FORM 5 SCIENCE WEEK 2 NOTES

FORMUAE AND IONIC COMPOUNDS

- The formula of an ionic compound shows the ions present and the ratio of each ion in the compound.
- Ionic compounds are neutral if the total positive charges of the cations equal to the total negative charges of the anions.
- The cation is written (and named) first and the anion comes second.
- The charge on each of the ions is not shown when the ions are written as part of the formula of an ionic compound.

Example

1. Lead chloride is an ionic compound. Lead cations have +2 charge, chloride anions have a -1 charge. Therefore lead chloride contains 2 chloride ions for every lead ion, so the formula of lead chloride is $PbCl_2$.

2. Aluminium oxide is an ionic compound which has the formula Al_2O_3. The "Al_2" and "O_3" shows us that there are two Aluminium ion (Al^{+3}) for each Oxide ion (O^{-2}).

Writing the formulae of Ionic Compounds

To write the formula of an ionic compound, follow the three steps below.

Example: Formula for Sodium Carbonate

Step 1: From the name of the compound, identify the cations and the anion and write their symbol and charges.

Sodium	**Carbonate**
Na^+	CO_3^{-2}

Step 2: Balance the number of negative charge with the number of positive charges.

Na	*CO_3*	
+1	-2	
X 2	**x1**	
+2	**-2**	**(BALANCED)**

Therefore, two Na^+ would equal the charge of one CO_3^{-2}

Step 3: Write the formula with the cation first and the anion last, showing the ratio of each ion as subscript.

Formula for Sodium Carbonate = Na_2CO_3

Note: if the ratio of an atom is one, it is usually ignored and the subscript 1 is not included in the formula. Writing of subscripts begins at ratio 2.

BALANCING CHEMICAL EQUATIONS

For any reaction follow the steps below:

1. Identify the reactants and products by looking at the information given or observing the reaction carefully.
2. Write a **word equation**. In a word equation, the reactants and products are named.
3. Decide on the symbols and formulae for the reactants and products and write a chemical equation with these symbols and formulae.
4. **Balance** the equation if necessary.

Example:

When sulphur dioxide and oxygen react together sulphur trioxide forms.

Sulphur dioxide and oxygen are the reactants, while sulphur trioxide is the product.

- The **word equation** for the reaction is:

  Sulphur dioxide + Oxygen ⟶ Sulphur trioxide

- Putting in **chemical formula** gives:

  $SO_2 + O_2 \longrightarrow SO_3$ (unbalanced equation)

- Balancing the equation gives:

  $2SO_2 + O_2 \longrightarrow 2SO_3$

ACIDS AND BASES

- Acids and bases are 2 important groups of chemical compounds. They are used to produce a variety of products in the food, farming, plastics, building and many other industries.

Acids – *are substances which form acidic solutions with water.*

- Acidic solutions contain water and ions, particularly hydrogen ions, H^+.

Common Acids used in school laboratory are:

- Hydrochloric acid, HCl
- Sulphuric acid, H_2SO_4
- Nitric acid, HNO_3
- Acetic acid, CH_3COOH

Bases – *are substances that form alkaline solutions with water.*

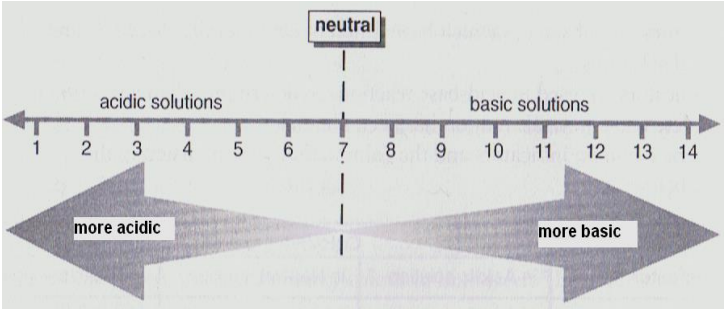
- Basic solutions contain water and ions, particularly OH^-.
- Bases neutralize acids by forming **WATER** and **SALT.**

Common Bases used in the laboratory are:

- Sodium hydroxide, NaOH
- Potassium hydroxide, KOH
- Calcium hydroxide, $Ca(OH)_2$
- Ammonia, NH_3

The pH scale

- Some acids are stronger than others and some bases are stronger than others.
- The strongest acids produce the highest concentration of hydrogen ions, H^+.
- Similar amounts of weaker acids produce lower concentrations of H^+ in a solution.
- Similarly, strong alkalis produce high concentration hydroxide ions, OH^- while similar amounts of weak ones produce low concentrations of OH^- in solution.
- The pH scale is used to measure how acidic or basic a solution is:



- Acidic solutions have pH values of less than 7.
- Basic solutions have pH values of more than 7.
- Neutral solutions at pH = 7.

ACID-BASE INDICATORS

Indicators – *are substances which have different colours in acidic, basic and neutral solutions.*

- Indicators are used in acid-base reactions to determine when a reaction is complete and a neutral solution has been obtained.
- Some common indicators and the colours they give are listed in the chart below.

Indicator	Colour		
	In Acid	In Neutral	In Base
1. Litmus Paper	Red	Green	Blue
2. Universal Indicator	Red, Orange, Yellow	Green	Blue, Purple
3. Phenophthalein	Colourless	Colourless	Pink

TYPES OF CHEMICAL REACTIONS

a) Decomposition Reaction

- a type of chemical reaction where a compound ***breaksdown*** when heated to form different compounds.

For example:

1. When Copper Carbonate ($CuCO_3$) is *heated*, it breaks down to form Copper Oxide (CuO) and Carbon dioxide(CO_2).

$$CuCO_3 \xrightarrow{decomposition} CuO + CO_2$$

ii) **Displacement Reaction.**

- A type of chemical reaction where one element (usually a cation) replaces another element during the reaction.

For example:

1. When Calcium Chloride reacts with Magnesium, it forms magnesium chloride and calcium.

$$CaCl_2 + Mg \longrightarrow MgCl_2 + Ca$$

iii) Combustion Reaction

- A type of chemical reaction that occurs when an element or compound is *burned* in oxygen gas,
- The product is often the oxide of the ***element*** being burned.

e.g $\underset{copper}{2Cu} + \underset{oxygen}{O_2} \longrightarrow \underset{copper\ oxide}{2CuO}$

$\underset{aluminium}{2Al} + \underset{oxygen}{3O_2} \longrightarrow \underset{Aluminium\ oxide}{2Al_2O_3}$

- In terms of ***hydrocarbons*** being burned, the product is often WATER and CARBON DIOXIDE gas.

$\underset{ethane}{C_2H_6} + \underset{oxygen}{O_2} \longrightarrow \underset{carbon\ dioxide}{CO_2} + \underset{water}{H_2O}$

iv) Hydrogenation Reaction

- A type of chemical reaction where a compound reacts with the element, hydrogen gas.

e.g $\underset{ethene}{C_2H_4} + \underset{hydrogen}{H_2} \longrightarrow \underset{ethane}{C_2H_6}$

- Hydrogen is one of the reactants.

v) Neutralization Reaction

- A type of chemical reaction that occurs when an ***acid*** reacts with a ***base***.
- The product formed is always WATER and SALT.

> ***SALT*** – refers to any compound that is made up of a cation and an anion e.g $MgCl_2$, Al_2O_3, ZnS.

For example:

1. When hydrochloric acid reacts with sodium hydroxide, it forms sodium chloride and water.

$$\underset{\text{hydrochloric acid}}{HCl} + \underset{\text{sodium hydroxide}}{NaOH} \longrightarrow \underset{\text{sodium chloride (SALT)}}{NaCl} + \underset{\text{water}}{H_2O}$$

2. When sulphuric acid reacts with calcium hydroxide, it produces calcium sulphate and water.

$$\underset{\text{sulphuric acid}}{H_2SO_4} + \underset{\text{calcium hydroxide}}{Ca(OH)_2} \longrightarrow \underset{\text{calcium sulphate (SALT)}}{CaSO_4} + \underset{\text{water}}{H_2O}$$

TESTING FOR THE PRESENCE OF GAS

The table below lists some of the important gases often tested in the laboratory, the method of testing for the presence of that particular gas and the expected outcome if the gas is present.

Name of Gas	How to Test?	Expected Outcome if present
1. Oxygen	Glowing splint	Glowing splint will light up to flame.
2. Hydrogen	Pop test	Pop sound will be heard
3. Carbon dioxide	Use limewater	Limewater will turn milky

Note:
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Self-check #4: Formulae and Ionic Compounds.

1. The chloride ion has 18 electrons and is charged -1.
   a) Write the symbol for the chloride ion.
   b) How many protons has the chloride ion?

2. The magnesium ion has 12 protons and is charged +2.
   a) Write down its symbol.
   b) Decide how many electrons the magnesium ion has.

3. What would be the charge on the following ions:
   a) An ion with 20 protons and 18 electrons.
   b) An ion with 10 electrons and 13 protons.

4. Write the symbols for the following ions:
   a) Magnesium ion
   b) Chloride ion
   c) Sodium ion
   d) Copper ion
   e) Oxide ion
   f) Potassium ion
   g) Nitrate ion
   h) Hydroxide ion

5. Name each of the following ions:
   a) Mg^{+2}
   b) K^{+}
   c) OH^{-}
   d) H^{+}
   e) HCO_3^{-}
   f) Cu^{+2}
   g) SO_4^{-2}
   h) CO_3^{-2}
   i) Cl^{-}
   j) Zn^{+2}
   k) Al^{+3}
   l) O^{-2}
   m) Na^{+}

6. Which of the following choice best represents the symbol for a chloride ion? Circle the best answer.
   A. Cl^{+}
   B. Cl_2
   C. Cl^{-}
   D. Cl

7. Name the following compounds:
   a) MgS
   b) $FeCl_3$
   c) $NaNO_3$
   d) $CuCO_3$
   e) ZnO
   f) $Pb(NO_3)_2$

8. Write the formula of the following ionic compounds.
   b) Copper (II) hydroxide
   c) Calcium chloride
   d) Lead oxide
   e) Magnesium nitrate
   f) Sodium hydrogen carbonate
   g) Iron (II) oxide
   h) Potassium carbonate

i) Aluminium nitrate

9. Circle the choice that best represent the correct formula for sodium sulphate.

   A. $NaSO_4$
   B. $Na(SO_4)_2$
   C. $(Na)_2SO_4$
   D. Na_2SO_4

10. The formula for ammonium carbonate is $(NH_4)_2CO_3$. The charge on the ammonium ion must be:
   A. -2
   B. -1
   C. +1
   D. +2

11. The ratio of aluminium ions to hydroxide ions in the compound aluminium hydroxide is:
   A. 1:1
   B. 1:3
   C. 2:1
   D. 3:1

12. Two atoms namely **X** and **Y** have the following components:

	Atom X	**Atom Y**
No. of protons	9	9
No. of neutrons	10	11
No. of electrons	9	9

   a) What is the atomic number of Atom X and Atom Y?
   b) Calculate the mass number of Atom X and the mass number of Atom Y.
   c) What chemical term can be used to describe Atom X and Atom Y?
   d) From the Periodic Table, what name would Atom X and Atom Y be?
   e) Give the ion formed by Atom X and Atom Y.

Self-check #5: Balancing Equations

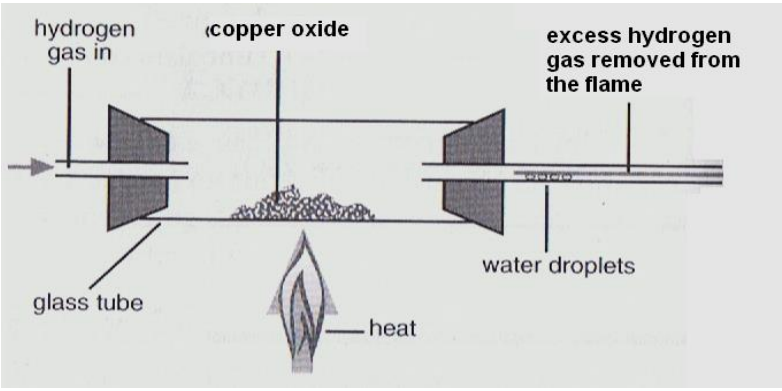
1. For each of the following symbols and formulae, write down how many of each type of atom is present.
   a) H_2
   b) CO_2
   c) C_3H_8
   d) $CuSO_4$
   e) Fe_2O_3
   f) Al_2O_3
   g) $Cu(OH)_2$
   h) $(NH_4)_2SO_4$

2. Write down the total number of atoms represented by the following symbols and formulae:
   a) $2NO_2$
   b) $2Ca_3(PO_4)_2$
   c) $2C_6H_{12}O_6$
   d) $3H_2O$
   e) $2CaCO_3$
   f) $4MgCl_2$
   g) $4NH_3$
   h) $5C_4H_{10}$
   i) $4Na_2CO_3$
   j) S_8
   k) $2CH_3OH$
   l) $2H_2SO_4$

3. Balance the following chemical equations:
   a) $C + H_2O \longrightarrow CO + H_2$
   b) $Mg + O_2 \longrightarrow MgO$
   c) $CH_4 + O_2 \longrightarrow CO_2 + H_2O$
   d) $CuO + H_2 \longrightarrow Cu + H_2O$
   e) $C_2H_6 + O_2 \longrightarrow CO_2 + H_2O$
   f) $Mg + H_2O \longrightarrow MgO + H_2$
   g) $Fe_2O_3 + CO \longrightarrow Fe + CO_2$
   h) $Fe + Cl_2 \longrightarrow FeCl_3$

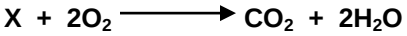
4. Write a balanced equation for each of the following reactions.
   a) Hydrogen gas reacts with oxygen gas forming water.
   b) Copper oxide reacts with hydrogen forming copper metal and water.
   c) Aluminium reacts with oxygen forming aluminium oxide.
   d) When calcium carbonate is heated, calcium oxide and carbon dioxide forms.
   e) Nitrogen gas reacts with hydrogen forming ammonia.
   f) Sulphur dioxide, SO_2 reacts with oxygen to form sulphur trioxide, SO_3.

5. When black copper oxide is heated strongly in the presence of hydrogen gas, a red-coloured solid forms, which is identified as copper metal. Drops of water form at the cooler end of the tube.



   a) Name the reactants.
   b) Name the products.
   c) Write a **word equation** for the reaction.
   d) Rewrite the word equation using chemical symbols.
   e) Is this equation balanced?

6. Sample X burns in air with a clear, almost colourless flame. No products are visible. The balanced equation for this reaction can be written as:



a) What chemical element must **X** contain?
b) Give the chemical formula of **X**.
c) Suggest a reason why no products are visible.

Self-check #3: Acids and Bases

1. Label the following solutions A to F as acid, alkaline or neutral.

Solutions	A	B	C	D	E	F
pH	9.3	4.2	1.4	7.0	11.8	6.9

2. From Q1 above, which sample is:
   a) The strongest acid?
   b) The weakest alkali?
   c) The weakest acid?
   d) Neither acidic nor alkaline.

3. Which one of the following indicators could NOT be used to find the pH of a substance?
   A. litmus C. starch
   B. limewater D. universal indicator

4. a) Name 2 common indicators that can be used to test for the presence of acid in food.
   b) Explain what would be the result or outcome of the test if acid is present in the food being tested.
   c) Name 3 acid commonly used in the lab.
   d) Name 3 common base used in the lab.