S. Chand's

ICSE PHYSICS

BOOK I

FOR CLASS IX



PANKAJ BHATT

S. CHAND School

S. Chand's

ICSE PHYSICS

BOOK–I

CLASS – IX

Strictly according to the Latest Syllabus (March, 2014) for ICSE (Class IX) prescribed by the Council for Indian School Certificate Examinations, New Delhi

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BOOK–I

CLASS – IX

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PREFACE TO THE REVISED EDITION

The present textbook of **S. Chand's ICSE Physics for Class IX** is based on the Latest ICSE syllabus prescribed for students of ICSE courses. An attempt has been made in this textbook to ensure that it fulfills all the requirements of Physics students of class IX.

Basic definitions and formulae of the subject remain the same in every textbook but the main difference lies in explaining and presenting them with supporting examples and formulae so that the student does not feel any difficulty in grasping the subject.

This textbook contains all that the students need and the main features are detailed below:

1. The basic principles are explained with examples from students daily life situations and every topic is followed by thought provoking questions.
2. Relevant illustrations have been given wherever necessary.
3. The language used is simple and lucid, which keeps the interest of the students alive till the end of the topic.
4. The book caters both to the needs of very intelligent students as well as the average students.

I am myself a teacher in a ICSE reputed school teaching the subject for the last about 3 decades and I have utilized to make the entire textual material helpful for the students and the teachers.

I am sure that the book will create interest of the students in learning the basics of Physics and motivate them in choosing it for higher studies.

I am thankful to S. Chand & Company Ltd. for popularising this book in ICSE schools all over India. The book has been printed in an attractive format and I thank all those who are associated with its designing and printing.

Feedback from students and teachers is most welcome, which will help me to make this textbook error-free and user-friendly.

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NEW SYLLABUS (March, 2014)

ICSE Class-IX

There will be one paper of ***one*** *and* ***half-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 S.I. Units are to be used while teaching and learning, as well as for answering questions.*

1. Measurements and Experimentation

(*i*) Estimation by orders of magnitude of size (length, area and volume), mass and time.

Order of magnitude as statement of magnitude in powers of ten; familiarity with the orders of magnitude of some common sizes (length, area and volume), masses and time intervals e.g. idea of mass of atoms, bottle of water, planets, diameter of atom, length of football field, inter stellar distances, pulse rate, age of earth etc.

(*ii*) International System of Units, **the required SI units with correct symbols are given at the end of this syllabus**. Other commonly used system of unit - fps and cgs.

(*iii*) Measurements using common instruments (metre rule, Vernier calipers and micrometer screw gauge for length, volume by displacement using a measuring cylinder, stop watch and simple pendulum for time, equal arm beam balance for comparison of masses).

This section should be taught along with demonstration or laboratory experiments. Measurement of length using metre rule, Vernier calipers and micrometer screw gauge. They have increasing accuracy and decreasing least-count; zero error, zero correction (excluding negative zero error in Vernier calipers), pitch of the screw and least-count (LC); no numerical problems on calipers and screw gauge. Volume units, m^3, cm^3, litre and milliliter; their mutual relations. Measurement of volume of irregular solid bodies both heavier and lighter than water including those soluble in water, by displacement of water or other liquids in a measuring cylinder. Measurement of time using stopwatch; simple pendulum; time period, frequency, experiment for the measurement of T, graph of length l vs. T^2 only; slope of the graph. Formula $T = 2\pi\sqrt{\frac{l}{g}}$ [no derivation]. Only simple numerical problems. Beam balance; simple introduction; conditions for balance to be true (without proof). Faulty balance is <u>not</u> included.

(*iv*) Presentation of data in tabular and graphical form (straight line graphs only);

Presentation of data in tabular form of two types; headed columns (e.g. simple pendulum) and numbered rows (e.g., volume measurement). Graph – various steps in plotting a graph, such as title, selection of origin and axes, labeling of axes, scale, plotting the points, best-fit straight line, etc. Meaning of slope and of straight-line graph. **[No numerical problems].**

2. Motion in one dimension

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

Rest and motion: [motion in two and three dimensions not to be covered in Class IX]; 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: $v = u + at$;

$S = ut + 1/2at^2$; $S = 1/2(u + v)t$; $v^2 = u^2 + 2aS$.

[Equation for S_n^{th} is **not** included].

Simple numerical problems.

3. Laws of Motion

(i) Newton's First Law of Motion (qualitative discussion) to introduce 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).

(ii) 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;

$\Delta p/\Delta t = m\Delta v/\Delta t = ma$

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

Numerical problems combining $F = \Delta p/\Delta t = ma$ and equations of motion. Units of force - only cgs and SI (non gravitational).

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

Statement with qualitative discussion; examples of action-reaction pairs, say F_{BA} and F_{AB}; action and reaction always act on different bodies. Numerical problems based on second law.

(iv) 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 $p = h\rho g$; derivation of $p = h\rho g$ and 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; laboratory demonstration; common manifestation (and consequences) – Variations of pressure with altitude, qualitative only; mention applications such as weather forecasting and altimeter. Simple numerical problems on $p = h\rho g$.

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

Buoyancy, upthrust (F_B); definiton; different cases. F_B>, = or < weight W of the body immersed; characteristic properties of upthrust; Archimedes' principle; explanation of cases where bodies with density ρ >, = or < the density ρ' of the fluid in which it is immersed.

Floatation : principle of floatation; experimental verification; 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 of ship, submarine; iceberg, balloons, etc. Relative density $RD = \rho_1 / \rho_2 = m_1 / m_2$ for volume same; RD and Archimedes' principle; $RD = W_1 / (W_1 - W_2)$.

Experimental determination of RD of a solid denser/lighter than water. [RD of a liquid using Archimedes' Principle of RD using specific gravity bottle are ***not*** included].

The hydrometer; common hydrometer for RD of liquid heavier/lighter than water - qualitative only; common practical applications, such as lactometer and battery hydrometer. Simple numerical problems involving Archimedes' principle, buoyancy and flotation.

5. Heat

(i) Concept of heat and temperature.

Heat as energy SI unit – joule,

1 cal = 4.186 J exactly.

(*ii*) Expansion of solids liquids and gases (qualitative discussion only); uses and consequences of expansion (simple examples); anomalous expansion of water.

Expansion of solids, and cubical expansion of liquids and gases, real and apparent expansion of liquids; simple examples of the uses of expansion of solids; steel rims, riveting, disadvantages of expansion; examples - railway tracks, joints in metal pipes and electric cables. Anomalous expansion of water; graphs showing variation of volume and density of water with temperature in the 0 to 10^{o}C range. Simple numerical problems with α, β, γ in solids.

(*iii*) Thermometers: Temperature scales – Celsius Fahreheit, Kelvin and their relation. Simple ***problems*** based on conversion between these scales.

[Problems on faulty thermometer **not** included].

(*iv*) Transfer of heat (simple treatment) by conduction, convection and radiation; thermal insulation; keeping warm and keeping cool; vacuum flask; ventilation.

Conduction: examples to illustrate good and bad conductors and their uses; water is a bad conductor of heat. Convection; Penomenon in liquids and gases; some consequences including land breeze and sea breeze. Radiation; detection by blackened bulb thermometer.

Applications; simple common uses; thermal insulation, simple examples of house insulation, personal insulation; insulation of household appliances, laboratories. Vacuum flask, Global warming - melting polar ice caps - polar ice caps reflects solar radiation back whereas sea water absorbs it. Increase in CO_2 content in the atmosphere enhances ***green house effect***.

(*v*) 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. (Only a general understanding is required ex-energy flow is linear but nutrients flow is cycle. No numerical testing will be done on this topic).

(*vi*) Practices for conservation of resources—search for alternatives, promotion of renewable resouce. Advantages and disadvantages of renewable resources when compared to non renewable resources. Study of the functioning of biogas, solar, wind and hydro power.

6. Light

(*i*) Reflection of light; image formed by a plane mirror regular and irregular reflection; images formed by a pair of parallel and perpendicular plane mirrors; simple periscope.

Regular and irregular reflection; laws of reflection; experimental verification; images of (*a*) point object and (*b*) extended object formed in by a plane mirror - using ray diagrams and their characteristics; lateral inversion; characteristics of images formed in a pair of mirrors, (*a*) parallel and (*b*) perpendicular to each other; uses of plane mirrors; simple periscope with ray diagram with two plane mirrors.

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

Brief introduction to spherical mirrors - concave and convex mirrors, center and radius of curvature, pole and principal axis, focus and focal length; $f = R/2$ with proof; simple ray diagram for the formation of images in (*a*) concave mirror, when a small linear object is placed on the principal axis at very large distance ($u >> R$), at the center of curvature, between C and F, at F, between F and P. (*b*) convex mirror a small linear object is placed on the principal axis in front of the mirror.

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.

Introduction about sound and its production from vibrations; sound propagation, terms—frequency (ν), wavelength (λ), velocity (V), relation $V = \nu\lambda$ and medium [qualitative ideas only]; bell jar experiment. Speed of sound in different media; some values; values of v in air, water and steel as examples including v_0 at 0°C in air as standard value. [***No*** derivation, ***no*** numerical problems]; comparison of speed of sound with speed of light; consequences of the large difference in these speeds in air; thunder and lightning.

(*ii*) Range of hearing; ultrasound, a few applications.

Elementary ideas and simple applications only.

Frequency ranges for (i) hearing and (ii) speaking. Difference between ultrasonic and supersonic.

8. Electricity and magnetism

(i) Static electricity — electric charge; charging by friction; simple orbital model of the atom; detection of charge (pith ball and electroscope); sparking; lightning conductors.

Historical introduction: charging by friction; examples; different types of charges on comb and glass rod: attraction, repulsion; simple orbital model of atom with examples of H, He and another atom; positive and negative ions; charge on electrons as quantum of electric charge, $Q = n.e$; explanation of charge on a body in terms of transfer of electron and its detection, lightning; lightning conductor-action; prevention and control of damage due to lightning.

[***No numerical problems***].

(ii) 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); resistance in series and parallel.

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 $V = W/q$; resistance R from Ohm's law $V/I = R$; Insulators and conductors. **(No derivation of formula, calculation or numerical problems).**

Governmental initiatives of not building large dams for generating hydro electric power which leads to less land being submerged and less displacement of people. Improving efficiency of existing technologies and introducing new eco-friendly technologies.

Social initiatives: Creating awareness and building trends of sensitive use of resources and products, e.g., reduced use of electricity.

(iii) Properties of a bar magnet: induced magnetism; lines of magnetic field, Magnetic field of earth, Neutral points in magnetic fields.

Magnetism: properties of a bar magnet; 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. Plotting 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.

CONTENTS

CHAPTER 1

MEASUREMENT AND EXPERIMENTATION

LEARNING OBJECTIVES

(i) Estimation by orders of magnitude of size (length, area and volume), mass and time.

Scope-Order of magnitude as statement of magnitude in powers of ten; familiarity with the orders of magnitude of some common sizes (length, area and volume), masses and time intervals.

(ii) International system of units (the required S.I. units are given at the end of this syllabus) and other commonly used units of the relevant physical quantities.

Scope-Mention the British system (FPS), the French or metric system (CGS), and the MKS/MKSA system as historical background. The seven base (basic/fundamental) units selected by the General Conference of Weights and Measures and their standard symbols. The latest definition (1983) of metre in terms of the speed of light; mention the old ones of 1889 and 1960. Use of standard prefixes from micro to mega with their standard symbols [giga, pico and femto may also be introduced] for sub and multiple units. Non-metric units A.U., ly., Å, and fermi; [nm is preferred to Å which is outdated, though still in wide use]. Definition of kilogram (1889). [Definition of second of 1967 and of other base units need not be memorized]. Common units of time - minute, hour, day, month, lunar month, year, leap year, decade, millennium and century may be introduced. Elementary introduction of derived unit with simple

1.1 THE PURPOSE OF MEASUREMENT

Physics is the science of measurement. We measure different quantities in every day life to get exact idea about any particular object or event. These measurable quantities like mass, length, volume of any object or the speed of a moving car or trains are called *physical quantities*.

Any physical quantity has two components, **magnitude** (n) of the physical quantity and its **unit** (u). For example, when we say light travels in air at speed 300000 km/sec, we mean that magnitude of the physical quantity "speed of light" is 300000 and the unit is km/sec.

Thus, a

Physical Quantity = magnitude × unit. **or,** $\boxed{Q = n \cdot u}$

Any physical quantity without a proper unit has no meaning. For example, if I say the radii of two solid spheres are 2 and 5. You are not sure which of the two spheres is bigger in size? Contrary to common expectation their radii might be 2cm and 5mm. (Figure 1.1)

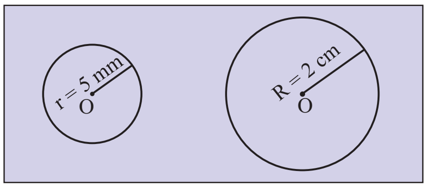

Fig. 1.1 It is difficult to estimate the size without unit

Let us separate the magnitude and unit part in the following physical quantities:

(*i*) Height of a person is 1.82 metre.
(*ii*) A car weighs 400 kilogram.
(*iii*) Capacity of an overhead water tank is 1000 litres.
(*iv*) Maximum speed of the Rajdhani Express train is 150 km/hr.
(*v*) Electric power of a tube light is 40 watt.
(*vi*) My school is 2.5 km away from my home.
(*vii*) Every day I play for 2 hours in the evening.
(*viii*) Volume of a tumbler is 260 ml.
(*ix*) An electric fan completes one rotation in 0.02 sec.
(*x*) Light takes nearly 480 sec. to reach from sun to earth.

Now, the question that comes to mind next is 'what is the need of measurement'?

examples. More of this can be done when new physical quantities are introduced in later chapters. Simple numerical problems involving the above units, sub units and multiple units.

(iii) Measurements using common instruments (metre rule, vernier callipers and micrometer screw guage for length, volume by displacement using a measuring cylinder, stop watch and simple pendulum for time, equal arm beam balance for comparison of masses); Least count of measuring instruments; significant figures; percentage error associated with a measurement.

Scope–This section should be taught along with demonstration or laboratory experiments. Measurem- ent of length using metre rule, Vernier callipers and micrometer screw gauge. They have increasing accuracy and decreasing least count; zero error, zero correction (excluding negative zero error in Vernier Callipers), pitch of the screw and least count (LC); no numerical problems on callipers and screw gauge. Volume units, m^3, cm^3, litre and millilitre; their mutual relations. Measurement of volume of irregular solid bodies both heavier and lighter than water including those soluble in water by displacement of water or other liquids in a measuring cylinder. Measurement of time using stopwatch; simple pendulum; time period, frequency, experiment for the measurement of T, 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. Beam balance; simple introduction; conditions for balance to be true (without proof). Faulty balance is not included.

Significant figures; rules for counting the number of sf, addition and subtraction, multiplication and division; absolute, relative and percentage error. Simple numerical problems.

(iv) Presentation of data in tabular and graphical form (straight line graphs

A measurement leads us from an unknown to known situation

Suppose you are interested in finding the perimeter of your school field. You start moving from one corner of the field along its boundary and complete one round. Count the total number of steps you took. Let number of steps you took be 474. It means the perimeter of the field is 474 steps of yours. Is it a satisfying answer? No. Ask your friends to do the same exercise. They might cover the same distance depending on their normal stride in different number of steps. Again the question that puzzles us is 'what is the exact perimeter of the field'?

The method to get correct perimeter of the field is to measure the entire length with the help of a measuring tape. It uses the standard unit of length as 'one metre'. Let perimeter of the field be measured as 450 metre. It means that perimeter of the field is 450 times more than the standard unit of length 'one metre'.

Thus, the use of certain standard units like metre, kilogram, second, etc. avoids us from the confusion in the measurement of different physical quantities.

In any measurement, numerical magnitude (n) is inversely propor-tional to size of the unit (u) selected i.e. $n \propto \frac{1}{u}$ or $n_1 u_1 = n_2 u_2$.

1.2 ESTIMATION BY ORDER OF MAGNITUDE

In physics, we used to measure various physical quantities that differ greatly in magnitude. On one hand, velocity of light in vacuum is 300000000 m s^{-1} and on the other hand size of an atom is 0.000000001 m. It is very inconvinent to write and remember the magnitude of these quantities. The scientific method to write the magnitude is as follows :

Magnitude of physical quantity = $P \times 10^n$, where P is a number greater than 1 but less than 10 and n is positive or negative integer.

Learn : $10^0 = 1$ also, $0.1 = \frac{1}{10} = 10^{-1}$

$10^1 = 10$ $0.01 = \frac{1}{100} = 10^{-2}$

$10^2 = 100$ $0.001 = \frac{1}{1000} = 10^{-3}$ and so on.

$10^3 = 1000$

$10^4 = 10,000$ etc.

Let us take the examlpe of velocity of light once again.

$$c = 300000000 \text{ m s}^{-1}$$
$$= 3 \times 100000000 \text{ m s}^{-1}$$
$$= 3 \times 10^8 \text{ m s}^{-1}.$$

Here $P = 3$ as it lies in between digits 1 and 10 and $n = +8$.

Also, size of an atom = 0.0000000001 m

$$= \frac{1}{10000000000} \text{ m} = \frac{1}{10^{10}} \text{ m}$$
$$= 1 \times 10^{-10} \text{ m}.$$

See, few more examples.

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