UNIT 1

LAWS OF MOTION

Important Points

- Mechanics is divided into statics and dynamics.
- Ability of a body to maintain its state of rest or motion is called Inertia.
- Moment of the couple is measured by the product of any one of the forces and the perpendicular distance between two forces.
- SI unit of force is newton (N). C.G.S unit is dyne.
- When a force Facts on a body for a period of time t, then the product of force and time is known as 'impulse'.
- The unit of weight is newton or kg f.
- The weight of a body is more at the poles than at the equatorial region.
- Mass of a body is defined as the quantity of matter contained in the object. Its SI unit is kilogram (kg).
- Apparent weight is the weight of the body acquired due to the action of gravity and other external forces on the body.

TEXT BOOK EVALUATION

I. Book Exercise – Choose the best answer

1. Inertia of a body depends on

a. weight of the object
b. acceleration due to gravity of the planet
c. mass of the object
d. Both a & b

Ans : (c) mass of the object

2. Impulse is equal to

a. rate of change of momentum
b. rate of force and time
c. change of momentum
d. rate of change of mass

Ans : (c) change of momentum

3. Newton's III law is applicable

a. for a body is at rest
b. for a body in motion
c. both a and b
d. only for bodies with equal masses

Ans : (c) both (a) & (b)

4. Plotting a graph for momentum on the X-axis and time on Y-axis. slope of momentum-time graph gives

a. Impulsive force
b. Acceleration
c. 1/Force
d. Rate of force

Ans : (c) 1/F)

5. In which of the following sport the turning of effect of force used

a. swimming
b. tennis
c. cycling
d. hockey

Ans : (c) cycling

6. The unit of 'g' is m s^{-2}. It can be also expressed as

a. cm s^{-1}
b. N kg^{-1}
c. N m^2 kg^{-1}
d. cm^2 s^{-2}

Ans : (b) N Kg^{-1}

7. One kilogram force equals to

a. 9.8 dyne
b. 9.8×10^4 N
c. 98×10^4 dyne
d. 980 dyne

Ans : (c) 98×10^4 dyne

8. The mass of a body is measured on planet Earth as M kg. When it is taken to a planet of radius half that of the Earth then its value will be _____ kg

a. 4 M b. 2M c. M/4 d. M

Ans : (c) M/4

9. If the Earth shrinks to 50% of its real radius its mass remaining the same, the weight of a body on the Earth will

a. decrease by 50% b. increase by 50% c. decrease by 25% d. increase by 300%

Ans : (c) decrease by 25%

10. To project the rockets whice of the following principle(s) is /are required?

a. Newton's third law of motion b. Newton's law of gravitation

c. law of conservation of linear momentum d. both a and c

Ans : (d) both (a) and (c)

II. Book Exercise – Fill in the blanks

1. To produce a displacement _____ is required. **Ans :** Force
2. Passengers lean forward when sudden brake is applied in a moving vehicle. This can be explained by _____ **Ans :** Inertia of motion
3. By convention, the clockwise moments are taken as _____ and the anticlockwise moments are taken as _____. **Ans :** Negative, Positive
4. _____ is used to change the speed of car. **Ans :** Gears
5. A man of mass 100 kg has a weight of _____ at the surface of the Earth. **Ans :** 980 N

III. Book Exercise – True or False (correct the statement if it is false)

1. The linear momentum of a system of particles is always conserved.

Ans : False. The linear momentum of a system of particles is always conserved only if no external force is applied.

2. Apparent weight of a person is always equal to his actual weight.

Ans : False. Apparent weight and actual weight is not equal during upward or downward motion.

3. Weight of a body is greater at the equator and less at the polar region.

Ans : False. Weight of a body is lesser at the equator and more at the polar region as $g \alpha \frac{1}{R^2}$.

4. Turning a nut with a spanner having a short handle is so easy than one with a long handle.

Ans : False. Moment of force in longer handle is easy than one with a short handle.

5. There is no gravity in the orbiting space station around the Earth. So the astronauts feel weightlessness.

Ans : False. Apparent weight is zero. They are in the state of weightlessness.

IV. Book Exercise – Match the following

	Column I		**Column II**
1.	**Newton's I law**	**(a)**	**propulsion of a rocket**
2.	**Newton's II law**	**(b)**	**stable equilibrium of a body**
3.	**Newton's III law**	**(c)**	**law of force**
4.	**Law of conservation of linear momentum**	**(d)**	**flying nature of bird**

Ans :

Column I		**Column II**	
1	Newton's I law	b	stable equilibrium of a body
2	Newton's II law	c	law of force
3	Newton's III law	d	flying nature of bird
4	Law of conservation of linear momentum	a	propulsion of a rocket

V. Book Exercise – Assertion and Reason

Mark the correct choice as

a) If both the assertion and the reason are true and the reason is the correct explanation of assertion.

b) If both the assertion and the reason are true, but the reason is not the correct explanation of the assertion.

c) Assertion is true, but the reason is false.

d) Assertion is false, but the reason is true.

1. Assertion: The sum of the clockwise moments is equal to the sum of the anticlockwise momen.

Reason: The principle of conservation of momentum is valid if the external force on the system is zero.

Ans : (b) both the assertion and the reason are true, but the reason is not the correct explanation of the assertion

2. Assertion: The value of 'g' decreases as height and depth increases from the surface of the Earth.

Reason: 'g' depends on the mass of the object and the Earth.

Ans : (c) Assertion is true, but the reason is false

VI. Book Exercise – Answer briefly

1. Define inertia. Give its classification.

The inherent property of a body to resist any change in its state of rest (or) the state of uniform motion, unless it is influenced upon by an external unbalanced force is known as Inertia.

Types of Inertia :

- Inertia of rest.
- Inertia of motion.
- Inertia of direction.

2. Classify the types of force based on their application.

The 2 types of forces are,

- Like parallel forces.
- Unlike parallel forces.

3. If a 5 N and a 15 N forces are acting opposite to one another. Find the resultant force and the direction of action of the resultant force.

Resultant Force $= F_2 - F_1$

$= 15N - 5N$

$= 10N.$

4. Differentiate mass and weight.

S.No.	Mass	Weight
1	Fundamental quantity	Derived quantity
2	It is the amount of matter contained in a body	It is the gravitational pull acting on the body
3	It's unit is kilogram	It is measured in newton
4	Remains the same	Varies from place to place
5	It is measured using physical balance	It is measured using spring balance

5. Define moment of a couple.

The line of action of the two forces does not coincide. It does not produce any translatory motion since the resultant is zero. But a couple results in causes the rotation of the body. Rotating effect of a couple is known as moment of a couple.

Moment of couple $= F \times S$

$M = F \times S.$ (S I Unit is Nm)

6. State the principle of moments.

When a number of like or unlike parallel forces act on a rigid body and the body is in equilibrium, then the algeberic sum of the moments in the clockwise direction is equal to the algebraic sum of the moments in the anticlockwise direction.

7. State Newton's second law.

The force acting on a body is directly proportional to the rate of change of linear momentum of the body and the change in momentum takes place in the direction of the force.

8. Why a spanner with a long handle is preferred to tighten screws in heavy vehicles?

The turning effect of a force is called moment of force.

$$\text{Moment of Force} = \text{Force} \times \text{Perpendicular distance}$$
$$= F \times d$$

For the spanner with a long handle, 'd' is large. Therefore the moment of force is also large and hence it is easier to rotate the object (nut).

9. While catching a cricket ball the fielder lowers his hands backwards. Why?

In cricket, a fielder pulls back his hands while catching the ball. He experiences a smaller force for a longer interval of time to catch the ball, resulting in a lesser impulse on his hands.

10. How does an astronaut float in a space shuttle?

On the astronaut there is no external force on him due to planet or space ship. By the first law of motion the acceleration on him is zero. So he floats.

VII. Book Exercise – Solve the given problems

1. Two bodies have a mass ratio of 3:4 The force applied on the bigger mass produces an acceleration of 12 ms^{-2}.What could be the acceleration of the other body, if the same force acts on it.

Let mass of the body A = 3 m

Mass of the body B = 4 m

Force applied = F

For body A

$$F = \text{mass} \times \text{acceleration}$$
$$F = 3m \times 12\ ms^{-1}$$
$$F = 36\ N.$$

For body B

$$F = \text{mass} \times \text{acceleration}$$
$$\text{Acceleration} = \frac{\text{Force}}{\text{Mass}}$$
$$= \frac{36\,N}{4m}$$
$$= 9\ ms^{2}.$$

2. A ball of mass 1 kg moving with a speed of 10 ms^{-1} rebounds after a perfect elastic collision with the floor. Calculate the change in linear momentum of the ball.

Mass of the ball = 1 kg

Initial speed = 10 ms^{-1}

Final speed = $-10ms^{-1}$ (rebounds)

Change in momentum

$$\Delta P = mV - mu$$
$$\Delta P = 1 \times (-10) - 1 \times 10$$
$$= -10 - 10$$
$$\Delta P = -20\ kg\ m/s.$$

3. A mechanic unscrew a nut by applying a force of 140 N with a spanner of length 40 cm. What should be the length of the spanner if a force of 40 N is applied to unscrew the same nut?

Equating the torque in both the cases.

$$F_1 l_1 = F_2 l_2$$
$$140N \times 40cm = l_2 \times 40N$$
$$l_2 = \frac{140\,N \times 40\,cm}{40\,N}$$
$$l_2 = 140 \text{ cm.}$$
$$l_2 = 1.4 \text{ m.}$$

4. The ratio of masses of two planets is 2:3 and the ratio of their radii is 4:7 Find the ratio of their accelerations due to gravity.

$$g_1 = \frac{GM_1}{R_1^2}$$
$$g_2 = \frac{GM_2}{R_2^2}$$
$$M_1 : M_2 = 2 : 3$$
$$R_1 : R_2 = 4 : 7$$
$$\frac{g_1}{g_2} = \frac{\cancel{G}M_1}{R_1^2} \times \frac{R_2^2}{\cancel{G}M_2}$$
$$= \frac{M_1}{R_1^2} \times \frac{R_2^2}{M_2}$$
$$= \frac{2}{(4)^2} \times \frac{(7)^2}{3}$$
$$= \frac{2}{16} \times \frac{49}{3}$$
$$= \frac{98}{48}$$
$$\frac{g_1}{g_2} = \frac{49}{24}.$$

VIII. Book Exercise – Answer in detail

1. What are the types of inertia? Give an example for each type.

There are 3 types of Inertia. They are;

- **Inertia at rest :** The resistance of a body to change its state of rest is called inertia of rest.
  Example : When you vigorously shake the branches of a tree, some of the leaves and fruits are detached and they fall down (Inertia of rest).
- **Inertia of motion :** The resistance of a body to change its state of motion is called inertia of motion.
  Example : An athlete runs some distance before jumping because this will help him jump longer and higher.
- **Inertia of direction :** The resistance of a body to change its direction of motion is called inertia of direction.
  Example : When a bus turn towards right, the passangers are thrown towards left.

2. State Newton's laws of motion?

Newton's First Law : This law states that everybody continues to be in its state of rest (or) the state of

uniform motion along a straight line unless it is acted upon by some external force.

Newton's Second Law : According to this law, the force acting on a body is directly proportional to the rate of change of linear momentum of the body and the change in momentum takes place in the direction of the force.

Newton's Third Law : Newton's third law states that for every action, there is an equal and opposite reaction. They always act on two different bodies.

3. Deduce the equation of a force using Newton's second law of motion.

This law helps us to measure the amount of force. So it is also called as "law of force". Let 'm' be the mass of a moving body, moving along a straight line with an initial speed 'u' after a time interval of 't', the velocity of the body changes to 'v' due to the impact of an unbalanced external force 'F'.

Initial momentum of the body $P_i = mu$

Final momentum of the body $P_f = mv$

Change in momentum $P = P_f - P_i$

$= mv - mu$

By Newton's second law of motion,

Force, F α rate of change of momentum.

F α change in momentum / time.

$$F \alpha \frac{mv - mu}{t}$$

$$F = K \frac{m(v-u)}{t}$$

Here K is the proportionality constant. K=1 in all systems of units. Hence,

$$F = \frac{m(v-u)}{t}$$

$$\text{since acceleration} = \frac{\text{change in velocity}}{\text{time}}$$

$$a = \frac{(v-u)}{t}$$

Hence we have

$$F = m \times a$$

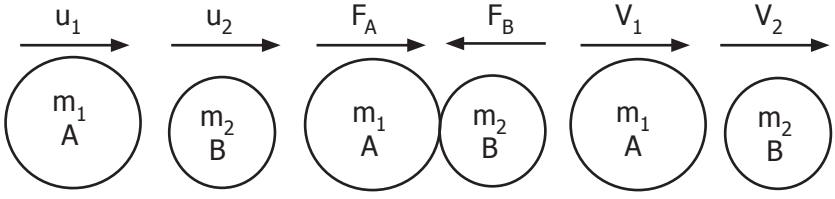
$$\text{Force} = \text{mass} \times \text{acceleration}$$

No external force is required to maintain the motion of a body moving with uniform velocity. When the net force acting on a body is not equal to zero, then definitely the velocity of the body will change.

4. State and prove the law of conservation of linear momentum.

There is no change in the linear momentum of a system of bodies as long as no net external force acts on them.

Let us prove the law of conservation of linear momentum with the following illustration.



Proof : Let two bodies A and B having masses m_1 and m_2 move with initial velocity u_1 and u_2 in a straight line. Let the velocity of the first body be higher than that of the second body. i.e., $u_1 > u_2$. During an interval of time 't' second, they tend to have a colliusion. After the impact, both them move along the same straight line with a velocity V_1 and V_2 respectively.

Force on body B due to A

$$F_B = \frac{m_2(v_2-u_2)}{t}$$

Force on body A due to B

$$F_A = \frac{m_1(v_1 - u_1)}{t}$$

By Newton's III law of motion,

$$\text{Action Force} = \text{Reaction Force}$$

$$F_A = -F_B$$

$$\frac{m_1(v_1 - u_1)}{t} = -\frac{m_2(v_2 - u_2)}{t}$$

$$m_1 V_1 + m_2 V_2 = m_1 u_1 + m_2 u_2$$

The above equation confirms in the absence of an external force, the algebraic sum of momentum after collision is numerically equal to the algebraic sum of the momentum before collision.

Hence the law of conservation of linear momentum is proved.

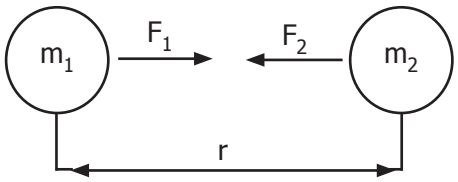
5. Describe rocket propulsion.

- Propulsion of rockets is based on the law of conservation of linear momentum as well as Newton's III law of motion.
- Rockets are filled with a fuel in the propellant tank.
- When the rocket is fired, this fuel is burnt and a hot gas is ejected with a high speed from the nozzle of the rocket, producing a huge momentum.
- To balance this momentum, an equal and opposite reaction force is produced in the combustion chamber, which makes the rocket project forward.
- While in motion, the mass of the rocket gradually decreases, until the fuel is completely burnt out.
- Since, there is no net external force acting on it, the linear momentum of the system is conserved.
- The mass of the rocket decreases with altitude, which results in the gradual increase in velocity of the rocket.
- At one stage, it reaches a velocity, which is sufficient to just escape from the gravitational pull of the Earth. This velocity is called escape velocity.

6. State the universal law of gravitation and derive its mathematical expression.

This law states that every particle of matter in this universe attracts every other particle with a force. This force is directly proportional to the product of their masses and inversely proportional to the square of the distance between the centers of these masses. The direction of the force acts along the line joining the masses.

Force between the masses is always attractive and it does not depend on the medium where they are placed.



Let, m_1 and m_2 be the masses of two bodies A and B placed r metre apart in space

Force $F \alpha m_1 \times m_2$

$$F \alpha \frac{1}{r^2}$$

On combining the above two expressions

$$F \alpha \frac{m_1 \times m_2}{r^2}$$

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

Where G is the universal gravitational constant. Its value in SI unit is 6.674×10^{-11} N m^2 kg^{-2}.

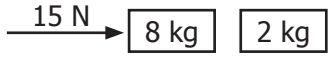
7. Give the applications of universal law gravitation.

- Dimensions of the heavenly bodies can be measured using the gravitation law. Mass of the Earth, radius of the Earth, acceleration due to gravity, etc. can be calculated with a higher accuracy.
- It helps in discovering new stars and planets.
- One of the irregularities in the motion of stars is called 'Wobble' lead to the disturbance in the motion of a planet nearby. In this condition the mass of the star can be calculated using the law of gravitation.
- Helps to explain germination of roots is due to the property of geotropism which is the property of a root responding to the gravity.
- Helps to predict the path of the astronomical bodies.

IX. Book Exercise – HOT question

1. Two blocks of masses 8 kg and 2 kg respectively lie on a smooth horizontal surface in contact with one other. They are pushed by a horizontally applied force of 15 N. Calculate the force exerted on the 2 kg mass.

Solution : If 2 blocks are of mass 8 kg and 2 kg



Data

m_1 = 8 kg
m_2 = 2 kg
m_T = Total mass
= 8+2
= 10kg

$$F = m_T \times a$$

$$15 = (8 + 2) \times a$$

$$15 = 10 \times a$$

$$a = \frac{15\,N}{10\,kg} = \frac{3}{2}\ ms^{-1}$$

Force exerted by block 2 (2 kg)

$$\text{So } F = m \times a$$

$$= 2 \times \frac{3}{2}$$

Exerted Force = 3 N.

2. A heavy truck and bike are moving with the same kinetic energy. If the mass of the truck is four times that of the bike, then calculate the ratio of their momenta. (Ratio of momenta = 1:2)

Solution : According to kinetic energy,

Since K.E are equal

$$\frac{1}{2} m_1 v_1^2 = \frac{1}{2} m_2 v_2^2$$

$$\frac{m_1}{m_2} = \frac{v_2^2}{v_1^2}$$

$$\frac{4m_1}{m_2} = \frac{v_2^2}{v_1^2}$$

$$\frac{v_2}{v_1} = 2$$

Data

m_1 = Truck mass
m_2 = Bike mass
v_1 = Truck velocity
v_2 = Bike velocity
Given K.E are equal
$m_1 = 4m_2$
ratio of momentum = ?

$$\text{Ratio of momentum} = \frac{m_1 v_1}{m_2 v_2}$$

$$= \frac{4m_2 v_1}{m_2 v_2}$$

$$= 4 \text{ X } \frac{1}{2} = \frac{2}{1}$$

Ratio of momentum = 2:1

3. "Wearing helmet and fastening the seat belt is highly recommended for safe journey" Justify your answer using Newton's laws of motion.

Explanation :

1. **Wearing a helmet** is strongly recommended for safe journy, because when a person fall from bike he exerts a force equal to product of mass of the persion and acceleration of the bike (Newton's II law). According to Newton's III law, inturn the ground offers and equal and opposite force on the persion, which will porduce large damage. In order to mimnse damages the persion must wear helmet.

2. **Fastening of seat belt** will not allow a persion to meve from seat why the vechicle comes to rest suddengly by applying brake or by having some accidents.

This is deu to inertia of motion. (Newton's I law). When the speeding vechicle stops suddently the lower part in contact with the seat stops while the upperr patr of the body tends to maintain its uniform motion. Hence the persion will trun forward and obtain injuries. Inorder to avoid this, fastening of seat belt is important.

Additional – Choose the best answer

1. Rest and motion are _____.

a) Interrelated b) Independent c) either dependent or independent d) neither dependent nor independent

Ans : (a) Interrelated

2. Force is called as _____.

a) pull b) push c) pull or push d) none of these

Ans : (c) pull or push

3. Who formulated the theory of laws of motion?

a) Newton b) Galileo c) Aristotle d) Thales

Ans : (a) Newton

4. _____ is the branch of physics that deals with the effort of force on bodies.

a) Mechanics b) Statics c) Dynamics d) kinematice

Ans : (a) Mechanics

5. _____ deals with the bodies, which are at rest under the action of forces.

a). Mechanics b) Statics c) Dynamics d) Kinetics

Ans : (b) Statics

6. _____ is the study of moving bodies under the action of forces.

a) Mechanics b) Statics c) Dynamics d) Kinetics

Ans : (c) Dynamics

7. _____ deals with the motion of bodies without considering the cause of motion.

a) Dynamics b) Kinematics c) Kinetics d) statics

Ans : (b) Kinematics

8. _____ deals with the motion of bodies considering the cause of motion.

a) Dynamics b) Kinematics c) Kinetics d) statics

Ans : (c) Kinetics

9. Force independent is called _____ motion.

a) Natural b) Violent c) radial d) circular

Ans : (a) Natural

10. Force dependent is called _____ motion.

a) Natural b) Violent c) radial d) circular

Ans : (b) Viokent

11. The product of mass and velocity is known as _____.

a) Impulse b). Linear momentum c) Resultant force d) None

Ans : (b) Linear momentum

12. _____ helps to measure the magnitutde of a force.

a) Impulse b) Linear momentum c) Resultant force d) None

Ans : (b) Linear momentum

13. Unit of momentum is SI system is _____.

a) Kg ms^{-2} b) Kg ms^{-1} c) Kg ms d) Kg^2ms^{-2}

Ans : (b) Kg ms^{-1}

14. Unit of momentum in CGS system is _____.

a) g cms^{-2} b) g cms^{-1} c) g^2 cms^{-2} d) g cm^2s^{-1}

Ans : (b) g cms^{-1}

15. Force is _____ quantity.

a) Vector b) Scalar c) both d) Tensor

Ans : (a) Vector

16. Force has _____.

a) magnitude b. direction c) both d) none

Ans : (c) both

17. Based on the direction, Force can be classified into _____ types.

a) 3 b) 4 c) 2 d) none

Ans : (c) 2

18. _____ is equal to the vector sum of all the forces.

a) Resultant force b) Imulse c) Torque d) moment of force

Ans : (a) Resultant force

19. Parallel forces acting in the same direction, the resultant force is _____.

a) $F_{net} = F_1 - F_2$ b) $F_{net} = F_1 + F_2$ c) $F_{net} = F_2 - F_1$ d) $F_{net} = F_2 + F_1$

Ans : (b) $F_{net} = F_1 + F_2$

20. An example of unlike parallel force is _____.

a) Tug of war b) Action of lever c) pulling a cart d) both a and c

Ans : (a) Tug of war

21. An example of unbalanced force is _____.

a) Tug of war b) Action of lever c) pulling a cart d) both a and c

Ans : (b) Action of lever

22. The axisof the fixed edge about which the door is rotated is called as the _____.

a) axis of rotation b) point of rotation c) moment of force d) both a and c

Ans : (d) both a and c

23. The rod will be turned about the fixed point is called as _____.

a) axis of rotation b) point of rotation c) moment of force d) both b and c

Ans : (d) both b and c

24. _____ is measured by the product of the force and the perpendicular distance.

a) Couple b) Torque c) force d) none

Ans : (b) Torque

25. Torque is a _____ quantity.

a) vector b) scalar c) tensor d) either scalar or vector

Ans : (a) vector

26. SI unit of Torque is _____.

a) Nm b) Kgs^{-1} c) gs^{-1} d) Nm^{-1}

Ans : (a) Nm

27. Turning a tap is an example of _____.

a) Moment of couple b) Couple c) Torque d) both a and c

Ans : (d) both a and c

28. _____ is the measured by the product of the force and perpendicular distance between the line of action of forces.

a) Couple b) Moment of couple c) torque d) both a and b

Ans : (d) both a and c

29. The unit of moment of couple is _____.

a) Newton b) Newton metre c) Metre d) Newton / metre

Ans : (b) Newton metre

30. The unit of moment couple in CGS system is _____.

a) dyne cm^2 b) dyne cm c) dyne cm^3 d) dyne $/cm^2$

Ans : (b) dyne cm

31. In seasaw, when the heavier person comes closer to the pivot point the distance of the line of action of the force _____.

a) Increases b) Decreases c) None d) both a and b

Ans : (b) Decreases

32. _____ the algebraic sum of moments in the clockwise direction is equal to the algebraic sum of the moments in the anticlockwise direction.

a) Moment b) Principle of moment c) action of points d) center of mass

Ans : (b) Principle of moment

33. Force = mass x _____.

a) distance b) accelertion c) velocity d) displacement

Ans : (b) acceleration

34. The acceleration is produced along the radius called as _____.

a) centripetal acceleration b) acceleration c) radial acceleration d) both a and c

Ans : (d) both a and c

35. SI unit of Force is _____.

a) Newton b) dyne c) kg ms^{-2} d) kg ms

Ans : (a) Newton

36. CGS unit of Force is _____.

a) Newton b) dyne c) gms^{-2} d) gms

Ans : (b) dyne

37. One Newton is equal to _____.

a) 1 kg ms^{-1} b) 1 kg ms^{-2} c) 1 gms^{-2} d) 1 gms

Ans : (b) 1 kg ms^{-2}

38. One dyne is equal to _____.

a) 1 g cm^{-2} b) 1 g ms^{-1} c) 1 kg ms^{-1} d) 1 kg ms^{-2}

Ans : (a) 1 g cm^{-2}

39. 1 Newton = _____ dyne.

a) 10^3 b) 10^5 c) 10^6 d) 10^4

Ans : (b) 10^5

40. A large force acting for a verys hort interval of time is called as _____.

a) Impulsive force b) Resultant Force c) force d) none

Ans : (a) Impulsive force

41. Unit of Impulsive Force is _____.

a) Kg ms^{-2} b) NS c) both (a and b) d) none

Ans : (c) both a and b

42. G is the _____.

a) Gas constant b) Universal gravitational constant c) force constant d) spring constant

Ans : (b) Universal gravitational constant

43. Value of G is _____.

a) 6.674×10^{-10} N m^2 kg^{-2} b) 6.674×10^{-9} N m^2 kg^{-2}

c) 6.674×10^{-11} N m^2 kg^{-2} d) 6.674×10^{-11} N m^2 kg^2

Ans : (c) 6.674×10^{-11} N m^2 kg^{-2}

44. Radius of the Earth R value is _____.

a) 6388 km b) 6478 km c) 6378 km d) 6578 km

Ans : (c) 6378 km

45. $g = GM/R^2$ is the _____.

a) Acceleration due to radius of the Earth b) Acceleration due to Gravity

c) Acceleration due to Moon d) Acceleration due to any planet

Ans : (b) Acceleration due to Gravity

46. Mass of the Earth is

a) $M = 5.729 \times 10^{24}$ kg b) $M = 5.729 \times 10^{22}$ kg

c) $M = 5.972 \times 10^{24}$ kg d) $M = 5.972 \times 10^{23}$ kg

Ans : (c) 5.972×10^{24} kg

47. Value of g depends on.

a) volume of earth b) mass of earth c) geometric centre of earth d) none

Ans : (c) geometric centre of earth

48. Value of g is _____ at the centre of the Earth.

a) 1 b) zero c) (a) and (b) d) none

Ans : (b) zero

49. The value of acceleration due to gravity on the surface of the Moon is _____.

a) 1.256×10^2 ms^{-2} b) 1.625 ms^{-2} c) 1.276 ms^{-2} d) 1276

Ans : (b) 1.625 ms^{-2}

50. If a person whose mass is 60 kg stands on the surface of Earth, his weight would be _____.

a) 688 N b) 588 N c) 690 N d) 780 N

Ans : (b) 588 N

51. If a same person whose mass is 60 kg stands on the surface of Moon, his weight would be _____ N.

a) 98.5 N b) 97.5 N c)985 N d) 975 N

Ans : (b) 97.5 N

52. Lift is moving upward with an acceleration, apparent weight is _____.

a) greater b) lesser c) zero d) none

Ans : (a) greater

53. Lift is moving downward with an acceleration apparent weight is _____ than the actual weight.

a) greater b) lesser c) zero d) none

Ans : (b) lesser

54. Lift is at rest, apparent weight is _____.

a) greater b) lesser c) equal d) either a or b

Ans : (c) equal

55. Lift is falling down freely, apparent weight is equal to _____.

a) greater b) lesser c) zero d) either a or b

Ans : (c) zero

56. When a = g, this motion is called as _____.

a) free fall b) resiessive fall c) both a and b d) neither a nor b

ns : (a) free fall

57. In free fall condition R = _____.

a) m (g + a) b) R < W c) R = W d) R = O

Ans : (d) R = O

58. _____ helps to predict the path of the astronomical bodies.

a) Newton's law of gravitation b) Acceleration c) velocity d) orbital speed

Ans : (a) Newton's law of gravitation

59. _____ helps to explain germination of roots is due to the property of geotropism.

a) Newton's law of gravitation b) Acceleration c) velocity d) rotational speed

Ans : (a) Newton's law of gravitation

60. The mass of the star can be calculated using the law of _____.

a). Gravitation b) Inertia c) motion d) non

Ans : (a) Gravitation

Additional – Fill in the blanks

1. Some bodies are at _____ and some are in _____. **Ans:** Rest, Motion
2. _____ and _____ are interrelated terms. **Ans:** Rest, Motion
3. _____ or _____ is called as Force. **Ans:** pull, push
4. _____ proposed the laws of three motion. **Ans:** Sir Isaac Newton
5. Direction of motion is due to _____. **Ans:** Force
6. _____ is the branch of physics that deals with the effect of force on bodies. **Ans:** Mechanics
7. Mechanics is divided into _____ branches. **Ans:** 2
8. Mechanics is divided into _____ and _____. **Ans:** Statics, dynamics
9. _____ deals with the bodies, which are at rest under the action of forces. **Ans:** Statics
10. _____ is the study of moving bodies under the action of forces. **Ans:** Dynamics
11. Dynamics is further classified into _____ and _____. **Ans:** Kinematics, Kinetics
12. _____ deals with the motion of bodies without considering the cause of motion. **Ans:** kinematics
13. _____ deals with the motion of bodies considering the cause of motion. **Ans:** Kinetics
14. _____ is a Greek philosopher and scientist who stated that the natural state of earthly bodies is rest. **Ans:** Aristotle
15. A moving body naturally comes to rest without any external influence of the force. Such motions are termed as _____. **Ans:** Natural motion
16. Natural motion is a force _____. **Ans:** Independent
17. A force is needed to make the bodies to move from their natural state and behave contrary to their own natural state called as _____. **Ans:** Violent motion
18. Violent motion is a force _____. **Ans:** Dependent

19. When two different bodies are dropped from height, in earth's atmosphere, the heavier body falls _____ than the lighter one. **Ans:** Faster
20. _____ proposed the concepts of force , motion and inertia of bodies. **Ans:** Galileo
21. A body in motion will continue to be in the _____ state of motion as long as no external force is applied. **Ans:** Same
22. When a force is applied on bodies, they resist any change in their state. This property of bodies is called _____. **Ans:** inertia
23. The coin falls into tumbler due to gravity. This happen due to _____. **Ans:** Inertia
24. The resistance of a body to change its state of rest is called _____. **Ans:** Inertia of rest
25. The resistance of a body change its state of motion is called _____. **Ans:** Inertia of motion
26. The resistance of a body change its direction of motion is called _____. **Ans:** Inertia of direction
27. An athlete runs some distance before jumping. Because this will help him jump longer and higher. This is an example of _____. **Ans:** Inertia of motion.
28. When you make a sharp turn while driving a car, you tend to lean sideways. It is an example of _____. **Ans:** Inertia of direction
29. When you vigorously shake the branches of a tree, some of the leaves and fruits are detached and they fall down. It is an example of _____. **Ans:** Inertia of rest.
30. The impact of a force is more if the velocity and the mass of the body is _____. **Ans:** More
31. The _____ measures the impact of a force on a body. **Ans:** linear momentum.
32. The product of mass and velocity of a moving body gives the magnitude of _____.

    Ans: Linear momentum
33. _____ acts in the direction of the velocity of the object. **Ans:** Linear momentum
34. _____ is a vector quantity. **Ans:** linear momentum
35. Linear momentum = _____. **Ans:** Mass × velocity
36. _____ helps to measure the magnitude of a force. **Ans:** Linear momentum
37. Unit of momentum in SI system is _____. **Ans:** Kg m S^{-1}
38. Unit of momentum in CGS system is _____. **Ans:** g cm s^{-1}
39. _____ law states that everybody continues to be in its state of rest or the state of uniform motion along a straight line unless it is acted upon by some external force. **Ans:** Newton's first
40. _____ gives the definition of force as well as inertia. **Ans:** Newton's first law
41. _____ is an external effort in the form of push or pull. **Ans:** Force
42. _____ produces or tries to produce the motion of a static body. **Ans:** Force
43. _____ stops or tries to stop a moving body. **Ans:** Force
44. _____ changes or tries to change the direction of motion of a moving body. **Ans:** Force
45. Force has both _____ and _____. **Ans:** Magnitude, direction
46. Force is a _____ quantity. **Ans:** vector
47. Parallel forces can be classified into _____ and _____forces.

    Ans: like parallel , unlike parallel
48. Two or more forces of equal or unequal magnitude acting along the same direction, parallel to each other are called_____. **Ans:** like parallel forces.
49. If Two or more forces of equal or unequal magnitude acting along the opposite direction, parallel to each other, then they are called _____. **Ans:** Unlike parallel forces.

50. _____ is adding the magnitude of the forces with their direction. **Ans:** Resultant force.
51. _____ is equal to the vector sum of all the forces. **Ans:** Resultant force
52. Line of action of forces which are acting in the same direction is _____ . **Ans:** like parallel forces
53. In like parallel forces, resultant force F_{net} = _____. **Ans:** $F_1 + F_2$
54. Line of action of forces which are acting in the opposite direction _____. **Ans:** unlike parallel forces
55. _____ are acting in opposite directions in the same line of action. **Ans:** parallel equal forces
56. _____ is an example of Unlike parallel forces. **Ans:** Tug of war.
57. _____ is an example of Unbalanced forces. **Ans:** Action of lever
58. The axis of the fixed edge about which the door is rotated is called as the _____.
Ans: Axis of rotation.
59. The rod will be turned about the fixed point is called as _____. **Ans:** point of rotation.
60. The rotating or turning effect of a force about a fixed point or fixed axis is called _____.
Ans: Moment of the force or torque
61. _____ is measured by the product of the force (F) and the perpendicular distance (d) between the fixed point or the fixed axis and the line of action of the force. **Ans:** Torque
62. Torque = _____. **Ans:** Force × Distance
63. Torque is a _____ quantity. **Ans:** Vector
64. SI unit of torque is _____. **Ans:** Nm
65. Two equal and unlike parallel forces applied simultaneously at two distinct points constitute a _____.
Ans: Couple
66. Rotating effect of a couple is known as _____. **Ans:** Moment of a couple or torque
67. Turning a tap is an example of _____. **Ans:** Moment of a couple or torque
68. Spinning of top is an example of _____. **Ans:** Moment of a couple
69. Moment of a couple = _____.
Ans: Force × perpendicular distance between the line of action of forces
70. M = _____. **Ans:** F × S
71. The SI unit of moment of a couple is _____. **Ans:** Newton metre.
72. The CGS unit of moment of a couple is _____. **Ans:** dyne cm
73. A small steering wheel enables you to monoeuore a car easily by transferring a torque to the wheels with _____ effort. **Ans:** less
74. A _____ is a circular wheel with teeth around its rim. **Ans:** Gear
75. _____ helps to change the speed of rotation of a wheel by changing the torque and helps to transit power. **Ans:** Gear
76. Principle of moments _____.**Ans :** Moment in clockwise direction = Moment in anticlockwise direction.
77. According to principle of moments _____. **Ans:** $F_1 \times d_1 = F_2 \times d_2$
78. _____ law helps us to measure the amount of force. **Ans:** Newton's second
79. Newton's law is also called as _____. **Ans:** Law of force
80. Change in momentum ΔP = _____. **Ans:** mv-mu
81. Force is _____ proportional to the rate of change of momentum. **Ans:** directly
82. Change in momentum takes place in the _____. **Ans:** direction of force

83. The change may takes place either in _____ or in _____ or in _____.
Ans: Magnitude, direction, both

84. _____ is required to produce the acceleration of the body. **Ans:** Force

85. In a _____ circular motion the speed remains constant. **Ans:** Uniform

86. The acceleration is produced along the radius called as _____ acceleration. **Ans:** centripetal or radial

87. The force, which produces radial acceleration is called as _____ force. **Ans:** Centripetal

88. SI unit of force is _____. **Ans:** Newton

89. In CGS system, the unit of force is _____. **Ans:** Dyne

90. _____ is defined as the amount of force required for a body of mass 1Kg produces an acceleration of 1m s^{-2}. **Ans:** 1 newton

91. 1 Newton is _____. **Ans:** 1 kg ms^{-2}

92. _____ is defined as the amount of force required for a body of mass 1gram produces an acceleration of 1cm s^{-2}. **Ans:** 1 dyne

93. 1 dyne is _____. **Ans:** 1g cm s^{-2}

94. 1 newton = _____ dyne. **Ans:** 10^5

95. The amount of force required to produce an acceleration of 1ms^{-2} in a body of mass 1kg is called _____. **Ans:** Unit force

96. In the SI system of units, gravitational unit of force is _____. **Ans:** Kg f

97. In the CGS system gravitational unit is _____. **Ans:** g f

98. 1kg f = _____. **Ans:** 1 kg × 9.8 ms^{-2} = 9.8 N

99. 1 gf = _____ **Ans:** 1g × 980cm^{-2} = 980 dyne

100. A large force acting for a very short interval of time is called as _____. **Ans:** Impulsive force

101. Impulse is _____. **Ans:** $J = F \times t$

102. Impulse is equal to the _____. **Ans:** Magnitude of change in momentum

103. The unit of Impulse is _____. **Ans:** $kgms^{-1}$ or Ns

104. A _____ acting for a _____is impulse. **Ans:** large force, short time

105. A _____ acting for a _____is impulse. **Ans:** smaller force, longer time

106. Automobiles are fitted with _____ and _____ to reduce jerks while moving on uneven roads.
Ans: springs, Shock absorbers

107. In cricket, a fielder _____ his hands while catching the ball. **Ans:** pulls back or lowers

108. _____ law states that for every action, there is an equal and opposite reaction. They always act on two different bodies. **Ans:** Newton's third

109. While in motion, the mass of the rocket gradually _____ until the fuel is completely burn out.
Ans: decreases

110. _____ is based on the law of conservation of linear momentum as well as Newton's III law of motion.
Ans: Propulsion of rockets

111. The symbol for the Universal gravitational constant is _____. **Ans:** G

112. SI unit of G is _____. **Ans:** Nm^2kg^{-2}

113. The value of G is _____. **Ans:** 6.674×10^{-11}

114. Acceleration due to gravity of the earth is denoted as _____. **Ans:** g

115. The SI unit of g is _____. **Ans:** ms^{-2}

116. Mean value of the acceleration due to gravity is taken as _____ ms^{-2}. **Ans:** 9.8

117. The value of g is not the _____ at all points on the surface of the earth. **Ans:** Same

118. The radius of the Earth R is _____. **Ans:** 6378km

119. According to Newton universal law F = _____. **Ans:** GMm/R^2

120. According to Newton universal law g = _____. **Ans:** GM / R^2

121. Mass of the Earth M = _____. **Ans:** $g R^2 / G$

122. Value of Mass of the Earth M = _____. **Ans:** 5.972×10^{24} Kg

123. _____ of a body is defined as the quantity of matter contained in a body. **Ans:** mass

124. SI unit of mass is _____. **Ans:** Kilogram

125. _____ of a body is defined as the gravitational force exerted on it due to the Earth's gravity alone. **Ans:** Weight

126. Weight is a _____ quantity. **Ans:** Vector

127. Direction of weight is always towards the _____ of the earth. **Ans:** Centre

128. SI unit of weight is _____. **Ans:** Newton

129. The value of acceleration due to gravity on the surface of the moon is _____. **Ans:** 1.625 ms^{-2}

130. Value of g is _____ at the centre of the Earth. **Ans:** Zero

131. _____ is the weight of the body acquired due to the action of gravity and other external forces acting on the body. **Ans:** Apparent weight

132. When the person is a lift moves down with an acceleration or equal to the acceleration due to gravity ie a = g. This motion is called _____. **Ans:** free fall

133. The force which keeps the satellite in orbit is _____. **Ans:** Centripetal force

134. Both the astronauts and the space station are in the state of _____. **Ans:** weightlessness

135. _____ helps in discovering new stars and planets. **Ans:** Newton's law of gravitation

136. One of the irregularities in the motion of stars is called _____. **Ans:** Wobble

137. _____ lead to the disturbance in the motion of a planet nearby. **Ans:** wobble

138. _____ helps to explain germination of roots is due to the property of geotropism which is the property of a root responding to the gravity. **Ans:** Newton's law of gravitation

139. _____ helps to predict the path of the astronomical bodies. **Ans:** Newton's law of Gravitation.

Additional – Say true or false

1. **Rest and motion are not related terms.**
   Ans: False.
   Correct Statement : Rest and motion are interrelated terms.

2. **Natural motion is a force dependent**
   Ans: False.
   Correct Statement : Natural motion is a force independent.

3. **Violent motion is a force dependent.**
   Ans: True.

4. **If the resultant force of all the forces acting on a body is equal to zero, then the body will be in equilibrium. Such forces are called Unbalanced forces.**
   Ans: False. **Correct Statement :** If the resultant force of all the forces acting on a body is equal to zero, then the body will be in equilibrium. Such forces are called balanced forces.

5. If a person whose mass is 60kg stands on the surface of the Earth, his weight would be 500 N.
Ans: False.
Correct Statement : If a person whose mass is 60kg stands on the surface of the Earth, his weight would be 588 N (W = mg = 60 × 9.8 = 588 N).

Additional – Correct the mistakes:

1. Kinematics deals with the motion of bodies considering the cause of motion.
Ans: Kinetics deals with the motion of bodies considering the cause of motion.

2. Inertia of rest is the resistance of a body to change its state of motion.
Ans: Inertia of motion is the resistance of a body to change its state of motion.

3. Linear momentum is a scalar quantity.
Ans: Linear momentum is a Vector quantity.

4. 1 N = 10^3 dyne.
Ans: 1 N = 10^5 dyne.

5. Geometric radius of the Earth is Minimum in the polar region, the value of g is maximum.
Ans: Geometric radius of the Earth is Maximum in the polar region, the value of g is minimum.

Additional – Match the following

1.

	Terms	SI Unit	CGS Unit
i)	Linear Momentum	Kgms–1	dyne cm
ii)	Moment of couple	6.674×10^{-11} Nm^2kg^{-2}	g cms^{-1}
iii)	Force	Nm	———
iv)	G	Newton	dyne

Ans :

S.No.	Terms	SI Unit	CGS Unit
i)	Linear Momentum	Kg ms–1	g cms–1
ii)	Moment of couple	NM	dyne cm
iii)	Force	N	dyne
iv)	G	6.674×10^{-11} Nm^2kg^{-2}	———

2.

1.	An athlete runs some distance before jumping	(a)	Inertia
2.	Sharp turn while driving car	(b)	Inertia of motion
3.	Some of the leaves and fruits are detached	(c)	Inertia of direction
4.	Force is applied on bodies they resist any change in their state	(d)	Inertia of rest

Ans :

1	An athlete runs some distance before jumping	b	Inertia of motion
2	Sharp turn while driving car	c	Inertia of direction
3	Some of the leaves and fruits are detached	d	Inertia of rest
4	Force is applied on bodies they resist any change in their state	a	Inertia

3.

1.	Like parallel forces	(a)	$F_{net} = O$
2.	Unlike parallel forces	(b)	$F_{net} = F_1 + F_2$
3.	Parallel equal forces	(c)	$F_{net} = F_2 - F_1$ (if $F_2 > F_1$)
4.	Unbalanced forces	(d)	Action of a lever

Ans :

1	Like parallel forces	b	$F_{net} = F_1 + F_2$
2	Unlike parallel forces	c	$F_{net} = F_2 - F_1$ (if $F_2 > F_1$)
3	Parallel equal forces	a	$F_{net} = O$
4	Unbalanced forces	d	Action of a lever

4.

1.	**1 Newton**	**(a)**	**980 dyne**
2.	**1 dyne**	**(b)**	**9.8 N**
3.	**1 kg f**	**(c)**	**1 g cm s^{-2}**
4.	**1 g f**	**(d)**	**1 kg ms^{-2}**

Ans :

1	1 Newton	d	1 kg ms^{-2}
2	1 dyne	c	1 g cm s^{-2}
3	1 kg f	b	9.8 N
4	1 g f	a	980 dyne

Additional – Assertion and reason

1. **Assertion:** The resistance of a body to change its state of rest is called inertia of rest.
Reason: When you vigorously shake the branches of a tree, some of the leaves and fruits are detached and they fall down.

a) A is true R is wrong
b) A is wrong R is true
c) R explain A
d) R does not explain A

Ans : (c) R explain A

2. **Assertion:** Parallel equal forces are acting in opposite directions in the same line of action.
Reason: $F_{net} = F_1 - F_2$ (given: $F_1 = F_2$).

a) A is true R is wrong
b) A is wrong R is true
c) R explain A
d) R does not explain A

Ans : (c) R explain A

3. **Assertion:** Torque is measured by the product of the force and the perpendicular distance between the fixed point or the fixed axis and the line of action of the force.
Reason: Automobiles are fitted with springs and shock absorbers to reduce jerks while moving on uneven roads.

a) A and R are wrong
b) A and R are correct
c) R explain A
d) R does not explain A

Ans : (b) A and R are correct

4. **Assertion:** A rocket works on the principle of conservation of linear momentum.
Reason: Higher the velocity, smaller in the pressure and vice versa.

a) A is true R is wrong
b) A is wrong R is right
c) A and R are wrong
d) A and R are correct.

Ans : (a) A is true R is wrong

5. **Assertion:** lift is falling down freely.
Reason: R = m(g — g) = 0.

a) A is true R is wrong
b) A is wrong R is right
c) A and R are wrong
d) A and R are correct

Ans : (d) A and R are correct

Additional – Short answer questions

1. Write the different types of motion.

The different types of motion are:

- ✦ Linear motion.
- ✦ Circular motion.
- ✦ Ozcillatory motion.

2. What do you mean by Force?

A body needs a push or pull to move or bring at rest or change its velocity. Hence this 'push' or 'pull' is called as Force. It is an exteranal agency to change the states of rest or motion.

3. What do you mean by Mechanics write its types?

Mechanics is the branch of physics that deals with the effect of force on bodies. It is divided into 2 branches as Statics and Dynamics.

4. Define Statics.

The branch of Physics deals with the bodies which are at rest under the action of forces.

5. Define Dynamics.

The branch of Physics deals with the study of moving bodies under the action of forces.

6. Write the types of Dynamics.

Dynamics have 2 types. They are;

- ✦ Kinematics.
- ✦ Kinetics.

7. Define Kinematics.

It deals with the motion of bodies without considering the cause of motion.

8. Define Kinetics.

It deals with the motion of bodies considering the cause of motion.

9. Define natural motion.

Moving body naturally comes to rest without any external influence of the force. Such motions are formed as natural motion.

10. Define violent motion.

A Force is needed to make the bodies to move from their natural state and behave contrary to their own natural state called as violent motion.

11. Describe the activity about inertia of rest.

Take a glass tumbler and place a small card board on it. Now keep a coin at the centre of the card board. Then flick the card board quickly. The inertia of the coin keeps it in the state of the rest when the card board moves, and so the coin falls into the tumbler due to gravity. This happen due to inertia of rest.

12. Define linear momentum.

The product of mass and velocity of a moving body gives the magnitude of linear momentum. It acts in the direction of the velocity of the object.

$$\text{Linear momentum} = \text{Mass} \times \text{Velocity.}$$

$$P = M \times V. \text{ SI unit is } kgms^{-1}$$

13. Force is an external effort is the form of push (or) pull explain.

Since force can

- ✦ Produce or try to produce the motion of a static body.
- ✦ Stops (or) tries to stop a moving body and also
- ✦ Changes (or) tries to change the direction of motion of a moving body. So it is an external effort in form of push or a pull

14. Explain the types of forces.

Force can be classified into 2 types.

- **Like Paralle Forces :** Two or more forces of equal or unequal magnitutde action along the same direction, parallel to each other are called Like Parallel Forces.
- **Unlike Parallel Forces :** If two or more equal forces or unequal forces act along opposite directions parallel to each other, then they are called Unlike Parallel Forces.

15. Define Resultant Force.

When several forces act simultaneously on the same body, then the combined effect of the multiple forces can be represented by a single force which is termed as Resultant Force.

16. Define Balanced Force.

If the resultant of all the forces acting on a body is equal to zero, then the body will be in equilibrium. Such forces are called Balanced Forces.

17. Define Unbalanced Forces.

If the resultant force is not equal to zero, then it causes the motion of the body due to unbalanced forces.

Eg.: Drawing water from a well, force applied with a crowbar, forces on a weighing balance.

18. Define Equilibrant.

A system can be brought to equilibrium by applying another force which is equal to the resultant force in magnitude but in opposite direction. Such force is called as Equilibrant.

19. Have you observed the position of the handle in door?

The door can be easily opened or closed when you apply the force at a point far away from the fixed edges deu to large moment of force.

20. It is easier to open a door by applying a force near the handle rather than near hinges. Why?

While applying force near handle, the moment of force is larger than applying a force near the hinges. So it is easier to open the door.

21. What do you mean by axis of rotation?

The axis of the fixed edge about which the door is rotated is called as the axis of rotation.

22. What do you mean by point of rotation?

Fix one end of a rod and apply a force at the other end tangentially. The rod will be turned about the fixed point and it is called as "Point of rotation".

23. Define Moment of force.

The rotating or turning effect of a force about fixed point or fixed axis is called moment of the force.

24. Define Torque.

Torque is the product of the Force (F) and the perpendicular distance (d) between the fixed point or the fixed axis and the line of the action of the force.

$T = F \times d$ (T – Torque, F – Force and d – distance) SI unit Nm.

25. Define couple.

Two equal and unlike parallel forces applied simultaneously at the two distinct points constitute a couple.

26. Define 1 Newton.

The amount of force required for a body of mass 1 kg produces an acceleration of $1ms^{-2}$, $1N = 1kgms^{-2}$.

27. Define 1 dyne.

The amount of force required for a body of mass 1 gram produces an acceleration of $1cms^{-2}$, 1 dyne = $1\ gcms^{-2}$, also $1N = 10^5$ dyne.

28. Define Unit force.

The amount of force requried to produce an acceleration of $1ms^{-2}$ in a body of mass 1 kg is called unit force or 1N of force.

29. Define Gravitational unit of force.

In the SI system of units, gravitational unit of force is kilogram force, represented by Kg F. In the CGS system its unit is gram force, represented by gf.

$1 \text{ kg f} = 1 \text{ kg} \times 9.8 \text{ ms}^{-2} = 98 \text{ N}.$

$1 \text{ gf} = 1 \text{ g} \times 980 \text{ cms}^{-2} = 980 \text{ dyne}.$

30. Explain acceleration due to gravity of the earth.

The velocity of the object keeps changing as it falls down. This change in velocity must be due to the force acting on the object. The acceleration of the body is due to the Earth's gravitational force. So it is called as acceleration due to the gravitational force of the earth (or) acceleration due to gravity of the earth. It is represented by as 'g'.The average value of $g = 9.8 \text{ ms}^{-2}$.

31. How could you calculate the mass of the earth (M)?

Mass of the Earth (M) = gR^2/G. Substituting the known value of g, R and G. We calculate the mass of the earth as $M = 5.972 \times 10^{24}$ kg.

32. Define Mass.

Mass is the basic property of a body. Mass of a body is defined as the quantity of matter contained in the body. SI unit is Kilogram (kg).

33. Define Weight.

Weight of a body is defined as the gravitational force exested on it due to the Earth's gravity alone.

Weight = Gravitational Force.

= mass (m) × acceleration due to gravity (g).

= m × g.

34. Define Apparent weight.

Apparent weight is the weight of the body acquired due to the action of gravity and other external forces acting on the body.

35. State Weightlessness.

Whenever a body or a person falls freely under the action of Earth's gravitational force alone, it appears to have zero weight. This state is referrred to as Weightlessness.

Additional – Solved problems

1. Calculate the velocity of a moving body of mass 5 kg whose linear momentum is 2.5 kg m s^{-1}.

Solution :

Linear momentum = mass × velocity.

Velocity = linear momentum / mass.

$$V = \frac{2.5}{5}.$$

$= 0.5 \text{ m s}^{-1}$.

2. A door is pushed, at a point whose distance from the hinges is 90 cm, with a force of 40 N. Calculate the moment of the force about the hinges.

Solution :

Formula : The moment of a force M = F × d

Given : F = 40 N and d = 90 cm = 0.9 m.

Hence, moment of the force = 40 × 0.9 = 36 N m.

3. At what height from the centre of the Earth the acceleration due to gravity will be ¼th of its value as at the Earth.

Solution :

Data : Height from the centre of the Earth,

$R' = R + h$

The acceleration due to gravity at that height, g = g/4.

Formula: $g = GM/R^2$

$$\frac{g}{g^1} = \left(\frac{R^1}{R}\right)^2 = \left(\frac{R+h}{R}\right)^2 = \left(1+\frac{h}{R}\right)^2$$

R'

$$\frac{g'}{4} = \left(1+\frac{h}{R}\right)^2$$

$$2 = 1+\frac{h}{R}$$

$$2 = 1+\frac{h}{R} = \frac{R+h}{R}$$

$2R = R + h = R'$

So $R' = 2R$

From the centre of the Earth, the object is placed at twice the radius of the earth.

Additional – Long answer questions

1. Tabulate the Action of forces.

Action of forces	Diagram	Resultant force (F_{net})
Parallel forces are acting in the same direction	F_1 → F_2 →	$F_{net} = F_1 + F_2$
Parallel unequal forces are acting in opposite directions	F_1 → ← F_2	$F_{net} = F_1 - F_2$ (if $F_1 > F_2$) $F_{net} = F_2 - F_1$ (if $F_2 > F_1$) F_{net} is directed along the greater force
Parallel equal forces are acting in opposite directions in the same line of action (F1 = F2)	F_1 → ← F_2	$F_{net} = F_1 - F_2$ ($F_1 = F_2$) $F_{net} = 0$

2. Write the application of Torque.

i) **Gears :**

A gear is a circular wheel with teeth around its rim. It helps to change the speed of rotation of a wheelby changing the torqueand helps to transmit power.

ii) **Seasaw :**

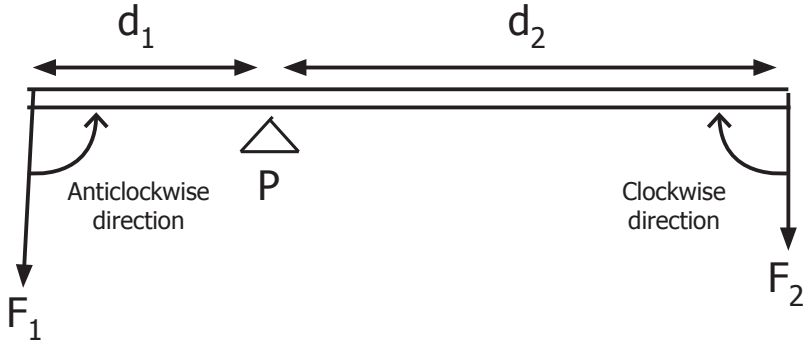
In Seasaw, there is a difference in the weight of the persons sitting on it, the heavier person lifts the lighter person. When the heavier person comes closer to the pivot point the distance of the line of action of the force decreases. It causes less amount of torque to act on it. This enables the lighter person to lift the heavier person.

iii) **Steering Wheel :**

A small steering wheel enables you to manoeuore a car easilyby tsransferring a torque to the wheels with less effort.

3. Explain the principle of moments :

At equilibrium, the algebraic sum of the moments of all individual forces about any point is equal to zero.



In the illustration, the force F_1, produces an anticlockwise rotation at a distance d, from the point of pivot (P) called fulcnum and force F_2 produces a clockwise rotation at a distance d2 from the point of pivot P. The principle of moments can be written as follows;

Moment in Clockwise direction = Moment in Anticlockwise direction

$$F_1 \times d_1 = F_2 \times d_2$$

4. Explain Impulse.

A large force acting for a very short interval of time is called as Impulsive force.

When a force 'F' acts on a body for a period of time 't' then the product of force and time is known as 'impulse' represented by 'J'.

$$\text{Impulse } J = F \times t \quad \text{.....(1)}$$

By Newton's second law

$$F = \Delta P/t \ (\Delta \text{ refers to change})$$

$$\Delta P = F \times t \quad \text{.....(2)}$$

From 1 & 2, $J = \Delta P$

Impulse is also equal to the magnitude of change in momentum. It's unit is $Kgms^{-1}$ (or) Ns.

Change in momentum can be achieved in 2 ways. They are;

- A large force acting for a short period time and
- A smaller force acting for a longer period of time.

Examples :

- Automobiles are fitted with springs and shock absorbes to reduce jerks while moving on uneven roads.
- In cricket, a fielder pull back his hands while catching the ball. He experiences a smaller force for a longer interval of time to catch the ball, resulting in a lesser impulse on his hands.

5. Explain Newton's Third Law with an example.

Newton's third law states that "for every action, there is an equal and opposite reaction". They always act on two different bodies.

If a body 'A' applies a force F_A on a body 'B', then the body 'B' reacts with force F_B on the body 'A', which is equal to F_A inmagnitude but opposite in direction. $F_B = -F_A$.

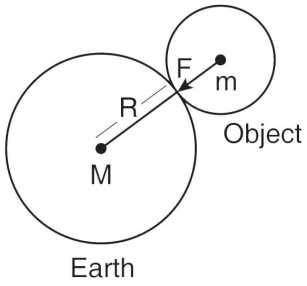
Examples :

- When **birds** fly, they push the air downwards with their wings (Action) and the air pushes the bird upward (Reaction).
- When a **person swims**, he pushes the water using the hands backwards (Action) and the water pushes the swimmer in the forward direction (Reaction).
- When you **fire a bullet**, the gun recoils backward. The bullet is moving forward (Action) and the gun equalises this forward action by moving backward (Reaction).

6. Write the relationship between 'g' and 'G'.

Explanation : When a body is at rests on the surface of the Earth, it is acted upon by the gravitational force of the Earth. Let us compute the magnitude of this force in two ways. Let 'M' be the mass of the Earth and

'm' be the mass of the body. The entire mass of the Earth is assumed to be concentrated at its centre. The radius of the Earth is 6378 km (=6400 km approximately). By Newton's law of gravitation, the force acting on the body is given by



$$F = \frac{GMm}{R^2} \qquad \text{.....(1)}$$

Here, the radius of the body considered is negligible when compared with the Earth's radius. Now, the same force can be obtained from Newton's second law of motion. According to this law, the force action on the body is given by the product of its mass and acceleration (called as weight). Here acceleration of the body is under the action of gravity, hence a = g.

$$F = Ma = mg.$$

$$F = \text{weight} = mg \qquad \text{.....(2)}$$

comparing (1) and (2) we get,

$$mg = \frac{GMm}{R^2}$$

Acceleration due to gravity,

$$g = \frac{GM}{R^2}$$

7. Tabulate the apparent weight of a person in a moving lift.

Ans :

Case 1 : Lift is moving upward with an acceleration 'a'	Case 2 : Lift is moving downward with an acceleration 'a'	Case 3 : Lift is at rest	Case 4 : Lift is falling down freely
$R–W = F_{net} = ma$ $R = W + ma$ $R = mg + ma$ $R = m (g + a)$	$W – R = F_{net} = ma$ $R = W – ma$ $R = mg – ma$ $R = m (g – a)$	Here the acceleration is zero $a = 0$ $R = W$ $R = mg$	Here the acceleration is equal to g $a = g$ $R = m (g – g)$
$R > W$	$R < W$	$R = W$	$R = 0$
Apparent weight is greater than the actual weight	Apparent weight is lesser than the actual weight	Apparent weight is equal to the actual weight	Apparent weight is equal to zero

UNIT TEST-1

Time : 1.15 Hrs. Marks : 50

I. Choose the best answer (5 × 1 = 5)

1. The momentum of a heavy object at rest will be _____.
a) large b) small c) infinity d) zero

2. The SI unit of force is _____.
a) energy b) joule c) newton d) dyne

3. Rocket works on the principle of _____.
a) conservation of mass b) conservation of energy
c) conservation of momentum d) conservation of velocity

4. Momentum is a _____ quantity.
a. vector b) scalar c) tensor d) none

5. Torque is a _____ quantity.
a) vector b) scalar c) tensor d) either a ro b

II. Fill in the blanks (5 × 1 = 5)

6. Direction of motion is due to _____.
7. _____ proposed the concepts of force , motion and inertia of bodies.
8. Unit of momentum in CGS system is _____.
9. Torque = _____ × _____.
10. SI unit of G is _____.

III. State whether the statements are true or false. Correct the false statement (4 × 1 = 4)

11. Rest and motion are not related terms.
12. Violent motion is a force dependent.
13. The unit of impulse and force is same.
14. If the resultant force of all the forces acting on a body is equal to zero, then the body will be in equilibrium. Such forces are called Unbalanced forces.

IV. Match the following (4 × 1 = 4)

15.	Force	(a)	cause of motion
16.	Moment of force	(b)	momentum
17.	Newton	(c)	push or pull
18.	m × v	(d)	Torque

V. Assertion and Reasoning (3 × 1 = 3)

Direction: In each of the following questions, a statement of Assertion is given and a corresponding statement of Reason is given just below it. Of the statements given below, mark the correct answer as

a. If both A and R are true and R is the correct explanation of A.
b. If both A and R are true but R is not the correct explanation of A.
c. If A is true but R is false.
d. If both A and R are false.

19. **Assertion:** The sum of the clockwise moments is equal to the sum of the anticlockwise moments.

Reason: The principle of conservation of momentum is valid if the external force on the system is zero

20. **Assertion:** The resistance of a body to change its state of rest is called inertia of rest.
    Reason: When you vigorously shake the branches of a tree, some of the leaves and fruits are detached and they fall down
21. **Assertion :** Torque is measured by the product of the force and the perpendicular distance between the fixed point or the fixed axis and the line of action of the force.
    Reason: Automobiles are fitted with springs and shock absorbers to reduce jerks while moving on uneven road.

VI. Write the answer for the following questions in word or sentence (3 × 1 = 3)

22. What do you mean by force?
23. Who proposed the law of motion?
24. One of the irregularities in the motion of stars is called?

VII. Find the odd one out (3 × 1 = 3)

25. Newton, Galileo, Aristotle, Einstein.
26. $F = F_1 + F_2$, $F = F_1 - F_2$, $F = F_1 = F_2$, R=0.
27. 980 dynes, 9.8 N, 10^5 dyne.

VIII. Correct the mistakes (3 × 1 = 3)

28. Kinematics deals with the motion of bodies considering the cause of motion.
29. Inertia of rest is the resistance of a body to change its state of motion
30. Geometric radius of the Earth is Minimum in the polar region, the value of g is maximum.

IX. Write the short answer for ANY 5 of the following questions. (5 × 2 = 10)

31. Define linear momentum.
32. What is Torque?
33. Define 1 Newton.
34. What is couple?
35. What is Impulsive force?
36. What is called apparent weight?
37. What is meant by weightlessness?

X. Write long answer for the following questions (2 × 5 = 10)

38. Describe rocket propulsion.
    [OR]
39 Explain the types of Inertia with examples.
40. Differentiate between Mass and Weight.
    [OR]
41 Derive the relation between g and G.