BASIC SCIENCE

JS TWO SECOND TERM NOTES

INSTRUCTION
COPY THE FIRST TWO TOPICS

WEEK ONE
PHYSICAL GROWTH AND DEVELOPMENT

Growth can be defined as an irreversible or permanent increase in size or dry mass of a living organism as a result of food intake, cell division, cell elongation and differentiation. There are two main types of growth, these are:

1. Limited Growth: this is the type of growth that does not continue throughout life. It stops at maturity. This takes place in man and other animals.
2. Unlimited Growth: this is the type of growth that continues throughout life until the organism dies. This type of growth takes place in plants, most invertebrates and some vertebrates.

GROWTH PATTERN IN MAN

In Human beings, growth increase is higher at initial stage and gradually reduces until it stops. There are two periods of rapid growth in man. They are:
i) Infancy stage (0-2years).
ii) Adolescence stage (9-20years).

In humans, boys and girls show different growth patterns. At the early stage, girls grow faster than the boys, that is, between the ages of 10 to 14 years; then from 15-20years, the boys grow faster than the girls.

Development

Development is the emergence of an individual's ability to function well in a particular environment; It is also seen as the gradual changes that occur in living organisms as they come to maturity. Development involves a gradual process that leads to maturation of function, social and emotional behavior and acquisition of skills as we are growing. These changes (e.g. during the age of puberty) that take place in our body shows that we are developing.

Maturity: an organism or individual is said to be matured if he has attained sufficient development, such that he can perform certain functions. In other words, an organism is said to be matured if such an organism has developed sufficiently and is ready to perform a particular function.

DEVELOPMENTAL STAGES IN HUMAN LIFE

There are four developmental stages in human life. They are: -
i) Infancy stage, 0-2 years
ii) Childhood stage, 3-8 years
iii) Adolescence stage, 9-20 years
iv) Adulthood stage, 21-65 years and above

CHARACTERISTICS OF THE INFANCY STAGE

The new born baby is known as a Neonate. The characteristics features of this stage include.
i) Development of locomotory structure; i.e. to sit, crawl, walk etc.
ii) Language development start, i.e. speaking.
iii) The child cries at all times.
iv) The head is often huge in proportion to the rest of the body.
v) Teething begins. (Appearance of milk teeth).
vi) The bones are soft and flexible.
vii) Fixing their eyes on light.
viii) Controlling the arm and feet.
ix) Learning how to hold objects, touch objects and look at what they hear.
X) Noticeable rapid growth.

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xi) Inability to distinguish various odours and tastes.

CHARACTERISTICS OF CHILDHOOD STAGE

i) Development and expansion of language.
ii) Accepting any idea without thinking out.
iii) Growth rate reduce at lower rates.
iv) The cartilages in the skeleton are being replaced by bones.
v) Milk teeth are being replaced by permanent teeth.
vi) The ability to control movement increases.
vii) The sizes and numbers of bones increase and become harder.

CHARACTERISTICS OF ADOLESCENCE STAGE

(i) Rapid growth
(ii) Appearance of secondary sexual characteristics in both and girls.
(iii) Adolescents think and behave like adults.

CHARACTERISTICS OF ADULTHOOD STAGE

This is the stage when the body has grown to full height and size. The characteristics of this stage include:

(i) They think logically and coherently
(ii) They are independent and more responsible.
(iii) Marriage and rearing of children starts.
(iv) It is a peak of physical development, as the muscles, blood, heart, lungs operate at maximum efficiency.
(v) In the late 50's the body begins gradual physical decline.
(vi) At late adulthood, weakness of bones and organs occurs.

DIFFERENCES BETWEEN GROWTH AND DEVELOPMENT

S/No	GROWTH	DEVELOPMENT
1.	Refers to changes in one particular aspect of the body.	Implies to changes in the organism as a whole.
2.	Ceases at maturity in man	Continues till the end of life.
3.	It is structural (quantitative)	It is functional (qualitative)
4.	Can be estimated by measuring height or weight in cm or grams.	It cannot be measured.
5.	Does not follow a particular order	Follows directional pattern

FACTORS AFFECTING GROWTH AND DEVELOPMENT

(1) Food.
(2) Diseases
(3) Hereditary factors (genes).

Every individual has tiny substances in their cells called Genes. (this is a segment of DNA found on the chromosomes and are responsible for transmission of hereditary characters from parents to off springs). Through the impact of genes, tall parents or short parents are likely to have tall or short children.

(4) Effect of Glands:

Glands are structures in organisms that secrete specific chemical substances called hormones. Growth and development in animals may be affected by the hormones produced by two major glands found in the endocrine system in the body. These glands are:

(1) Pituitary gland
(2) Thyroid gland

(1) Pituitary Gland:

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This gland is located at the fore head. It has a very important effect on growth. It is known as the 'master gland', because its secretions control other glands in the body. It produces an important hormone called Growth stimulating hormone (also called Pituitarin).

Over secretion of this hormone causes GIGANTISM, while under secretion causes DWARFISM.

(2) Thyroid Gland:

It also has a strong effect on growth. It is found in the neck region, and it secretes a hormone called Thyroxin, which stimulates the rate at which glucose is oxidized or broken down in our body and also affects mental growth.

Over secretion of thyroxin causes hyperactivity, high rate of metabolism, loss of weight and bulging eyes.

Under secretion of thyroxin causes cretinism in children and myxoedema in adults. A person suffering from cretinism is called a cretin. Some notable features of a cretin include; mental retardation, sexual immaturity, thick dry skin, enlarged and protruding tongue, large head with broad nose, short arm and legs compared to the rest of the body.

Deficiency of Iodine in diets results in the swelling of the thyroid gland. A condition referred to as Goitre. Iodine diet or supplement is essential to avoid this ailment.

WEEK TWO

FOOD NUTRIENTS

There are six classes of food nutrients. They are:

i) Carbohydrate
ii) Protein
iii) Fat and oil or Lipids
iv) Vitamins
v) Mineral salt
vi) Water

CARBOHYDRATES

These are energy giving foods. They are generally called Sugar. The elements that make up carbohydrates are Carbon, Hydrogen and Oxygen. The Hydrogen and Oxygen are combined in the ratio of 2:1. Carbohydrates have a general formular of $C_x (H_2O)_y$

TYPES OF CARBOHYDRATES

There are three types of carbohydrates. These are:

(1) Simple sugar or Reducing sugar or Monosaccharide:

These are carbohydrates that consist of one sugar molecule. This sugar is common in plants and animals. They are colourless, and soluble in water. Three common examples of monosaccharide are:

i) Glucose
ii) Fructose (Fruit sugar)
iii) Galactose

They have a chemical formular of $C_6H_{12}O_6$.

(2) Complex or non – reducing sugar or Disaccharide:

These are carbohydrates that are made up of two molecules of monosaccharide. They are formed by the condensation or joining together of two Simple sugar. When heated with dilute hydrochloric acid, they are broken down into Simple sugar; this process is known as hydrolysis. The chemical formula of disaccharides is $C_{12}H_{22}O_{11}$

Examples include:

i) Sucrose – Also known as Cane sugar.
ii) Lactose: also known as Milk sugar.
iii) Maltose: also known as Malt sugar.

(3) Polysaccharides

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These are carbohydrates that are made up of three or more monosaccharide molecules. The common examples are:

a. Cellulose – found in plant tissues.
b. Starch – also, found in plants
c. Glycogen – found in animals
d. Cotton wool.

It should be noted that too much of carbohydrates causes obesity; and lack of carbohydrates in the body results to tiredness, weakness or fatigue.

PROTEIN

The simplest unit of protein is amino acid. The elements that make up Proteins are Nitrogen, Sulphur, Oxygen, Hydrogen, Carbon, and Phosphorus.

Deficiency of protein in diets causes kwashiorkor. A child suffering from this will have poor growth, loss of weight, swollen legs, Oedema, thin limbs, swollen stomach, change of hair colour, pale body and split skin. Marasmus occurs in children below the age of one, when there is lack of both carbohydrate and protein in diets.

FAT AND OIL/LIPIDS

They are substances found in both plants and animals. The smallest unit of fat and oil is fatty acid and glycerol. Like carbohydrates, the elements that make up fat and oil are carbon, hydrogen and oxygen. The oxygen present in fats is of smaller proportion when compared with oxygen in carbohydrates.

VITAMINS

These are organic substances that are required in smaller quantities for maintenance of healthy body functions. There are two groups of vitamins. These are:

a. Fat soluble vitamins: they are vitamins A, D, E and K.
b. Water soluble vitamins: they are vitamins B and C.

S/NO	VITAMIN	MAIN SOURCE	FUNCTION	DEFICIENCY
1.	A (Retinol)	Green vegetable, liver, egg, egg yolk, red palm oil carrot, red	For proper vision in dim light	1. Dry scaly skin 2. Night blindness.
2.	Vitamin B. complex (B1, B2, B5, B6, B12)	Yeast, Egg yolk, liver Groundnut and water.	Good growth and proper functioning of the heart and muscles.	I) Beriberi ii) Pellagra
3.	C (Ascorbic acid)	Fresh fruit, e.g. mango, orange, banana, apple, and leafy vegetable.	Aids healing of wound and help to resist infection.	Scurvy
4.	D (Calciferol)	Liver, Egg yolk, morning sunlight.	Proper development of bone and teeth.	Rickets. That is softening of bones.
5.	E (Tocopherol)	Vegetable, Egg, Liver oil	Concerned with reproduction.	Sterility and absorption in some animals.
6.	K (Phylioquinone)	Fruits and green vegetable.	Aids blood clotting	Inability of blood to clot or Haemophilia

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MINERAL SALTS

They are required in small quantities for growth and development and regulation of metabolic processes in the body.

S/NO	TYPES	FUNCTION	SOURCE	DEFICIENCY
1.	Calcium	Formation of strong bones and teeth.	Milk and meat	Rickets
2.	Phosphorous	Constituent of bone cell	Meat, Egg etc.	Rickets
3.	Iodine	Normal formation of thyroid	Fresh and dry sea food.	Goitre/ Cretinism in children
4.	Iron	Formation of haemoglobin	Grains and liver, vegetable, kidney etc.	Anaemia
5.	Copper	Formation of red blood cells	Liver and nuts	Anaemia

FOOD TEST

This is a way of finding out the type of food nutrient present in a particular food sample. They include:

1) Test for simple / reducing sugar, e.g. Glucose.
   Reagents used are:
   a. Fehling's solution.
   b. Benedict's solution

TEST	OBSERVATION	INFERENCE
To 30cm^3 of glucose solution in a test tube, add few drops of Fehling's solution A or B and heat	It changes from colourless solution to brick red precipitate	Glucose is present and confirmed.
To 30cm^3 of glucose solution in a test tube, add few drops of Benedict's solution and heat	Colourless to light blue. On heating, changes to orange or yellow precipitate	Glucose is present and confirmed.

2) Test for Complex / Non-reducing sugar, e.g. sucrose.
   Reagents used are:
   a. Dilute hydrochloric acid (HCl)
   b. Sodium hydroxide (NaOH)
   c. Benedict's solution.

TEST	OBSERVATION	INFERENCE
Sucrose + dilute HCl acid + few drops of sodium hydroxide (NaOH), shake and add a few drops of Benedict's solution and heat.	Colourless solution. On adding Benedict's solution turns to light blue; and on heating, changes to orange yellow precipitate.	Sucrose is present and confirmed. Note: HCl is used to carry out hydrolysis and NaOH is to neutralize the acid.

3) Test for starch
   Reagent: Iodine solution.

TEST	OBSERVATION	INFERENCE
Add few drops iodine solution to boiled yam.	Blue black colour observed.	Starch present and confirmed.

Cellulose: Add concentrated H_2SO_4 (hydrogen tetraoxo sulphate (vi) acid)	Blue precipitate	Cellulose present and confirmed

TEST FOR PROTEIN

TEST	OBSERVATION	INFERENCE
1. Millon's test: To egg albumen, add few drops of Millon's reagent and heat.	A white precipitate which quickly turns to red precipitate on heating.	Protein present and confirmed.
2. Biuret test: To milk solution, add sodium hydroxide (NaOH), then 1% of copper. (ii) sulphate and shake thoroughly	Purple or violet colour appears	Protein present and confirmed.

TEST FOR FAT AND OIL

TEST	OBSERVATION	INFERENCE
1. To groundnut oil in a test tube, add few drops of Sudan (III) solution and shake.	A red colouration is formed	Fat and oil are present and confirmed
2. Rub oil/fat on a white paper and hold it against a light background	Translucent marks appear.	Fat and oil and confirmed.

WEEK THREE

NON-LIVING COMPONENTS OF THE ENIVORNMENT

The living and non-living components of the environment are constantly interacting. These interactions bring about certain changes in matter.

There are two major types of changes undergone by matter, namely:

i) Physical change or temporary change.
ii) Chemical change or permanent change.

PHYSICAL CHANGE

A physical change is a change that is easily reversible and in which no new substance is formed as a result of the change.

Examples of physical changes are;

i) Melting of candle wax
ii) Melting of ice
iii) Mixing of salt in water
iv) Boiling of water until it changes to steam
v) Freezing of water to ice
(vi) Magnetization and demagnetization of iron.

CHEMICAL CHANGE

A chemical change is a change that is irreversible, and in which new substances are formed as a result of the change.

Examples of chemical changes are;

i) Burning of wood, paper, cloth, plastic etc.
ii) Rusting of nail, zinc roofing sheet etc.
iii) Decaying of leaves.
iv) Mixing acid with base.
v) Heating sugar to form caramel.
vi) Digestion of food.

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DIFFERENCES BETWEEN PHYSICAL CHANGE AND CHEMICAL CHANGE

S/No	**Physical change**	**Chemical change**
1.	No new substances are formed.	New substances are formed.
2.	It is easily reversible	It is not easily reversible.
3.	There is no change in the mass of the substance undergoing the change.	There is change in the mass of the substance undergoing the change.
4.	It does not involve any great heat change.	Heat change is usually involved to a considerable extent.

ELEMENTS, COMPOUNDS AND MIXTURES

1. **Element:**

An element is a substance which cannot be split into simpler substances by an ordinary chemical process. Examples are Oxygen, Nitrogen, Carbon, Fluorine, Sodium, and Zinc. Elements are usually represented with chemical symbols.

2. **Compound:**

A compound is a substance that consists of two or more elements chemically combined. Examples are, Carbon (iv) oxide (CO_2) Carbohydrate ($C_6H_{12}O_6$), Clay, Urea, Common Salt etc. Compounds are represented with chemical formula.

S/No	**Compound**	**Constituent elements**	**Formula**
1.	Water	Hydrogen and Oxygen	H_2O
2.	Sand	Silicon and Oxygen	SiO_2
3.	Limestone	Calcium, Carbon and Oxygen	$CaCO_3$
4.	Common salt	Sodium and Chlorine	$NaCl$
5.	Sugar (Glucose)	Carbon, Hydrogen and Oxygen	$C_6H_{12}O_6$
6.	Ethanol	Carbon, Hydrogen and Oxygen	C_2H_5OH
7.	Washing soda	Sodium, Hydrogen, Carbon and Oxygen	$Na_2CO_3.10H_2O$
8.	Soap	Sodium, Hydrogen, Carbon and Oxygen	$C_{17}H_{35}COONa$
9.	Caustic soda	Sodium, Oxygen and Hydrogen	$NaOH$

3. **Mixture**:

A mixture is a combination of two or more substances physically combined. Constituents of mixtures can be elements or compounds, or both.

Examples of mixtures are; Soil, Palm Wine, Milk, Wine, Blood, Crude Oil, Sweat, Sea Water, Brass, Bronze, etc.

DIFFERENCES BETWEEN MIXTURE AND COMPOUND

S/No	Mixture	Compound
1.	Mixtures can be homogenous or heterogeneous.	Compounds are always homogenous.
2.	A mixture can be separated using a physical method.	A compound cannot be separated by using a physical method.
3.	It cannot be represented by any chemical formular.	It can be represented by a chemical formular.

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4.	The properties of a mixture are related to the properties of its constituents.	The properties of a compound are different from that of the substances that formed it.

WEEK FOUR

IDENTIFICATION OF PURE AND IMPURE SUBSTANCES

A pure substance is a substance that does not contain any impurity.

An impure substance is a substance that contains some impurities. For instance, a table salt is said to be impure if it contains some few grains of sand. Water is also said to be impure if it contains sugar in it.

The purity of substances can be determined through the following ways:

a. From the melting point of the substance
b. From the boiling point of the substance.
c. From the density of the substance
d. By using chromatographic technique.

a. Melting Point:

A pure substance will have a definite or sharp melting point. The presence of impurity will lower the melting point of the substance. For instance, the melting point of paraffin wax is 46^oC, but when there is any form of impurity in it, the melting point goes lower.

b. Boiling point:

A pure substance will have a definite or fixed boiling point. But the presence of impurity will raise the boiling point of the substance. For instance, the boiling point of pure water is 100^0c; however, impurities may raise the boiling point to 105^0c or more.

c. Density:

A pure substance will have a definite density. However, the presence of impurity will increase the density.

d. Chromatography Technique:

A pure substance will give only one spot, if it undergoes the process of chromatography, but an impure substance will produce more than one spot.

WEEK FIVE

SEPARATION OF MIXTURES

There are several methods of separating mixtures. These methods depend on the physical properties of their constituents.

These methods include:

1. Hand picking
2. Filtration
3. Sieving
4. Chromatography
5. Evaporation
6. Distillation
7. Fractional distillation
8. Decantation
9. Precipitation
10. Use of separating funnel
11. Crystallization
12. Fractional Crystallization
13. Magnetization
14. Sublimation

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15. Destructive distillation

FILTRATION

This is used to separate an insoluble solid from a liquid. For example, a mixture of powdered chalk and water, sand and water can be separated by using this method. After filtration, the liquid collected is known as filtrate; while the solid part on the filter paper is called the residue. Filtration is used in water purification industries.

DIAGRAM (Leave half page spaces)

SIEVING:

This is used to separate solid particles of different sizes. For example, in the separation of garri particles or sand from stone. The mixture is placed on a sieve with a mesh of a particular size, particle smaller than the mesh size of the sieve will pass through the sieve while bigger particles remain on the sieve. Sieving is applied in mining industries, such as those involving diamond and gold.

CHROMATOGRAPHY:

Chromatography is used to separate mixtures that contain colours; e.g. the constituents of ink, Chlorophyll, blood, urine, and fruit juice etc. At the end of the chromatography, if only one spot is observed, it means that the mixture consists of only one constituent, but more than one will be observed when the mixture has more than one constituents.

EVAPORATION:

This is used to separate a soluble solid from its solution. In evaporation, the solvent is lost, since it is allowed to evaporate off while the solute is retained. Evaporation can be used in salt making industries to obtain salt from water or sea water.

DIAGRAM **(Leave half page spaces)**

DISTILLATION:

This is used to recover a solvent from a solution. It is also used for the separation of miscible liquids with a far range of boiling points. E.g. a mixture of water and ethanol. The boiling point of water is 100°C while that of ethanol is 78°C. During distillation, the mixture is heated to make the solvent turn to vapour at their different boiling point. The vapour is converted back to liquid as it passes along an instrument called the liebig condenser and then collected in another. The collected liquid is called distillate.

DIAGRAM **(Leave half page spaces)**

USE OF SEPARATING FUNNEL

This is used to separate two immiscible liquids in a mixture, e. g kerosene and water, oil and water. When the mixture is poured into separating funnel there would be a band separating both of the constituents. The water be below and the oil on top. When the tap is opened, the water runs first while the tap is closed on sealed off when the oil gets to the tap, leaving the kerosene in the funnel.

DIAGRAM **(Leave half page spaces)**

SUBLIMATION

This is the process whereby some solids, when heated change directly to gaseous state without passing through the liquid state. Examples of solids that sublime are ammonium chloride, iodine crystals, camphor, solid carbon dioxide etc.

Sublimation is used to separate a mixture of solids that include sublimable ones. It can also be used to separate subliming solids from their impurities. When heated, the solids change into gaseous state, and when the vapour is cooled, it changes back to solid through a process called deposition. Sublimation can be used to separate a mixture of ammonium chloride and sodium chloride (common salt), iodine crystals and sodium chloride etc.

DIAGRAM **(Leave half page spaces)**

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DESTRUCTIVE DISTILLATION

This is the process of heating organic substances e.g. wood, or coal in the absence of air, so as to separate them into their various constituents.

Destructive distillation of coal.

This is heating of coal in the absence of air at a very high temperature. This is used to separate coal into its various constituents. Products obtained from the destructive distillation of coal include.

i. Coal gas
ii. Coal tar
iii. Ammoniacal liquor
iv. Coke

Generally, coal is used as a source of fuel to generate power for steam engines, factories, and electric plants.

Coal gas is also used as a fuel in industries.

Coal tar is to make drugs used to treat skin irritations like dandruff. It can also be used to make pesticides, roofing materials and explosives.

Coke is also used as a source of fuel and in the production of iron and steel.

Ammoniacal liquor is used as fertilizer, among other uses.

FRACTIONAL DISTILLATION OF PETROLEUM OR CRUDE OIL.

Crude oil or petroleum is a dark, sticky viscous liquid found in huge underground deposits in many parts of the world, such as Nigeria, Iraq, Kuwait, Saudi Arabia, Libya, U.S.A and so on. These countries form members of the Organization of Petroleum Exporting Countries (OPEC). Crude oil is a complex mixture of hydrocarbons consisting of gases, liquids and solids, which can be separated by fractional distillation.

Fractional distillation of crude oil, also referred to as refining of crude oil, is the process of converting crude oil into a range of products in demand to meet up an economic market standard. This is done in refineries. In Nigeria, refineries can be found in Port Harcourt and Kaduna and Warri in Delta state.

After the fractional distillation of crude oil, products obtained include:

a. Petroleum gases, e.g. methane, propane, butane etc.
b. Petrol
c. Kerosene
d. Diesel oil
e. Lubricating oils, e.g. engine oil, Grease, etc.
f. Paraffin wax
g. Bitumen.

USES OF CRUDE OIL FRACTIONS

1. Diesel oil: it is used as fuel for long vehicles, trailers, tippers and tractors and generators.
2. Kerosene: They are two types:
   a. Household Kerosene, which is used as domestic fuel for cooking.
   b. Aviation kerosene: used as fuel for jet engines and Airplanes.
3. Lubricating oil: serves as fuel for ships; while Grease and engine oil is used for lubricating moving parts of machines.
4. Paraffin wax: is used to make petroleum jelly e.g. Vaseline etc.
5. Bitumen: for road construction, and roofing.
6. Petrol: is used as fuel for Automobiles and Generators.
7. Petroleum gases are used as fuel for cooking.

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PETROCHEMICALS

Petrochemicals are chemicals derived from Petroleum and natural Gas.

S/No	Petrochemical	Uses
1.	Methane	Used as fuel in making carbon black. Carbon black is used in making inks, tyres, black shoe polish, carbon paper.
2.	Phenol	It is used in making detergents, nylon, herbicides and dye.
3.	Ethene	For making plastic, e.g. bucket, cups, jerry cans etc.
4.	Benzene	Used in making detergent, dyes, resins, plastics drugs e.t.c.
5.	Xylene	Used to produce plastics and synthetic fibers.
6.	Polyvinyl chloride (PVC)	Used in making irrigation pipes, rigid sheet, cup, plates etc.

TYPES OF FUEL

There are three types of fuel. They are:

i) Liquid fuel. E.g. Kerosene, Petrol, Diesel.

ii) Solid fuel. E.g. Coal, Coke, Wood and Charcoal.

iii) Gaseous fuel: it includes;

a. Petroleum gas in a mixture of Carbon mono oxide and nitrogen.
b. Water gas is a mixture of hydrogen gas and carbon mono oxide.
c. Coal gas is a mixture of hydrogen, hydrogen sulphide, methane, Carbon mono oxide and ethane.
d. Natural gas contains nitrogen, carbon di oxide and water vapour.
e. Producer gas contains Nitrogen, Carbon monoxide, and Hydrogen.

WEEK SIX

PREPARATION OF OXYGEN AND HYDROGEN

OXYGEN

The word oxygen means "acid producer". Oxygen is the most abundant element on earth. It is also a component of air and the most reactive component of air.

Laboratory preparation of Oxygen

There are 2 ways of preparing oxygen in the laboratory, and they are:

(A) By the catalytic decomposition of hydrogen peroxide, using manganese (IV) oxide as a catalyst, this reaction does not involve heat. The moment the hydrogen peroxide decomposes, a colourless gas is collected by downward displacement of water.

$$2H_2O_2 \xrightarrow{MnO} 2H_2O + O_2$$

(B) By the thermal decomposition of potassium trioxochlorate (VI). This involves the use of heat, manganese (IV) oxide can also be added to the potassium chlorate to make the reaction fast.

$$2KClO_3 \xrightarrow{Heat} 2KCl + 3O_2$$

Test for Oxygen

Oxygen gas rekindles a glowing wooden splint. This test confirms the presence of oxygen.

Physical properties of Oxygen

1. Oxygen is appropriately 1.1. times denser than air.
2. It rekindles a glowing splint.
3. It is an odourless, colourless and tasteless gas.
4. It is a diatomic gas.
5. It is a natural and moderate gas.
6. It is neutral to moist litmus paper.

Chemical properties of Oxygen

1. Oxygen reacts with hydrogen to produce water
   $2H_2 + O_2 \rightarrow 2H_2O$
2. Oxygen reacts with metal to form metallic oxides copper burns in oxygen to produce copper oxide.
   $2Cu + O_2 \rightarrow 2CuO$
3. Oxygen reacts with non-metals such as sulphur, carbon and phosphorus to produce non-metalic oxides e.g. carbon reacts with oxygen to produce carbon (IV) oxide
   $C + O_2 \rightarrow CO_2$

Uses of Oxygen

1. It is used for burning (Combustion)
2. It is required for respiration
3. Oxygen combines with acetylene to produce oxy-acetylene flame with is used for cutting and welding of metals.
4. Oxygen is used in the preparation of acids
5. Liquid oxygen and fuel are used as propellants for space rockets.
6. It is used by deep sea divers and mountain climbers for respiration in surrounding that contain little or no air.

OXIDES

Oxides are compounds formed when elements combines with oxygen.

Types of oxides

1. Acidic Oxides: These are oxides of non-metals. They dissolve in water to form acids. Acidic oxides turn blue litmus paper red. Examples of acidic oxides are: carbon (IV) Oxide, Nitrogen (IV) oxide, sulphur (Iv) oxide.
2. Basic Oxides: These are oxides of metals they react with acids to form salt and water only and they turn red timus paper blue. Basic oxides include: Magnesium oxide (MgO), Sodium oxide (Na_2O), Calcium oxide (CaO), Potasium oxide (K_2O)
3. Amphoteric Oxides: These are oxides of metals and they behave like basic oxides and acidic oxides that can turn blue litmus red and red litmus to blue.
   Examples include:
   Zinc Oxide (ZnO)
   Lead Oxide (PbO)
   Tin Oxide (SnO)
   Aluminum Oxide (Al_2O_3)
4. Neutral Oxides: These are oxides of non-metals. They do not change the colour of litmus paper. Examples include: Water (H_2O), Carbon (II) Oxide (CO), Nitrogen (I) oxide (N_2O)
5. Peroxides: Peroxides are oxides that contain a higher proportion of oxygen than the ordinary oxide. Examples are Hydrogen peroxide (H_2O_2), Sodium peroxide (Na_2O_2), calcium peroxide (CaO_2), Barium peroxide (BaO_2)

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HYDROGEN

The word hydrogen means water former. Hydrogen is the lightest gas known, it is lighter than air and it is not a component of air.

Hydrogen exists in a combined state in compounds like water, acids, carbohydrates and other organic compounds.

Laboratory preparation of hydrogen

Hydrogen can be prepared in the laboratory in the following ways:

1. By the action of hydrochloric acid on zinc
   $2HCl + Zn \rightarrow ZnCl_2 + H_2$
2. When magnesium reacts with Hydrogen tetraoxosulphate (VI) acid
   $H_2SO_4 + Mg \rightarrow Mg\,SO_4 + H_2$

Test for Hydrogen

Hydrogen gas gives a pop sound when it burns in air, and in large quantity. It can extinguish a flame of fire.

Physical properties of Hydrogen

1. It is the lightest known gas.
2. It is insoluble in water.
3. When flames are brought near it, it makes a pop sound.
4. It is colourless, odourless and testless.
5. It is neutral to litmus paper.

Chemical properties of Hydrogen

1. Hydrogen reacts with oxygen to produce water
   $2H_2 + O_2 \rightarrow 2H_2O$
2. Hydrogen is a reducing agent. It reduces copper II oxide to copper metal
   $CuO + H_2 \rightarrow 2Cu + H_2O$
3. Hydrogen reacts with non-metals to produce gaseous compounds e.g.
   $N_2 + 3H_2 \rightarrow 2NH_3$
4. Hydrogen combines with sulphur to produce hydrogen sulphide.
   $H_2 \rightarrow S + H_2S$

Uses of Hydrogen

1. It is used in the manufacture of ammonia, water and magnesium
2. Liquid hydrogen is used as fuel in some rockets
3. Dry hydrogen is used in filling balloons
4. It is used in hydrogen flame, which is used to melt metals

Water as a product of hydrogen and oxygen

When hydrogen burns in oxygen, the gas produced is in the form of vapour or steam and when this vapour is cooled or condensed, it is collected as liquid water.

$2H_2 + O_2 \rightarrow 2H_2O$

It should be noted that the ratio of hydrogen to oxygen is 2:1, meaning that 2 volumes of hydrogen will react with 1 volume of oxygen to give water.

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In order to show that water is actually produced from hydrogen and oxygen, the liquid collected is passed into a copper (II) tetral sulphate (VI) solution. If a blue colour is observed, it shows that water is present.

WEEK SEVEN

ELECTROLYSIS

Definition of electrolysis

Electrolysis is defined as the chemical decomposition of a compound in a molten state or solution by passing electric current through it. Electrolysis is carried out in an electrolytic cell, also known as a Voltameter.

Some terms associated with Electrolysis

1. Electrolyte

An electrolyte is a compound which in molten state or in solution nconducts electricity and is decomposed in the process. Electrolytes decompose into their component ions. There are two types of electrolytes.

a. Strong electrolytes: These are compounds that decompose completely when electric current is passed through them and conduct electricity well. Examples include; potassium hydroxide (KOH), Hydrogen tetraoxosulphate (VI) acid (H_2SO_4), Coppersulphate ($CuS0_4$), Sodium Chloride (NaCl) etc.

b. Weak electrolytes: These are compounds that decompose partially when electric current is passed through them, and do not conduct electricity well. Examples include water, ethanoic acid, phosphoric acid(H_3PO_4), ammonia etc.

Any compound which in molten state or in a solution cannot conduct electricity and cannot be decomposed on the passage of electric current is a non-electrolyte. E.g. Ethanol, Glucose, table sugar, benzene, urea etc.

2. Electrodes:

Electrodes are two poles of carbon or other metals through which electric current enters or leaves the electrolyte. There are two types of electrodes: anode and Cathode.

a. Anode

This is the positively charged electrode through which current enters the electrolyte.

b. Cathode

It is the negatively charged electrode through which current leaves the electrolyte.

3. Ions

Ions are atoms of element that possess positive or negative charges. There are two types of ions:

a. Anion

It is a negatively charged ion.

b. Cation

It is a positively charged ion.

Diagram of an electrolytic cell.
(10 lines)

Electrolysis of water

The decomposition of water to yield hydrogen and oxygen gas is carried out by means of the process, electrolysis.

Water is a weak electrolyte, hence, during the electrolysis of water, a few drops of hydrogen tetraoxosulphate (VI) acid or hydrochloric acid are added to the water to make it a strong electrolyte. This is why this process is usually described as the electrolysis of acidified water.

At the end of the electrolysis of water, hydrogen gas is given off and collected at the Cathode, while oxygen gas is given off and collected at the anode in a volume ratio 2:1 respectively;

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that is, 2moles of hydrogen, to one mole of oxygen. This process is carried out in a Hofmann Voltameter.

RUSTING OF METAL

Rusting is a chemical process that results in corrosion or oxidation when oxygen comes in contact with a metal e.g. Iron.

Conditions necessary for rusting

There are two conditions necessary for rusting:

(1) Air
(2) Water or moisture

Experiments to show the two conditions necessary for rusting:

1. Put three shining nails in attest tube A and cover them with distilled water.
2. In test tube B put three shining nails, allow air to enter then at the button of the test tube put anhydrous calcium chloride, this is to take away all the moisture out of the air. This means the nails are in contact with air and no water.
3. To test tube C, water is boiled for about 5 minutes and the boiled water is poured into the test tube quickly then three shinning nails are dropped into the water in the test tube and some oil or Vaseline is poured on top of the hot water in the test tube and the test tube is corked. Here the nails are in contact with water only.

Observation

After one week it was found that only the nails that were in contact with the water and air, that is those in test tube A were rusted.

Conclusion

From the experiment above it shows that water and air are conditions necessary for rusting to occur.

Rusting of Iron

Iron is a very useful metal. It is strong and can be bent into any shape without breaking. When carbon is added to iron we call it steel.

Rusting of iron occurs when iron combines with oxygen in the presence of water to form brown hydrated Iron (III) Oxide ($Fe_2O_3.XH_2O$) his is known as rust. Rusted iron is soft and breaks easily.

Methods of preventing rusting of Iron

1. By greasing movable iron parts with grease or oil.
2. By forming an alloy between iron and other metals e.g steel which is a combination of iron and carbon.
3. By coating the iron with protective materials like oil, enamel, paint etc
4. By galvanizing: - Galvanizing is the process of dipping iron into molten-zinc in order to prevent rusting.
5. By painting: paints prevent rusting and also adds beauty to an iron ware.
6. By electroplating: This involves using of electricity to coat iron with another metal that will not rust. Such metals include copper, gold, silver, tin

Differences between rusting and burning

	Rusting	Burning
1	Rusting is a slow and gradual process	Burning is a quick and rapid process
2	In rusting, oxygen and water are required or must be present	Burning requires only oxygen
3	Rusting releases small amount of heat	Burning releases large amount of heat

Similarities between rusting and burning

1. Both of them requires oxygen that is both of them are oxidation processes
2. In both heat energy is released

WEEK EIGHT

CONCEPT OF ENERGY

Energy is defined as the ability or capacity to do work. The S.I. unit of energy is Joule (J). When work is done energy is used; hence, work done is measured in Joules.

SOURCES OF ENERGY

The sun is the major and primary source of energy. Energy from the sun are solar energy, heat or radiant energy, and light energy. However, sources of energy can be divided into two groups:

(a) Natural sources: E.g. plants after photosynthesis, food, wood, crude oil, coal, sun, natural gas, water, wind etc
(b) Manufactured or Artificial sources: E.g. Batteries and generators.

FORMS OF ENERGY

The various forms of energy include:

(a) Light energy
(b) Heat energy
(c) Sound energy
(d) Solar energy
(e) Mechanical energy: This is divided into kinetic and potential energy
(f) Electrical energy
(g) Chemical energy
(h) Atomic/Nuclear energy

HEAT ENERGY

This can be described as a form of energy which flows from one point to another due to the temperature difference between the two points. Heat energy is used to drive locomotive engines and steam engines. It is also used for cooking.

PROPERTIES OF HEAT ENERGY

1. Heat energy can flow from one point to another when there is temperature difference between the two points.
2. Heat energy can be radiated. E.g. the sun radiates heat to the earth.
3. Heat energy can be absorbed. Dull or black surfaces are very good heat absorbers while polished surfaces are the worst heat absorbers.
4. Heat is reflected from shiny surfaces, just like light.

LIGHT ENERGY

This is the energy from the sun. It helps the eye to see things

PROPERTIES OF LIGHT ENERGY

1. It travels in a straight line, for this reason, it forms shadow when an object is placed on its path. e.g. formation of shadow during an eclipse
2. Light travels with a velocity of speed $3X10^{8}m/s$.
3. Light travels through vacuum.
4. Light as a wave can be reflected, refracted and diffracted.
5. Light can be absorbed by coloured objects.

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SOUND ENERGY

This is the form of energy which causes the ear OSSICLES to vibrate.

PROPERTIES OF SOUND ENERGY

1. The velocity/speed of sound energy is 330m/s
2. Sound does not travel through vacuum
3. Sound energy is transmitted in form of wave motion
4. Sound as a wave motion can be reflected by a hard surface as echoes.

TEMPERATURE

Temperature is a degree of hotness or coldness of a body or a place. Temperature is measured by an instrument called a Thermometer.

EFFECT OF HEAT

Heat can have several effects on an object. These effects include:

1. Evaporation: When liquids are heated, they change into a gaseous state. This is called evaporation.
2. Chemical changes, such as combustion or burning.
3. Melting of substances: E.g. when ice is heated, it changes (melts) to a liquid.
4. Boiling: When liquids are heated, they boil at certain temperatures.
5. Change of State: When substances are heated, they change from one state to another; that I, solid to liquid, liquid to gaseous state.
6. Increase in Temperature: When substances are heated, there is a rise in temperature
7. Expansion of an object: Addition of heat usually causes an increase dimension of an object.
8. Thermionic Emission: addition of heat to a metal may result in the emission of electrons from the surface of the metal. This process is known as thermionic emission.
9. Change in Physical properties of a body: Addition of heat may bring about change in the physical properties of a body. Such as magnetic properties, conductivity, elasticity, density, colour of a body etc. For instance, heat can change the magnetic property of an object.

EXPANSION

When most solids and liquids are heated, they expand, and when cooled, they contrast. Expansion means an increase in the size of an object.

Expansion of liquids

When liquids are heated, they undergo expansion. This expansion is only in volume.

Expansion of Gases

Gases expand when heated. They expand more than liquids. Unlike solids and solids, gases expand equally when heated. Also, unlike solids and liquids, gases are sensitive to changes in pressure.

WAYS OF PRODUCING HEAT

1. Heat is produced during combustion, e.g. during the burning of fuel such as wood, kerosene, petrol etc
2. Heat can also be produced through friction. Example when rubbing the two palms together.
3. Heat can be produced by converting another form of energy to heat energy. E.g. converting electrical energy to heat energy in appliances like boiling ring, electric kettle, pressing iron etc.

Heat is also generated when work is done on a gas by compressing it. E.g. in using a bicycle pump to pump a bicycle tyre.

CONCEPT OF LIGHT

Light is a form of energy visible to the eye that is radiated from a source. Light energy is also known as luminous energy. The greater part of what we know about our surroundings is as a result of vision.

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SOURCES OF LIGHT

We see objects either by the light they produce or the light reflected from them. There two sources of light:

a. Luminous body or sources

b. Non-luminous body or sources.

LUMINOUS SOURCES

These are objects or bodies that generate and emit light by themselves. E.g. Star, Sun, Fire flies, some Deep Sea fishes, Electric light bulbs, Candle light, Photographic flash etc.

NON-LUMINOUS SOURCES

These objects or bodies that do not produce light on their own and can only produce light when they reflect light that falls on them from a luminous body. E.g. Moon, Jewelries, Golden necklaces, sign posts, road signs, etc.

LIGHT RAYS AND BEAMS

A light ray is the path or direction along which light energy travels. Light rays are indicated in diagrams by thin lines with arrow heads which indicate the direction of travel of the light.

A light ray ⟶

A collection of rays is called a beam. There are three (3) types of beams;

1. Parallel Beam:

This is a beam which the light rays are parallel to each other in the same direction and never meet one another. E.g. beams from search-lights.

(Leave 5 lines)

2. Convergent Beam:

This is a beam in which the light rays come from different directions to meet at a point. A hand lens can be needed to produce such a beam.

(Leave 5 lines)

3. Divergent beam:

This is a beam in which the light rays come from a point and spread out to different directions. Bulbs and Lamps produce a divergent beam of light

(Leave 5 lines)

Rectilinear Propagation of Light

The phenomenon of light travelling in straight lines is known as rectilinear propagation of light.

Evidence that proves the rectilinear propagation of light are

a. Formation of shadows.

b. Formation of eclipses.

c. Operation of the Pin-hole Camera.

The Pinhole Camera

A pinhole camera consist of a light proof box one end of which has a small hole made with a pin or needle point. The opposite end has a science made training paper or ground glass. Light from an object in front of the pinhole passes through it and forms an image on the screen. Some characteristics of images formed by a pinhole camera include:

1. The image is real
2. The image is inverted
3. If the distance between the hole and the screen is increased, the image is larger but not so bright.

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Reflection of Light

This is the sending back or throwing back of light rays when they fall on a smooth polished surface. Two rays are involved in refection:

a. Incident ray: this is the ray of light that strikes the smooth surface or a mirror.

b. Reflected ray: this is the ray of light that is bounced back or sent back from the smooth surface or a mirror.

DIAGRAM (10 lines)

The diagram between shows the incident ray, reflected ray and the normal on a mirror.

The angle of incidence (1) is the angle between the incident ray and the normal, while the angle of reflection is the angle between the normal and the reflected ray.

The angle of incidence (i) is equal to the angle of reflection (r)

REFRACTION

This is the bend or change in the direction of light rays as it passes from one medium to another of different density. Refraction is due to the difference in the speed of light in the different media. For instance, when light passes from air to a glass block or a prism block, refraction occurs.

MIRROR

A mirror is a smooth polished surface that reflects light and gives a true representation of an object.

There are two types of mirror.

a. Plane mirror

b. Curved mirror

PLANE MIRROR

A plane mirror is a mirror that has a flat surface.

Characteristic of image formed by a plane mirror

1. It is virtual.
2. It is erect and upright
3. It is laterally inverted
4. The object in front is as far as the mages behind in the mirror.
5. The image is the same size as the object.

Uses of plane mirrors

1. A periscope is a practical application of reflection by plane mirrors.
2. Inclined plane mirrors are applied in the making of kaleidoscope.
3. It is used at homes and fashion houses.

Curved mirror

These are mirrors that have spherical shape. When light is reflected by a curved mirror, the image produced is usually a distorted version of the object.

Types of curved mirror

There are two types of curved mirror.

a. Concave mirror or converging mirror

b. Convex mirror or diverging mirror

Concave mirror

This is a curved mirror that has its reflecting surface curved inwards.

Convex mirror

This is the mirror whose reflecting surface is curved outwards.

Uses of Curved Mirrors

1. Concave mirrors are used as shaving mirror because when a man place his face near the mirror, he sees an enlarged erect and virtual image of his face.
2. Concave mirrors are also used as reflectors in telescopes and microscopes.

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3. Convex mirrors are used as driving mirrors of motor cars because they provide a wide field of view, such that objects within a large angle can be seen by the driver.

LENSES

A lens is any transparent material with two faces, of which at least one face is curved. It causes a beam of light passing through it to either converge or diverge.
There are two types of lenses:

a. Convex or converging lens
b. Concave or diverging lens.

CONVEX LENS

This is a lens that is thicker at the centre or middle and thin at the ends. It makes a parallel beam of light to converge to a point. Convex lens is used to correct long sightedness.

CONCAVE LENS

This is a lens that is thinner at the middle and thick at its ends. It makes a parallel beam of light to diverge from a point. Concave lenses are used to correct short sightedness.

THE CAMERA AND OUR EYES

A camera has a converging lens which focuses the image on the photographic film. Also, the eye has a converging lens which focuses an image of the object on the sensitive screen of the eye called the retina.

PRISMS

These are rectangular or triangular glass blocks that change the direction of light rays as it passes through them from another medium. Prisms can also produce coloured images.

DISPERSION OF LIGHT

In an experiment first performed by Isaac Newton, it was observed that when white light is passed through a prism, an elongated coloured pattern of light is obtained on a screen placed behind the prism.
Dispersion of light is defined as the separation of white light into its component colours by a prism. The dispersion of light shows that white light is made of seven colours. A band of colours produced by white light when it is passed through a prism is known as a spectrum.
The spectrum of white light consists of seven colours which are:

a. Red
b. Orange
c. Yellow
d. Green
e. Blue
f. Indigo
g. Violet

These colours make up white light and can be represented with the acronym ROYGBIV.

COLOURS OR OBJECTS

What makes a grass green, your shirt yellow, and your shoe black is the white light from the sun which falls on them. When white light falls on an object e.g a green leaf, the green leaf appears green because it reflects green colour and absorbs all other colours.

Similarly, a red rose flower appears red in day light because it reflects red colour but if it is placed in a dark room and a blue light is shown on it, it will appears black because it absorbs all the blue light and does not reflect any colour.

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MIXING OF COLOURS

We can obtain a variety of colours by mixing the different colours of the spectrum. However, Red, Green and blue cannot be obtained by mixing other colours. These three colours are called primary colours. Adding primary colours produce other colours called secondary colours. E.g.

1. Red + Green = yellow
2. Blue + Green = Cyan
3. Blue + Red = Magenta (a Purple colour)
4. Red + Green = White

WEEK NINE

MEASUREMENT

Measurement is a very important aspect in science. No fact in science is accepted unless it can be exactly measured and quantified. Measurements are carried out with the use of measuring devices. These devices are used for measuring physical quantities.

There are two types of quantities:

a. **Fundamental quantities:** these are basic quantities from which other quantities are obtained or gotten from. Examples are length, mass, time, temperature, current, etc

b. **Derived quantities:** these are the quantities obtained by some simple combination of two or more fundamental quantities. Examples are area, density, velocity, energy, volume, pressure force, power, acceleration etc.

Fundamental units: these are basic units upon which other units can be obtained. Examples are metre, kilogram, second, Kelvin, Amperes etc.

Derived units: these are units obtained through the combination of some fundamental units. Examples are Joule, Watts, Newton, Pascal, Newton per meter square etc.

Some Quantities, their Units and Symbols

S/N	QUANTITY	UNIT	SYMBOL
1.	Mass	Kilogram	Kg
2.	Length	Metre	m
3.	Time	Second	s
4.	Temperature	Kelvin or Centigreele	K or ^{0}C
5.	Area	Metre Square	m^2
6.	Volume	Metre Cube	m^3
7.	Force	Newton	N
8.	Density	Kilogram per metre cube	Kg/m^3
9.	Velocity	Metre per second	ms^{-1}or m/s
10.	Pressure	Newton per metre square or Pascals	N/m^2 or Nm^{-2}or Pa
11.	Weight	Newton	N
12.	Power	Watt	W
13.	Energy	Joule	J

MASS

Mass can be defined as the quantity of matter that is contained in a body. Its S.I. unit is Kilogram (kg), and it can be measured using a beam balance or chemical balance.

WEIGHT

Weight is defined as the force acting on a body due to gravity. It is also defined as the force with which the earth attracts a body to its centre.

Weight is expressed mathematically as W=mg

That is, weight = mass x acceleration due to gravity.

The S.I. unit of weight is Newton, and it can be measured with a spring balance.

DIFFERENCE BETWEEN MASS AND WEIGHT

S/N	WEIGHT	MASS
1.	It can be measured using a spring balance	It can be measured using a chemical or beam balance.
2.	The S.I. unit of weight is Newton	The S.I unit of mass is Kilogram
3.	Weight is a Vector quantity i.e.; it has magnitude and direction.	Mass is a scalar quantity i.e. it has only magnitude but does not have direction.
4.	Weight is not always constant but varies with the position of the earth	Mass is always constant.

DENSITY

This is simply defined as the mass per unit volume. It is expressed mathematically as $D = \frac{M}{V}$

$$\text{That is Density} = \frac{Mass}{Volume}$$

The S.I. unit of density is kilogram per metre cube (Kgm^{-3} or kg/m^3).

PRESSURE

Pressure can be defined as the force acting per unit area. It is expressed mathematically as $P = \frac{F}{A}$

$$\text{Pressure} = \frac{\text{Force}}{\text{Area}}$$

The S.I. unit of pressure is Newton per metre square (Nm^{-2}) or Pascal (Pa)

MEASUREMENT OF PRESSURE

Measurement of pressure can be done in three ways:

1. Atmospheric pressure is measured using an instrument called Barometer.
2. Gas pressure can be measured using a Manometer or a Burden gauge
3. Pressure in liquids can also be measured using a Manometer.

MACHINES

Machines are devices that enable us to do work more easily, quickly and conveniently. There are two main types of machines:

a. Simple machines, e.g. broom hoes, knife, nut cracker, opener, claw hammers etc.,
b. Complex machines, e.g. the human body, sewing machine, bicycle pump, tractor, motorcycle, cars etc.

TYPES OF SIMPLE MACHINES

The types of simple machines are:

a. Lever

b. Pulley
c. Wheel and exile
d. Inclined plane
e. Screw
f. Wedge

LEVER

Levers can be described as one of the most efficient and simplest machines which applies small force to overcome a large load or resistance.

Parts of a Lever

There are three parts of lever:

a. Pivot or fulcrum: This is the turning point of a machine around which the force revolves.
b. Effort: This is the force applied to overcome the work or load.
c. Load: This is the object to be lifted, or the object been lifted. It is also referred to as the resistance to be overcome.

CLASSIFICATION OF LEVER

The classification of lever depends on the position of the fulcrum, the point where the effort is applied and the position of the load.

There are three basic classes of levers

a. First class lever
b. Second class lever
c. Third class lever

First Class Lever

This is the type of lever that has the fulcrum or pivot between the effort and the load. Examples are scissors, claw hammer, see-saw, pliers etc.

Second Class Lever

This is lever that has the load in between the effort and the fulcrum.
Examples are, wheel barrow, nut cracker, bottle cork opener etc.

Third Class Lever

This is a lever that has the effort in between the load and the fulcrum. In most cases, the effort is nearer to the pivot than the load. Examples are; a pair of forceps, sugar tongs, the human forearm etc.

PULLEY

A pulley is a small wheel with a groove around its rim. In the pulley system, the effort is applied to the rope that passes over the pulley at one end and the load is attached to the other end.

The pulley system is used to raise the Nigeria flag in schools; it is also used in cranes for loading and unloading of heavy loads, and also for lifting load to higher levels by builders and auto mechanics.

WHEEL AND AXLE

A wheel and axle are a simple machine which consists of a round cylindrical drum (the wheel) which has a large radius (R); at the centre of the wheel is an axle of smaller radius (R). The axle is fixed to the wheel such that the wheel and the axle have a common centre. Examples are wind lass used to lift buckets of water from wells: steering wheel of a motor car, crankshaft, Door knobs etc.

APPLICATION OF THE WHEEL AND AXLE

The wheel and axle are applied in the following areas:

1. The brace and bits used by carpenters to boreholes in woods.
2. The windlass with a bucket attached to the axle end is used to fetch water from a deep well.

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3. The operation of the steering wheel of a car with respect to front or rear wheel is based on the principle of wheel and axle.

INCLINED PLANE

This type of machine is used to raise heavy loads such as drums of oil, up a sloping plank to higher floors. The slopping plank is an example of an inclined plane.

A heavy load is easily raised by rolling it gradually along an inclined plane than lifting it up at once. Machines that work on the principle of inclined plane are Screw, Jack and Wedge. A staircase is an example of an inclined plane.

SCREW

A screw is an inclined plane wrapped round a metal cylinder in form of a thread. It is a simple machine that requires a lot of turning. Examples of screws are bolt and nut, car jack and carpenter's screw.

PARTS OF A SCREW

A screw is a long inclined plane. It is made up of a metal rod that consists of a head, a thread and a pitch. The pitch is the space or gap or distance between two consecutive threads.

WEDGE

A wedge is a double inclined plane shaped like a 'V' on a solid piece of object. It is a device used separate bodies which are held together by large forces, e.g. in splitting wood (timber). Examples of wedge type of machine are axes, chisels, knives and other cutting tools.

GEAR

A gear is a simple machine with a wheel that has toothed edges. It applies the principle of the wheel and axle.

The gear system is made up of two types of gears:

a. The big driving gear.
b. The small driven gear.

Effort is applied through the driving gear and work done is obtained from the driven gear.

The two gears are meshed or interlocked, such that as the driving gear make one rotation, the driven gear rotates at the same time. The number of the rotation of the driven gear is equal to the circumference of the driving gear.

A car has a gear box which is used to transfer energy from the engine to the driving wheels. A change in gear means either an increase or decrease in the rotation of the driving gear per driven gear.

Application of Gears

1. A vehicle uses gear for overcoming resistance against motion.
2. Gears enable cars to transfer energy from the driving wheels, making them to rotate and therefore allowing them to be in motion.
3. The gear makes a crushing machine more powerful in crushing hard objects.

Gear Ratio

Gear ratio is defined as the ratio of the number of teeth on the driven gear to the number of teeth on the driving gear

Mathematically:

$$\text{Gear ratio} = \frac{\text{Number of teeth on driven gear}}{\text{Number of teeth on driving gear}}$$

RELATION BETWEEN THE GEAR SPEEDS

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If a driving gear rotates at a speed of 500 revolutions per minute, the driven gear will rotate at a speed of 250 revolutions per minute.

If S is the gear speed, S_1 the speed of driver gear and S_2 the speed of driven gear, gear speed can be expressed as.

$$S = \frac{S_2}{S_1}$$

In relation with the gear teeth, the relationship will be

$$\frac{T_2}{T_1} = \frac{S_2}{S_1}$$

MECHANICAL ADVANTAGE OR FORCE RATIO OF A MACHINE

The mechanical advantage (MA) is the ability of a machine to overcome a large load through a small effort. It is also known as the force ratio. Mechanical advantage (MA)is given by

$$MA = \frac{\text{Load}}{\text{Effort}} \quad \text{i.e. } L/E$$

Or

$$MA = \frac{\text{Force output}}{\text{Force input}}$$

When the force ratio is greater than one, we have mechanical advantage; but when it is less than one, we have mechanical disadvantage of the system.

VELOCITY RATIO (V.R.)

This is defined as the ratio of the distance moved by the effort to the distance moved by load, in the same time interval. It is given by the formula.

$$VR = \frac{\text{Distance moved by effort}}{\text{Distance moved by load}}$$

The higher the velocity ratio, the lower the efficiency level of the machine.

EFFICIENCY

The efficiency of a machine is defined as the percentage of work done in a machine to the energy supplied to do the work. It is given by

$$\text{Efficiency} = \frac{\text{Work output}}{\text{Work input}} X\ 100\%$$

Since work = energy

$$\text{Efficiency} = \frac{\text{Work output}}{\text{Work input}} X\ 100\%$$

Work output = Effort x distance moved

Work input = Load x distance moved

Relationship between mechanical advantage, velocity ratio and efficiency.

The relationship between them is given by

$$\text{Efficiency} = \frac{\text{Mechanical advantage}}{\text{Velocity ratio}} X\ 100\%$$

$$\text{Efficiency} = \frac{MA}{VR} X\ 100\%$$

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