SUBJECT:

PHYSICS

CLASS:

SENIOR SECONDARY SCHOOL 1

TERM:

THIRD

SCHEME OF WORK

WEEK TOPIC

1. Electricity – Electric current, Potential difference, Electromotive force, Resistance, Ohm's law, Resistivity and conductivity
2. Resistors and Cells – Arrangement in Series & Parallel and calculation
3. Electrical Energy and Power – Buying electric current
4. Safety Device – Fuse
5. Particle nature of matter – Atomic Structure, state of matter, Diffusion, Osmosis, Brownian motion
6. Crystal Structure of Matter – Amorphous and Crystalline structure/substances
7. Surface Tension – Definition, effects, application and reduction; Simple calculation
8. Capillarity – Adhesion, Cohesion and Application
9. Elasticity – Hooke's law, tensile stress, tensile strain and Young's Modulus
10. Energy in Elastic materials
11. Revision
12. Examination

WEEKONE

ELECTRICITY

- **Definition and functions of electric circuit and its components**
- **Definition of some physical quantities in dc circuit**
- **Verification of ohm's law**

Terms used in electricity:

1. *Conductors*: They are materials which allow electrons to pass through them easily e.g. metal, graphite, acids, salt solution etc.
2. *Semiconductors*: They are materials whose resistivity is mid-way between good conductors and insulators e.g. germanium, silicon etc.
3. *Insulators*: They are materials which do not allow electrons to pass through them e.g. paper, plastic, glass, oil, cotton, dry hair, polythene etc.

Electric Circuit: An electric circuit is a complete path provided for the flow of electric current. The circuit diagram below is a symbolic representation of such circuit

Functions of dc circuit components

- Cells are chemical devices which produces electric force/pressure that pushes the current to flow.
- Switch / key is a device used to start or stop the current flow.
- Ammeter measures the electric current flowing in a circuit
- Voltmeter measures the potential difference across the terminal of a load
- Rheostat varies the flow of current
- Resistor is a component that limits or regulate the flow of electric current

DEFINITIONS OF SOME PHYSICAL QUANTITIES

Electric Current (I):

It is the measure of the rate of movement (flow) of charged particles along an electrical conductor (a circuit). It is simple electric charge (Q) in motion which consists of moving electrons.

$I = Q/t$ ____________ (1a) where t – time (s)

$Q = It$ ……………… (1b)

Potential Difference (V):

Potential difference between two points in a circuit is the work done (W) when one coulomb of charge moves from one point to another.

$W = Q (VB – VA) = QV$ ____________ (2a)

$V = W/Q$ ……………………………… (2b)

Electromotive Force (E):

E.m.f. of a cell is the p.d between the terminals of the cell when it is not delivering any current to the circuit.

Internal Resistance (r):

The internal resistance of a cell is the resistance offered by the electrolyte to the motion of the current.

Resistance (R):

This is the ratio of the p.d across the conductor to the current flowing through it.

Ohm's Law

Ohm's law states that the electric current in a given metallic conductor is directly proportional to the potential difference applied provided that the temperature and other physical factors remain constant i.e. $V \alpha I$

Verification of Ohm's Law

Aim: To show that metallic/ohmic conductor obey ohm's law

Apparatus: voltmeter, ammeter, rheostat, battery, key, pieces of wire and ohmic conductor x

Diagram:

Procedure: set up the apparatus as shown above

Observation: As the rheostat is been varied, the reading of the voltmeter is also changing. Also, the current in the ammeter is increasing with increase in potential difference.

Table:

Graph:

Slope = $\Delta V / \Delta I = R$

Where R is the constant of proportionality and it is called resistance (R)

Conclusion: ohmic conductors obey ohm's law.

i.e.

$V = IR$_______________ 3(a)

$I = V/R$______________ 3(b)

R= V/I _____________ 3(c)

NB: The relationship between I, E, R & r is that

I = E / R + r = V/R ……………4

CLASSWORK 1

1. **Draw a simple electric circuit**
2. **What is an electric circuit?**
3. Define the following terms (a) Electromotive force of a cell (b) Potential difference (c) Electric current
4. State Ohm's law and give the mathematical relation

ASSIGNMENT 1

SECTION A

1. A current of 10A passes through a conductor for 10s, calculate the charge flowing through the conductor (a) 100.0C (b) 10.0C (c) 1.0C (d) 0.1C
2. The symbol  represents (a) resistor (b) capacitor (c) diode (d) current
3. The SI unit of voltage is (a) ampere (b) volts (c) ohm's (d) coulomb
4. The symbol  (a) resistor (b) capacitor (c) diode (d) current
5. Which of the following correctly express Ohm's law (a) V=IR (b) Q=It (c) R=IV (d) W=QV

SECTION B

1. Determine the length and conductivity of a wire with diameter 2.0mm constructed from an alloy of resistivity $22 \times 10^{-8}\Omega m$, if its resistance is 0.42Ω (π=22/7)
2. Describe an experiment to verify ohm's law
3. Calculate the resistivity in ohm-m of a 5m wire whose cross-sectional area is $1.0 \times 10^{-3} m^2$ and resistance is 1ohm

WEEK TWO

RESISTORS & CELLS CONNECTED IN SERIES & PARALLEL

- **Resistors and Cells**
- **Arrangement in Series & Parallel**
- **Calculations**

Resistors

Resistors in series: These are end to end connection.

Characteristics

i. Same current flow through each resistor
ii. Potential difference across each resistor is different
iii. Potential difference are additive
iv. Power are additive
v. Applied voltage equals the sum of different potential difference
vi. Resistance are additive

$R_T = R_1 + R_2 + R_3$ ________ for 3 resistors

$R_T = R_1 + R_2 + R_3 \ldots.. + R_n$ ____ for n numbers or resistors

Resistors in parallel: These are side by side connection.

Characteristics

i. Different resistors have their individual current
ii. Potential difference across each resistor is the same
iii. Branch current are additive
iv. Conductance are additive
v. Power are additive

$1/R_T = 1/R_1 + 1/R_2 + 1/R_3$ _____ for 3 resistors

$1/R_T = 1/R_1 + 1/R_2 + 1/R_3 \ldots.. + 1/Rn$ _____ for n numbers of resistors

Cells

Cells in series: End to end connections

$E_T = E + E + E = 3E$

For n cells; $E_T = n E$

$E_T = E_1 + E_2 + E_3$

Cells in parallel: Side by side connections

E_T = E+E+E/3 = 3E/3 = E

Calculations

If 2Ω, 3Ω, and 5Ω resistors are connected in (a) series (b) parallel, calculate the equivalent resistance

(a) R_T = 2+3+5 = 10Ω

(b) 1/R_T = 1/2 +1/3+1/5 = 15+10+6/30 = 31/30

R_T = 30/31Ω

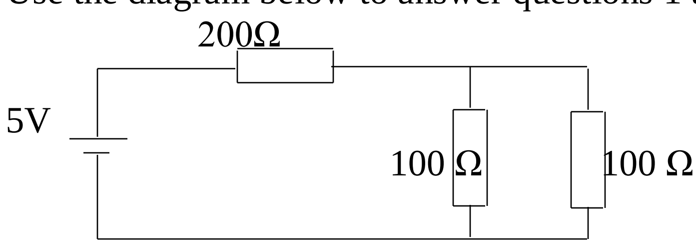
CLASSWORK 2

1. State three differences between resistors connected in series and parallel
2. What is: (a) a resistor? (b) a cell?
3. If 2Ω, 2Ω, and 1Ω resistors are connected in (a) series (b) parallel, calculate the equivalent resistance

ASSIGNMENT 2

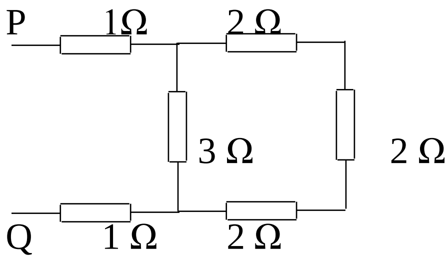
SECTION A

Use the diagram below to answer questions 1 and 3



1. A car fuse marked 15A and operates normally on a 12V battery, calculate the resistance of the fuse wire (a) 0.8 Ω (b) 1.3 Ω (c) 3.0 Ω (d) 27.0 Ω
2. Calculate the potential difference across each of the 100 Ω resistor (a) 1v (b) 2v (c) 4v (d) 5v
3. A wire of 5Ω resistance is drawn out so that its new length is twice the original length. If the resistivity of the wire remains the same and the cross-sectional area is halved, the new resistance is(a) 5Ω (b) 10Ω (c) 40Ω (d)20 Ω
4. Five 5Ω resistors are connected in parallel, the equivalent resistance is (a)1Ω (b) 2.5Ω (c) 6.5 Ω (d) 12.5 Ω

5.



The total resistance measured at PQ in the diagram above is (a) 18.0Ω (b) 11.0Ω (c) 4.0Ω (d) 2.0Ω

SECTION B

1. The resistance of 7m uniform wire of cross sectional area $0.1x10^{-4}m^2$ is 0.125Ω. What is the resistivity of the material of the wire?
2. A battery of 20v and internal resistance 5Ω is connected to a resistor 0f 20Ω. Calculate the value of (a) electric current (b) terminal voltage (c) lost voltage.

WEEK THREE

ELECTRICAL ENERGY AND POWER – BUYING ELECTRIC CURRENT

- **Electrical Energy**
- **Electrical Power**
- **Buying Electrical Power**

ELECTRICAL ENERGY

Energy = Work (Joules)

$W = QV$ ________________________(1)

But $Q = It$

$W = VIt$ _______________________(2)

From ohm's law $V = IR$

$W = I^2Rt$_______________________(3)

From ohm's law $I = V/R$

$W = V^2t/R$______________________(4)

$W = QV = VIt = I^2Rt = V^2t/ R$

Electrical Power

Power = work done/time taken (watt) __ (5)

$P = QV/t = VI = I^2R = V^2/R$…………….(6)

BUYING OF ELECTRICAL ENERGY

Commercial power is consumed in kilowatt- hour (kWh)

NB: 1kwh = 3.6 x106 J = 3.6MJ

Cost = Pct/ 1000………………………….(7)

P – Power (w)

NB: P(W)/ 1000 = P (KW)

c – Cost per kWh (unit) it means that it is in kWh

T – Time (hr)

CLASSWORK 3

1. State four factors that affect the resistance of a conducting wire
2. A lamp is rated 240V, 60W, calculate the resistance of its filament
3. The headlamp of a car takes a current of 0.4A from a 12v supply. Calculate the energy produced in 5 minutes.
4. Find the cost of running two 100w amplifier, ten 50w television and twenty 60w lamp for 24hrs, if the electrical energy cost 60k/unit

ASSIGNMENT 3

SECTION A

1. Find the heat in joules produced in an electric coil of resistance 15ohms when a current of 5 amperes flows through it for 30 minutes (a) $6.75x10^5$ (b) $0.75x10^5$ (c) $2.5x10^5$ (d) $6.75x10^2$
2. A lamp is rated 240V, 60W, calculate the resistance of its filament (a) 240Ω (b) 360Ω (c) 960Ω (d) 1440Ω
3. A fully-charged 6v accumulator can give a current of 2A for 30hours. Calculate the energy given out during its discharge (a) $1.2x10^3$J (b) $1.3x10^6$J (c) $0.5x10^3$J (d) $2.5x10^6$J
4. If a p.d of 240v is applied across a lamp that supplies energy at the rate of 60w. What is the value of the resistance? (a) 96Ω (b) 48Ω (c) 960Ω (d) 900Ω
5. A wire of length 5m and cross sectional area $4.0x10^{-8}m^2$ has a resistance of 10Ω. Calculate the conductivity (a) $1.25x10^7\ \Omega^{-1}m^{-1}$ (b) $2.50x10^7\ \Omega m^{-1}$ (c) $5.00x10^7\ \Omega^{-1}m^{-1}$ (d) $8.00x10^7\ \Omega^{-1}m^{-1}$
6. Given that the diameter of a cylindrical material wire whose 1.0m length has a resistance of 2.0ohms? Calculate the resistivity of the wire (a) (b) (c) (d)
7. The headlamp of a car takes a current of 0.40A from a 12v supply. Calculate the energy produced in 5 minutes (a) $1.25x10^3$J (b) $0.5x10^7$J (c) $1.4x10^3$ (d) $1.25x10^{-3}$
8. The maximum power dissipated by 100Ω resistor in a circuit is 4W; calculate the voltage across the resistor (a) 10V (b) 20V (c) 25V (d) 400V

SECTION B

1. Electricity is supplied to a school along a cable of total resistance 0.5Ω with the maximum current drawn from the main as 100A. The maximum energy dissipated as heat for 1hour is?

2. A landlord has eight 40w electric lighting bulb, four 60w bulb and two 100w bulb. If he has all the point on for 5hrs, what is the bill for 30 days?
3. State ohm's law. Given a coil of resistance wire, how would you make a coil of resistance 1.0 Ω from the wire?

WEEK FOUR

SAFETY DEVICE – FUSE

- **Fuse**
- **Types of Fuse**
- **Detecting Fault in a Circuit**

FUSE

Fuse is a protective device, designed to melt at the passage of excess electric current through it. It can also be defined as a device for opening circuit, by means of a conductor designed to melt when an excessive current flows along it. The conductor actually designed to melt is called fuse element.

FUSE ELEMENT

This is the part of the fuse that is designed to melt and then open the circuit.

Current rating of a fuse: it is the minimum current which the fuse will carry for an indefinite/ unlimited period without deterioration of the fuse element

Fusing current: is the minimum current that will cause the fuse element to heat up and melt/ rapture or blow.

Fusing factor is the ratio of the fusing current upon the current rating.

Fusing factor = fusing current/ current rating

TYPES OF FUSE

i. Re-wire able fuse
ii. Cartridge fuse
iii. High breaker capacity fuse
iv. Others

DETECTING FAULT IN ELECTRIC CIRCUIT

i. Merger tester – insulation resistance test
ii. Test bell – polarity test
iii. Earth-loop impudence tester – test for earthling
iv. Continuity tester – test for continuity

CLASSWORK 4

1. Define the following terms (a) fuse (b) fuse element (c) current rating of a fuse
2. List three types of fuse

ASSIGNMENT 4

SECTION A

1. Fuse is a protective device, design to ……….. (a) stick (b) melt (c) disappear (d) repel
2. The conductor designed to melt is called ……. (a) fuse element (b) fuse (c) resistor (d) cartridge fuse
3. The following are examples of fuse except ……. fuse (a) re-wire able (b) merger (c) cartridge (d) high breaking capacity
4. The motion of the prongs of a sounding turning fork is (a) random (b) translational (c) rotational (d) vibratory

SECTION B

1. Mention four ways of detecting fault in an electric circuit
2. State the relationship between fusing factor, fusing rating and current rating

WEEK FIVE

PARTICLE NATURE OF MATTER – ATOMIC STRUCTURE, STATE OF MATTER, DIFFUSION, OSMOSIS, BROWNIAN MOTION

- **Atomic Structure**
- **Molecular Theory of Matter**
- **Diffusion and Osmosis**

MATTER

Matter is defined as anything that has mass and occupies space. All substances are made up of matter. It exists in three states namely, solid liquid and gas. Examples of solids are ice, brick, metal, concrete, wood etc. examples of liquid are water, milk, oil etc. while that of gas are oxygen, nitrogen, CO_2

Structure of Matter

Matter is made up of discrete particles namely atom, molecules and ion.

1. *Atom*: An atom is the smallest particle of an element which can have a separate existence. Atom is made up of a nucleus and a revolving electron around an orbit or shell. The nucleus consists of proton and neutron. The proton is positively charge, electron is negatively charge and neutron is neutral (i.e. has no charge). The number of protons equates the number of electrons. An atom that contains the same number of protons and electrons is said to be electrically neutral.
2. *Molecule*: A molecule is a group of atoms of the same or different elements joined in simple proportion. They come together to make up matter

BROWNIAN MOTION

- Molecules exist
- Molecules are continually in motion

Molecular Theory of Matter

Using kinetic theory to explain the:

(i) definite structure of solid
(ii) shape of liquid

(iii) gas

(i) *Solid***:** Matter consists of molecules which are tightly held together by intermolecular forces to make the molecules to vibrate about their mean positions, giving the solid definite shape. If the solid is heated, the total energy is divided among the molecules to make them vibrate faster. Eventually, they move so fast that they break loose from their fixed position.

(ii) *Liquid*: The molecules of a liquid can move about within the given volume of the container. Hence, liquid has its own size but no shape. If the liquid is heated, its molecules gain kinetic energy and move faster, until eventually molecules can escape from the surface. The liquid then vanishes and turns to gaseous state.

(iii) *Gas*: The molecules of a gas are also in constant motion like the liquid but comparatively far apart. They move at high speed, colliding with one another and with the walls of their containing vessel. They fill the vessel and exert pressure on the walls of the container. The pressure of the gas is caused by the collision of the molecules with the walls of the container.

DIFFUSION AND OSMOSIS

Diffusion

Diffusion is the process by which different forms of matter (fluids) mix intimately with one another owing to the kinetic nature of their molecules. It is also the tendency of a gas to mix with another and fill an empty space as a result of the constant random motion of the molecules.

Factors Affecting the Rate of Diffusion

(i) density
(ii) mass
(iii) temperature
(iv) pressure
(v) concentration

GRAHAM'S LAW OF DIFFUSION

It states that at constant temperature, gas diffuse at rates inversely proportional to the square root of their vapour densities.

$R \alpha 1/\sqrt{M} \rightarrow R = K/\sqrt{M}$.;$K = R\sqrt{M}$

Hence, $R1\sqrt{M1} = R2\sqrt{M2} = \ldots = Rn\sqrt{Mn}$

Hence, $R1/R2 = \sqrt{M2}/\sqrt{M1}$

Where: R - rate of diffusion,

M – Relative molecular mass.

NB: (i) R = volume (gas)/time

(ii) Relative molecular mass is twice its vapour density

Osmosis

This is the movement of water molecules from the region of higher concentration to a region of lower concentration through a semi-permeable membrane.

CLASSWORK 5

1. Using kinetic theory, explain the definite structure of solid
2. State four factors that affect the rate of diffusion

ASSIGNMENT 5

SECTION A

1. Which of the following statements about matter is not correct (a) each molecule of a substance moves to and fro about a fixed position (b) energy is require to break the forces of attraction between molecules (c) molecules of liquids are more closely packed than those of gases (d) molecules of solids move more freely than molecules of liquids
2. The nucleus of an atom consist of (a) proton and electron (b) neutron and electron (c) proton and neutron (d) none of the above
3. The odour of a leaking gas is perceived at a distance from the source. This is made possible by the process of (a) capillarity (b) evaporation (c) osmosis (d) diffusion
4. When is atom said to be electrically neutral (a) when the number of proton equals the number of neutron (b) when the number of protons equals the number of electrons (c) when the number of proton is greater than the number of electron (d) when the number of neutron equals the number of electron
5. Atoms of solids having crystalline structures are arranged in regular patterns called (a) energy levels (b) atomic structure (c) lattices (d) orbits

SECTION B

1. Using kinetic theory, explain the definite structure of solid
2. State four factors that affect the rate of diffusion
3. What is the importance of Brownie’s motion

MID-TERM PROJECT

Using a white cardboard, draw the **FCC, BCC and HCP** *crystal structure*

WEEK SIX

CRYSTAL STRUCTURE OF MATTER – AMORPHOUS AND CRYSTALLINE STRUCTURE/SUBSTANCES

- **Crystal Structure**
- **Crystalline and Amorphous Substance**

The term crystal structure is generally used to describe the internal structure of solids. A crystal is a material whose atoms are packed closely together in a regular structure. The particles of a solid are orderly arranged in parallel planes. In other words, solid crystals consist of particles arranged in parallel planes. Crystals are built up from simple structural units called unit cells. A unit cell (also called a space lattice) is made up of few atoms, ions or molecules. It is the smallest part of the crystal which has all the properties of the solids. Basically, there are three basic unit cells are: body centered cube (BCC), face centered cube (FCC) and hexagonal closed-packed structure (HCP)

In general, there are seven types of unit cells. Each type gives rise to a crystal system. They include cubic, rhombic, monoclinic, triclinic, tetragonal, rhombohedra and hexagonal crystal system. X- ray analysis of crystal shows that three pairs of opposite parallel faces bund the unit cells in all crystal systems, except in hexagonal system. We can draw three imaginary lines between the centres of the opposite parallel faces.

These imaginary lines represent three axes of symmetry. The length of these axes of symmetry and the angles between them determines the system to which a crystal belongs. This is demonstrated using cubic and monoclinic crystal systems.

In a cubic crystal system, the axes of symmetry have equal length and at right angles to each other. This type of crystal system is found in copper, sodium chloride, silver, gold, iron, sodium, potassium etc. however, the type of cubic crystal system found in copper, silver, gold and sodium chloride is different from the type found in sodium, iron and potassium. The former is called face centred cubic, while the latter is called body centred cubic. In a monoclinic system, the axes are not equal in length and only two of them are at right angles to each other. These crystal systems are in sugar, washing soda, ferrous sulphate etc.

DIFFERENCES BETWEEN CRYSTALLINE AND AMORPHOUS SUBSTANCES

On the basis of internal structure of solid, we can classify a solid as either a crystal substance (e.g. common salt) or an amorphous substance (e.g. glass). The differences between the two substances are:

Amorphous substances	Crystalline substance
1. Have a definite internal arrangement of particles.	Have a haphazard distribution of particles
2. Have a cleavage planes along which they fracture when struck	They do not have cleavage planes
3. Meets sharply at a definite temperature when heated.	They not meet sharply at a definite temperature
4. Regarded as true solid	Regarded as super cooled liquids
5. Have a long range order of arrange-ment of particles	Have short range order of arrangement of particles
6. Are efflorescence substance	Are not efflorescence substance

CLASSSWORK 6

1. Define amorphous substance
2. What is crystalline structure? Give two examples of crystalline substances

ASSIGNMENT 6

SECTION A

1. Unit cell is also known as (a) monoclinic system (b) polyclinic system (c) space lattice (d) none of the above
2. Crystal structure is generally used to describe (a) the external structure of solids (b) the internal structure of solids (c) the internal structure of liquids (d) the external structure of liquid
3. Particles of a solid are orderly arranged in….. planes (a) parallel (b) horizontal (c) vertical (d) none of the above
4. In which of the following are crystalline structures observable? I Gas II Liquid III solid (a) I only (b) II only (c) III only (d) I and II

5. ………… substance has a definite internal arrangement of particles (a) Amorphous (b) Crystalline (c) Elastic (d) Atomic

SECTION B

1. What is a crystal?
2. Give three differences between crystalline and amorphous substances
3. Draw the BCC structure

WEEK SEVEN

SURFACE TENSION – DEFINITION, EFFECTS, APPLICATION AND REDUCTION; SIMPLE CALCULATION

- **Definition of surface tension**
- **Effect of surface tension**
- **Application of surface tension**
- **Reduction of surface tension**

SURFACE TENSION

- It is the property of a liquid to make its surface behave as though it is covered by an elastic skin.
- It is the force per unit length acting at right angles on one side of a line drawn in the surface, Y= F/2L
- It is the force acting parallel to the surface of the liquid

EFFECTS OF SURFACE TENSION

1. Soap bubbles are spherical in shape
2. Water skaters are able to walk on the surface of water
3. Razor blade or needle gently placed on the surface of water floats
4. Spilled mercury on glass surface form spherical droplets

APPLICATION OF SURFACE TENSION

1. Use in the manufacturing of rain proof or water proof
2. Absorption of ink with blotting paper
3. Rising of oil in lamp wicks
4. Movement of melted wax into the neck of a burning candle

REDUCTION OF SURFACE TENSION

1. Adding impurities such as detergent/soap, alcohol, oil, camphor, kerosene, grease
2. By heating the liquid.

CLASSWORK 7

1. Define surface tension
2. Discuss three applications of surface tension
3. Highlight two ways of reducing surface tension

ASSIGNMENT 7

SECTION A

1. A few grains of table salt were put in a cup of cold water kept at constant temperature and left undisturbed. Eventually, all the water tasted salty. This action is due to: (a) osmosis (b) diffusion (c) conductivity (d) capillarity
2. Which of these is the effect of surface tension (a) the floating of the ship in water (b) Soap bubbles are spherical in shape (c) the osmotic pressure of the liquid (c) all of the above
3. Which of the following factors may be used to explain why a steel pin may float in water? (a) the force of cohesion between the pin and the water (b) the force of adhesion between the pin and the water (c) the surface tension of water (d) the force due to capillarity
4. In which of the following is surface tension important? (a) the floating of the ship in water (b) the floating of dry needing in water (c) the floating of a balloon in air (d) the diffusion of sugar solution across a membrane
5. The rise or fall of a liquid in a narrow tube is due to (a) the friction between the walls of the tube and the liquid (b) the viscosity of the liquid (c) the osmotic pressure of the liquid (d) the surface tension of the liquid

SECTION B

1. Give two ways of reducing surface tension
2. Mention the three effects of surface tension
3. Enumerate three applications of surface tension

WEEK EIGHT

CAPILLARITY – ADHESION, COHESION AND APPLICATION

- **Definition of Capillarity**
- **Cohesion and adhesion**
- **Application of capillarity**

Capillarity is defined as the tendency of liquids to rise or fall in narrow capillary tubes.

Cohesive force is the force of attraction between molecules of the same substance

Adhesive force is the force of attraction between molecules of different substance or it refers to the force which makes molecules of different substance to attract.

Application of Capillarity

Adhesion of water to glass is stronger than the cohesion of water, hence, when water is spilled on a clean glass surface, it wets the glass. The cohesion of mercury is greater than its adhesion to glass; hence, mercury spilled 0n glass forms small spherical droplets.

CLASSWORK 8

1. What is cohesion?
2. Define adhesion
3. Differentiate between adhesion and cohesion

ASSIGNMENT 8

1. Write short note on the rise of water in a glass capillary tube using kinetic theory
2. Explain why water forms a concave meniscus in a glass tube
3. Why does water wet a clean glass and water does not?

WEEK NINE

ELASTICITY – HOOKE'S LAW, TENSILE STRESS, TENSILE STRAIN AND YOUNG'S MODULUS

- **Definition of elasticity**
- **Hooke's law**
- **Tensile stress, tensile strain and young modulus**

Elasticity

This is the tendency of a material to regain its original size or shape after deformation or after it has been compressed or extended.

Hooke's Law

It states that provided the elastic limit is not exceeded, the extension in an elastic material (wire) is proportional to the force applied i.e. $F \alpha e$

$F = Ke$……………………………………………1

Where K is force constant, stiffness or elastic constant

Force Constant

This is the amount of force that causes a unit extension. It is the ratio of force to extension of an elastic material.

K → force constant, stiffness or elastic constant

A →proportional limit

L →elastic limit

B →yield point

OL → elastic deform

BC → plastic deform

Hook's law applies up to the elastic limit. For load beyond L the wire (material) stretch permanently. The point where small ↑ in load produces large extension is known as **yield point.**

Breaking point: This is the point where the wire cannot withstand any further increase in load.

Yield point: it is the minimum stress/load acting on an elastic material beyond which plastic deformation sets in.

Elastic limit: Is the maximum load (force) which a body can experience and still regain its original size.

Tensile stress

This is the force acting on a unit CSA of a wire/rod or force per unit CSA of a wire or rod.

Tensile stress = Force/Area

Tensile strain

This is the extension per unit length

Tensile strain = extension/Original length

Young modulus

It can be defined as the ratio of tensile stress to tensile strain

Young modules = tensile stress/ tensile strain

CLASSWORK 9

1. What is elasticity?
2. Write short note on the following terminology as used in elasticity: (a) elastic limit (b) elastic constant (c) yield point (d) breaking point
3. State Hooke's law of elasticity

ASSIGNMENT 9

SECTION A

1. Young's modulus of elasticity is the ratio of stress to strain, provided the load does not exceed the (a) breaking point (b) elastic limit (c) yield point (d) stress limit
2. The ratio of tensile stress to tensile strain is known as ….. (a) modulus of rigidity (b) modulus of elasticity (c) Young's modulus (d) shear modulus
3. The SI unit of tensile stress is ….. (a) N/m (b) Nm (c) N/m^2 (d) m^2
4. Hooke's law states that (a) F α A (b)F α e (c) E α F (d) E α A
5. The spiral spring of a spring balance is 25.0cm long when 5N hangs on it and 30.0cm when the weight is 10N. What is the length of the spring if the

weight is 3N assuming Hooke's law is obeyed? (a) 15.0cm (b) 17.0cm (c) 20.0cm (d) 23.0cm

SECTION B

1. Define young modulus of elasticity
2. (a) Sketch the graph of the relation between the extension of a spiral spring and the load attached to it when it is gradually loaded up to elastic limit. Indicate the following points: elastic limit, yield point, maximum load, and breaking point. (b) If the spring has a stiffness of $950Nm^{-1}$, what work will be done in extending the spring by 60mm?
3. A force of 80N applied at the end of a wire of length 5m and radius 4cm produces an extension of 0.24mm. Calculate the: (a) stress on the wire (b) strain on the wire (π=3.14)

WEEK TEN

ENERGY IN ELASTIC MATERIALS

- **Force in a bar**
- **Energy stored in a wire**
- **Energy stored per unit area**

Force in A Bar

When a bar is heated and then prevented from contracting as it cools, a considerable force is exerted at the end of the bar. Given a bar of a young modulus E, a cross sectional area A, a linear expansivity of magnitude α and a decrease in temperature of Θ, then

E = stress/strain = $F/A/e/L$

$= F/A \times L/e$

$E = FL/Ae$

$F = EAe/L$ …………………………..1

Recall, Linear expansivity α = change in length/original length x temperature change

$\alpha = e/L \times \Theta$

$e = \alpha L\Theta$

$F = EA\alpha eL\Theta/eL$

$F = EA\alpha\Theta$ ……………………………2

Energy Stored in a Wire

The application of force on any wire provided the elasticity limit is not exceeded is proportional to the extension provided.

Consequently, the force in the wire has increase from zero to F

Average force = $f + O/2 = f/2$

Recall work done = Average force x distance

$W = f/2 \times e = \frac{1}{2} Fe$ …………………………..3

Substitute equation 1 into 3

$W = EAe^2/2L$……………………………….4

Energy Stored Per Unit Volume

W_V = ½ X Stress X Strain…………………..5

This implies that $WV = Ee^2/2L^2$

Substances which lengthen considerable and undergo plastic deformation until they break are known as ductile substance e.g. lead, copper, wrought iron.

Substances which break after the elastic limit is reached are known as brittle substance e.g. glass and high carbon steel. It should be noted that brass, bronze and many alloys appears to have no yield point. By this we mean that this material increase in length beyond the elastic limit as the lead is increased without the sudden appearance of a plastic stage.

CLASSWORK 10

1. A uniform steel wire of length 10m and are of cross section $2x10^{-6}m^2$ is extended by 1mm. Calculate the energy stored in the wire if the elastic limit is not exceeded (young modulus = $2x10^{11}n/m^2$)
2. Calculate the energy stored in a spring if the force constant is $100n/m^2$ and the spiral spring is compressed by 0.015m.
3. A steel rod of cross sectional area $2cm^2$ is heated to 100˚C and then prevented from contracting when it cooled to 10˚C. Find the force exerted on the steel = 12 x 10^{-6}/K and young modulus is $2x10^{11}N/m^2$

ASSIGNMENT 10

1. Show that F = EAαΘ when a bar is heated and then prevented from contracting as it cools
2. A steel rod of cross sectional area $2cm^2$ is heated to 100˚C and then prevented from contracting when it cooled to 10˚C. Find the force exerted on the steel = 12 x 10^{-6}/K and young modulus is 2 $x10^{11}N/m^2$
3. A uniform steel wire of length 4m and are of cross section $3x10^{-6}m^2$ is extended by 1mm. Calculate the energy stored in the wire if the elastic limit is not exceeded (young modulus = $2x10^{11}n/m^2$)

WEEK ELEVEN
Revision

WEEK TWELVE
Examination