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MATTER AND MATERIALS

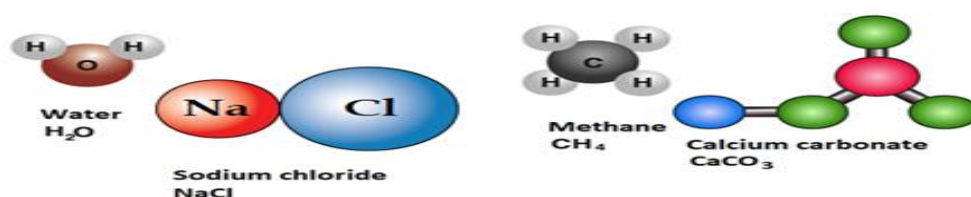
ELEMENTS AND COMPOUNDS

A COMPOUND

(a) A **chemical compound** is a chemical combination (bonding) of two or more atoms from different elements.

(b) A compound can be composed of many identical molecules.

EXAMPLES OF COMPOUNDS



ELEMENTS IN A COMPOUND

Complete the table below:

Name of the compound	Elements in the compound	Chemical formula
A. Water		
B. Carbon dioxide		
C. Ammonia		
D. Calcium carbonate (CaCO ₃)		
E. Glucose (C ₆ H ₁₂ O ₆)		
F. Table salt		
G. Baking soda / Calcium bicarbonate (NaHCO ₃)		

NAMING A CHEMICAL COMPOUND

- (a) There are mostly two part words in the name of a compound, e.g. MgO.
- (b) The first part in the name is for the first element in the compound, e.g. CO₂ – Carbon dioxide.
- (c) The second part in the name is for the second element in the compound and the number of the elements in that compound e.g. CO₂ Carbon dioxide i.e. two oxygen's.
- (d) The following words are used in the naming to indicate the number of atoms “di” for two, “tri” for three, “tetra” for four, “penta” for five, “hexa” for six, “hepta” for 7, “octa” for 8, “nona” for nine and “deca” for 10.
- (e) The first element is named as it is whereas the second element is slightly changed, e.g. NaCl becomes sodium chloride.
- (f) If a metal reacts with a non-metal, the metal comes first and the non-metal second, e.g. MgO, the name would be Magnesium oxide (Magnesium is a metal and it comes first and Oxygen is a nonmetal and it comes second) e.g. SiO₂ – silicon dioxide, NaCl – sodium chloride, NaI – sodium iodide, NaF – sodium fluoride, CuO – Copper oxide, Fe₂O₃ – iron oxide, MgO – magnesium dioxide.
- (g) If the compound has two non-metals, e.g. CO₂ the first part is for the element that is more to the left, in this case C or the one lying higher than the other and the ending changes to **-ide**, e.g. CO₂ - carbon dioxide, SO₂ sulfur dioxide, SO₃ - sulfur trioxide, etc.
- (h) If a metal reacts with two non-metals and one of them is oxygen the suffix (last part) becomes **-ate**, e.g. KNO₃ is potassium nitrate, Na₂CO₃ is sodium carbonate.
- (i) Another rule concerns transitional elements which have more than one ion, so that has to be indicated in the name, e.g. Iron (II) oxide or Iron (III) oxide.
- (j) Some compounds have polyatomic ions.

Polyatomic ion	Formula	Example	Name of the compound
Sulfate	SO ₄ ²⁻	MgSO ₄	Magnesium sulfate
Nitrate	NO ₃ ⁻	KNO ₃	Potassium nitrate
Phosphate	PO ₄ ³⁻	(NH ₄) ₃ PO ₄	Ammonium phosphate
Carbonate	CO ₃ ²⁻	CaCO ₃	Carbon carbonate
Ammonium	NH ₄ ⁺	NH ₄ Cl	Ammonium Chloride

Answer the following questions:

1. In the compound MgO what are the two elements?

2. What is the name of the compound MgO?

3. Which element is a metal and which one is a non-metal in the compound MgO?

4. Explain the meaning if the words “di”, “tri”, “tetra”, “penta”, “hexa”, “hepta”, “octa”, “nona” and “deca” in the naming of compounds.
5. What is the name of the compound NaCl?

6. What do we observe in the name of the compound NaCl?

7. What is the name of the compound MgCl_2 ?

8. Which rule is observed in the naming of a compound if the compound has two non-metals?

9. What are the names of the following compounds; NaCl, CuO, MgO, NaF, Si_2O and SO_2 ?

10. Are the elements in the compounds: NaCl, CuO, MgO, NaF, Si_2O and SO_2 metals or non-metals?

11. What happens to the name if the compound has a metal reacting with two non-metals and one of them is oxygen?

12. What are the names of the compounds: KNO_3 and Na_2CO_3 ?

13. Complete the table below:

Polyatomic ion	Formula	Example	Name of the compound
Sulfate	SO_4^{2-}	MgSO_4	
Nitrate	NO_3^-	KNO_3	
Phosphate	PO_4^{3-}	$(\text{NH}_4)_3\text{PO}_4$	
Carbonate	CO_3^{2-}	CaCO_3	
Ammonium	NH_4^+	NH_4Cl	

THE PERIODIC TABLE

1. What is the periodic table?

- It is a chart that organizes the elements by their increasing atomic numbers as well as by their **physical** and **chemical** properties.

2. Who is the father of the periodic table?

- A Russian chemist and inventor named Dmitri Mendeleev created the periodic table in 1869.

3. What ability did the periodic table have?

- The periodic table was designed to make room for and predict the existence of elements that had not yet been discovered.

INFORMATION ON THE PERIODIC TABLE

4. How is each element represented on the periodic table?

- Each element is represented by a chemical symbol (which is a capital letter or a capital letter and a small letter) with; the name of the element, the atomic number, the mass number and the physical state of the element.

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1. Complete The Periodic Table below by writing only the outstanding elements using a pencil without referring to the periodic table.
 2. Use the mnemonic to help you remember the elements.
 - A. Hi! He Lies Because Boys Can Not Operate Firearms.
 - B. New Nation Might Sign Peace Security Clause.
 - C. Arthur Kisses Carol.

Worksheet Periodic Table

Name: _____

School: _____ Class: _____

Periodic Table of the Elements

Fill in the blanks with the atomic symbols of the first 20 elements. And then write the element names in the blanks below.

Key:

Element name
Atomic number
symbol

1																	2
3	4											5	6	7	8	9	10
11	12											13	14	15	16	17	18
19	20	scandium 21 Sc 44.95591	titanium 22 Ti 47.867	vanadium 23 V 50.9415	chromium 24 Cr 51.9961	manganese 25 Mn 54.93805	iron 26 Fe 55.845	Cobalt 27 Co 58.9332	nickel 28 Ni 58.6934	copper 29 Cu 63.546	zinc 30 Zn 65.409	gallium 31 Ga 69.723	germanium 32 Ge 72.64	arsenic 33 As 74.9216	selenium 34 Se 78.96	bromine 35 Br 79.904	krypton 36 Kr 83.798
rubidium 37 Rb 85.4678	strontium 38 Sr 87.62	yttrium 39 Y 88.90585	zirconium 40 Zr 91.225	niobium 41 Nb 92.90638	molybdenum 42 Mo 95.94	technetium 43 Tc [98]	ruthenium 44 Ru 101.07	Rhodium 45 Rh 102.9055	palladium 46 Pd 106.42	silver 47 Ag 107.8682	cadmium 48 Cd 112.411	indium 49 In 114.818	tin 50 Sn 118.710	antimony 51 Sb 121.760	tellurium 52 Te 127.60	iodine 53 I 126.9045	xenon 54 Xe 131.293

- | | | | |
|-----------|------------|------------|------------|
| (1) _____ | (6) _____ | (11) _____ | (16) _____ |
| (2) _____ | (7) _____ | (12) _____ | (17) _____ |
| (3) _____ | (8) _____ | (13) _____ | (18) _____ |
| (4) _____ | (9) _____ | (14) _____ | (19) _____ |
| (5) _____ | (10) _____ | (15) _____ | (20) _____ |

ARRANGEMENT OF ELEMENTS ON THE PERIODIC TABLE

- (a) To date there are 118 elements in the periodic table.
- (b) The elements in The Periodic Table are arranged according to their increasing atomic numbers.
- (c) There are 18 groups (columns) and 7 periods (rows).
- (d) Elements in the same group have the same number of electrons in the outer orbital (valence electrons).
- (e) Elements in the same period have the same number of atomic orbitals.

Uses of the elements:

1. hydrogen - a primary constituent of water
2. helium - many high-tech solutions, balloons for all sectors
3. lithium - Constituent of thermonuclear weapons;
4. beryllium - Many high-tech uses. Non-sparking drill bits/saw blades. Poisonous. Constituent in nuclear weapons.
5. boron - cleaning material
6. carbon - Charcoal, everyday fuel; graphite (pencils) and diamonds (best friends).
7. nitrogen - Keeps oxygen from burning the world up. Found in fertilizers, most explosives, rocket fuels.
8. oxygen - vital constituent of the air we breathe, component of fire, etc.
9. fluorine – tooth pastes
10. neon - used in signage
11. sodium – In table salt, necessary to the body for nerve operation;
12. magnesium - alloy component;
13. aluminum - widely used for light metal structures.
14. silicon – In almost all electronics
15. phosphorous - proteins and in DNA itself, matches, etc.
16. sulfur – In many explosives, for growth fertilizer;
17. Chlorine - bleaching/oxidization agent, disinfecting water or killing microorganisms in water, etc.
18. Argon - component of the atmosphere;
19. Potassium - vital to nervous system function; important mineral for good plant growth.

20. Calcium - component of most all plasters, animal bones, teeth and eggshells.

Answer the following questions:

1. How many elements are there in the Periodic Table of Elements?

2. How are the elements in The Periodic Table of Elements arranged?

3. Discuss the number of groups and periods in the periodic table.

4. What do elements in the same group have in common?

5. What is the relationship between elements in the same period?

FIND THE PLACES USING THE PERIODIC TABLE OF ELEMENTS

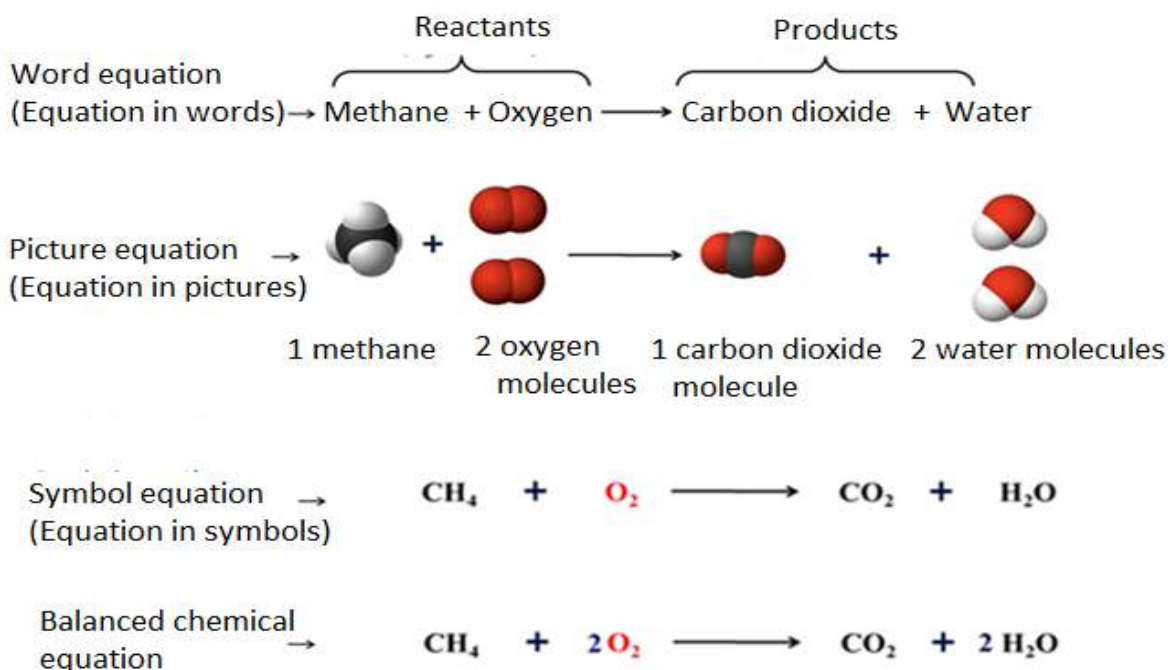
1. Complete the table by using the atomic numbers to find the country

Atomic Numbers of Elements in the Periodic Table	Country
95 68 53 20	AmErICa
16 91 53 7	SPaIN
85 2 7 16	AtHeNS
84 57 60	PoLaNd
10 90 68 57 60 16	
74 13 99	
9 88 7 58	
6 1 53 11	
18 32 7 22 11	
35 53 73 53 7	
15 68 92	
9 49 57 60	
91 19 53 16 73 7	

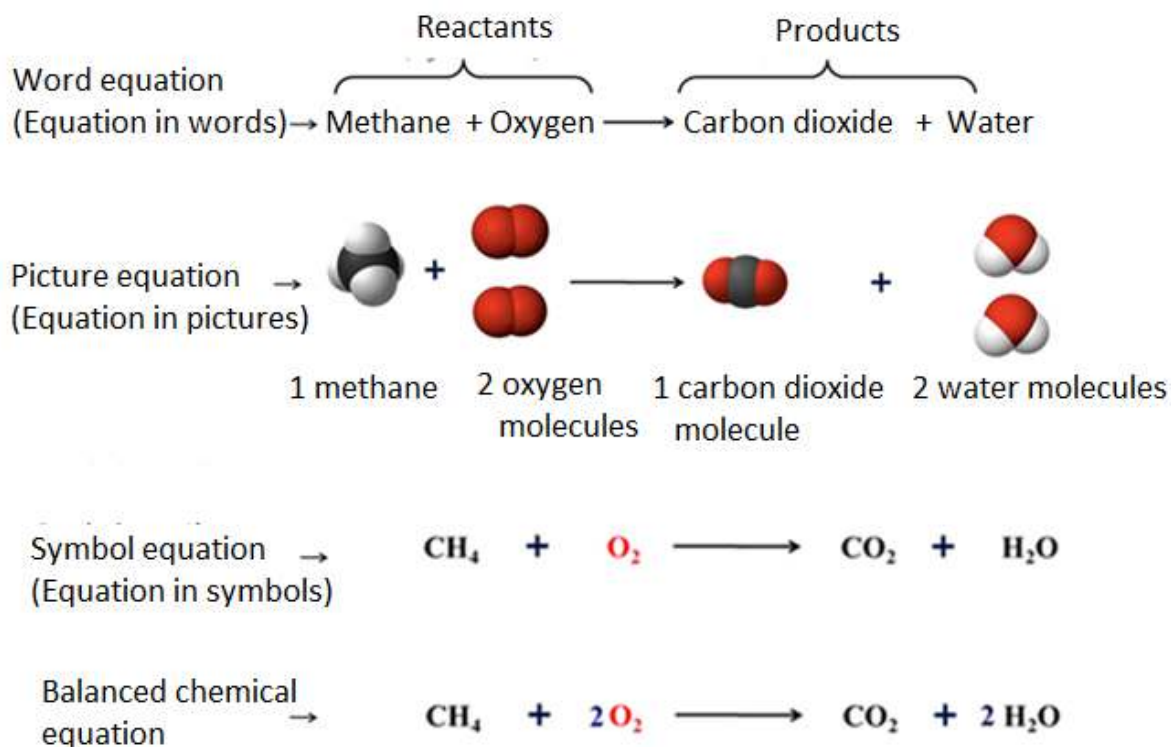
2. Try and write your name using atomic numbers. _____

CHEMICAL REACTIONS: CHEMICAL EQUATIONS TO REPRESENT REACTIONS

- When we represent a chemical reaction in terms of chemical formulae (symbols), it is called a **chemical equation**. $C + O_2 \rightarrow CO_2$
- (a) Chemical reactions are usually represented with symbols:
- (b) What is a chemical reaction? A **reaction** or **chemical reaction** is a **chemical** change which results in the formation of new substances.
- (c) When a chemical equation is expressed in words, it is called a **word equation**.
- (d) When an equation is expressed using pictures or even models, it is a **picture equation**.
- (e) When symbols are used to represent chemical reaction, it is known as **symbol equation**.



Answer the following questions:



1. In the diagram above, what type of equations are represented by A, B and C?

2. In equation B, how many oxygen atoms are shown on the left of the equation?

3. How many carbon atoms (C) are on the right of the equation?

4. Write a word equation for: $2\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O}$

BALANCING EQUATIONS

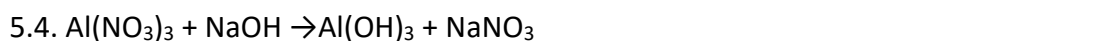
- According to the law of conservation of matter, "**matter is neither created nor destroyed.**" As a result a chemical equation must have **equal numbers of atoms of the same kind** on both sides of the equation.

Answer the following questions:

- A _____ tells the story of a chemical reaction. _____ are the starting substances in the reaction while _____ are the new substances that are formed.
- The large numbers in front of some of the formulas are called _____. These numbers are used to _____ the equation because chemical reactions must obey the Law of _____ of Matter.
- State the law of conservation of matter.

- The number of atoms of each element on both sides of the equation must be _____ because matter cannot be _____ or _____.
- When balancing equations, the only numbers that can be changed are _____; remember that _____ must never be changed in order to balance an equation.

5. Balance the following equations:



Reactions of metals with oxygen: The general reaction of metals with oxygen

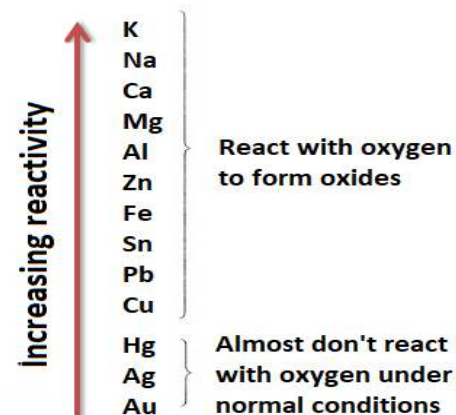
- (a) Not all but some metals react with oxygen during burning (combustion)
- (b) A metal reacting with oxygen forms a metal oxide.
- (c) The **general equation** for the reaction between a metal and oxygen is always:



REACTIONS OF METALS WITH OXYGEN

Answer the following questions:

1. Magnesium + oxygen $\rightarrow$ _____
2. Magnesium + _____ $\rightarrow$ _____
3. Iron + oxygen $\rightarrow$ _____
4. Iron + _____ $\rightarrow$ iron oxide
5. What is steel wool mainly made of? _____
6. During the reaction of metals with oxygen, the oxygen gas can / cannot _____ be seen.
7. What do we call reactions where a substance burns in air? _____
8. The product of magnesium + oxygen looks like is (soft / hard) _____ in a form of a (liquid / solid / gas) and is (white / black / yellow) _____ in colour.
9. Study the diagram and answer the questions that follow.



Reactivity series of metals with oxygen

- 9.1 Which metal do you think reacts more with oxygen?

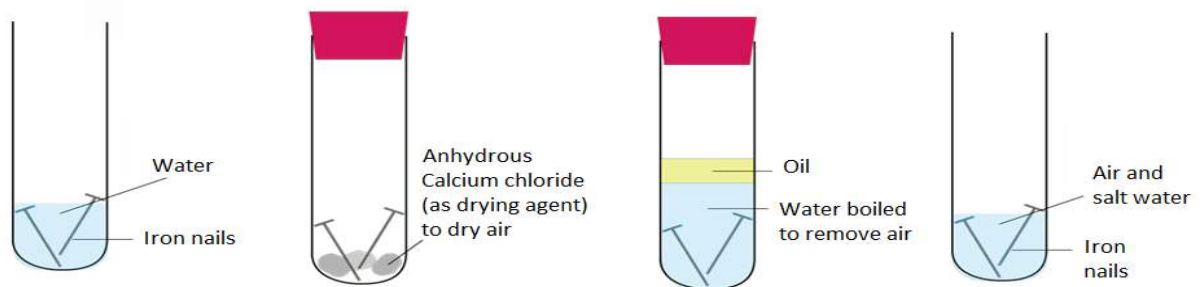
- 9.2 What is the meaning of increasing reactivity?

- 9.3 Do all metals react with oxygen? Discuss your answer by referring to the diagram.

- 9.4 Briefly explain the reactivity series of metals with oxygen using the diagram.

FORMATION OF RUST

- (a) Rust is a form of **iron oxide** that forms when iron and materials made from iron are exposed to **air**.
- (b) Rust forms on iron and **steel** when exposed to **water** and **oxygen**.
- (c) Both water and oxygen are needed for **rust** to occur.
- (d) Sea water corrodes metals about five times faster than fresh water.
- (e) Electrolyses reactions due to the salty water causes the metal to corrode even faster.
- (f) The product forming on iron will be **iron oxide**.



Answer the following questions:

1. What are the two requirements for rust to occur? _____
2. What do you think is the use of the drying agent?

3. Why must the water in C be boiled? _____

4. Discuss why rust will not occur in all the four test tubes by also mentioning where it will occur or not occur.

5. Dado noticed that cars in the coastal areas (near the sea) rust faster than in the inland. Explain the possible reason for that.

WAYS TO PREVENT RUSTING

There are two ways of preventing rust:

- (a) Physical protection
- (b) Chemical protection

Some of the methods used:

- (a) Keeping away from moisture.
- (b) Painting and cleaning of the material.
- (c) Protective coating / galvanizing the material.
- (d) Plating or covering with a thin coat.
- (e) Heat treat - a process of heating materials to a certain temperature to change its physical and chemical properties, like changing a soft material to hard material, e.g. treated poles.

1. Discuss some of the methods listed that you know about.

2. Discuss the effects of rust by mentioning the economic and the material effect on materials.

3. **Galvanized pipes** are steel pipes that have been dipped in a protective zinc coating to prevent corrosion and rust. Galvanized piping was commonly installed in homes built before 1960. When it was invented, galvanized pipe was an alternative to lead pipe for water supply lines. Today, however, we have learned that decades of exposure to water will cause galvanized pipes to corrode and rust on the inside.

- 3.1 What are galvanized pipes?

3.2 Elaborate whether galvanized pipes corrode or not.

4. Siba and Karen conducted an investigation over a week and recorded their findings in the table below:

Conducted over a period of one week



Material used	Conditions	Observation
(a) Iron metal A	Normal air	Some rust
(b) Iron metal B	Air and no water	No rust
(c) Iron metal C	Water and dissolved air	Rusty
(d) Iron metal D	Water but no air	No rust
(e) Iron metal E	Water, air and salt	Very rusty

4.1 What conclusion can be drawn from their findings?

REACTIONS OF NON-METALS WITH OXYGEN

The general reaction of non-metals with oxygen

- (a) Non-metals react with oxygen to form non-metal oxides
- (b) Any non-metal is burnt in excess oxygen or react with oxygen, the general equation is always:
- non-metal + oxygen → non-metal oxide**
- (c) Coal is a form of carbon used as **fuel** for energy and is one of the primary **fossil fuels** that humans use to **generate** electricity.

Write the chemical equations for:

1. carbon + oxygen → carbon dioxide

2. sulphur + oxygen → sulphur dioxide

3. Balance the following equation: $P + O_2 \rightarrow P_2O_5$

4. When a non-metal reacts with oxygen the product of the reaction is a

5. For each of the following reactions, complete the tables by providing the missing equations:
 - 5.1 Reaction between oxygen and carbon:
 - (a) Write the word equation
 - (b) Draw the picture equation
 - (c) Write the chemical equation
 - 5.2 Write the chemical equation for the reaction between sulphur and oxygen.

The concept of pH value

Reactions of acids with bases: Part I Neutralisation and pH

- (a) When an acid reacts with a base it is called a neutralisation reaction.
- (b) A base reacts with an acid, to make it less acidic at the same time an acid reacts with a base, to make it less basic.
- (c) If we add a base to an acid, the pH of the resulting solution will increase
- (d) Non-metal oxides tend to be acidic (low pH)

Answer the following questions:

1. What do we call the reaction between a base and an acid?

2. Qhawe wanted to observe the change in pH in a reaction between vinegar and baking soda. Which one between the two reactants is an acid and which one is a base?

3. Qhawe observed that the pH of the two substances decreased as she kept on adding vinegar. Discuss why this is the case.

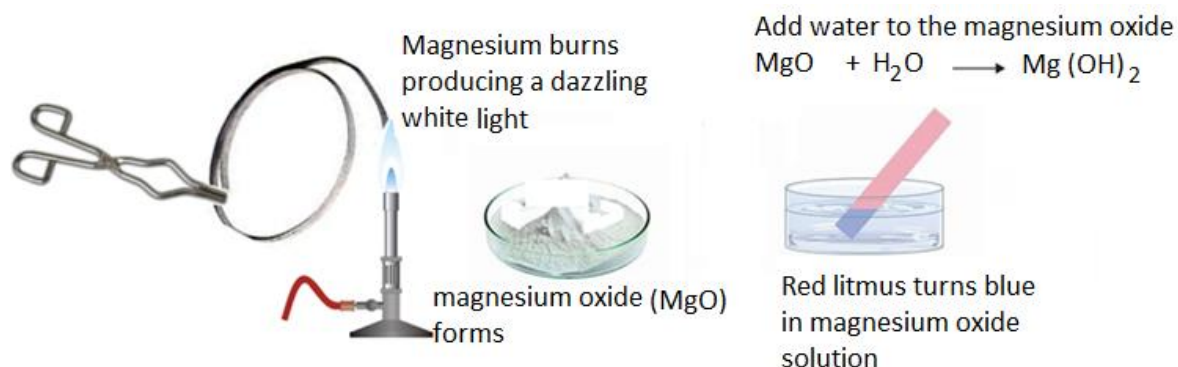
4. If we add a base to an acid, what will happen to the pH of the mixture?

5. What does it mean when the pH increases or decreases?



The general reaction of an acid with a metal hydroxide (base)

- (a) Metals reacting with *water* form hydroxides which are bases.
- (b) Acid reacting with a metal hydroxide produce *salt* and *water*.
- (c) The salt formed depends on the acid and metal oxide used.
- (d) The general equation is: **acid + metal hydroxide salt + water**



6. Test the pH of magnesium oxide dissolved in water using a universal indicator or a litmus paper. What is the pH you observed?

7. Discuss the how magnesium burns in oxygen by referring to the diagram shown above.

INVESTIGATION

Neutralisation of NaOH with dilute Hydrochloric acid (HCl)

Acid – base reactions produce **water** and **a salt**.

The salt will be determined by the acid used i.e. HCl the salt will be a chloride and H_2SO_4 the salt will be a sulfate.

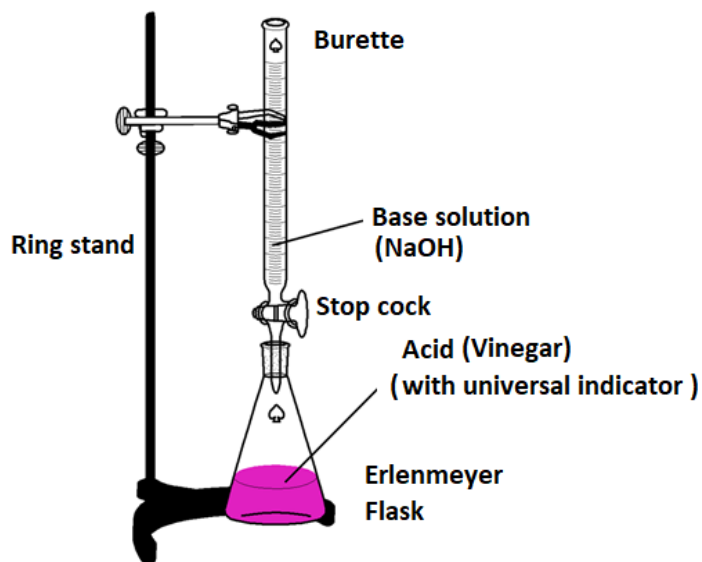
Acid + base $\rightarrow$ salt + water

Aim: To find the point at which the base completely neutralises the acid.

Method:

1. Assemble your apparatus as shown in the figure.
2. Handle your apparatus with great care.
3. Prepare 50 ml solution of Sodium hydroxide (NaOH).
4. Put 50ml of base in the burette.
5. First learn how to take a reading from a burette.
6. Open the stop cock to allow the base into the flask
7. Close the stop cock as soon as the indicator changes from yellow to red.

Acid - Base Titration



Or

Method

1. Put 20 ml vinegar into a glass beaker.
2. Prepare 50 ml base in a beaker.
3. Use a medicine dropper to add the base onto the vinegar.
4. Stop adding vinegar as soon as the indicator changes from yellow to green.
5. Calculate how much vinegar and base were used in the investigation.

Results: _____

Conclusion: _____

Answer the following questions:

1. What was the aim of the investigation?

2. What do we call the reaction between an acid and a base?

3. What is the general equation for an acid-base reaction?

4. Which indicator was used in this investigation?

5. Identify your acid and your base in the substances used for this reaction.

6. What volumes of acid and base were used in this investigation?

7. What was colour change indicated the end point?
