mathbf{2}H_2O$$

Now update the table:

Element	Left Side	Right Side
H	2	~~2~~ 4
O	2	~~1~~ 2

Step 4: Continue Balancing

Next, balance the hydrogen atoms by placing a coefficient in front of H_2:

$$2H_2 + O_2 \rightarrow 2H_2O$$

Update the table again:

Element	Left Side	Right Side
H	~~2~~ 4	4
O	~~2~~ 2	2

Step 5: Check Your Work
Ensure that the number of atoms for each element is the same on both sides of the equation. If they are, your equation is balanced.

The balanced equation is: **$2H_2 + O_2 \rightarrow 2H_2O$**

Questions

Balance the following equations.

1. $\square H_2 + \square O_2 \rightarrow \square H_2O$

2. $\square N_2 + \square H_2 \rightarrow \square NH_3$

3. $\square Fe + \square O_2 \rightarrow \square Fe_2O_3$

4. $\square Na + \square Cl_2 \rightarrow \square NaCl$

5. $\square Mg + \square H_2O \rightarrow \square Mg(OH)_2 + \square H_2$

6. ☐Ca + ☐O_2 → ☐CaO

7. ☐P_4 + ☐O_2 → ☐P_4O_{10}

8. ☐Zn + ☐HCl → ☐$ZnCl_2$ + ☐H_2

When group ions are involved, just treat the group ion as a whole – do not separate it into individual elements. e.g. count how many "SO_4"s there are in the following, do not count S and O separately.

9. ☐Al + ☐$CuSO_4$ → ☐$Al_2(SO_4)_3$ + ☐Cu

10. ☐$AgNO_3$ + ☐KCl → ☐AgCl + ☐KNO_3

11. ☐ $Fe(NO_3)_3$ + ☐ $NaOH$ → ☐ $Fe(OH)_3$ + ☐ $NaNO_3$

12. ☐ $CuSO_4$ + ☐ $BaCl_2$ → ☐ $CuCl_2$ + ☐ $BaSO_4$

13. ☐ $Al_2(SO_4)_3$ + ☐ $NaOH$ → ☐ $Al(OH)_3$ + ☐ Na_2SO_4

14. ☐ Na_2CO_3 + ☐ HCl → ☐ $NaCl$ + ☐ H_2O + ☐ CO_2

Extension questions:
Chemcord purple books (N5): page 38 - 40
SCHOLAR

Topic	2015	2016	2017	2018	2019
Formulae	MC – 6,8 S2 – 6b	MC – 1 S2 – 6b	MC – 3,7 S2 –	MC – S2 –	MC – S2 – 11a,

MC = multiple choice section, S2 = section 2, the written section.