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CBSE

CLASS-11th

THE CENTRAL BOARD OF SECONDARY EDUCATION

PHYSICS-I

SIERRA INNOVATIONS

CONTENT

PART - A

Chapter 1

PHYSICAL WORLD

Content

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What is Physics?

We have always been curious about the physical laws that govern the world around us and mathematics as, a language that is used to interpret and unveil the secrets hidden in the cosmos. This curiosity plays an extremely importantly role as curiosity leads to imagination and imagination is the epicentre for human development, science and research.

Science is a systematic knowledge gained by man through experimentation, observation, qualitative and quantitative reasoning, mathematical modelling and prediction.

Progress of science is carried out by interplay of theory and observation or experimentation and this process is never ending.There is no final theory. In fact, theories are subject to modifications caused by observations that lead to an increase in precision and detail or new experiments (or observations) that lead to new results.An example of such a modificationwould beexperiments that gave light to wave-particle duality as opposed to the then accepted wave theory of light that led to the birth of quantum mechanics. Newtonian gravity being contradicted by observation is another significant example. The scientific community realised a need for new theory of gravity and that led Einstein to investigate the notion of generalising his relativity theoryto treat accelerating frames on the same level as inertial frames.

It is hard to define Physics precisely. Broadly, it can be described as a study of the basic laws and their manifestation in different natural occurrences. It is distinct from other disciplines of science, but the boundaries remain impossible to define. More about physics and the so-called physical laws will be briefly described in the coming sections.

Scope and Excitement of Physics

Under this section, various subdisciplines of physics shall be discussed. Physics is broadly divided into two types – Classical Physics and Modern Physics.

Classical Physics

Classical Physics deals with the macroscopic phenomena. These include occurrences at laboratory, terrestrial and astronomical scales. It comprises of the following areas:

Mechanics – It is based on newtons laws of motion. It deals with motion of particles as well as physical properties of particles such as rigidity, deformability etc. Few examples include – need for seat belt in cars, revolution of the earth around the sun etc.

Electrodynamics – It studies the interaction of electric charges currents with magnetic fields and other electric charges or currents. Examples –Attraction forces between dry hair and comb, electromagnets etc

Optics – It deals with the study of the behaviour of light, its interaction with matter as well as the study of the construction of instruments that detect or manipulate light. Examples – Reflection of light, difference of the speed of light in different mediums, construction of telescopes etc.

Thermodynamics – It deals with the study of heat and its relations with other forms of energy. Examples –Melting of an ice cube, efficiency of heat engines etc.

Modern Physics

Modern Physics mainly deals with microscopic phenomena. Few of the common topics include:

Quantum Mechanics – It deals with the study of motion and interaction of subatomic particles, incorporating the concept of quantization of energy, wave particle duality and the uncertainty principle. Examples –Structure of the hydrogen atom, Quantum teleportation etc.

Quantum Field Theory – In its simplest form, quantum field theory id quantum electrodynamics. It deals with the study of fields and its interaction with other fields or particles.

Physics, Technology and Society

As the name suggests, this section deals with the impact of physics and its concepts on technological advancements and society.Few major discoveries and inventionsthatbrought about by physics are mentioned below:

Steam Engine – Laws of Thermodynamics

Computers – Digital Logic

Reflecting Telescopes – Optics

Aeroplane – Bernoulli's principle

Particle Accelerators – Electromagnetism

Fundamental Forces in Nature

Force is anything that causes an object to move with acceleration. There are fourfundamental forces in nature that governs everything that happens around us. Every force that we experience can be boiled down to these forces. They are:

Gravitational Force –It is the mutual force of attraction between any two objects with mass. It is a universal force. It explains the Earth's motion around the sun. This force happens to be the weakest of the four forces.

Electromagnetic Force –It is the force of attraction between two charges. Unlike the gravitational force, these forces can be attractive or repulsive.

Strong Nuclear Force – This force is responsible for holding together the subatomic particles inside the nucleus of an atom. This force is charge dependent. It also happens to be the strongest of the four forces.

Weak Nuclear Force – It is a force that governs the decay of certain unstable particles. It acts on fermions. It was initially devised to explain the beta decay.

Unification of Forces –The idea of unification is to be able to view all of natures forces as a manifestation of one single, all encompassing force. This is the basic quest of physics. Scientists today are trying to unify the four forces. There are many Grand Unified Theory models that theorise the existence of this unification.

Physics in Relation to Other Sciences

Physics is a very significant branch of science which plays a crucial role in understanding the developments pertaining to the other branches of science such as Chemistry, Biology etc.

(i) Physics in relation to Mathematics. Study of physical variables led to the idea of differentiation, integration and differential equation. Meaningful interpretation of Mathematics becomes Physics.

(ii) Physics in relation to Chemistry. The concept of X-ray diffraction and radioactivity has helped to distinguish between the various solids and to modify the periodic table. Understanding the bonding and the chemical structure of substances is easy with the help of the concept of interactions between various particles.

(iii) Physics in relation to Astronomy. Optical telescopes of reflecting and refracting type enabled man to explore the space around. Discoveries like radio telescopes have revolutionised the study of Astronomy.

(iv) Physics in relation to Biology. The conceptual study of pressure and its measurement has helped us to know blood pressure and hence the functioning of heart. Invention of X-rays developed the field of diagnosis. Electron and optical microscopic designs have revolutionised the study of medical science.

(v) Physics in relation to Meteorology. The discoveries regarding the study of pressure variations help us to forecast the weather.
Various other inventions of physics have opened new vistas of study in the field of sciences and social sciences.

Physics in Relation to Technology and Society

Advancement in physics has led to new technologies and vice-versa. Sometimes technology gives rise to new dimension of physics; at other times physics generates new technology. In fact, the technological development is closely related to the application of science and physics in particular. Physics has a dominant influence on society. It has helped the human being to develop its ideas. Development of digital communication systems, rapid mass transport system, lasers making bloodless surgeries, etc., has made human life easy and pleasant.

There are four fundamental forces in nature that govern the diverse phenomena of the microscopic and macroscopic world. These are the ‘gravitational force’, the ‘electromagnetic force’; the ‘strong nuclear force’, and the ‘weak nuclear force’. Unification of forces is a basic quest in physics. The electromagnetic and the weak nuclear forces have now been unified and are seen as aspects of a single ‘electro-weak’ force. Attempts are being made to unify electro-weak and the strong force.

Conservation of energy, momentum, angular momentum, charge, etc., are considered to be the fundamental laws in physics. Conservation laws have a deep connection with symmetries of nature. Symmetries of space and time, and other types of symmetries play a central role in modem theories of fundamental forces in nature.

Miscellaneous Concepts

Hypothesis, axioms and models:

As explained previously, physics is based on assumptions from observations. Based on these assumptions, postulates or axioms are established. Post establishment, the development of a subject is carried out exactly and consistently in line with the set postulates.

The definitions of the words used above as given as follows:

- Hypothesis is a supposition without assuming that it is true. It may not be proved but can be verified through a series of experiments.
- Axiomis a self-evident truth that is accepted without controversy or question.
- Model is a theory proposed to explain observed phenomena.
- Assumption is the reasoning of physics wherein several phenomena can be explained. These are generally based on experiments, observations and data.

Points to remember

1. The scope of physics is indeed very wide and vast. It covers a tremendous range of magnitudes of various physical quantities.
2. In the study of physics, there are two principal thrusts, unification and reductionism, applicable to all domains of life, from the microscopic to the macroscopic domains.
3. The electrostatic force acts between two electrified objects. This force makes an electrically charged balloon stick to a wall.
4. The magnetic force is exerted between the poles of magnets. It is the force with which a magnet picks up iron nails.
5. The scope of physics is wide, covering a tremendous range of magnitude of physical quantities.
6. Fundamental forces are the gravitational force, the electromagnetic force, the ‘strong’ force and the ‘weak’ force.
7. Gravitational force is the weakest force of all the fundamental forces.
8. The physical quantities that remain unchanged in a process are called conserved quantities.
9. The strong nuclear force is a force that binds nucleons together in the nucleus of an atom.

10. In any reaction involving the charged particles, the total charges before and after the reaction are always the same.
11. In certain reaction, charged particles may be destroyed, yet the net electric charge remains constant.

1 Mark Questions

Ques1. What are the four fundamental laws of nature? State them in order of weakest to strongest.

Ans.

The gravitational force

The weak nuclear force

The electromagnetic force

The strong nuclear force

Ques2. What is the range of the electromagnetic force?

Ans. The range of the electromagnetic force is infinite.

Ques3. What concept of physics led to the invention of a steam engine?

Ans. Thermodynamics

Ques4. What is the relative strength (if the strong nuclearforce is 1) of the weak nuclear force?

Ans. 10^{-13}

Ques5. What do you mean by central forces?

Ans. Forces acting along the line joining centres of two bodies is called central force.

2 Mark Questions

Ques1. No physicist has ever "seen" an electron. Yet, all physicists believe in the existence of electrons. An intelligent but superstitious man advances this analogy to argue that 'ghosts' exist even though no one has 'seen' one. How will you refute his argument?

Ans. Many phenomena which depend upon the existence of electrons have been predicted and actually observed in everyday life. There is no phenomenon which can be explained on the basis that ghosts exist though they are not seen. So, obviously, the comparison between two situations does not make any sense.

Ques2. The industrial revolution in England and Western Europe more than two centuries ago was triggered by some key scientific and technological advances. What were these advances?

Ans. Some of the key advances during that period in science and technology include the application of heat and thermodynamics to form the steam engine. Discovery of electricity helped in designing dynamos and motors. Study of gravitation led to the study of motion and making guns and cannons. This gave power in the hands of western countries and they ruled over rest of the world. The discovery of explosives not only helped army but also mineral exploration. These are some examples of scientific and technological advances which helped England and Europe to have their prominent positions in the world. In fact, the progress in chemistry, physics and natural sciences brought the industrial revolution in England and Western Europe.

Ques3. It is often said that the world is witnessing now a second industrial revolution, which will transform the society as radically as did the first. List some key contemporary areas of science and technology, which are responsible for this revolution.

Ans. Some key contemporary areas of science and technology, which are chiefly responsible for a new industrial revolution taking place now and likely to take place in near future are: (i) Design of super-fast computers.

- Biotechnology.
- Developments in the field of space sciences.
- Development of super-conducting materials at room temperature.
- Advancements in the field of electronics, information technology and nanotechnology.

Chapter 2

UNITS AND MEASUREMENT

Content

- ✓ Physical Quantities
- ✓ Units
- ✓ Types of Unit
- ✓ Supplementary Fundamental Units
- ✓ Practical Units
- ✓ Classification of Physical Quantities (On The Basis of Dimensions)
- ✓ Dimensional Formula of Some Important Physical Quantities
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- ✓ Significant Figures
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- ✓ Accuracy, Precision of Instruments and Errors in Measurements
- ✓ Errors in Measurements
- ✓ Propagation of Error
- ✓ Important Questions

The comparison of any physical quantity with its standard unit is called measurement.

Physical Quantities

All the quantities in terms of which laws of physics are described, and which can be measured directly or indirectly are called physical quantities.

To measure a physical quantity, we have to find out how many times a standard amount of that physical quantity is present in the quantity being measured. The number thus obtained is known as the magnitude or numerical value and the standard chosen is called the unit of the physical quantity.

Physical Quantity = Magnitude (m) x Unit (u)

As the unit (u) changes, the magnitude (m) will also change. But the product of Magnitude (m) and Unit (u) will remain constant.

Magnitude (m) x Unit (u) = Constant

Types of Physical Quantity

1. Fundamental Quantities: The physical quantities which do not depend upon other physical quantities are called fundamental or base physical quantities. There are seven fundamental quantities namely; mass, length, time, temperature, electric current, luminous intensity and amount of substance.

2. Derived Quantities: The physical quantities which depend on fundamental quantities are called derived quantities. For example; speed, acceleration, force, etc.

Units

The unit of a physical quantity is an arbitrarily chosen standard which is widely accepted by the society and in terms of which other quantities of similar nature may be measured.

Characteristics of a Unit

1. It should be suitable in size.

2. It should be accurately defined.

3. It should be easily reproducible.

4. It should not change with time.

5. It should not change with change in physical conditions like temperature, pressure, moisture etc.

Types of Unit

1. Fundamental or Base Units: Fundamental units are those, which are independent of unit of other physical quantity and cannot be further resolved into any other units or the units of fundamental physical quantities are called fundamental or base units.

S .No.	Fundamental Quantities	Fundamental Units	Symbols
1	Length	Meter	m
2	Mass	Kilogram	kg
3	Time	Second	s
4	Temperature	Kelvin	K
5	Electric Current	Ampere	A
6	Luminous Intensity	Candela	cd
7	Amount of Substance	Mole	mol

Definitions of Fundamental Units

i. **Kilogram:** The mass of cylinder (of height and diameter 39 cm) made up of Platinum-iridium alloy kept at International Bureau of weights and measures in Paris is defined as 1kg.

ii. **Metre:** 1 metre is the distance that contains 1650763.73 wavelength of orange-red light of Kr-86.

iii. **Second:** It is the duration of 9,192,631,770 periods of radiation corresponding to the transition between the two hyperfine levels of the ground state of Caesium (133) atom.

iv. **Kelvin:** 1 kelvin is the $\frac{1}{273.16}$ part of the thermodynamics temperature of the triple point of water.

v. **Candela:** It is the luminous intensity in a perpendicular direction, of a surface of $\frac{1}{60,000}$ square metre of a black body at the temperature of freezing platinum under a pressure of 1.013×10^5 N/m^2.

vi. **Ampere:**1 ampere is the electric current which it maintained in two straight parallel conductor of infinite length and of negligible cross-section area placed one metre apart in vacuum will produce between them a force 2×10^{-7} N/m.

vii. **Mole:**1 mole is the amount of substance of a system which contains a many elementary entities (may be atoms, molecules, ions, electrons or group of particles, as this and atoms in 0.012 kg of carbon isotope $^6C_{12}$.

Supplementary Fundamental Units

Besides the above mentioned seven units, there are two supplementary base units.

i. **Radian (rad):** It is the unit of plane angle. One radian is an angle subtended at the centre of a circle by an arc of length equal to the radius of the circle.
ii. **Steradian (sr):** It is the unit of solid angle. One steradian is the solid angle subtended at the centre of the sphere by its surface whose area is equal to the square of the radius of the sphere.

2. Derived Units: Those physical quantities which are derived from fundamental quantities are called derived quantities and their units are called derived units. For example; velocity, acceleration, force, work etc.

Systems of Units

A system of units is the complete set of units, both fundamental and derived, for all kinds of physical quantities. The common system of units which are used is given below,

1. **CGS (Centimetre - Gram - Second) System:** In this system, the unit of length is centimetre, the unit of mass is gram and the unit of time is second.
2. **FPS (Foot - Pound - Second) System:** In this system, the unit of length is foot, the unit of mass is pound and the unit of time is second.
3. **MKS (Metre - Kilogram - Second) System:** In this system, the unit of length is metre, the unit of mass is kilogram and the unit of time is second.
4. **SI (International system) System:** This system contain seven fundamental units and two supplementary fundamental units.

Quantities	**Name of System**			
	C.G.S	**F.P.S**	**M.K.S**	**S.I.**
Length	centimetre	foot	meter	meter
Mass	gram	pounds	kilogram	kilogram
Time	second	second	second	second
Temperature	kelvin		kelvin	kelvin

Electric Current			ampere	ampere
Luminous Intensity				candela
Amount of Substance				mole

Practical Units

1. **Length:**

(i) 1 fermi = 1 *fm* = 10^{-15} *m*

(ii) 1 *X*-ray unit = 1*XU* = 10^{-13} *m*

(iii) 1 angstrom = 1Å = 10^{-10} *m* = 10^{-8} *cm* = 10^{-7} *mm* = 0.1 □*mm*

(iv) 1 micron = μm = 10^{-6} *m.*

(v) 1 astronomical unit = 1 *A.U.* = 1. 49 × 10^{11} *m* ≈ 1.5 × 10^{11} *m* ≈ 10^{8} *km*

(vi) 1 Light year = 1 *ly* = 9.46 × 10^{15} *m*

(vii) 1 *Parsec* = 1*pc* = 3.26 light year

2. **Mass:**

(i) Chandra Shekhar unit: 1 *CSU* = 1.4 times the mass of sun = 2.8 × 10^{30} *kg*

(ii) Metric tonne: 1 Metric tonne = 1000 *kg*

(iii) Quintal: 1 Quintal = 100 *kg*

(iv) Atomic mass unit (*amu*): *amu* = 1.67 × 10^{-27} *kg* mass of proton or neutron is of the order of 1*amu*

3. **Time:**

(i) Year: It is the time taken by earth to complete 1 revolution around the sun in its orbit.

(ii) Lunar month: It is the time taken by moon to complete 1 revolution around the earth in its orbit.
1 *L.M.* = 27.3 days

(iii) Solar day: It is the time taken by earth to complete one rotation about its axis with respect to sun. Since this time varies from day to day, average solar day is calculated by taking average of the duration of all the days in a year and this is called Average Solarday.

(iv) Sedrial day: It is the time taken by earth to complete one rotation about its axis with respect to a distant star.
1 Solar year = 366.25 Sedrial day = 365.25 average solar day Thus 1 Sedrial day is less than 1 solar day.

S.I. Prefixes

The magnitudes of physical quantities vary over a wide range. For example, the atomic radius, is equal to 10^{-10} m, radius of earth is 6.4×10^{6} m and the mass of electron is 9.1×10^{-31} kg. The internationally recommended standard prefixes for certain powers of 10 are given in the table.

Prefix	Power of 10	Symbol
exa	18	E
peta	15	P
tera	12	T
giga	9	G
mega	6	M
kilo	3	k
hecto	2	h
deca	1	da
deci	-1	d
centi	-2	c
milli	-3	m
micro	-6	μ
nano	-9	n
pico	-12	p
femto	-15	f
atto	-18	a

Merits of SI Units

1. **SI is a coherent system of units:** This means that all derived units are obtained by multiplication and division without introducing any numerical factor.
2. **SI is a rational system of units**: This is because it assigns only one unit to a particular physical quantity.
3. **SI is an absolute system of units:** There is no gravitational unit in this system.
4. SI system is applicable to all branches of science.

Note:

1. **Unit is never written with capital initial letter.**
2. **The unit or symbol is never written in plural form.**
3. **Punctuations marks are not written after the symbol.**