Physics

CHAPTER 1

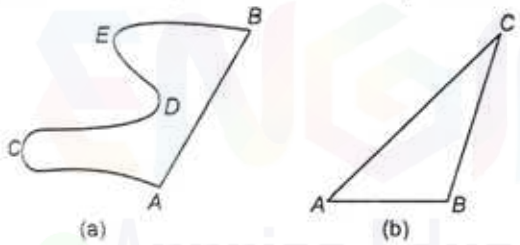
Mechanics

Motion

A body is said to be in motion when its position changes continuously with respect to a stationary body taken as a reference point.

Distance and Displacement

- The distance covered by a body is the actual length of the path travelled by the body between the initial position and final position.
- The displacement of a particle is the change in position of the particle in a particular direction and is given by a vector drawn from its initial position to its final position.



- In Fig. (a), AB is the displacement and $(AC+CD+DE+EB)$ is the distance travelled.
- Also in Fig. (b), AC is displacement and distance covered is $(AB+BC)$.

Speed

It is the distance moved by a moving body in unit time. Its unit is m/s or km/h.

$$\text{Speed} = \frac{\text{Distance travelled}}{\text{Time taken}} \quad \text{or } u = \frac{s}{t} \text{ or } s = ut$$

where, u = speed, s = distance, t = time taken

- An object is said to be moving with a uniform speed, if it covers equal distances in equal intervals of time.
- An object is said to be moving with a variable speed, if it covers equal distances in unequal intervals of time or unequal distances in equal intervals of time.
- Average speed for a motion is the ratio of the total distance travelled by the object to the total time taken.

$$\text{Average speed } u_{av} = \frac{s_1 + s_2 + \ldots}{t_1 + t_2 + \ldots}$$

If the body covers equal distances with different speeds then

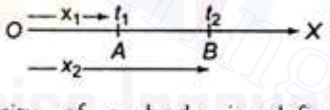
$$u_{av} = \frac{2u_1u_2}{u_1 + u_2}$$

Velocity

- It is the rate with which a body moves in a particular direction. It is a vector quantity.

$$\text{Velocity} = \frac{\text{Displacement in particular direction}}{\text{Time taken}}$$

- A body is said to be moving with uniform velocity, if equal displacements of the body take place in same direction in equal intervals of time.
- If a body moves in such a way that its speed or the direction or both changes with time, the body is said to have variable velocity.



- Average velocity of a body is defined as the net displacement divided by the time taken for displacement.

$$\vec{v}_{av} = \frac{\vec{x}_2 - \vec{x}_1}{t_2 - t_1}$$

as net displacement $= \vec{x}_2 - \vec{x}_1$ and time taken $= t_2 - t_1$

Relative Velocity

The rate of change of position of a body with reference to moving observer is regarded as the relative velocity of body w.r.t. observer when the two are moving in same direction, then relative velocity $= v_1 - v_2$. When the two are moving in opposite directions, then relative velocity $= v_1 + v_2$

Acceleration

- It is the rate of change of velocity with time. Its SI unit is m/s^2.

- If the velocity of an object increases without change in direction, it is said to be moving with positive acceleration.
- If the velocity of an object decreases without change in direction, the object is said to be moving with negative acceleration or deceleration or retardation.
- Acceleration of an object is zero, if it is at rest or moving with uniform velocity.
- An object is said to be moving with uniform acceleration, if its velocity changes by equal amounts in equal intervals of time.
- An object is said to be moving with a variable acceleration, if its velocity changes by unequal amounts in equal intervals of time.

Scalar and Vector Quantities

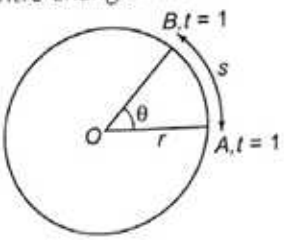
- A physical quantity which is completely described by magnitude only is known as scalar quantity. *e.g.*, time, distance, mass, speed, area, volume, work, power, pressure, charge and length.
- A physical quantity which is completely described by its magnitude as well as direction is known as vector quantity. *e.g.*, displacement, velocity, acceleration, force, weight, torque, momentum and electric field.

Circular Motion

- When an object moves along a circular path with uniform speed, its motion is called uniform circular motion.
- Circular motion is accelerated even if the speed of the body is constant. The motion of a satellite is accelerated motion.

Angular Velocity

- Angular velocity is the rate at which angle swept by the radius at the centre changes with time. Its unit is rad/s.



- Angular velocity, $\omega = \frac{\theta}{t}$

$s = u \times t$

and $\omega = \frac{\theta}{t}, \theta = \frac{s}{r}$

So, $u = \omega \times r$

as u = linear speed ,

ω = angular velocity,

r = radius of the circular path.

Thus, linear speed = angular velocity × radius of circular path.

Centripetal Force

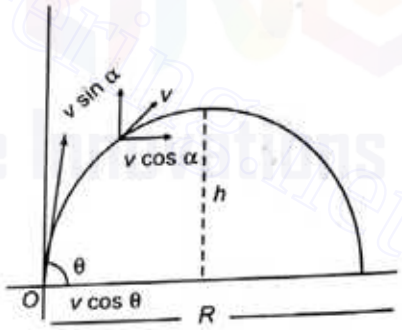
- A body performing circular motion is acted upon by a force which is always directed towards the centre of the circle. This is called 'centripetal force'.
- If a body of mass m is moving on a circular path of radius R with uniform speed u then the required centripetal force, $F = \frac{mu^2}{R}$
- Centripetal force can be mechanical, electrical or magnetic force.

Centrifugal Force

- In applying the Newton's law of motion we have to consider some forces which cannot be assigned to any object in the surrounding. These fources are called pseudo force.
- Centrifugal force is such a pseudo force. It is equal and opposite to centripetal force.
- Cream separator, centrifugal drier work on the principle of centrifugal force.

Projectile Motion

- When a body moves under an acceleration whose direction is different from the direction of the initial velocity, then both the magnitude and direction of its velocity changes with time. Hence, the body moves on a curved path in a plane. This type of motion is called projectile motion.



- Flight time of projectile, $T = \frac{2u\sin\theta}{g}$
- Height of projectile, $h = \frac{u^2 \sin^2\theta}{2g}$
- Range of projectile, $R = \frac{u^2 \sin 2\theta}{g}$

- We drop down a ball from a roof and at the same time throw another ball in a horizontal direction, then both the balls would strike the earth simultaneously at different places.
- The horizontal range is the same when the body is projected at θ and $(90° - \theta)$.
- The horizontal range of a projectile is maximum when angle of projection is 45°.

Force

- Force is a push or pull which produces or tends to produce a change in uniform motion of body, stops or tends to stop a body which is in motion. Its unit is newton.
- It is a vector quantity and the straight line along which a force is directed is called the line of action of the force.
- The rotational effect of a force on a body about an axis of rotation is described in terms of moment of force.

Inertia

- The property of bodies by virtue of which they oppose only change in their present state is called inertia.
- Mass is a measure of the inertia of a body.

Moment of Inertia

- The property of a body by virtue of which it opposes any change in its state of rotation about an axis is called the moment of inertia of the body about that axis.
- Moment of inertia of a circular lamina passing through the CC and perpendicular to the plane

$$I = MR^2$$

Newton's Laws of Motion

First Law

It states that every body continues in its state of rest or in uniform motion in a straight line, unless it is compelled by an external force to change that state.

- First law is also called law of Galileo or law of inertia.

Applications

- Athlete runs some distance, before taking a long jump.
- A ball thrown upwards in a train moving with uniform velocity returns to the hand of thrower.
- The mud from the wheels of a moving vehicle flies-off tangentially.
- When we shake the branch of a mango tree, the mangoes fall down.
- A man jumping from a moving train may fall down.
- If a cloth placed under a book is given a sudden pull, it comes out without disturbing the book.
- When a horse suddenly starts moving, the rider falls backward.
- When a running horse suddenly stops, the rider falls forwards.
- We hit a carpet with a stick to remove the dust.

Second Law

- According to it, the force acting on an object is directly proportional to the product of the mass of the object and the acceleration produced on it.

or

$$F \propto m \times a \Rightarrow F = kma$$

Value of k is 1 in SI system $\Rightarrow F = ma$

It's SI unit is newton.

- Newton's second law gives the magnitude of force.
- Newton's first law is contained in the second law.

Applications

- China wares are wrapped in straw or paper before packing.
- A person falling on pucca floor (or frozen ice) is likely to receive more injuries than one falling on kuccha floor (loose earth).
- While catching a ball, a cricket player lowers his hands to save himself from getting hurt.
- Bogies of the trains are provided with buffers to avoid severe jerks during shunting of trains.

Third Law

According to this law, to every action there is an equal and opposite reaction.

Applications

- In order to walk, we press the ground in backward direction with our feet. As a result, the earth on other hand pushes us in forward direction.
- It is difficult to drive a nail into a wooden block without holding the block. A jet plane moves on the principle of Newton's third law of motion. As exhaust gases come out from the nozzle at a greater speed, the reaction of the same moves the plane forwards.

Momentum

- The momentum of a body is defined as the product of its mass and its velocity.

$$\text{Momentum} = \text{Mass} \times \text{Velocity}$$

$$p = m \times v$$

- It's direction is the same as the direction of velocity of the body.

  It is a vector quantity. Its SI unit is kgm/s.
- Concept of momentum was introduced by Newton.
- In the absence of external forces, the total momentum of the system is conserved.

  i.e., $m_1v_1 = m_2v_2$ for a body.

  and $m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$ for two bodies.

Applications of Conservation of Momentum

- When a bullet is fired from a gun, the gun recoils or gives a sharp pull in backward direction.
- While firing a bullet, the gun must be held tight to the shoulder.
- When a man jump from a boat to the shore, the boat slightly moves away from the shore.
- Rocket works on the principle of conservation of momentum.
- If someone left on a frictionless floor desires to get out of it, he can do so by blowing air out of his mouth.

Impulse

- An impulse is a large force acting on a body for a short time to produce a finite change in momentum.
- Impulse = Force × Time
  = Change in momentum
  i.e., $I = F \times t$
  Its SI unit is N-s or kg-m/s.

Examples of Momentum and Impulse

- In catching a ball, a player by drawing his hands backwards increases the time of contact.
- An athlete is advised to come to stop slowly after finishing a fast race.
- The layer of bricks is broken by player.

Friction

- It is the opposing force that is set-up between the surface of contact, when one body slides or rolls or tends to do so, on the surface of another body.
- The maximum value of the force of friction which comes into play before a body just begins to slide over the surface of another body is called **limiting friction**.
- The force of friction that comes into play between the surfaces of two bodies before the body actually starts moving is called **static friction.**
- The force of friction that opposes relative motion between two surfaces in contact is called **kinetic or sliding friction.**
- The frictional force developed when a body rolls over a surface, is known as the **rolling friction.**

Static friction is a self adjusting force and it adjusts itself so that it became equal to the applied force.

Laws of Friction

- Friction acts in a direction opposite to the direction of motion of the objects. Friction depends upon the nature of the two surfaces in contact.
- Friction is independent of the area of contact of the two surfaces. Rolling friction is less than sliding friction.
- Force of friction (F) is directly proportional to the normal reaction (R).
  i.e., $F \propto R \Rightarrow F = \mu R$
  where, μ = coefficient of friction.
  Also $\mu = \tan \alpha$, where α is angle of friction.
  Angle of repose = Angle of friction *i.e.*, $\theta = \alpha$

Advantages

- Due to friction, we are able to move on the surface of earth.
- The fibres of thread are held together due to force of friction.
- The brakes applied in automobiles work only due to friction.
- Sledges are used in arctic region as friction is very low on the surface of ice.

Disadvantages

- A lot of energy is wasted in the form of heat that causes wear and tear of the moving parts.
- Due to friction, speed of automobiles cannot be increased beyond a certain limit.

Methods for Reducing Friction

- By using lubricants *e.g.*, grease, oil etc.
- By using ball or roller bearings.
- By changing sliding to rolling.
- By using soap solution.
- By using powder.

The tyres are threading which also increases the friction between the tyres and the road.

Work

- Work is said to be done, if a force acting on a body is able to actually move it through some distance in the direction of the force.
- Work = Force × Distance, *i.e.*, $W = \vec{F} \cdot \vec{s}$
- Its SI unit is a joule (J).

Positive Work Done (Examples)

- When body falls freely under gravitational pull.
- When a horse pulls a cart on a level road.

Negative Work Done (Examples)

- When a body is made to slide over a rough surface. When a positive charge is moved towards another positive charge.

Zero Work Done (Examples)

- When a coolie travels on a platform with a load on his head.
- When a body is moved along a circular path with the help of a string. When a person does not move from his position but he may be holding any amount of heavy load.

Energy

- The energy of an object is its capacity for doing work. It is a scalar quantity and its unit is joule (J).
- Energy can exist in different forms such as mechanical energy, heat energy, sound energy, light energy etc.
- Mechanical energy is of two types *i.e.*, kinetic energy and potential energy.

Kinetic Energy

- The energy possessed by a body by virtue of its motion is called its kinetic energy.
- A body of mass m and moving with velocity v has

$$\text{kinetic energy} = \frac{1}{2}mv^2 = \frac{p^2}{2m}$$

- When momentum is doubled kinetic energy becomes four times.

Examples
1. Kinetic energy of air is used to run wind mills.
2. Kinetic energy of running water is used to run the water mills.
3. A bullet fired from a gun can pierce a target due to its kinetic energy.

Potential Energy

- It is the energy possessed by a body by virtue of its position.
- Suppose a body is raised to a height h above the surface of the earth, then potential energy of body $= mgh$
- Also here potential energy = work done $= mgh$

Examples
1. The potential energy of the wound spring of a clock is used to drive the hands of the clock.
2. Due to potential energy of the stretched bow, the arrow goes forward with a large velocity on releasing the bow.
3. The potential energy of water in dams is used to run turbines in order to produce electric energy using the generators

Principle of Conservation of Energy

- Energy can neither be created nor destroyed but can only be transformed from one form to another.
- The total amount of energy in the universe remains constant.
- The body falls its potential energy decreases but, at the same time kinetic energy increases by an equal amount.

Transformation of Energy

- In a heat engine, heat energy changes into mechanical energy. In the Sun, mass changes into radiant energy.
- In an electrical heater, the electric energy is converted into heat energy.
- In an electric bulb, the electric energy is converted into light energy. In burning coal, oil etc., the chemical energy changes to heat energy.
- When we rub our hands, heat is generated. Here mechanical energy of muscles is converted into heat energy.
- In an electromagnet, the electric energy is converted into magnetic energy.

Mass-Energy Equivalence

- In 1905, Einstein proved the relation between mass and energy.
- $E = mc^2$, where c is the velocity of light.
- $E = mc^2$ leads to verification of the two laws—law of conservation of mass and law of conservation of energy.

Power

- The time rate of doing work is called power.
- If W is work done in time t then power P, is $P = \frac{W}{t}$
- Power is a scalar quantity with SI unit Watt or Joule/s.
  1 watt hour = 3600 joule
  1 kilowatt hour $= 3.6 \times 10^6$ J
- 1 HP = 746 watt

Gravitation

Gravitation

- Every body attracts other body by a force called force of gravitation.

Newton's Law of Gravitation

- The force of gravicational attraction between two point bodies is directly proportional to the product of their masses and inversely proportional to the square of the distance between them *i.e.*, $F = G\frac{m_1 m_2}{r^2}$; *where G is universal gravitational constant, it's value is* 6.67×10^{-11} N-m^2 kg^{-2}.

Gravity

- The gravitational force of earth is called gravity *i.e.*, gravity is force by which earth pulls a body towards its centre.
- The acceleration produced in a body due to force of gravity is called acceleration due to gravity and its value is 9.8 m/s^2.

Variation in g

- Value of g decreases with height or depth from earth's surface.
- g is maximum at poles.
- g is minimum at equator.
- g decreases due to rotation of earth.
- g decreases, if angular speed of earth increases, and increases, if angular speed of earth decreases.

Satellite

- Satellite are natural or artificial bodies revolving around a planet under its gravitational attraction.
- Orbital speed of a satellite is independent of its mass and depends upon the radius of orbit.
- The orbital speed of a satellite revolving near the surface of earth is 7.9 km/s.
- Time period of revolution of satellite revolving near the surface of earth is 1 hr 24 min (84 min).
- Period of revolution of a satellite depends upon the height of satellite from the surface of earth.
- Every body inside the satellite is in a state of weightlessness.
- Period of revolution of a satellite is independent of its mass.
- If a satellite revolves in equatorial plane in the direction of earth's rotation *i.e.*, from west to east with a period of revolution equal to time period of rotation of earth on its own axis i.e., 24 hours, then the satellite will appear stationary relative to earth. Such a satellite is called geo-stationary satellite. Such a satellite revolves around the earth at a height of 3600 km.

- Polar satellite revolves around the earth in polar orbit at a height of 800 km. Time periods of the satellites is 84 min.
- These are used for weather forecasting and mapping etc.

Escape Velocity

- Escape velocity is that minimum velocity with which a body should be projected from the surface of earth, so as it goes out of gravitational field of earth and never return to earth.
- Escape velocity at the earth surface is 11.2 km/s.
- Escape velocity is given by $v_e = \sqrt{2gR}$.
- The escape velocity at moon surface is 2.4 km/s. So, there is no atmosphere.
- The value of g on the moon is 1/6th of that on the earth.

Mass and Weight

- The mass of a body is the quantity of matter contained in it. It is scalar quantity and its SI unit is kg. Mass does not change from place to place and remains constant.
- The weight of body is the force with which it is attracted towards the centre of the earth.
- Weight of the body $w = mg$
- Weight of a body is not constant it changes from place to place.

Weight of a Body in Lift

- If lift is stationary or moving with uniform speed (either upward or downward), the apparent weight of a body is equal to its true weight.
- If lift is going up with acceleration, the apparent weight of a body is more than the true weight.
- If lift is going down with acceleration, the apparent weight of a body is less than the true weight.
- If the rod of the lift is broken, it fall freely. In this situation, the weight of a body in the lift become zero. This is the situation of weightlessness.

Simple Harmonic Motion

- If a particle repeats its motion about a fixed point after a regular time interval in such a way that at any moment the acceleration of the particle is directly proportional to its displacement from the fixed point at that moment and is always directed towards the fixed point than the motion of the particle is called simple harmonic motion.
- When a particle executing SHM passes through the mean position
  (a) no force acts on the particle.
  (b) acceleration of the particle is zero.
  (c) velocity is maximum.
  (d) kinetic energy is maximum.
  (e) potential energy is maximum.
- When a particle executing SHM is at the extreme end, then
  (a) acceleration of the particle is maximum.
  (b) restoring force acting on particle is maximum.
  (c) velocity of particle is zero.
  (d) kinetic energy of particle is zero.
  (e) potential energy is maximum.

Periodic Motion

- A motion which repeats itself after equal intervals of time is called a **periodic motion.**

Oscillatory Motion

- A motion in which an object moves back and forth repeatedly about a fixed position is called an oscillatory motion.

Simple Pendulum

- A simple pendulum consists of a small metal ball suspended by a long thread from a rigid support, such that the bob is free to swing back and forth.
- The distance of the pendulum from its mean position is called its displacement.
- The maximum displacement of the pendulum on either side of its mean postition is called the amplitude of oscillations.
- Time period is the time taken by the pendulum to complete one full oscillation.
- Frequency is the number of full oscillations completed by the pendulum in one second.
- Second pendulum is one whose time period is 2 seconds.
- Time period of simple pendulum $T = 2\pi\sqrt{\frac{L}{g}}$, where L is length of thread. The time period of a simple pendulum of infinite length 84.6 min. A pendulum clock goes slow in summer and fast in winter.

Points to be Remember

- When a particle returns to the starting points, its average velocity is zero but average speed is not zero.
- Distance is a scalar quantity and displacement is a vector quantity.
- Displacement of an object in a given time interval can be positive, negative or zero. The displacement of an object between two given points is a measure of the shortest distance between them.
- Speed is always equal to or greater than magnitude of the velocity.
- When a vehicle takes a turn on a circular path it requires centripetal force. If friction provides this centripetal force then vehicle can move circular path sefely. If friction force ≥ Required centripetal force.
- All bodies fall freely with the same acceleration.
- The acceleration of the falling bodies does not depend on the mass of the body. The angular velocity of revolution of a plant around the sun in an elliptical orbit increases when the planet came closer to sun and *vice-versa*.
- A person carrying having weight in his hands and standing on a rotating platform can changes the speed of platform.
- When the person suddenly folds his arms. Its moment of inertia decreases and in accordance the angular speed increases.
- A heavier body has a larger linear momentum than a lighter body moving with the same velocity.
- A heavier body has a smaller velocity than a lighter body having same linear momentum.
- The center of gravity of a body is that point through which the entire weight of body acts.

Exercise

1. External forces acting on an object
   (a) are always balanced
   (b) are always unbalanced
   (c) may or may not be balanced
   (d) None of the above

2. Momentum has the same unit as that of
   (a) couple (b) torque
   (c) impulse (d) moment of momentum

3. A scooter driven over an oily road generally slips because on the oily road
   (a) inertia of the scooter tyres increases
   (b) inertia of the scooter tyres decreases
   (c) friction between tyres and road increases
   (d) friction between tyres and road decreases

4. The force of gravitation between two bodies does not depend on
   (a) their separation
   (b) the product of their masses
   (c) the sum of their masses
   (d) the gravitational constant

5. The acceleration due to gravity
   (a) has the same value everywhere in space
   (b) has the same value everywhere on the earth
   (c) varies with the latitude on the earth
   (d) is greater on the moon due to its smaller diameter

6. When the distance, an object travels is directly proportional to the length of time, it is said to travel with
   (a) zero velocity (b) uniform velocity
   (c) constant velocity (d) constant acceleration

7. When work is done on the body
   (a) it gains energy
   (b) it loses energy
   (c) its energy remains constant
   (d) None of the above

8. The escape velocity of a projectile from the surface of the earth is approximately
   (a) 11.3 km / s (b) 11.2 km / s
   (c) 11.5 km / s (d) 11.4 km / s

9. When a body falls freely
   (a) its PE is converted into KE
   (b) its KE is converted into PE
   (c) its mechanical energy is converted into heat energy
   (d) None of the above

10. When milk is churned, the cream is separated from it due to
    (a) gravitational force (b) centrifugal force
    (c) cohesive force (d) adhesive force

11. The escape velocity of an object from the surface of the earth is 11.6 km/s. If the mass of the earth is increased four times, the resultant escape velocity would be
    (a) 11.6 km/s (b) (11.6×2) km/s
    (c) (11.6×4) km/s (d) $\left(11.6 \times \frac{1}{2}\right)$ km/s

12. A line drawn from the Sun to a planet, moving around it, sweeps over a fixed area in a given interval of time. This is according to
    (a) Kepler's law (b) Ohm's law
    (c) Lenz's law (d) Newton's law

13. When a mass undergoes simple harmonic motion, there is always a constant ratio between its displacement and
    (a) period (b) acceleration (c) mass (d) velocity

14. A parachute helps a parachuter, while jumping from aeroplanes, to
    (a) protect him from frictional forces of the air
    (b) to protect him from the attack of birds
    (c) to reduce his speed of descent due to upward thrust of the air on the open parachute
    (d) to reduce his speed of descent controlling the air currents

15. Which of the following changes when a particle is moving with uniform velocity?
    (a) Speed (b) Acceleration
    (c) Velocity (d) Position

16. Rocket works on the principle of conservation of
    (a) mass (b) energy
    (c) momentum (d) None of these

17. When horse starts running all of a sudden, the rider on the horse falls back because
    (a) he is afraid
    (b) he is taken a back
    (c) due to inertia of motion, the lower part of his body comes in motion
    (d) due to inertia of rest, the upper part of his body remains at rest

18. Two balls of different masses have the same kinetic energy. The ball having greater momentum will be
    (a) lighter one (b) heavier one
    (c) Both having equal masses (d) Cannot say

19. A boy suddenly comes and sits on a circular rotating table. What will remain conserved?
    (a) Angular momentum (b) Potential energy
    (c) Linear momentum (d) Kinetic energy

20. A missile is launched with a velocity less than the escape velocity. The sum of its kinetic and potential energy is
    (a) positive
    (b) negative
    (c) zero
    (d) May be positive or negative depending upon its initial velocity

21. The chance of a vehicle to overturn while negotiating a circular path depends on
    (a) speed of the vehicle only
    (b) radius of the circular path only
    (c) speed and height of the vehicle and radius of the circular path
    (d) height of the vehicle only

22. Three pendulum clocks *A*, *B* and *C* are synchronised on the surface of the earth at the sea-level. The clock *A* is taken to the top of a mountain and the clock *B* is taken under a deep mine. The temperature at the three locations are assumed to be the same. On the basis of the above, which one of the following is correct?
(a) Both *A* and *B* run faster than *C*
(b) Both *A* and *B* run slower than *C*
(c) *A* runs slower than *B* but runs faster than *C*
(d) *B* runs slower than *C* but *A* runs faster than *C*

23. The time period of a pendulum on moon
(a) becomes zero (b) decreases
(c) increases (d) remains the same

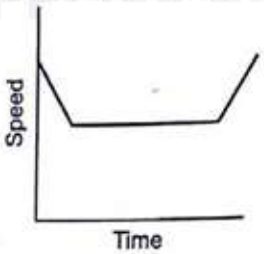
24. When an object is thrown up, the force of gravity
(a) is opposite to the direction of motion
(b) is in the same direction as the direction of motion
(c) decreases as it rises up
(d) increases as it rises up

25. The period of the pendulum depends on its
(a) mass (b) length
(c) energy (d) amplitude

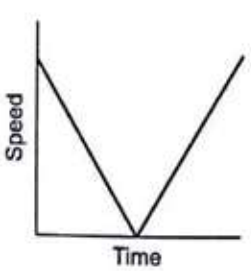
26. The time period of a simple pendulum is given by
(a) $T = 4\pi^2\sqrt{\frac{L}{g}}$ (b) $T = 2\pi\sqrt{\frac{g}{L}}$
(c) $T = 2\pi\sqrt{\frac{L}{g}}$ (d) $T = 2\pi\frac{L}{g}$

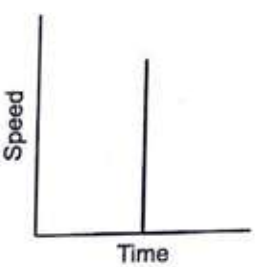
27. If the amplitude of a simple pendulum is made one-fourth, its time period will become
(a) twice (b) half
(c) one-fourth (d) Will not change

28. Which of the following graphs represent the case of a cricket ball thrown vertically upwards and returns to the hands of the thrower?

(a) 

(b) 

(c) 

(d) 

29. The work done in lifting 200 kg of water through a vertical height of 6m is ($g = 10\ m/s^2$)
(a) 12000 kJ (b) 12000 J
(c) 1200 J (d) 120 kJ

30. If acceleration due to gravity is 10 m/s^2, then the potential energy of a body of mass 1 kg kept at a height of 5 m, is
(a) 50 J (b) 100 J
(c) 500 J (d) 50 kJ

31. A train travels a distance with a speed of 30 km/h and returns with a speed of 50 km/h. The average speed of the train is
(a) 36 km/h (b) 37.5 km/h
(c) 38 km/h (d) 40 km/h

32. If acceleration due to gravity is 9.8 m/s^2, then the mass of the object whose weight is 49 N, is
(a) 14 kg (b) 10 kg
(c) 9 kg (d) 5 kg

33. Friction between any two objects is due to
(a) attraction between them
(b) repulsion between them
(c) even surface of them
(d) bumps and cracks on them

34. The motion along a straight line is
(a) rectilinear (b) translatory
(c) rotating (d) oscillatory

35. The momentum of a heavy object at rest will be
(a) zero (b) small
(c) large (d) None of these

36. It is easier to roll a barrel along the road than to pull it because
(a) rolling involves only one point of contact between the barrel and the earth
(b) rolling friction is considerably less than the sliding friction
(c) the full weight of the barrel does not become effective while rolling
(d) None of the above

37. A cricket player moves his hands along the direction of the moving ball while catching it in order to
(a) kill the googly of the ball
(b) conserve energy
(c) conserve mass
(d) reduce the force of impulse

38. A car has a speedometer to measure the
(a) average velocity (b) instantaneous velocity
(c) mean velocity (d) acceleration

39. Sound waves travel with a speed of about 330 m/s. The wavelength of sound whose frequency is 550 Hz is
(a) 0.8 m (b) 8.4 m
(c) 0.6 m (d) 0.2 m

40. Light year is the unit of
(a) time (b) mass
(c) speed of light (d) distance

41. If acceleration due to gravity is 9.8 m/s^2. A bag of wheat weighs 200 kg. The height to which it should be raised so that its potential energy may be 9800 J, is
(a) 5 m (b) 4 m
(c) 3 m (d) 10 m

42. A horse and a dog are running with the same speed. Then, the ratio of their kinetic energies, if the weight of the horse is ten times that of dog, is
(a) 10 : 1 (b) 100 : 1 (c) 1 : 9 (d) 9.8 : 98

43. A communication relay satellite is able to telecast programmes continuously from one part of the world to another, because
(a) its period of revolution is greater than the period of rotation of the earth on its axis
(b) its period of revolution is equal to the period of rotation of the earth on its axis
(c) its period of revolution is less than the period of rotation of the earth on its axis
(d) its mass is less than the mass of the earth

44. If the velocity of a particle is reduced to half of its initial value, then the kinetic energy of the particle will
(a) get doubled
(b) become four times
(c) reduce to half of its original value
(d) reduce to one-fourth of its original value

45. The earth revolves around the sun in an elliptical orbit, its speed
(a) is greatest when it is farthest from the sun
(b) is greatest when it is closest to the sun
(c) remains the same at all points on the orbit
(d) goes on decreasing continuously

46. A lift is descending at a constant speed v. A passenger in the lift drops a coin. The acceleration of the coin towards the floor will be
(a) zero (b) $+g$ (c) $-g$ (c) g^2

47. A man pushes a wall but fails to displace it, he does
(a) negative work (b) positive work
(c) no work at all (d) maximum work

48. A particle of mass m has momentum p. Its kinetic energy will be
(a) mp (b) p^2m (c) p^2/m (d) $p^2/2m$

49. Moment of momentum is called
(a) torque (b) weight
(c) moment of inertia (d) angular momentum

50. The square of time period of revolution of a planet round the Sun is
(a) directly proportional to its average distance from the Sun
(b) directly proportional to the square of its average distance from the Sun
(c) directly proportional to the cube of its average distance from the Sun
(d) inversely proportional to its average distance from the Sun

51. If the distance between two objects is doubled, the force of attraction between them will
(a) become 1/4 times (b) become 2 times
(c) become 1/8 times (d) remain same

52. The weightlessness experienced while orbiting the earth in spaceships, is the result of
(a) inertia (b) acceleration
(c) centre of gravity (d) zero gravity

53. Average velocity of an object is equal to the mean of its initial and final velocities, if the acceleration is
(a) uniform (b) variable
(c) Both of these (d) None of these

54. **Assertion (A)** Moon's gravity is equivalent to one-eighth of earth's gravity.
Reason (R) Due to less gravity, moon is unable to retain its atmosphere.
(a) Both A and R are individually true and R is the correct explanation of A
(b) Both A and R are individually true, but R is not the correct explanation of A
(c) A is true, but R is false
(d) A is false, but R is true

55. **Assertion (A)** A light body and a heavy body have equal kinetic energy but heavy body consists of greater momentum.
Reason (R) Momentum is directly proportional to the mass of body.
(a) Both A and R are individually true and R is the correct explanation of A
(b) Both A and R are individually true, but R is not the correct explanation of A
(c) A is true, but R is false
(d) A is false, but R is true

56. The motion of the wheel of a cycle is
(a) rectilinear (b) translatory and rotatory
(c) rotatory (d) translatory

57. An object whose speed is constant
(a) must be accelerated (b) might be accelerated
(c) cannot be accelerated (d) has a constant velocity

58. Force can be defined on the basis of
(a) Newton's second law of motion
(b) Newton's first law of motion
(c) Newton's third law of motion
(d) Newton's law of gravitation

59. Which one of the following is a vector quantity?
(a) Force (b) Area
(c) Volume (d) Density

60. It is difficult to walk on ice than on road because
(a) ice is harder than road
(b) road is harder than ice
(c) ice does not offer any reaction when we push it with our foot
(d) ice has a lesser friction than road

61. The rate of change of momentum gives
(a) moment (b) acceleration
(c) force (d) impulse

62. A body at rest may possesses
(a) kinetic energy (b) momentum
(c) potential energy (c) None of these

63. Ball bearings are used in cycles and scooters to
(a) reduce the area of contact between the two surfaces
(b) increase frictional force between wheel and axle
(c) reduce frictional force between wheel and axle
(d) reduce frictional force between ground and vehicle

64. A solid sphere, a disc and a ring of the same mass and radius are allowed to roll down a frictionless, inclined plane simultaneously from the same height. In this context, which one of the following statements is correct?
(a) The disc reaches down first
(b) The ring reaches down first
(c) The sphere reaches down first
(d) All of them reach down simultaneously

65. Power of the moving body is stored in the form of
(a) work and time (b) force and distance
(c) force and velocity (d) distance and acceleration

66. A boy sitting on the topmost berth in the compartment of a train which is just going to stop on a railway station, drops an apple aiming at the open hand of his brother situated vertically below his hands at a distance of about 2m. The apple will fall
(a) precisely in the hand of his brother
(b) slightly away from the hand of his brother in the direction of motion of the train
(c) slightly away from the hand of his brother in the direction opposite to the direction of motion of the train
(d) None of the above

67. Newton's second law of motion connects
(a) momentum and acceleration
(b) change of momentum and velocity
(c) rate of change of momentum and external force
(d) rate of change of force and momentum

68. One horse power is equal to
(a) 746 W (b) 738 W
(c) 726 W (d) 764 W

69. An object of mass 2 kg is lifted vertically through a distance of 1.5 m. The work done in process is
(a) 29.4 J (b) 19.4 J
(c) 17.4 J (d) 20.4 J

70. Two bodies of equal mass are kept at a height of h and $3h$. Then, the ratio of gravitational potential energies is
(a) 1 : 9 (b) 3 : 1 (c) 1 : 3 (d) 1 : 1

71. Two bodies of equal mass move with the velocity of $2v$ and $3v$ respectively. Then, the ratio of their kinetic energies is
(a) 4 : 9 (b) 2 : 3 (c) 3 : 2 (d) 8 : 11

72. The length of a simple pendulum becomes four times the original length. If the initial time period of pendulum is T, then the new time period is
(a) T (b) $2T$ (c) $3T$ (d) $4T$

73. A body falls from rest. The velocity acquired by falling a distance $2h$ is
(a) $2\sqrt{gh}$ (b) $\sqrt{gh}$
(c) $\sqrt{2gh}$ (d) None of these

74. A body has a mass of 6 kg on the earth; when measured on the moon, its mass would be **(CDS 2011 II)**
(a) nearly 1 kg (b) less than 1 kg
(c) less than 6 kg (d) 6 kg

75. The cat can survive a fall from a height much more than human or any other animal. It is because the cat **(CDS 2011 II)**
(a) can immediately adjust itself to land on all four paws and bend the legs to absorb the impact of falling
(b) has elastic bones
(c) has thick and elastic skin
(d) also gets injury equally with other animals but has tremendous endurance, resistance and speedy recovery

76. A passenger in a moving train tosses a five rupee coin. If the coin falls behind him, then the train must be moving with a uniform **(CDS 2010 II)**
(a) acceleration (b) deceleration
(c) speed (d) velocity

77. If an object having mass of 1 kg is subjected to a force of 1 N, it moves with **(CDS 2010 II)**
(a) a speed of 1 m/s
(b) a speed of 1 km/s
(c) an acceleration of 10 m/s^2
(d) an acceleration of 1 m/s^2

78. A boy throws four stones of same shape, size and weight with equal speed at different initial angles with the horizontal line. If the angles are 15°, 30°, 45° and 60°, at which angle the stone will cover the maximum horizontally? **(CDS 2010 I)**
(a) 15° (b) 30°
(c) 45° (d) 60°

79. Fat can be separated from milk in a cream separation because of **(CDS 2009 II)**
(a) cohesive force (b) gravitational force
(c) centrifugal force (d) centripetal force

80. On which one of the following conservative laws, does a rocket work? **(CDS 2008 II)**
(a) Mass (b) Energy
(c) Linear momentum (d) Angular momentum

Answers

1. (c)	**2.** (c)	**3.** (d)	**4.** (c)	**5.** (c)	**6.** (b)	**7.** (a)	**8.** (b)	**9.** (a)	**10.** (b)
11. (a)	**12.** (a)	**13.** (b)	**14.** (c)	**15.** (d)	**16.** (c)	**17.** (d)	**18.** (b)	**19.** (a)	**20.** (a)
21. (c)	**22.** (a)	**23.** (c)	**24.** (a)	**25.** (b)	**26.** (c)	**27.** (d)	**28.** (c)	**29.** (b)	**30.** (a)
31. (b)	**32.** (d)	**33.** (a)	**34.** (a)	**35.** (a)	**36.** (b)	**37.** (d)	**38.** (b)	**39.** (c)	**40.** (d)
41. (a)	**42.** (a)	**43.** (b)	**44.** (d)	**45.** (b)	**46.** (b)	**47.** (c)	**48.** (d)	**49.** (d)	**50.** (c)
51. (a)	**52.** (d)	**53.** (a)	**54.** (d)	**55.** (a)	**56.** (b)	**57.** (b)	**58.** (b)	**59.** (a)	**60.** (d)
61. (c)	**62.** (c)	**63.** (c)	**64.** (c)	**65.** (c)	**66.** (b)	**67.** (c)	**68.** (a)	**69.** (a)	**70.** (c)
71. (a)	**72.** (b)	**73.** (a)	**74.** (d)	**75.** (a)	**76.** (a)	**77.** (d)	**78.** (c)	**79.** (c)	**80.** (c)