Physics Notes

The knowledge gained through observations and experimentations is called **Science**. The word science is derived from the Latin word **scientia**, which means knowledge. Not until eighteenth century, various aspect of material objects were studied under a single subject called **natural philosophy**. But as the knowledge increased, it was divided into two main streams; Physical sciences — which deal with the study of non-living things and Biological sciences — which are concerned with the study of living things.

BRANCHES OF PHYSICS

Mechanics:
It is the study of motion of objects, its causes and effects.

Sound:
It deals with the physical aspects of sound waves, their production, properties and applications.

Electricity and Magnetism:
It is the study of the charges at rest and in motion, their effects and their relationship with magnetism.

Heat:
It deals with the nature of heat, modes of transfer and effects of heat.

Light (Optics):
It is the study of physical aspects of light, its properties, working and use of optical instruments.

Atomic Physics:
It is the study of the structure and properties of atoms.

Nuclear Physics:
It deals with the properties and behaviour of nuclei and the particles within the nuclei.

Geophysics:
It is the study of the internal structure of the Earth.

Plasma Physics:
It is the study of production, properties of the ionic state of matter – the fourth state of matter.

PHYSICAL QUANTITIES

All measurable quantities are called **physical quantities** such as length, mass, time and temperature. A physical quantity possesses at least two characteristics in common. One is its numerical magnitude and the other is the unit in which it is measured. For example, if the length of a student is 104 cm then 104 is its numerical magnitude and centimetre is the unit of measurement. Similarly when a grocer says that each bag contains 5 kg sugar, he is describing its numerical magnitude as well as the unit of measurement. It would be meaningless to state 5 or kg only. Physical quantities are divided into **base quantities** and **derived quantities**.

BASE QUANTITIES

There are seven physical quantities which form the foundation for other physical quantities. These physical quantities are called the base quantities. These are length, mass, time, electric current, temperature, intensity of light and the amount of a substance.

DERIVED QUANTITIES

Those physical quantities which are expressed in terms of base quantities are called the derived quantities. These include area, volume, speed, force, work, energy, power, electric charge, electric potential, etc.

$$
\begin{aligned}
1\ \text{L} &= 1000\ \text{mL} \\
1\ \text{L} &= 1\ \text{dm}^3 \\
&= (10\ \text{cm})^3 \\
&= 1000\ \text{cm}^3 \\
\therefore\ 1\ \text{mL} &= 1\ \text{cm}^3
\end{aligned}
$$

Base quantities, their SI units with symbols

Quantity		Unit	
Name	**Symbol**	**Name**	**Symbol**
Length	l	metre	m
Mass	m	kilogramme	kg
Time	t	second	s
Electric current	I	ampere	A
Intensity of light	L	candela	cd
Temperature	T	kelvin	K
Amount of a substance	n	mole	mol

Derived quantities and their SI units with symbols

Quantity		Unit	
Name	**Symbol**	**Name**	**Symbol**
Speed	v	metre per second	ms^{-1}
Acceleration	a	metre per second per second	ms^{-2}
Volume	V	cubic metre	m^3
Force	F	newton	N or (kg m s^{-2})
Pressure	P	pascal	Pa or (N m^{-2})
Density	ρ	kilogramme per cubic metre	kg m^{-3}
Charge	Q	coulomb	C or (As)

PREFIXES

Prefixes are the words or letters added before SI units such as **kilo**, **mega**, **giga** and **milli**.

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

1 km	10^{3} m
1 cm	10^{-2} m
1 mm	10^{-3} m
1 μm	10^{-6} m
1 nm	10^{-9} m

SCIENTIFIC NOTATION

A simple but scientific way to write large or small numbers is to express them in some power of ten. The Moon is 384000000 metres away from the Earth. Distance of the moon from the Earth can also be expressed as 3.84×10^8 m. This form of expressing a number is called the standard form or scientific notation.

For example, a number **62750** can be expressed as $\mathbf{62.75 \times 10^3}$ or $\mathbf{6.275 \times 10^4}$ or $\mathbf{0.6275 \times 10^5}$. All these are correct. But the number that has one non-zero digit before the decimal i.e. $\mathbf{6.275 \times 10^4}$ preferably be taken as the standard form. Similarly the standard form of 0.00045 s is 4.5×10^{-4} s.

THE METRE RULE

A metre rule is a length measuring instrument It is commonly used in the laboratories to measure length of an object or distance between two points. It is one metre long which is equal to 100 centimetres. Each centimetre (cm) is divided into 10 small divisions called milimetre (mm). Thus one millimetre is the smallest reading that can be taken using a metre rule and is called its least count.

TYPES OF MOTION

There are three types of motion.

(i) Translatory motion (linear, random and circular)

(ii) Rotatory motion

(iii) Vibratory motion (to and fro motion)

TRANSLATORY MOTION

In translational motion, a body moves along a line without any rotation. The line may be straight or curved.

LINEAR MOTION

Straight line motion of a body is known as its linear motion.

CIRCULAR MOTION

The motion of an object in a circular path is known as circular motion.

RANDOM MOTION

The disordered or irregular motion of an object is called random motion.

ROTATORY MOTION

The spinning motion of a body about its axis is called its rotatory motion.

VIBRATORY MOTION

To and fro motion of a body about its mean position is known as vibratory motion.

SCALARS

A scalar quantity is described completely by its magnitude only.

VECTORS

A vector quantity is described completely by magnitude and direction.

DISTANCE AND DISPLACEMENT

Length of a path between two points is called the distance between those points.

Displacement is the shortest distance between two points which has magnitude and direction.

SPEED AND VELOCITY

The distance covered by an object in unit time is called its speed.

$$\text{Speed} = \frac{\text{distance covered}}{\text{time taken}}$$

$$\text{Distance} = \text{speed} \times \text{time}$$

$$S = vt$$

UNIFORM SPEED

A body has uniform speed if it covers equal distances in equal intervals of time however short the interval may be.

VELOCITY

The rate of displacement of a body is called its velocity.

$$\text{Velocity} = \frac{\text{displacement}}{\text{time taken}}$$

$$\mathbf{v} = \frac{\mathbf{d}}{t}$$

$$\mathbf{d} = \mathbf{v}t \quad \ldots \quad \ldots$$

A paratrooper attains a uniform velocity called terminal velocity with which it comes to ground,

UNIFORM VELOCITY

A body has uniform velocity if it covers equal displacement in equal intervals of time however short the interval may be.

ACCELERATION

Acceleration is defined as the rate of change of velocity of a body.

NEWTON'S THIRD LAW OF MOTION

To every action there is always an equal but opposite reaction.

When a force acts on a body, it produces an acceleration in the body and will be equal to the rate of change of momentum of the body.

SI unit of momentum
is newton-second (Ns) which is the same as $kgms^{-1}$.

LAW OF CONSERVATION OF MOMENTUM

The momentum of an isolated system of two or more than two interacting bodies remains constant.

FRICTION

The force that opposes the motion of moving objects is called friction.

UNIFORM CIRCULAR MOTION

The motion of an object in a circular path is known as circular motion.

CENTRIPETAL FORCE

Centripetal force is a force that keeps a body to move in a circle.

CENTRIFUGAL FORCE

Centripetal reaction that pulls the string outward is sometimes called the centrifugal force.

STATES OF EQUILIBRIUM

There are three states of equilibrium; stable equilibrium, unstable equilibrium and neutral equilibrium. A body may be in one of these three states of equilibrium.

STABLE EQUILIBRIUM

A body is said to be in stable equilibrium if after a slight tilt it returns to its previous position.

UNSTABLE EQUILIBRIUM

If a body does not return to its previous position when sets free after a slightest tilt is said to be in unstable equilibrium.

NEUTRAL EQUILIBRIUM

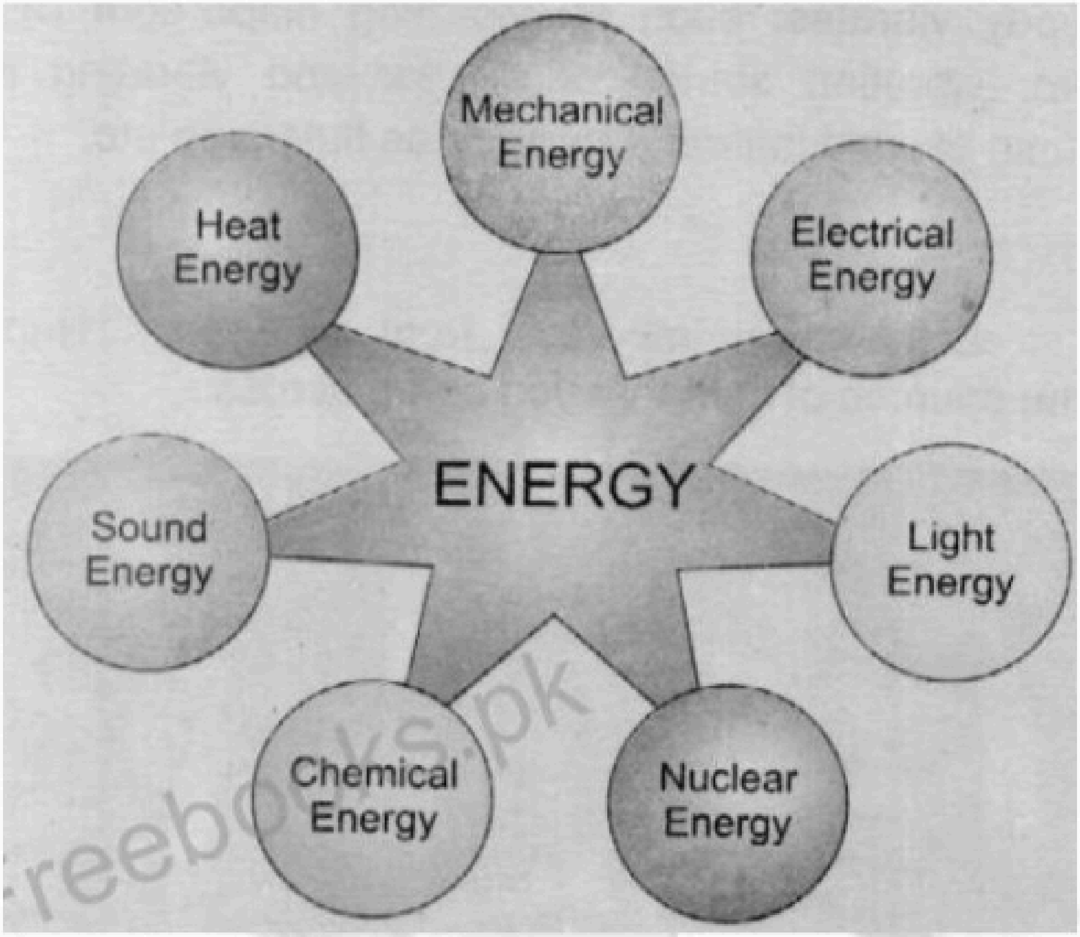
If a body remains in its new position when disturbed from its previous position, it is said to be in a state of neutral equilibrium.

LAW OF GRAVITATION

Everybody in the universe attracts every other body with a force which is directly proportional to the product of their masses and inversely proportional to the square of the distance between their centres.

$$F = G\frac{m_1 m_2}{d^2}$$

FORMS OF ENERGY



MECHANICAL ENERGY

The energy possessed by a body both due to its motion or position is called mechanical energy. Water running down a stream, wind, a moving car, a lifted hammer, a stretched bow, a catapult or a compressed spring etc. possess mechanical energ

HEAT ENERGY

Heat is a form of energy given out by hot bodies. Large amount of heat is obtained by burning fuel. Heat is also produced when motion is opposed by frictional forces. The foods we take provide us heat energy. The Sun is the main source of heat energy.

ELECTRICAL ENERGY

Electricity is one of the widely used form of energy. Electrical energy can be supplied easily to any desired place through wires. We get electrical energy from batteries and electric generators. These electric generators are run by hydro power, thermal or nuclear power.

SOUND ENERGY

When you knock at the door, you produce sound. Sound is a form of energy. It is produced when a body vibrates; such as vibrating diaphragm of a drum, vibrating strings of a sitar and vibrating air column of wind instruments such as flute pipe etc.

EFFICIENCY

Efficiency of a system is the ratio of required form of energy obtained from a system as output to the total energy given to it as input.

$$\text{Thus Efficiency} = \frac{\text{required form of output}}{\text{total input energy}}$$

POWER

Power is defined as the rate of doing work.

Mathematically,

$$\text{Power} \quad P = \frac{\text{Work done}}{\text{Time taken}}$$

$$\text{or} \quad P = \frac{W}{t} \quad \ldots \ldots$$

Since work is a scalar quantity, therefore, power is also a scalar quantity. SI unit of power is **watt** (W). It is defined as

The power of a body is one watt if it does work at the rate of 1 joule per second (1 Js^{-1}).

Bigger units of power are kilowatt (kW), megawatt (MW) etc.

$$1\text{kW} = 1000\text{ W} = 10^3\text{ W}$$

$$1\text{MW} = 1000\,000\text{ W} = 10^6\text{ W}$$

1 horse power = 1hp = 746 W