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UNIT 1: FUNDAMENTALS

Topics And Assessment Objectives:

- **1.1 Physical Quantities and their Units (9 Periods)**

- **Dimensions of fundamental quantities**
- **Fundamental units of ; mass (kg) , length(m), time (s), current (A), temperature(k), amount of substance (mol)**
- **Dimensions of derived quantities**
- **Use of dimensions to check equations**
- **Scalars and Vectors**

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- **addition and subtraction of vectors by the component method**
- **resolution of vectors in two perpendicular directions**
- **components of a vector**

Assessment Objectives:

By the end of the topic, the student should be able to :

- State the basic physical quantities and state their SI units.
- Measure and read basic and derived physical quantities using linear and circular scales.
- Work out the dimensions of the derived physical quantities.
- Use Dimensions to check equations.
- Define scalars and vectors.
- Distinguish between scalars and vectors.

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- Solve problems involving vectors by the component method.

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UNIT 7: THERMAL PROPERTIES OF MATTER

- **Temperature** (9 Periods)
  - **Temperature scales.**
  - **Practical thermometers.**
    - **liquid in glass**
    - **constant volume gas thermometer**
    - **electrical resistance**
    - **thermocouples**
    - **pyrometers**
  - **Absolute temperature scale.**

Assessment objectives

By the end of this topic, the student should be able to:

- List the different types of thermometers available for measurement

measurement of temperature and the thermometric properties used.

- Describe the steps involved in setting up a celcius scale of temperature.
- Describe the structure and action of the liquid- in-glass, constant volume gas thermometer, platinum resistance and thermocouple thermometers.
- Perform and describe measurement of temperature by the thermistor.
- Perform and describe measurement of temperature using a resistance of an insulated copper coil and metre bridge.
- Perform and describe measurement of temperature using thermocouple.
- Compare temperature measured thermometers using different thermometric

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properties.

- State the relative merits (advantages and disadvantages) of different

  thermometers.
- Define the absolute temperature scale.
- Convert temperatures in degrees celcius to absolute temperatures.
- Describe and explain the structure and mode of operation of the optical

  and total radiation pyrometers.

7.2 Specific Heat Capacity (9 Periods)

Definition and its measurement.

- **method of mixtures; Newton's law of cooling; cooling corrections**
- **electrical methods including; the continuous flow method for liquids.**

Assessment objectives

By the end of this topic, the student should be able to:

- Define specific heat capacity.
- Perform and describe an experiment to determine the specific heat capacity

  of a solid and a liquid by the method of mixtures.
- Explain what cooling correction is.
- Obtain a cooling correction in the method of

  mixtures for the determination

  of the specific heat capacity of a poor conductor of heat like rubber using the graphical method.
- Perform and describe an experiment to determine the specific heat capacities

  of solids and liquids by electrical methods including the continuous flow method.

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- State the advantages and disadvantages of the method of mixtures and the continuous flow method.
- Solve problems involving heat loss and gain.
- Perfom and describe an experiment for comparison of specific heat capacities of liquids using Newton's law of cooling.

7.3 Change of state. (9 Periods)

- **Molecular theory explanation of melting, evaporaiton and boiling.**
- **Specific latent heat of fusion and vaporization. Internal and external latent heat of vaporisation.**
- **Electrical method of measuring specific latent heat of vaporization.**

Assessment objectives

By the end of this topic, the student should be able to:

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- Explain melting, evaporation and boiling using molecular theory.
- Define specific latents of fusion and vaporization.
- Perform and describe experiments for determination

  of specific

  latent heats using method of mixtures.
- Perform and describe an electrical method for determination of

  specific latent heats of fusion and vaporization.
- Solve problems involving changes of state and changes in temperature.

- **7.4 Expansion of gases.** (5 Periods)
  - **The gas laws and the equation $PV = Nk_BT$ or nRT**
  - **Pressure and volume coefficients of expansion.**

Assessment objectives

Assessment objectives

By the end of this topic, the student should be able to:

- State Boyle's, Charles's and the pressure laws.
- Perform and describe experiments to verify the laws.
- Derive and use the equation **$PV = Nk_BT$** or **$PV = nRT$**
- Define pressure and volume coefficients of expansion and show that

  they are equal.

7.5 Kinetic Theory of gases. (10 Periods)

- **Brownian motion and evidence of molecules**
- **Postulates about the molecules of an ideal gas.**
- **Derivation of $P = \frac{1}{3} r <c^2>$ and comparison with $PV = Nk_BT$ or nRT.**
- **Deduction from the ideal gas equation.**
  - **Avogadros hypothesis**

- **Graham's law of diffusion.**
- **Dalton's law of partial pressures.**

Real gases.

- **Van der Waal's equation of state.**

$$\left(P + \frac{a}{v^2}\right)(V - b) = RT$$

P vs V curves for a real gas.

- **critical temperature.**

Saturated and unsaturated vapours, saturated vapour pressure.

- **connection with boiling of a liquid.**

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KINETIC THEORY (CON'T)

Assessment objectives

By the end of this topic, the student should be able to:

- Explain what is meant by kinetic theory of gases.
- Explain quantitatively why a gas exerts pressure on the walls

  of its container.
- Derive the expression $\mathbf{P = \underline{1}\ \ r <c^{2}>}$ stating any assumptions made.

assumptions made.

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- Relate the mean kinetic energy of a gas to its absolute temperature.
- Use the formula **P = 1r <c2>** to deduce Avogadro's Hypothesis,

3

Boyle's law, Charles's law, Dalton's law of partial pressures and Graham's
law of diffusion.

- Distinguish between a real and an ideal gas.
- Account for the difference between equations **PV = RT** and

$$\left(P + \frac{a}{V^2}\right)(V - b) = RT$$

- Define critical temperature T_c of a gas.
- Draw labelled **P-V** diagrams to show the behaviour of a real gas under

compression for temperatures above and below the

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compression for temperatures above and below the critical temperature.

- Distinguish between a gas and a vapour.
- Distinguish between saturated an unsaturated vapour and define saturated vapour pressure.(s.v.p)
- Explain the occurrence of saturated vapour pressure using molecular theory.
- Use kinetic theory to explain the effect of volume and temperature change on s.v.p.
- Distinguish the behaviour of saturated vapours from that of unsaturated ones.
- Use Dalton's law of partial pressures to solve problems on s.v.p
- Relate variation of s.v.p to boiling point.
- Describe an experiment to measure the variation of s.v.p of water with temperature.

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7.6 Thermodynamics (12 Periods)

- **Work done by an expanding gas**
- **Internal Energy**
- **First law of thermodynamics DQ = DU + DW**
- **Principle specific heat capacities, the relation C_p-C_v = R**
- **Isothermal and adiabatic changes of a gas inlcuding work done by a gas on such a process.**

Assessment objectives

By the end of this topic, the student should be able to:

- State the component of the internal energy of a real gas and the factors on which they depend.
- Define an ideal gas and show that the internal energy of an ideal gas has no

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potential energy component.

- Explain the meanings of terms: isovolumetric, isobaric, isothermal, and adiabatic changes.
- Derive the expression **W = Pdv** for the work done when a gas expands and relate it to the area under the **P-V** curve.
- State the first law of thermodynamics and apply it to isobaric processes.
- Explain why a gas has more than one specific heat capacity.
- Define specific heat capacity of a gas at constant pressure and constant volume.
- Explain why the molar principle heat capacity at constant pressure Cp is greater than that at at constant volume Cv

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is greater than that at constant volume Cv.

- Derive the expression $C_p - C_v = R$
- Relate $g = C_p/C_v$ to atomicity of a gas.
- Represent isovolumetric, isobaric, isothermal, and adiabatic processes on

  a **P-V** sketch.
- State the conditions necessary in practice to achieve isothermal and adiabatic

  processes.
- State and use the equations relating
- Derive expressions for the work done in isothermal and adiabatic processes.
- Solve problems involving isovolumetric, isobaric, isothermal, and adiabatic

  processes.

7.7 Transfer of Heat Energy

- **Thermal Conduction.**
  - **- Mechanism of thermal conduction in insulators and in metals.**
- **Thermal conductivity.**
- **The relation** $\frac{DQ}{Dt} = k A \frac{DT}{Dx}$
- **Measurement of thermal conductivity of good and bad conductors of heat.**
- **Convection as a consequence of change of density.**
- **Radiation as a form of energy.**
  - **Blackbody radiation**
  - **Energy distribution in the spectrum of blackbody radiation.**
  - **Stefan's law** $E = sT^4$.
  - **Wein's displacement law,** $l_m T = 2.9 \times 10^{-3}$ **mK.**
  - **Surface temperature of the sun.**
  - **Survey of the electromagnetic spectrum.**

Assessment objectives:

By the end of this topic, the student should be able to:

- Explain the mechanism of heat conduction in gases, liquids metallic

  and non-metallic solids.
- State the factors which determine the rate of heat transfer through

  a material.
- Define thermal conductivity k of a material.
- Draw a sketch graph to show the variation of temperature with length

  along a lagged and an unlagged metal bar.
- Perform and describe an experiment to determine thermal conductivity

  of a good conductor of heat like copper and a poor conductor of heat
  like glass.
- Solve problems involving conduction of heat

- Solve problems involving conduction of heat.
- Describe and explain the process of convection.
- State properties of infra-red radiation and describe how it can be detected.
- Define a blackbody and blackbody radiation.
- Describe how an approximate blackbody can be realised in practice.
- Draw sketch graphs to show variation of relative intensity with wavelength

  and describe their special features.

- State and use Wein's displacement law and Stefan's law in calculations, including

  the estimation of the temperature of the sun.
- State Prevost's theory of heat exchanges and apply it in calculations.
- Arrange the components of the electromagnetic spectrum in order of

  decreasing wavelength.

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UNIT 8: ELECTROSTATICS, ELECTRIC CURRENT AND ELECTRONIC DEVICES

- 8.1 Electrostatics.

- **8.1.1 Basic Electrostatics Phenomena.** (8 Periods)

  - **Charging by friction.**
  - **Types of charges.**
    - **use of electroscope to detect charge.**
  - **Charge by induction.**
  - **Distribution of charge outside and inside a hollow conductor at constant potential.**
  - **Principle of the Van der Graaf generator.**
  - **Applications**
    - **lightning conductor, electrostatic screening, paint spraying, and dust extraction.**

Assessment objectives

By the end of this topic, the student should be able to:

- Distinguish between a conductor and a non conductor.

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- Perform an experiment to show that there are two types of charges.
- Explain gharging by electrostatic induction.
- Explain the attraction of an uncharged material by a charged body.
- Describe the structure and action of a Gold Leaf Electroscope.
- Explain how a gold leaf electroscope can be charged negatively or

  positively.
- Describe how a gold leaf electroscope can be used to determine the

  charge on a body
- Describe Faraday's Ice Pail experiment and state the conclusions that

  can be deduced from it.
- Perform and describe an experiment to show the

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distribution of charge

on a charged conductor of different shapes.

- Explain corona discharge (action at points) and give an example of its

  application.
- Describe the structure and operation of the Van de Graaf generator.

8.1.2 The Electric Field

- **Electric fields and electric field lines.**
- **Force between point charges.**
  - **Coulomb's law.**
- **Electric Field Intensity.**
  - **electric field intensity of a point charge.**
  - **electric field intensity between charged parallel**

    metal plates.
- **Electric Potential**
  - **relationship between electric potential and electric**

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field intensity.

- **equipotential surfaces and electric field lines.**
- **electric potential at a point in the electric field of a point charge.**

Assessment objectives

By the end of this topic, the student should be able to:

- State Coulomb's law of electrostatics.
- Calculate the force between two point charges.
- Calculate force on a point charge due to a number of charges.
- Define electric field intensity, state its units and draw sketch diagrams to show the electric field patterns for different charge configuration.
- State the expression for the electric field intensity at a point charge.
- Calculate the electric field intensity at a point due to a number of point charges.
- Derive and use the relation between electric potential and electric field intensity.

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- Compare Coulomb's law with Newton's law of graviation.

8.1.3 Capacitors

- **Capacitor and capacitance , the farad**
- **Polarization of dielectrics**
  - **the dielectric constant**
- **Parallel plate capacitor**
- **Factors which affect capacitance**
- **Series and parallel arrangement of capacitors**
- **Energy stored in a charged capacitor**

Assessment Objectives

By the end of this topic the student should be able to:

- Define the capacitance of a capacitor
- State the factors which determine capacitance of a capacitor

capacitor

- Explain the action of a dielectric using the molecular theory
- Explain what is meant by dielectric constant (relative permitivity) and dielectric strength.
- Perform and describe experiments to investigate the dependence of capacitance of a parallel plate capacitor on the area, A, of the plates,the separation,d, of the plates and

  the nature of the dielectric material between the plates using a gold leaf electroscope.
- Perform and describe an experiment to measure dielecric constant of dielectric material.
- State and use the law of coservation of charge
- Derive and use expressions for effective capacitance of capacitors in series and in parallel.
- Derive and use the expression for energy stored in a charged capacitor.

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Electric Current

- **Electric current as flow of charge** $I = \frac{Q}{t}$

the ampere, the Coulomb, electric potential difference, the volt.

- **Electric power**
  - **resistance and Ohm's law**
  - **electric energy, kWh**
  - **Power delivered to an ohmic circuit element**
  - **Interule conversion of electrical energy with forms**

- **Simple d.c circuits**
  - **e.m.f of a source of electrical energy**
  - **internal resistance**
  - **conservation of charge at a junction in a circuit**
  - **resistors in series and parallel**

- **resistors in series and parallel.**
- **potential divider**
- **mechanism of metallic conduction, current density**
  $j = nev$
- **mechanism of the heating effect of an electric current**
- **temperature coefficients of resistance**
- **electrical resistivity, p: the relation $R = \frac{pl}{A}$**

Measurement of resistance and voltage

- the Wheat-stone bridge and its applications including
  measurement of temperature coefficient of resistance
- the potentiometer and its applications including
  measurement of voltage, current, thermocouple, e.m.fs, comparison of resistances.

Assessment Objectives:

By the end of this topic the student should be able to:

By the end of this topic the student should be able to:

- Define an electric current and state its unit
- State the charge carriers in different types of conductors (metals, ionized gases, electrolytes, semi-conductors)
- Explain the mechanism of electric conduction in metals.
- Derive and use the relation between current and the drift velocity of electrons in metals I = nAVde
- Explain the causes of electrical resistance in metals and identify the factors which determine resistance of a metallic conductor.
- Define the term electical resistivity and state its unit
- Explain the effect of temperature on resistance.
- Define temperature coefficient of resistance and state its unit.
- State Ohm's law and give examples of ohmic and non-ohmic

conductors, and draw sketch graphs to show their I-V characteristic
curves.

- Perform and describe an experiment to verify Ohm's law for metallic
  conductors.
- State and use the law of conservation of current at a junction.
- Derive and use expressions for effective resistance of resistor in series
  and in parallel.
- List sources of e.m.f
- Explain what is meant by e.m.f, E, and internal resistance, r, of a cell
- Explain how the e.m.f and iunternal resistance of a cell change with time

  and use.
- Derive and use the expression P = I2R
- Convert energy in joules into kWh.
- Convert electrical energy to other forms of energy.
- Derive the condition for maximum power dissipation

in the external
resistance and the expression for efficiency, **h**.

- Derive and use the condition for balance of Wheatstone bridge
- Perform and describe an experiment to compare resistances using simple
  metre bridge
- Perform and describe an experiment to determine the resistivity, p, and
  temperature coefficient of a resistance of a wire using a metre bridge.
- Explain why the Wheatstone bridge network is not suitable for comparison of two very high or very low

  resistances.
- Solve problems on simple bridges including calculations of end-corrections.
- Explain the principle of a slide wire Potentiometer
- Perform and describe an experiment to calibrate a slide wire potentiometer.
- Perform and describe experiments to determine the internal resistance, r, of a cell, the e.m.f. E, of

thermocouple using the slide wire potentiometer.

- Perform and describe experiments to calibrate an ammeter and voltmeter using a calibrated slide wire potentiometer.
- State the advantages and disadvantages of the potentiometer over an ordinary voltmeter for measurement of voltage
- State theadvantage of using a potentiometer instead of a Wheatstone bridge to compart resistances.

8.3 Electronic Derives

The Vacuum diode valve

- **thermionic emission**
- **anode current - anode voltage chracteristics**
- **incremental resistance of a diode**
- **half - wave rectification.**
- **full wave (bridge) rectification**

The vacuum triode

- **anode current-anode voltage characteristics**
- **anode current -grid voltage characteristics**
- **anode slope resistance, mutual conductance and amplification factor**
- **amplification by a triode - voltage gain, A = yRL**

Ra

+ RL

- **The p-n junction**

  - **I-V characteristic**
  - **half - wave rectification**
  - **full wave rectifier using semi-conducting diodes**

- **The transistor**

  - **transistor characteristics**

Assessment Objectives:

By the end of this topic the student should be able to :

- Explain the mechanism of thermionic emission

- Explain the mechanism of thermionic emission.
- Describe the structure and operation of a vacuum diode
- Draw a sketch graph of the anode current -anode voltage characteristics of a thermionic diode and

  explain its special features.
- Perform an experiment to obtain the I-V characteristic of a p-n junction and explain forward bias and reverse bias
- Explain half-wave and full-wave rectificatin and how they can be achieved
- Draw sketch graphs of the anode current-anode voltage and mutual characteristics of a triode.
- Define the terms anode resistance, mutual conductance and amplification factor of a triode.
- Derive and use the expression A = yRL for the voltage gain

  Ra + RL
- Describe the structure of n-p-n and p-n-p type transistorl
- Perform experiments to obtain I_B - V_{BE} , I_c - V_{CE}

and I_C - I_B characteristics of transistor.

9.1 Magnetic Effects of an Electric Current

- **Idea of a magnetic field as a field of force due to current**
    - **carrying conductors or permanent magnet**
- **Force on a current**
    - **carrying straight wire.**
    - **Fleming's left hand rule**
    - **definition of magnetic flux density and the tesla**
- **Magnetic field patterns due to an electric current in a straight wire, circular coil and long solenoid.**
- **Motion of a charge particle in a uniform magnetic field**
- **Hall effect**
    - **the Hall probe**
- **Torque on a current carrying coil in a uniform magnetic field**

- **Torque on a current carrying coil in a uniform magnetic field.**

    - **moving coil galvanometer**
    - **conversion of moving coil galvanometer into an ammeter and voltmeter**

- **Magnetic force between current carrying conductors**

    - **definition of ampere**
    - **simple form of current balance**

Assessment objectives

By the end of this topic the student should be able to:

- Define a magnetic field
- Perform experiments to obtain the magnetic field patterns for a bar magnet, a current - carrying

  straightwire, a current - carrying circular coil, and a current - carrying solenoid.
- Perform an experiment to determine the direction of the force on a straight current carrying conductor in

the force on a straight current carrying conductor in a magnetic field.

- State, explain and use the expressions B = m_0 I ,
  B = m_0 NI, and B = m_0nI

2pa 2R

for the magnetic flux density at a perpendicular distance a from a straight current carrying wire, at the centre

of a circular coil of N turns each of radius R and at centre of a long solenoid of n turns per metre.

Derive and apply the expression for the magnetic force between two long parallel current - carrying conductor

- Derive and apply the expression for the magnetic force between two long parallel current - carrying

  conductor
- Define the ampere
- Describe a simple form of a current balance.
- Recall and use the expression **F = Bqv sin q** for the force on a particle of charge q, moving in a uniform magnetic field of flux density **B**.

- Describe quantitively the motion of a charge particle in a uniform magnetic field.
- Explain the Hall Effect
- Explain how a calibrated Hall Probe can be used to measure magnetic flux density.
- Derive and use the expresion **t = BANI sin q** for the torque on a current carrying coil in a magnetic field.
- Describe how a moving coil galvanometer can be converted into an ammeter and into a voltmeter.
- Calculate the value of the resistor required to convert a moving coil galvanometer into an ammeter or voltmeter.

- Describe how a moving coil galvanometer is converted into a ballistic galvanometer.

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1.2 Kinematics (18 Periods)

- **Equations of uniformly accelerated linear motion.**
- **Distance, speed-time graphs for uniformly and non-uniformly accelerated linear motion.**
- **Interpretation of area under a speed-time graph.**
- **Meaning of the slope of the tangent at a point on the distance-time, speed-time graphs.**
- **Motion of a body falling freely near the surface of the Earth**
    - **Acceleration due to gravity (g)**

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- **Motion of a projectile:**
  - **An example of motion due to uniformly velocity in one direction and uniform acceleration in the perpendicular direction.**
  - **Time taken to reach maximum height, time of flight T, range of a projectile.**
- **Relative velocity**
  - **Examples.**

Assessment Objectives:

By the end of this topic, the student should be able to:

- Define displacement ,speed, velocity and acceleration.
- Draw sketchs and interpret various motion graphs.
- Determine the distance travelled and the acceleration from the velocity-time graph.
- Derive and use the following expressions:
- **$v = u + at$, $s = ut + ½ at^2$ and $v^2 = u^2 + 2as$**
- Perform and describe an experiment to determine **g**

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using a ticker-timer.

- Derive and use expressions for time taken to reach maximum height, time of flight,

  maximum height and range for a projectile.
- Solve problems involving relative velocity.

UNIT 2 : DYNAMICS 1

2.1 Newton's Laws of Motion and Momentum (9 Periods)

- **Newton's laws of motion.**
  - **inertia**
  - **resultant force F =ma**
- **Linear momentum and its conservation**
- **Impulse and relation to change momentum**
- **Elastic and perfect inelastic collisions.**

Assessment Objectives:

By the end of this topic, the student should be able to:

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- State and use Newton's laws of motion.
- Define linear momentum.
- Verify that linear momentum is conserved in a collision.
- Verify and use the Principle of conservation of linear momentum in collisions.
- Distinguish between elastic , inelastic and perfectly inelastic collisions.

- **2.2 Solid Friction** (8 Periods)
  - **Laws of friction.**
  - **Coeffients of static and kinetic friction.**
  - **Motion of a body on a rough inclined plane.**
  - **Molecular theory explanation of solid friction**

Assessment Objectives:

By the end of this topic, the student be able to:

- Perform and describe experiments to measure the coefficient of static

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and of kinetic friction.

- State and explain the laws of solid friction in terms of molecular theory.
- Solve problem involving motion of a body on rough surfaces.

2.3 Work, Energy and Power (15 Periods)

- **Work as a product of force and distance in the direction of force.**
- **Work-energy theorem**
- **Force-distance graphs**
- **Kinetic and gravitationa potential energy**
- **Elastic potential energy**
- **Conservative forces**
- **Energy conservation and conversion**
- **Dissipative forces**
- **Power as rate of transfer of energy; P = Fv**

Assessment Objectives.

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By the end of this topic, the student should be able to:

- Define work, energy and power.
- State and apply the Principle of energy conversion.
- Relate work to the force-distance graph.
- Calculate work done in a number of situations.
- Derive and use the expressions **K.E = ½ mv^2, P.E = mgh**
- Distinguish between kinetic energy and gravitational potential energy.
- Derive and use the relationship between work done and change in energy.
- Perform experiments to determine efficiency of a simple system.
- State the Principle of Conservation of mechanical energy and illustrate it

  with examples.
- Solve problems involving conservation of mechanical energy.
- Derive and use the expression **P = Fv**

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2.4 STATICS (Periods 15)

- Parallel forces
  - Resultant of parallel forces, turning effect of forces and moment of a force, couples.
- Coplanar forces

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- **Equilibrium of forces.**
- **Triangle of forces to represent forces in equilibrium.**
- **Principle of moments.**
- **Centre of gravity.**

- **Fluids in static equilibrium**
  - **Density, relative density.**
  - **Pressure at a point in a fluid.**
  - **Archimede's Principle**
  - **Floatation**

Assessment objectives:

By the end of this topic, the student should be able to:

- Define centre of gravity.
- Calculate the resultant of parallel forces.
- Define and use moment of a force, couple and torque.
- State and use the conditions for equilibrium for a system under the

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action of coplanar forces.

- Solve problems related to three coplanar forces in equilibrium.
- Define and use density and relative density.
- Derive and use the expression for pressure at a point in a fluid.
- State and use Archimede's Principle.
- State the Law of floation and use it to solve problems related to floating bodies.
- Perform and describe experiments involving the Principle of moments.

End of S5 Term 1 (Estimated time : 8 Weeks)

UNIT 3 : PROPERTIES OF MATTER

- **3.1 Fluid Flow** (9 Periods)

  - **Streamline and turbulent flow.**
  - **Terminal velocity**

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- **Terminal velocity**
- **Bernoulli's equation.**

- **Viscosity in liquids and its determination.**
  - **Poiseulle's and Stoke's law methods.**
- **Viscosity in gases.**

Assessment Objectives.

By the end of this topic, the student should be able to:

- Explain the terms steady (lamina, streamline) and

  turbulent flow as applied to the motion of a fluid.
- Explain the effects of viscosity of an object moving in a fluid
- Define the terms velocity gradient and coefficient of viscocity of a viscous fluid

  and state their units.
- State Stoke's Law and use it to define the expression

  for terminal velocity of a

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for terminal velocity of a sphere in a viscous fluid.

- Perform and describe an experiment to mesure viscocity of a viscous liquid.
- Derive and use Bernoulli's equation **$P + \frac{1}{2} rv^2 + rgh$ = a constant**
- Explain the applications of Bernoulli's Principles in the filter pumps, atomisers and erofoil.
- Explain the effects of temperature on viscocity of liquids and gases.

3.2 Deformation of Solids (9 Periods)

- **Classification of Solids on the basis of strength, stiffness, ductility and toughness.**
- **Stress-strain curve for ductile and brittle materials.**
- **Elastic and plastic behaviour**

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- **Elastic and plastic behaviour.**
  - **Hooke's law**
- **Work done in extension and compression.**
  - **elastic potential energy.**

Assessment Objectives

By the end of this topic, the student should be able to:

- Explain the term strength, stiffness, ductility, toughness and elasticity.
- Define stress, strain, and Young's modulus and state their units.
- Perform and describe an experiment to verify Hooke's law using springs,

  draw a sketch graph of the stress-strain and show the following features:
  limit of proportionality, elastic limit, yield point, breaking point.
- Explain the special features of the stress-strain graph for a ductile material.

for a ductile material.

- Distinguish the elastic behaviours of ductile and brittle materials.
- Compare the elastic behaviours of ductile materials, rubber and brittle materials.
- Perform and describe an experiment to determine Young's modulus of a metal in

  form of an elastic material.
- Relate the work done to the elasic potential energy.
- Relate the work done to area under the force-extension curve.

3.3 Surface Tension (12 Periods)

- **Simple surface tension phenomena.**
- **Molecular theory of matter**
  - **Explanation of surface tension.**
- **Definition of surface tension.**
- **Pressure difference across a spherical surface**

- **Pressure difference across a spherical surface.**
- **Angle of contact**
- **Capillary rise.**
- **Methods of measuring surface tension.**
- **Effects of temperature on surface tension.**

Assessement Objectives

By the end of this topic, the students should be able to:

- Perform and describe experiments to show the existance of surface tension.
- Explain surface tension in terms of molecular theory of matter.
- Define surface tension and state its units.
- Derive and use expressions for excess pressure inside air and soap bubbles.
- Describe an experiment to measure angle of contact q.
- Explain capillarity.
- Derive and use the expression **h = 2g cos q**

- Derive and use the expression h = $\frac{2g \cos q}{rgr}$
- Perform and describe an experiment to measure surface using capillary.
- Explain the effects of impurities on surface tension.

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UNIT 4: DYNAMICS II

- **4.1 Circular Motion** (12 Periods)

  - **Speed of a body, v = rw, moving with uniform angular speed in a circle of radius r.**
  - **Centripetal acceleration, a = $\frac{v^2}{r}$ = rw^2 and centripetal force.**
  - **Examples**
    - **Conical pendulum**
    - **Banking of a road**
    - **Upsetting and skidding**
  - **Translation and rotation kinetic energy.**

Assessment Objectives

By the end of this topic, the student should be able to:

- Define centripetal force.
- Define the radian.
- Derive and use the expression **v = rw.**
- Derive and use the expression **a = v^2/r = rw^2** and state its direction.

- Use the expression $\mathbf{F = mrw^2 = mv^2/r}$ for centripetal force.
- Explain the following as applied to circular motion:
    - conical pendulum
    - banking of a road
    - motion in a vertical circle.
- Describe conditions for skidding and toppling of a cyclist or a vehicle

  moving round a bend.
- Define moment of inertia about a given axis.
- State the expression for rotational K.E of a body rotating about an axis with a

  constant angular velocity.
- Distinguish between transitional and rotational K.E
- Relate work done by a couple to rotational K.E

4.2 Gravitation (18 Periods)

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- **Kepler's law's.**
- **Newton's law's of gravitation.**
- **Gravitational field including local variations of g.**
- **Principle of laboratory determination of G.**
- **Gravitational Potential**
- **Satellites**
  - **Mechanical energy in a given orbit.**
  - **Parking satellites.**

Assessment Objectives

By the end of this topic, the student should be able to:

- State Kepler's laws
- State Newton's law of Gravitation.
- Derive dimensions of the gravitation **G.**
- Derive and use the relation between **G** and **g.**
- Describe the principle of laboratory determination of **G.**
- Derive and use Kepler's third law $\mathbf{T^2}$ a r $^{\mathbf{3}}$.
- Define and use gravitational potential.

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- Define the velocity of escape v_e
- Derive and use the expression v_e **= ÖR$_e$g**
- Describe the variation of **g** from the centre of the earth to a point

  above the earth's surface.
- Derive and use the formulae for K.E, P.E and mechanical energy of

  a satellite in orbit.
- Define parking orbit and relate it to communication satellites.

- Derive and use the expression **T^2= <u>4pR^3</u>** for parking orbit.**/**

  Gr^2

- Explain a state of weightlessness.
- Define free fall.
- Perform and describe an experiment to determine the acceleration

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of free fall.

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4.3 Oscillations (18 Periods)

4.3.1 Simple Harmonic Motion (SHM)

- **A special periodic motion defined by $a = -w^2x$.**
- **Derivation of the equation $a = -w^2x$.**
  - **a mass on a helical spring.**
  - **a simple pendulum.**
  - **a floating cylinder.**
  - **a liquid in a U-tube.**
- **Solution of $a = -w^2x$ of the form $x = A \sin wt$ or $x = A \cos wt$**
- **Graphical representations of displacement, speed and acceleration in SHM.**
- **Phase difference demostrated with two oscillating pendula or two masses oscillating at the end of helical springs**

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oscillating at the end of helical springs.

- Amplitude, Period and frequency.

  speed v = ± wÖ(A^2 - x^2)
- Interchange of kinetic and potential energy in SHM.
- Conservation of Energy.
- Measurement of acceleration due to gravity using
  - a simple pendulum.
  - a mass of a helical spring.

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Simple Harmonic Motion (continued)

Assessment objectives

By the end of this topic, the student should be able to:

- Derive the expression $\mathbf{a = -w^2x}$ component of acceleration of

  a body moving in a circle.
- Define simple harmonic motion.
- Verify that a simple pendulum, a mass at the end of a string, a liquid

  in a U-tube, floating cylinder and car piston oscillate with SHM.
- Define the terms period and amplitude.
- Derive and use the expression for the period in each of the above

examples of SHM.

- Verify that the solutions of the equation **a = -w^{2}x** are of the form

  x = A sin wt or **x = A cos wt** .
- Explain phase difference between two different simple harmonic

  oscillators.
- Draw sketch graphs to show the variation of displacement, velocity,

  acceleration with time.
- Derive and use the expression **v = ± wÖ(A^2 - x^2)** for the velocity of a simple

  harmonic oscillator.
- Derive and use expressions for potential energy and

  kinetic energy of a simple

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harmonic oscillator and hence the mechanical energy.

- Describe the interchange between kinetic energy and potential energy during

  SHM and show that mechanical energy is constant.
- Draw a sketch graph to show the variation of P.E and K.E and mechanical energy

  with displacement.

4.3.2 Damped and Free Oscillations.

- **Damped oscillations.**
- **Forced oscillations and resonance.**
  - **practical examples.**

Assessment objectives

By the end of this topic, the student should be able to:

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- Distinguish between free and damped oscillations.
- Describe practical examples of damped oscillations with
- particular reference to the degree of damping and the importance
- of critical damping in such cases as car suspension system.
- Explain forced oscillations and describe practical examples of forced
- oscillations and resonance.
- Describe graphically how amplitude of forced oscillations varies with
- frequency.
- Define resonance.
- State the factors which determine the frequency response and sharpness
- of the resonance of a forced oscillator.
- List examples od cases where resonance is useful and where it is undesirable.
- Perform and describe an experiment to determine acceleration due to gravity using ;

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(i) simple pendulum .
(ii) helical spring .

- Perform an experiment to determine Young's modulus of wood using a

  vibrating wooden beam .

End of S5 Term 2 : Estimated time : 10 weeks (9 Periods per week)

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UNIT 5: GEOMETRIC OPTICS

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5.1 Reflection of light at plane surfaces. (6 Periods)

- **Regular and diffuse reflection.**
- **Rotation of a plane mirror with direction of incident ray.**
- **Images formed in a plane mirror.**
- **Focal point, focal length, centre of curvature.**

Assessment objectives

By the end of this topic, the student should be able to:

- Define a ray of light.
- Define a beam of light and draw sketch diagrams for the convergent and divergent beams.
- Perform and describe an experiment to illustrate the principle of reversibility of light.
- State the laws of reflection of light.

- Perform and desctibe an experiment to illustrate the laws of reflection of light.
- Distinguish between regular an diffuse refleciton.
- Perform and describe an experiment to determine the relation between angle of rotation of a plane mirror and angle of the reflected ray while keeping the direction of the incident ray fixed.
- Describe the application of rotation of a plane mirror in the light beam galvanometer.
- Perform and describe an experiment to find the position and nature of an image formed by a plane mirror.
- Derive and use the expression relating the number of images formed by two inclined mirrors and the angle between the two mirrors.

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- List uses of plane mirrors.

5.2 Reflection of light at curved surfaces. (9 Periods)

- **The equation** $\frac{1}{u} + \frac{1}{v} = \frac{1}{f} = \frac{2}{r}$
- **Spherical aberration, caustic surface.**

Assessment objectives

By the end of this topic, the student should be able to:

- Describe the types of curved mirrors.
- Define the terms focal point, centre of curvature, radius of curvature,

  pole and aperure as applied to curved mirrors.
- Derive and use the relation **r = 2f** for curved mirrors.
- Distingiush between marginal and paraxial rays.
- Describe the formation of caustic surface.
- Describe spherical aberration and the use of

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parabolic mirrors to
- correct the defect.

Derive and use the formula $\frac{1}{u} + \frac{1}{v} = \frac{1}{f} = \frac{2}{r}$

- Determine image and object position, focal length and radius of curvature

by construction and calculation.
- Distinguish between the nature of images formed by convex and concave mirrors.
- Perform and describe experiments to detemine focal length or radius of curvature

of curved mirrors.
- Perform and describe experiments to determine

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of curved mirrors using a distant object, no-parallax and an illuminated object.
- List applications of concave and convex mirrors.

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5.3 Refraction of light at plane boundaries (9 Periods)

- **Snell's law.**
- **Real and apparent depth.**
- **Critical angle and total internal reflection.**
  - **applications, including optical fibres.**

Assessment objectives

By the end of this topic, the student should be able to:

- Perform and describe experiments to demonstrate refraction of light through a glass block and through a liquid.
- State the laws of refraction.
- Perform and describe an experiment to establish $\frac{\sin i}{\sin r}$ = constant

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- Define refractive index and explain its variation with optical media.
- Define refractive index in terms of velocities of light in the respective media.
- Derive and use relation $_g n_a = \frac{1}{_a n_g}$
- Derive and use the the expression $_1 n_3 = {_1 n_2} \times {_2 n_3}$ for three parallel sided transparent media.
- Derive and use the expression **n sini = constant.**
- Perform and describe an experiment to determine the refractive index by the apparent depth method.
- Explain critical angle and the total internal reflection.
- State the conditions for the occurence of total internal reflection.
- List applications of total internal reflection e.g fibre

optics, radio wave transmission,

binoculars, periscopes and mirage formation.

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5.4 Refraction through Prisms (9 periods)

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Minimum deviation

- **Deviation by thin prisms.**
- **Prism spectrometer and white light spectrum.**

Assessment objectives

By the end of this topic, the student should be able to:

- Explain dispersion of white light by a prism.
- Derive and use the expression for deviation

  $$d = (i_1 - r_1) + (i_2 - r_2)$$

- Derive and use the expression **d = (n - 1)A** for a small angled prism.
- State conditions required for minimum deviation to occur.
- Derive and use the expression **n = sin(A+D$_{min}$) / sin A**

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- Perform and describe experiments to measure angle **A** of

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a prism and **D$_{min}$** using a spectrometer.

- Perform an experiment to determine refractive index of the material of the prism

  using optical pins and spectrometer.
- Describe applications of glass prisms.

5.5 Refraction through a thin lens. (12 Periods)

- **Types of lenses.**
- **Focal points, focal lengths**
- **Power of lens.**
- **Thin lens formula** $\frac{1}{u} + \frac{1}{v} = \frac{1}{f}$
- **Transverse magnification.**
- **Displacement formula,** $L^2 - d^2 = 4d¦$
- **Conjugate foci; Newton's formula** $xy = ¦^2$
- **Full lens formula** $\frac{1}{¦} = (n-1)\left(\frac{1}{r_1} + \frac{1}{r_2}\right)$ **for a thin lens in air.**
- **Methods of determination of focal lengths of both**

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converging and diverging lenses.

- **Defects of images formed by a lens;**
  - **spherical and chromatic aberration.**

Assessment objectives

By the end of this topic, the student should be able to:

- Identify converging and diverging lenses.
- Define the terms:- principle focus, principle axis, optical centre,

  focal length as applied to converging and diverging lenses.
- Draw ray diagrams to illustrate formation of real and virtual images.
- Derive and use the expression $\frac{1}{u} + \frac{1}{v} = \frac{1}{f} = \frac{2}{r}$
- Define transverse magnification.
- Derive and use the relation: **m = v**

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- Derive and use the expression **L² - d² = 4d¦**
- Derive and use the expression **1 = 1 + 1** for thin lenses in contact.

F ¦1 ¦2

- Define power of the lens and state its units.
- Derive and use Newton's formula **xy =¦²**
- Derive and use the expression **1 = (n - 1) (1 + 1)**

¦ r1 r2

- Explain chromatic aberration and spherical aberration in lenses and how

  they are minimised.
- Perform an experiment to demostrate chromatic aberration and spherical

  aberration in lenses.
- Perform and describe experiments to determine

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focal length and radii of the

surfaces of the lenses.

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- **5.6 Optical Instruments** (9 Periods)
  - **Magnifying power of an optical instrument.**
  - **The magnifying glass (simple microscope).**
  - **The compound telescope**

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- **The compound telescope**
    - **magnifying power in normal adjustment.**
- **Astronomical telescope and Galiliean telescope.**
    - **magnifying power in normal adjustment.**
- **Reflecting telescope.**
- **Prism binoculars.**

- **Simple lens camera.**
- **The human eye.**
    - **eye defects and their corrections.**

Assessment objectives

By the end of this topic, the student should be able to:

- Descirbe the optical parts of the human eye.
- Distinguish between long and short sightedness.
- Explain how the eye defects are corrected.
- Define the terms visual angle, angular magnification,

  near point and far point.
- Describe structure and action of: simple microscope, compound

microscope (normal adjustment) ,astronomical telescope, Galilean telescope,

reflecting telescope, simple lens camera, projector lantern.

- State the advantages and disadvantages of reflecting telescopes

  over refracting telescopes (Astronomical telescope and Galilean telescope)
- Derive and use the expression
  - **M =** ¦ for telescopes

    ¦
  - Define the eye-ring of a telescope and explain it's significance.
  - Describe the action of prism binoculars.

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6.1 Types of Wave Motion. (9 Periods)

- **Transverse and longitudinal wave motion.**
- **Relation between v, ¦, and l.**
- **Progressive waves.**
  - **the equation for th eprogressive wave.**

$$y = A \sin 2p\left(\frac{t}{T} - \frac{x}{l}\right)$$

- **Transmission of energy by waves.**
- **Relation between intensity, frequency and amplitude.**

Assessment objectives

By the end of this topic, the student should be able to:

- Describe longitudinal and transverse waves and explain their mode

  of propagation.

- Define the terms: displacement, amplitude, period, frequency and

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wavelength.

- Derive and use the expression **v = ¦l.**
- Perform and describe experiments to demonstrate progressive wave.
- Explain phase of vibrations.
- Derive and use the expression **y = A sin 2p(t - x)** and explain the
T l
significance of ± in the equation.
- Relate amplitude and frequency with energy.

6.2 Superposition of waves

- **Principle of superposition**
- **Stationary waves and their properties.**
- **Interference and beats, Doppler effect.**
- **Longitudeinal stationary waves and air columns, resonance.**
- **Stationary waves and stretched strings including the relation**
v = 1Ö(T/m)
2L
- **Overtones and harmonies.**

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Assessment objectives

By the end of this topic, the student should be able to:

- State and use the principle of superposition of waves.
- Explain interference fo waves and occurrence of beats.
- Derive and use the expression for beat frequency.
- Explain Doppler effect.
- Derive and use the expression for Doppler shift.
- Explain the formation of a stationary wave.
- Explain the terms node and antinode.
- Perform and describe experiments to demonstrate formation of

  stationary waves.
- Derive and use the relation **v = 1Ö(T/m)** for a stationary wave in

  2L

  a stretched string.

- Describe applications of stationary waves in strings.
- Perform and describe experiments to demonstrate longitudinal stationary

  waves in air columns using open pipes and closed pipes.
- Demonstrate and explain resonance.
- Explain overtones and harmonics.
- Perform and describe experiments to measure velocity and frequency of

  sound, using open and closed pipes.
- Derive and use a relationship between the frequency and length of an air

  column.
- Perform and describe experiments to show variation in speed of sound in

  different media and explain the variation.
- Explain the dependence of speed of sound in air on

pressure, temperature

density and direction of wind.

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Background

- **6.3 Wave theory of light** (18 Periods)

- **Huygen's construction as applied to reflection and refraction.**
- **Speed of light in air.**
- **Interference of light and its apllications.**
  - **conditions for interference.**
  - **Young's double slit interference; derivation of**

    l = aDx / D
  - **thin films.**
- **Diffraction**
  - **demonstration of diffraction using water wave in a ripple tank.**

    single slit diffraction of light.
  - **plane transmission grating and application of formula dsinq = nl**

    in the determination of wavelength.
- **Polarisation**
  - **as a phenomenon associated with transverse waves.**

- **producing polarised light by reflection, double**

  refraction,
  selective absorption and scattering.
- **application of polarisation.**

Assessment objectives

By the end of this topic, the student should be able to:

- Define a wave front.
- Distinguish between circular and plane wave fronts.
- Describe Huygen's construction.
- Apply Huygen's construction to reflection and refraction of

  light
- Describe a terrestrial method of measuring the speed of light.
- Explain the terms coherent sources of light, path difference and

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optical as applied to light.

- Explain interference by "division of wave fronts".
- Describe Young's double slit experiments.
- Explain destructive and constructive interference.

Derive and use the equation $\lambda = \frac{aDx}{D}$

- Describe an experiment for measuring λ using the double slit arrangement.
- State factors which determine the appearence of fringes.
- Explain interference by **"division of amplitude"**.
- Explain interference of light waves in thin films.
- Perform and describe an experiment to demostrate diffraction of water waves in a ripple tank.
- Explain diffraction of waves.
- Describe plane transmission grating.

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- Use the expression **dsinq = nl**
- Describe an experiment to determine **l** using diffraction grating.
- Explain the terms polarisation, polarised light and polaroid.
- Describe polarisation of light by: reflection, double refraction, selective

  absorption and scattering methods.
- State and use Brewster's Law.
- Explain applications of polarisation e.g. in saccharimetry, photoelasticity,
- reducing light intensity and 3-D pictures (holography)

End of S5 Term 3. Estimated Time: 10 weeks (90 lessons)

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