PHYSICS

Mechanics

1. **Units & Dimensions**

Fundamental Quantities—The quantities which are independent of each other are called fundamental quantities . There are seven fundamental quantities. **(a) length (b) mass (c) time (d) electric current (e) temperature (f) luminous intensity (g) amount** of **substance.**

A physical quantity = *nu*

(i) Fundamental Units

	Kosdamental Quantity	Fundamental Units
1	Length	Metre
2	Mass	Kilogram
3	Time	Second
4	Temperature	Kelvin
5	Electric Current	Ampere
6	Luminous intensity	Candela
7	Amount of substances	Mole

(ii) **Derived Units**

Physical Quantity	Derived Units
1. Area	metre^2 (m^2)
2. Volume	metre^3 (m^3)
3. Density	kg/m^3
4. Speed	m/s
5. Acceleration	m/s^2
6. Force	kg-m/s^2 or newton
7. Work	kg-m^2/s^2 or joule
8. Power	kg-m^2/s^3 or watt
9. Charge	ampere-sec or
10. Potential	joule/coulomb or
11. Resistance	volt/ampere or ohm

2. **Uses of Dimensions**

At a Glance

Some Important Practical Units

1 Par sec—It is the largest practical unit of distance.

1 par sec = 3.26 light year

2 **Slug—It is** the unit of mass.

1 slug = 14.59 kg

3 **Chandra Shekhar limit** —It is the largest practical unit of mass.

1 Chandra Shekhar limit = 1.4 x Solar mass

4 **Mach No.**—This unit is used to express velocity of supersonic jets.

1 mach no. = Velocity of sound
= 332 m/sec.

5 **Knot**—This unit is used to express velocity of ships in water.

1 knot = 1.852 km/hour

6 **Curie**—It is the unit of radioactivity.

1 curie = 3.7 x 10^{10} disintegration/sec

3. **Motion in one dimension**

1. **Average Speed :** if a body cover different distance with different speeds, then its average speed can the found with the formula.

$$\textbf{Average speed} = \frac{\textbf{total distance}}{\textbf{total time}}$$

Note:

i. If a body covers first half of a distance with speed v_1 and second half with speed v_2, then

$$Average\ speed = \frac{2v_1v_2}{v_1v_2}$$

ii. If a body covers first one-third distance with speed 'a', other one-third distance with speed 'b' and last one-third distance with speed 'c', then

$$Average\ speed = \frac{3abc}{ab + bc + ca}$$

Instantaneous Speed – The sped of the body at given instant is called instantaneous speed.
If $\Delta t \to 0$, then instantaneous speed

$$= \lim_{\Delta t \to 0} \frac{\Delta s}{\Delta t} = \frac{ds}{dt}$$

2. **Velocity :**

$$Velocity = \frac{displacemetn}{time}$$

$$Average\ velocity = \frac{total\ displacemetn}{total\ time}$$

Note:

i. If a body is moving on a circular path, then after completing one complete cycle, its average velocity is zero.

ii. When a body covers equal half distances with the velocities v_1 and v_2 respectively, then

$$Average\ speed = \frac{2v_1v_2}{v_1 + v_2}$$

iii. When a body travels with velocity v_1 for time t_1 and v_2 for time t_1 then,

$$Average\ speed = \frac{v_1t_1 + v_2t_2}{t_1 + t_2}$$

3. **Acceleration :** Rate of change of velocity with time is as acceleration. It is a **vector** quantity.
If $\Delta \vec{v}$ is the change in velocity in time $\Delta t,$ then acceleration

$$\vec{\alpha} = \frac{\Delta \vec{v}}{\Delta t}$$

Also, $\alpha = \frac{d}{dt}(v) = \frac{d}{dt}(\frac{dx}{dt})$

Or, $\alpha = \frac{d^2x}{dt^2}$

4. Equations of Motion (With Usual Notation) At a Glance

Useful Information's

i. If a body is thrown upwards up to some height, and another body is thrown down words with same point, then time taken in both the cases are equal (provided resistance of air is negligible).

ii. Velocity and acceleration of a body may be in different directions.

iii. Velocity and acceleration of a body need not to be zero simultaneously.

iv. The ratio of distance covered by the body in successive seconds is 1 : 3 : 5 …. & velocity 1 : 2 : 3

v. If a body is dropped vertically down words with some height and another body is projected horizontally, then both body will reach the ground at same time.

5. **Motion in Two and Three Dimensions**

(a) Projectile Motion

i. The time of flight, $T = \frac{2u \sin \theta}{g}$

ii. The maximum height, $H = \frac{u^2 \sin^2 \theta}{2g}$

iii. The range, , $R = \frac{u^2 \sin 2\theta}{g}$

iv. Maximum range, , $R_{max} = \frac{u^2}{g}$

v. For a given range there are two directions of projection. They are θ and $(90 - \theta)$.

(b) **Angular Velocity**

The rate of change of angle with respect to time is known as anglular velocity and is expressed by ω .

$$Angular\ Velocity\ (\omega) = \frac{Angular\ displacement\ (\theta)}{time\ taken\ (t)}$$

Unit- The unit of angular velocity is rad/sec or rad sec^{-1}

(c) Linear Velocity

Liner velocity = Radius × Angular velocity

$$v = r\,\omega$$

(d) Frequency

Frequency (n) is defined as the number of revolutions per second and is given as

$$n = \frac{\omega}{2\pi}$$

5. **Salient Features of Circular Motion**

i. The rate of angular displacement $\left(\frac{d\theta}{dt}\right)$is called the **angular velocity.**

ii. If the body coves equal angular displacements in equal intervals of time, howsoever small this time intervals may be, the body is said to be moving with uniform angular velocity.

iii. During uniform circular motion, the direction of position vector changes continuously but he magnitude remains constant which is equal to r (radius of circular path)

iv. Speed, Kinetic energy and angular momentum remain constant in circular motion.

Exercise

1. A particle is travelling with a constant speed. This means
   (a) Its position remains constant as time passes
   (b) It covers equal distances in equal time intervals
   (c) Its acceleration is zero
   (d) It does not change its direction of motion
2. If circular motion the
   (a) Direction of motion is fixed
   (b) Direction of motion changes continuously
   (c) Acceleration is zero
   (d) Velocity is constant
3. A coin and a feather are dropped together vacuum.
   (a) The coin will reach the ground first
   (b) The feather will reach the ground first
   (c) Both the bodies will reach the ground together
   (d) The feather will not fall down
4. In which of the following cases is the potential energy of a spring minimum?
   (a) When it is compressed
   (d) When it is extended
   (c) When it is at its natural length
   (d) When it is at its natural length but is kept at a height h above the ground
5. When the speed of a particle is doubled, the ratio of its kinetic energy to its momentum
   (a) Remains the same
   (b) Gets double
   (c) Becomes half
   (d) None of the abve
6. Two simple pendulums have the same period of oscillation. The necessary condition of this is
   (a) Their lengths are equal and the suspended particles have the same mass
   (b) Their lengths are equal but the suspended particles need not have the same mass
   (c) Their lengths are different but the suspended particles have the same mass
   (d) The masses of the suspended particles must be in the inverse ratio of the lengths of the pendulums
7. A body executing simple harmonic motion while passing through its mean position will have
   (a) Kinetic energy only
   (b) Potential energy only
   (c) Both kinetic and potential energies
   (d) Minimum acceleration
8. A satellite rotating around the earth, has water in a jar kept inside it. A cork is pushed into the water in the jar and then released. The cork will
   (a) Remain stable at the pushed position
   (b) Stick to the wall of the jar
   (c) Stick to the bottom of the jar
   (d) Rise upto the surface of the water
9. Two trains, each 50 m long are travelling in opposite directions with velocities 10 m/s and 15 m/s. The time of crossing is
   (a) 2 s (b) 4 s
   (c) $2\sqrt{3}\ s$ (d) $4\sqrt{3}\ s$
10. Time period of a simple pendulum inside satellite orbiting earth is
   (a) Zero (b) infinite
   (c) T (d) 2T

Answer

1.	B	6.	B
2.	B	7.	D
3.	C	8.	A
4.	C	9.	D
5.	B	10.	B