

SCIENCE (52)
PHYSICS
SCIENCE Paper - 1

Aims:

1. To acquire knowledge and understanding of the terms, facts, concepts, definitions, laws, principles and processes of Physics.
2. To develop skills in practical aspects of handling apparatus, recording observations and in drawing diagrams, graphs, etc.
3. To develop instrumental, communication, deductive and problem-solving skills.
4. To discover that there is a living and growing physics relevant to the modern age in which we live.

CLASS IX

There will be one paper of two hours duration carrying 80 marks and Internal Assessment of practical work carrying 20 marks.

The paper will be divided into two sections, Section I (40 marks) and Section II (40 marks).

Section I (compulsory) will contain short answer questions on the entire syllabus.

Section II will contain six questions. Candidates will be required to answer any four of these six questions.

Note: Unless otherwise specified, only SI Units are to be used while teaching and learning, as well as for answering questions.

1. Measurements and Experimentation

- (i) International System of Units, **the required SI units with correct symbols are given at the end of this syllabus.** Other commonly used system of units - fps and cgs.
- (ii) Measurements using common instruments, Vernier callipers and *micro-metre* screw gauge for length, and simple pendulum for time.

Measurement of length using, Vernier callipers and micro-metre screw gauge. Decreasing least-count leads to an increase in accuracy; least-count (LC) of Vernier callipers and screw gauge), zero error (basic idea), (no numerical problems on callipers and screw gauge), simple pendulum; time period, frequency, graph of length l vs. T^2 only; slope of the graph. Formula $T=2\pi\sqrt{l/g}$ [no derivation]. Only simple numerical problems.

2. Motion in One Dimension

Scalar and vector quantities, distance, speed, velocity, acceleration; graphs of distance-time and speed-time; equations of uniformly accelerated motion with derivations.

Examples of Scalar and vector quantities only, rest and motion in one dimension; distance and displacement; speed and velocity; acceleration and retardation; distance-time and velocity-time graphs; meaning of slope of the graphs; [Non-uniform acceleration excluded].

Equations to be derived: $v = u + at$;

*$S = ut + \frac{1}{2}at^2$; $S = \frac{1}{2}(u+v)t$; $v^2 = u^2 + 2aS$. [Equation for S_n^{th} is **not** included].*

Simple numerical problems.

3. Laws of Motion

- (i) Contact and non-contact forces; cgs & SI units.

Examples of contact forces (frictional force, normal reaction force, tension force as applied through strings and force exerted during collision) and non-contact forces (gravitational, electric and magnetic). General properties of non-contact forces. cgs and SI units of force and their relation with Gravitational units.

- (ii) Newton's First Law of Motion (qualitative discussion) introduction of the idea of inertia, mass and force.

*Newton's first law; statement and qualitative discussion; definitions of inertia and force from first law, examples of inertia as illustration of first law. (Inertial mass **not** included).*

- (iii) Newton's Second Law of Motion (including $F=ma$); weight and mass.

Detailed study of the second law. Linear momentum, $p = mv$; change in momentum $\Delta p = \Delta(mv) = m\Delta v$ for mass remaining constant, rate of change of momentum;

$$\Delta p / \Delta t = m\Delta v / \Delta t = ma \text{ or}$$

$$\left\{ \frac{p_2 - p_1}{t} = \frac{mv - mu}{t} = \frac{m(v - u)}{t} = ma \right\};$$

Simple numerical problems combining

$F = \Delta p / \Delta t = ma$ and equations of motion. Units of force - only cgs and SI.

- (iv) Newton's Third Law of Motion (qualitative discussion only); simple examples.

Statement with qualitative discussion; examples of action - reaction pairs, (F_{BA} and F_{AB}); action and reaction always act on different bodies.

- (v) Gravitation

Universal Law of Gravitation. (Statement and equation) and its importance. Gravity, acceleration due to gravity, free fall. Weight and mass, Weight as force of gravity comparison of mass and weight; gravitational units of force, (Simple numerical problems), (problems on variation of gravity excluded)

4. Fluids

- (i) Change of pressure with depth (including the formula $p=h\rho g$); Transmission of pressure in liquids; atmospheric pressure.

Thrust and Pressure and their units; pressure exerted by a liquid column $p = h\rho g$; simple daily life examples, (i) broadness of the base of a dam, (ii) Diver's suit etc. some consequences of $p = h\rho g$; transmission of pressure in liquids; Pascal's law; examples; atmospheric pressure; common manifestation and consequences.- Variations of pressure with altitude, (qualitative only); applications such as weather forecasting and altimeter. (Simple numerical problems)

- (ii) Buoyancy, Archimedes' Principle;— floatation; relationship with density; relative density; determination of relative density of a solid.

Buoyancy, upthrust (F_B); definition; different cases, $F_B >$, = or $<$ weight W of the

body immersed; characteristic properties of upthrust; Archimedes' principle; explanation of cases where bodies with density $\rho >$, = or $<$ the density ρ' of the fluid in which it is immersed.

RD and Archimedes' principle. Experimental determination of RD of a solid and liquid denser than water. Floatation: principle of floatation; relation between the density of a floating body, density of the liquid in which it is floating and the fraction of volume of the body immersed; ($\rho_1/\rho_2 = V_2/V_1$); apparent weight of floating object; application to ship, submarine, iceberg, balloons, etc.

Simple numerical problems involving Archimedes' principle, buoyancy and floatation.

5. Heat and Energy

- (i) Concepts of heat and temperature.

Heat as energy, SI unit – joule,

$$1 \text{ cal} = 4.186 \text{ J exactly.}$$

- (ii) Anomalous expansion of water; graphs showing variation of volume and density of water with temperature in the 0 to 10 °C range. Hope's experiment and consequences of Anomalous expansion.

- (iii) Energy flow and its importance:

Understanding the flow of energy as Linear and linking it with the laws of Thermodynamics- 'Energy is neither created nor destroyed' and 'No Energy transfer is 100% efficient.'

- (iv) Energy sources.

Solar, wind, water and nuclear energy (only qualitative discussion of steps to produce electricity). Renewable versus non-renewable sources (elementary ideas with example).

Renewable energy: biogas, solar energy, wind energy, energy from falling of water, run-of-the river schemes, energy from waste, tidal energy, etc. Issues of economic viability and ability to meet demands.

Non-renewable energy – coal, oil, natural gas. Inequitable use of energy in urban and rural areas. Use of hydro electrical powers for light and tube wells.

- (v) Global warming and Green House effect:
Meaning, causes and impact on the life on earth. Projections for the future; what needs to be done.
Energy degradation – meaning and examples.

6. Light

- (i) Reflection of light; images formed by a pair of parallel and perpendicular plane mirrors; .
Laws of reflection; experimental verification; characteristics of images formed in a pair of mirrors, (a) parallel and (b) perpendicular to each other; uses of plane mirrors.

- (ii) Spherical mirrors; characteristics of image formed by these mirrors. Uses of concave and convex mirrors. (Only simple direct ray diagrams are required).

Brief introduction to spherical mirrors - concave and convex mirrors, centre and radius of curvature, pole and principal axis, focus and focal length; location of images from ray diagram for various positions of a small linear object on the principal axis of concave and convex mirrors; characteristics of images.

$f = R/2$ (without proof); sign convention and direct numerical problems using the mirror formulae are included. (Derivation of formulae not required)

Uses of spherical mirrors.

Scale drawing or graphical representation of ray diagrams not required.

7. Sound

- (i) Nature of Sound waves. Requirement of a medium for sound waves to travel; propagation and speed in different media; comparison with speed of light.

Sound propagation, terms – frequency (f), wavelength (λ), velocity (V), relation $V = f\lambda$. (Simple numerical problems) effect of different factors on the speed of sound; comparison of speed of sound with speed of light; consequences of the large difference in these speeds in air; thunder and lightning.

- (ii) Infrasonic, sonic, ultrasonic frequencies and their applications.

Elementary ideas and simple applications only. Difference between ultrasonic and supersonic.

8. Electricity and Magnetism

- (i) Simple electric circuit using an electric cell and a bulb to introduce the idea of current (including its relationship to charge); potential difference; insulators and conductors; closed and open circuits; direction of current (electron flow and conventional)

Current Electricity: brief introduction of sources of direct current - cells, accumulators (construction, working and equations excluded); Electric current as the rate of flow of electric charge (direction of current - conventional and electronic), symbols used in circuit diagrams. Detection of current by Galvanometer or ammeter (functioning of the meters not to be introduced). Idea of electric circuit by using cell, key, resistance wire/resistance box/rheostat, qualitatively.; elementary idea about work done in transferring charge through a conductor wire; potential difference $V = W/q$.

(No derivation of formula) simple numerical problems.

Social initiatives: Improving efficiency of existing technologies and introducing new eco-friendly technologies. Creating awareness and building trends of sensitive use of resources and products, e.g. reduced use of electricity.

- (ii) Induced magnetism, Magnetic field of earth. Neutral points in magnetic fields.

Magnetism: magnetism induced by bar magnets on magnetic materials; induction precedes attraction; lines of magnetic field and their properties; evidences of existence of earth's magnetic field, magnetic compass. Uniform magnetic field of earth and non-uniform field of a bar magnet placed along magnetic north-south; neutral point; properties of magnetic field lines.

- (iii) Introduction of electromagnet and its uses.

CLASS X

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1. Force, Work, Power and Energy

- (i) Turning forces concept; moment of a force; forces in equilibrium; centre of gravity; [discussions using simple examples and simple numerical problems].

Elementary introduction of translational and rotational motions; moment (turning effect) of a force, also called torque and its cgs and SI units; common examples - door, steering wheel, bicycle pedal, etc.; clockwise and anti-clockwise moments; conditions for a body to be in equilibrium (translational and rotational); principle of moment and its verification using a metre rule suspended by two spring balances with slotted weights hanging from it; simple numerical problems; Centre of gravity (qualitative only) with examples of some regular bodies and irregular lamina.

- (ii) Uniform circular motion.

As an example of constant speed, though acceleration (force) is present. Differences between centrifugal and centripetal force.

- (iii) Work, energy, power and their relation with force.

Definition of work. $W = FS \cos \theta$; special cases of $\theta = 0^\circ, 90^\circ$. $W = mgh$. Definition of energy, energy as work done. Various units of work and energy and their relation with SI units. [erg, calorie, kWh and eV]. Definition of Power, $P = W/t$; SI and cgs units; other units, kilowatt (kW), megawatt (MW) and gigawatt (GW); and horse power (1hp=746W) [Simple numerical problems on work, power and energy].

- (iv) Different types of energy (e.g. chemical energy, Mechanical energy, heat energy, electrical energy, nuclear energy, sound energy, light energy).

Mechanical energy: potential energy $U = mgh$ (derivation included) gravitational PE, examples; kinetic energy $K = \frac{1}{2} mv^2$ (derivation included); forms of kinetic energy: translational, rotational and vibrational - only simple examples. [Numerical problems on K and U only in case of translational motion]; qualitative discussions of electrical, chemical, heat, nuclear, light and sound energy, conversion from one form to another; common examples.

- (v) Machines as force multipliers; load, effort, mechanical advantage, velocity ratio and efficiency; simple treatment of levers, pulley systems showing the utility of each type of machine.

Functions and uses of simple machines: Terms- effort E, load L, mechanical advantage $MA = L/E$, velocity ratio $VR = V_E/V_L = d_E/d_L$, input (W_i), output (W_o), efficiency (η), relation between η and MA, VR (derivation included); for all practical machines $\eta < 1$; $MA < VR$.

Lever: principle. First, second and third class of levers; examples: MA and VR in each case. Examples of each of these classes of levers as also found in the human body.

Pulley system: single fixed, single movable, block and tackle; MA, VR and η in each case.

- (vi) Principle of Conservation of energy.

Statement of the principle of conservation of energy; theoretical verification that $U + K = \text{constant}$ for a freely falling body. Application of this law to simple pendulum (qualitative only); [simple numerical problems].

2. Light

- (i) Refraction of light through a glass block and a triangular prism - qualitative treatment of simple applications such as real and apparent depth of objects in water and apparent

bending of sticks in water. Applications of refraction of light.

Partial reflection and refraction due to change in medium. Laws of refraction; the effect on speed (V), wavelength (λ) and frequency (f) due to refraction of light; conditions for a light ray to pass undeviated. Values of speed of light (c) in vacuum, air, water and glass; refractive index $\mu = c/V$, $V = f\lambda$. Values of μ for common substances such as water, glass and diamond; experimental verification; refraction through glass block; lateral displacement; multiple images in thick glass plate/mirror; refraction through a glass prism simple applications: real and apparent depth of objects in water; apparent bending of a stick under water. (Simple numerical problems and approximate ray diagrams required).

- (ii) Total internal reflection: Critical angle; examples in triangular glass prisms; comparison with reflection from a plane mirror (qualitative only). Applications of total internal reflection.

Transmission of light from a denser medium (glass/water) to a rarer medium (air) at different angles of incidence; critical angle (C) $\mu = 1/\sin C$. Essential conditions for total internal reflection. Total internal reflection in a triangular glass prism; ray diagram, different cases - angles of prism ($60^\circ, 60^\circ, 60^\circ$), ($60^\circ, 30^\circ, 90^\circ$), ($45^\circ, 45^\circ, 90^\circ$); use of right angle prism to obtain $\delta = 90^\circ$ and 180° (ray diagram); comparison of total internal reflection from a prism and reflection from a plane mirror.

- (iii) Lenses (converging and diverging) including characteristics of the images formed (using ray diagrams only); magnifying glass; location of images using ray diagrams and thereby determining magnification.

Types of lenses (converging and diverging), convex and concave, action of a lens as a set of prisms; technical terms; centre of curvature, radii of curvature, principal axis, foci, focal plane and focal length; detailed study of refraction of light in spherical lenses through ray diagrams; formation of images - principal rays or construction rays; location of images from ray diagram for various positions of a small linear object on the principal axis; characteristics of images.

Sign convention and direct numerical problems using the lens formula are included (derivation of formula not required).

Scale drawing or graphical representation of ray diagrams not required.

*Power of a lens (concave and convex) – [simple direct numerical problems]: magnifying glass or simple microscope: location of image and magnification from ray diagram only [formula and numerical problems **not** included]. Applications of lenses.*

- (iv) Using a triangular prism to produce a visible spectrum from white light; Electromagnetic spectrum. Scattering of light.

Deviation produced by a triangular prism; dependence on colour (wavelength) of light; dispersion and spectrum; electromagnetic spectrum: broad classification (names only arranged in order of increasing wavelength); properties common to all electromagnetic radiations; properties and uses of infrared and ultraviolet radiation. Simple application of scattering of light e.g. blue colour of the sky.

3. Sound

- (i) Reflection of Sound Waves; echoes: their use; simple numerical problems on echoes.

Production of echoes, condition for formation of echoes; simple numerical problems; use of echoes by bats, dolphins, fishermen, medical field. SONAR.

- (ii) Natural vibrations, Damped vibrations, Forced vibrations and Resonance - a special case of forced vibrations. *Meaning and simple applications of natural, damped, forced vibrations and resonance.*

- (iii) Loudness, pitch and quality of sound:

Characteristics of sound: loudness and intensity; subjective and objective nature of these properties; sound level in db (as unit only); noise pollution; interdependence of: pitch and frequency; quality and waveforms (with examples).

4. Electricity and Magnetism

- (i) Ohm's Law; concepts of emf, potential difference, resistance; resistances in series and parallel, internal resistance.

Concepts of pd (V), current (I), resistance (R) and charge (Q). Ohm's law: statement, $V=IR$; SI units; experimental verification; graph of V vs I and resistance from slope; ohmic and non-ohmic resistors, factors affecting resistance (including specific resistance) and internal resistance; super conductors, electromotive force (emf); combination of resistances in series and parallel and derivation of expressions for equivalent resistance. Simple numerical problems using the above relations. [Simple network of resistors].

(ii) Electrical power and energy.

Electrical energy; examples of heater, motor, lamp, loudspeaker, etc. Electrical power; measurement of electrical energy, $W = QV = VIt$ from the definition of pd. Combining with ohm's law $W = VIt = I^2 Rt = (V^2/R)t$ and electrical power $P = (W/t) = VI = I^2 R = V^2/R$. Units: SI and commercial; Power rating of common appliances, household consumption of electric energy; calculation of total energy consumed by electrical appliances; $W = Pt$ (kilowatt \times hour = kWh), [simple numerical problems].

(iii) Household circuits – main circuit; switches; fuses; earthing; safety precautions; three-pin plugs; colour coding of wires.

House wiring (ring system), power distribution; main circuit (3 wires-live, neutral, earth) with fuse / MCB, main switch and its advantages - circuit diagram; two-way switch, staircase wiring, need for earthing, fuse, 3-pin plug and socket; Conventional location of live, neutral and earth points in 3 pin plugs and sockets. Safety precautions, colour coding of wires.

(iv) Magnetic effect of a current (principles only, laws not required); electromagnetic induction (elementary); transformer.

Oersted's experiment on the magnetic effect of electric current; magnetic field (B) and field lines due to current in a straight wire (qualitative only), right hand thumb rule – magnetic field due to a current in a loop; Electromagnets: their uses; comparisons with a permanent magnet; Fleming's Left Hand Rule, the DC electric motor- simple sketch of main parts (coil, magnet, split ring commutators and brushes); brief description and type of energy transfer(working not

required): Simple introduction to electromagnetic induction; frequency of AC in house hold supplies , Fleming's Right Hand Rule, AC Generator - Simple sketch of main parts, brief description and type of energy transfer(working not required). Advantage of AC over DC. Transformer- its types, characteristics of primary and secondary coils in each type (simple labelled diagram and its uses).

5. Heat

(i) Calorimetry: meaning, specific heat capacity; principle of method of mixtures; Numerical Problems on specific heat capacity using heat loss and gain and the method of mixtures.

Heat and its units (calorie, joule), temperature and its units ($^{\circ}C$ K); thermal (heat) capacity $C' = Q/\Delta T...$ (SI unit of C): Specific heat Capacity $C = Q/m \Delta T$ (SI unit of C) Mutual relation between Heat Capacity and Specific Heat capacity, values of C for some common substances (ice, water and copper). Principle of method of mixtures including mathematical statement. Natural phenomenon involving specific heat. Consequences of high sp. heat of water. [Simple numerical problems].

(ii) Latent heat; loss and gain of heat involving change of state for fusion only.

Change of phase (state); heating curve for water; latent heat; specific latent heat of fusion (SI unit). Simple numerical problems. Common physical phenomena involving latent heat of fusion.

6. Modern Physics

(i) Radioactivity and changes in the nucleus; background radiation and safety precautions.

Brief introduction (qualitative only) of the nucleus, nuclear structure, atomic number (Z), mass number (A). Radioactivity as spontaneous disintegration. α , β and γ - their nature and properties; changes within the nucleus. One example each of α and β decay with equations showing changes in Z and A . Uses of radioactivity - radio isotopes. Harmful effects. Safety precautions. Background radiation.

Radiation: X-rays; radioactive fallout from nuclear plants and other sources.

Nuclear Energy: working on safe disposal of waste. Safety measures to be strictly reinforced.

(ii) Nuclear fission and fusion; basic introduction and equations.