

**NAAHAR PUBLIC SCHOOL CBSE SENIOR SECONDARY
ACADEMIC YEAR (2022-2023)
HALF YEARLY EXAMINATION**

**STD: XI
SUB: PHYSICS
Tr. INITIAL: Mrs. GAYATHRI**

**TOTAL: 70
DATE: 21.12.2022
DURATION: 90 MINS**

General Instructions:

- (1) There are 35 questions in all. All questions are compulsory.
- (2) This question paper has five sections. Section A, Section B, Section C, Section D, and Section E. All the sections are compulsory.
- (3) Section A contains eighteen MCQ of 1 mark each, Section B contains seven questions of two marks each, Section C contains five questions of three marks each, Section D contains three long questions of five marks each and Section E contains two case study based questions of 4 marks each.
- (4) There is no overall choice. However, an internal choice has been provided in section B, C, D and E. You have to attempt only one of the choices in such questions.
- (5) Use of calculators is not allowed.

SECTION-A

1. The mass of a body which is equal to the ratio of the force acting on a body to the acceleration produced in the body is
- (a) the gravitational mass
 - (b) the electromagnetic mass
 - (c) the internal mass
 - (d) the inertial mass

Answer: (d) the inertial mass

2. The force required to produce an acceleration of 2 m/s^2 on a mass of 2 kg is

- (a) 4 N
- (b) 10 N
- (c) 22 N
- (d) 18 N

Answer: (a) 4 N

3. A machine gun fires a bullet of mass 40 g with a velocity of 1200 ms^{-1} . The man holding it can exert a maximum force on 144 N on the gun. How many bullets can he fire per second at the most?

- (a) one
- (b) four
- (c) two
- (d) three

Answer: (d) three

4. A passenger in a moving bus is thrown forward when the bus is suddenly stopped. This is explained

- (a) by Newton's first law
- (b) by Newton's second law
- (c) by Newton's third law
- (d) by the principle of conservation of momentum

Answer: (a) by Newton's first law

5. A block of wood is placed on a surface. A force is applied parallel to the surface to move the body. The frictional force developed acts

- (a) normal to the surface upwards
- (b) normal to the surface downwards
- (c) along the direction of the applied force
- (d) opposite to the direction of the applied force

Answer: (d) opposite to the direction of the applied force

6. Moment of inertia depends on

- (a) Distribution of particles
- (b) Mass
- (c) Position of axis of rotation
- (d) All of these

Answer: (d) All of these

7. Calculate the M.I. of a thin uniform ring about an axis tangent to the ring and in a plane of the ring, if it's M.I. about an axis passing through the centre and perpendicular to plane is 4 kg m^2 .

- (a) 12 kg m^2
- (b) 3 kg m^2
- (c) 6 kg m^2
- (d) 9 kg m^2

Answer: (c) 6 kg m^2

8. If a body is rotating about an axis, passing through its centre of mass then its angular momentum is directed along its

- (a) Radius
- (b) Tangent
- (c) Circumference
- (d) Axis of rotation

Answer: (d) Axis of rotation

9. A solid cylinder of mass 20 kg, has length 1 metre and radius 0.5m. then its momentum of inertia in kg m^2 about its geometrical axis is

- (a) 2.5
- (b) 5
- (c) 1.5
- (d) 3

Answer: (a) 2.5

10. Which is the wrong relation from the following?

- (a) $t = I a$
- (b) $F = ma$
- (c) $L = I \omega$
- (d) $I = t a$

Answer: (d) $I = t a$

11. 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

Answer: (b) Negative

12. What would be the duration of the year if the distance between the earth and the sun gets doubled?

- (a) 1032 days
- (b) 129 days
- (c) 365 days
- (d) 730 days

Answer: (a) 1032 days

13. A artificial satellite moving in a circular orbit around the earth has a total (kinetic + potential) energy E_0 . Its potential energy is

- (a) $2E_0$
- (b) E_0
- (c) $1.5 E_0$
- (d) $-E_0$

Answer: (a) $2E_0$

14. A body is projected vertically from the surface of the earth of radius R with velocity equal to half of the escape velocity. The maximum height reached by the body is

- (a) R
- (b) $R/2$
- (c) $R/3$
- (d) $R/4$

Answer: (c) $R/3$

15. The escape velocity for a body projected vertically upwards from the surface of the earth is 11 km/s. If the body is projected at an angle of 45° with the vertical, the escape velocity will be

- (a) $11/\sqrt{2}$ km/s
- (b) $11\sqrt{2}$ km/s
- (c) 2 km/s
- (d) 11 km/s

Answer: (d) 11 km/s

Directions: Each of these questions contains two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.

- (a) Assertion is correct, reason is correct; reason is a correct explanation for assertion.
- (b) Assertion is correct, reason is correct; reason is not a correct explanation for assertion
- (c) Assertion is correct, reason is incorrect
- (d) Assertion is incorrect, reason is correct.

16. **Assertion:** On a rainy day, it is difficult to drive a car or bus at high speed.

Reason: The value of coefficient of friction is lowered due to wetting of the surface.

Answer: (a) On a rainy day, the roads are wet. Wetting of roads lowers the coefficient of friction between the tyres and the road. Therefore, grip on a road of car reduces and thus chances of skidding increases.

17. **Assertion:** The centre of mass of a body may lie where there is no mass.

Reason: Centre of mass of body is a point, where the whole mass of the body is supposed to be concentrated.

Answer: (a) As the concept of centre of mass is only theoretical, therefore in practice no mass may lie at the centre of mass. For example, centre of mass of a uniform circular ring is at the centre of the ring where there is no mass.

18. **Assertion:** A body loses weight when it is at the centre of the earth.

Reason: At the centre of earth, $g = 0$. Therefore, weight $= mg = 0$.

Answer: (a)

SECTION-B

19. (a) Why a one rupee coin placed on a revolving table flies off tangentially?

Answer:

This is due to the inertia of direction.

(b) Why mud flies off tangentially to the wheel of a cycle?

Answer:

This is due to the inertia of direction.

20. a. Mention the conditions for the maximum and minimum pull of a lift on a supporting cable.

Answer:

1. The pull of the cable is minimum (zero) when the lift is falling freely.
2. The pull of the cable is maximum when the lift is moving up with the same acceleration.

b. Can a rocket operate in free space?

Answer:

Yes.

21. a. Can a body in linear motion be in equilibrium? Why?

Answer:

Yes, it will be in equilibrium if the vector sum of the forces acting upon the body is zero.

b. Is the law of conservation of momentum valid for a system consisting of more than two particles?

Answer:

Yes, the law of conservation of momentum is a general law that is applicable to all systems.

22. a. under what conditions, the torque due to an applied force is zero?

Answer:

We know that $\tau = rF \sin \theta$. If $\theta = 0$ or 180 ,

or

$r = 0$, then $\tau = 0$, $r = 0$ means the applied force passes through the axis of rotation.

b. A cat is able to land on her feet after a fall. Which principle of Physics is being used by her?

Answer:

Principle of conservation of angular momentum.

23. a. What is the formula for escape velocity in terms of g and R ?

Answer:

$$v_e = \sqrt{2gR}.$$

b. What is the orbital period of revolution of an artificial satellite revolving in a geostationary orbit?

Answer:

It is 24 hours.

24. a. How much energy is required by a satellite to keep it orbiting? Neglect air resistance? Why?

Answer:

No energy is required by a satellite to keep it orbiting. This is because the work done by the centripetal force is zero.

b. Where does a body weigh more at the pole or at the equator?

Answer:

It weighs more at the pole.

25. a. Why do we prefer to use a wrench with a long arm?

Answer:

The turning effect of a force is $\tau = r \times F$. When the arm of the wrench is long, r is larger. So smaller force is required to produce the same turning effect.

b. What is the rotational analogue of mass and force?

Answer:

M.I. and torque are the respective rotational analogue.

26. A rocket with a lift-off mass 20,000 kg is blasted upwards with an initial acceleration of 5.0 ms^{-2} . Calculate the initial thrust (force) of the blast.

Answer: Here, $m = 20000 \text{ kg} = 2 \times 10^4 \text{ kg}$

Initial acceleration = 5 ms^{-2}

Clearly, the thrust should be such that it overcomes the force of gravity besides giving it an upward acceleration of 5 ms^{-2} .

Thus the force should produce a net acceleration of $9.8 + 5.0 = 14.8 \text{ ms}^{-2}$.

Since, thrust = force = mass $\times$ acceleration

$$F = 2 \times 10^4 \times 14.8 = 2.96 \times 10^5 \text{ N}.$$

27. Find the components along the x , y , z -axes of the angular momentum l of a particle, whose position vector is r with components x , y , z and momentum is p with components p_x , p_y and p_z . Show that if the particle moves only in the x - y plane the angular momentum has only a z - component.

Answer:

We know that angular momentum $\vec{l}$ of a particle having position vector $\vec{r}$ and momentum $\vec{p}$ is given by

$$\vec{l} = \vec{r} \times \vec{p}$$

But $\vec{r} = [x\hat{i} + y\hat{j} + z\hat{k}]$, where x, y, z are the components of

$$\vec{r} \text{ and } \vec{p} = [p_x\hat{i} + p_y\hat{j} + p_z\hat{k}]$$

$$\therefore \vec{l} = \vec{r} \times \vec{p} = [x\hat{i} + y\hat{j} + z\hat{k}] \times [p_x\hat{i} + p_y\hat{j} + p_z\hat{k}]$$

$$\begin{aligned} \text{or } (l_x\hat{i} + l_y\hat{j} + l_z\hat{k}) &= \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ x & y & z \\ p_x & p_y & p_z \end{vmatrix} \\ &= (yp_z - zp_y)\hat{i} + (zp_x - xp_z)\hat{j} + (xp_y - yp_x)\hat{k} \end{aligned}$$

From this relation, we conclude that

$$l_x = yp_z - zp_y, \quad l_y = zp_x - xp_z \quad \text{and} \quad l_z = xp_y - yp_x$$

If the given particle moves only in the $x - y$ plane, then $z = 0$ and $p_z = 0$ and hence,

$$\vec{l} = (xp_y - yp_x)\hat{k}, \text{ which is only the } z\text{-component of } \vec{l}.$$

It means that for a particle moving only in the $x - y$ plane, the angular momentum has only the z -component.

28. Suppose there existed a planet that went around the Sun twice as fast as the Earth. What would be its orbital size as compared to that of the Earth?

Answer:

$$\text{Here, } T_e = 1 \text{ year; } T_p = \frac{T_e}{2} = \frac{1}{2} \text{ year; } r_e = 1 \text{ A.U.}$$

$$\text{Using Kepler's third law, we have } r_p = r_e \left(\frac{T_p}{T_e} \right)^{2/3}$$

$$\Rightarrow r_p = 1 \left(\frac{1/2}{1} \right)^{2/3} = 0.63 \text{ AU}$$

SECTION-C

29. What are the advantages and disadvantages of friction?

Answer:

Advantages of friction:

1. It helps in walking, talking, writing, sleeping, etc.
2. The brakes of vehicles can't work without friction.
3. Moving belts remain on the rim of wheels due to friction.
4. Adhesives work due to friction.
5. Cleaning with sandpaper is due to friction.
6. Nuts and bolts are held together due to friction.

Disadvantages of friction:

1. A significant amount of energy of a moving object is wasted in the form of heat energy to overcome friction.
2. It causes a lot of wear and tear of the parts of machinery in contact, thus reducing their lifetime.
3. It restricts the speed of moving vehicles like buses, airplanes, trains, etc.
4. The efficiency of machines decreases due to the presence of a force of friction.
5. A machine gets burnt due to the force of friction between its different moving parts due to friction.

30. a. What is the difference between the centre of gravity and C.M.?

Answer:

C.G.: It is the point where the whole of the weight of the body is supposed to be concentrated i.e. on this point, the resultant of the gravitational force on all the particles of the body acts.

C.M.: It is the point where the whole of the mass of the body may be supposed to be concentrated to describe its motion as a particle.

b. What do you understand by a rigid body?

Answer:

A rigid body is that in which the distance between all the constituting particles remains fixed under the influence of external force. A rigid body thus conserves its shape during its motion.

31. a. Why is it easier to balance a bicycle in motion?

Answer:

The rotating wheels of a bicycle possess angular momentum. In the absence of an external torque, neither the magnitude nor the direction of angular momentum can change. The direction of angular momentum is along the axis of the wheel. So the bicycle does not get tilted.

(b) Why spokes are fitted in the cycle wheel?

Answer:

The cycle wheel is constructed in such a way so as to increase the M.I. of the wheel with minimum possible mass, which can be achieved by using spokes and the M.I. is increased to ensure the uniform speed.

32. a. What are the uses of Artificial Satellites?

Answer:

Following are some of the important uses of Artificial Satellites:

1. They are used as communication satellites to send messages to distant places.
2. They are used as weather satellites to forecast weather.
3. They are used to know the exact shape of Earth.
4. They are used to telecast T.V. programs to distant places.
5. They are used to explore the upper region of the atmosphere.

b. Does a comet move faster at aphelion or perihelion?

Answer:

At the perihelion where it is close to Sun, the comet moves faster.

33. a. Why an astronaut has a sense of weightlessness in a satellite revolving around the Earth?

Answer:

For revolving around the Earth, the astronaut and the satellite require the centripetal force, and their weight is used up in providing the necessary centripetal force. So the astronaut feels weightlessness in space.

Why moon has no atmosphere? Explain.

Answer:

b. An atmosphere means the presence of a mixture of a number of gases. The molecules of these gases are in the state of continuous random motion moving with different velocities. As the value of escape velocity on the surface of the moon is small (only 2.5 km s^{-1}), the molecules of gases with velocities greater than the escape velocity moved out of the atmosphere. As time passed, nearly all the molecules escaped from the moon's atmosphere.

34. A constant retarding force of 50 N is applied to a body of mass 20 kg moving initially with a speed of 15 ms^{-1} . How long does the body take to stop?

Answer:

Here $m = 20 \text{ kg}$, $F = -50 \text{ N}$ (retardation force)

As $F = ma$

$$\Rightarrow a = \frac{F}{m} = \frac{-50}{20} = -2.5 \text{ ms}^{-2}$$

Using equation,

$$v = u + at$$

Given,

$$u = 15 \text{ ms}^{-1}, v = 0$$

Now,

$$0 = 15 + (-2.5)t$$

or,

$$t = 6 \text{ s.}$$

35. Let us assume that our galaxy consists of 2.5×10^{11} stars each of one solar mass. How long will a star at a distance of 50,000 ly from the galactic centre take to complete one revolution? Take the diameter of the Milky way to be 10^5 ly .

Answer:

Here, $r = 50000 \text{ ly} = 50000 \times 9.46 \times 10^{15} \text{ m} = 4.73 \times 10^{20} \text{ m}$

$$M = 2.5 \times 10^{11} \text{ solar mass} = 2.5 \times 10^{11} \times (2 \times 10^{30}) \text{ kg} = 5.0 \times 10^{41} \text{ kg}$$

We know that

$$M = \frac{4\pi^2 r^3}{GT^2}$$

$$\text{or } T = \left(\frac{4\pi^2 r^3}{GM} \right)^{1/2} = \left[\frac{4 \times (22/7)^2 \times (4.73 \times 10^{20})^3}{(6.67 \times 10^{-11}) \times (5.0 \times 10^{41})} \right]^{1/2}$$
$$= 1.12 \times 10^{16} \text{ s.}$$

SECTION-D

36. A body of mass 0.40 kg moving initially with a constant speed of 10 ms^{-1} to the north is subject to a constant force of 8.0 N directed towards the south for 30 s. Take the instant the force is applied to be $t = 0$, the position of the body at that time to be $x = 0$, and predict its position at $t = -5 \text{ s}$, 25 s , 100 s .

Here $m = 0.40 \text{ kg}$, $u = 10 \text{ ms}^{-1}$, $F = -8 \text{ N}$ (retarding force)

As $a = \frac{F}{m} = -\frac{8}{0.4} = -20 \text{ ms}^{-2}$

Also $S = ut + \frac{1}{2} at^2$

(i) Position at $t = -5 \text{ s}$

$$S = 10(-5) + \frac{1}{2} \times 0 \times (-5)^2 = -50 \text{ m}$$

(ii) Position at $t = 25 \text{ s}$

$$S_1 = 10 \times 25 + \frac{1}{2} \times (-20) \times (25)^2 = -6000 \text{ m} = -6 \text{ km}$$

(iii) Position at $t = 100 \text{ s}$

$$S_2 = 10 \times 30 + \frac{1}{2} \times (-20) \times (30)^2 = -8700 \text{ m}$$

At $t = 30 \text{ s}$, $v = u + at$

$$v = 10 - 20 \times 30 = -590 \text{ ms}^{-1}$$

Now, for motion from 30 s to 100 s

$$S_3 = -590 \times 70 + \frac{1}{2} (0) \times (70)^2 = -41300 \text{ m}$$

$$\text{Total distance} = S_2 + S_3 = -8700 - 41300 = -50000 \text{ m} = -50 \text{ km}.$$

(OR)

State and derive law of conservation of momentum.

Law of conservation of momentum states that in the absence of external forces, total momentum of a system comprising of two or more interacting bodies is constant.

Derivation:

Let us consider two moving balls A and B of masses m_1 and m_2 and having initial velocities u_1 and u_2 such that $u_2 < u_1$.

Suppose the balls collide at some point and there is no external force acting on this system.

Let their final velocities be v_1 and v_2 respectively.

According to Newton's third law of motion,

Force on ball B due to A = -Force on ball A due to B.

$$\text{Or, } F_{AB} = -F_{BA} \dots \dots \dots (i)$$

$$\text{Total initial momentum before collision } (p_i) = m_1 u_1 + m_2 u_2.$$

$$\text{Total final momentum after collision } (p_f) = m_1 v_1 + m_2 v_2.$$

According to Newton's second law,

$$F_{BA} = \frac{p'_A - p_A}{t} = \frac{m_1 v_1 - m_1 u_1}{t} \dots \dots \dots (ii)$$

$$F_{AB} = \frac{p'_B - p_B}{t} = \frac{m_2 v_2 - m_2 u_2}{t} \dots \dots \dots (iii)$$

From (i), (ii) and (iii),

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

$$\Rightarrow m_1 v_1 - m_1 u_1 = -(m_2 v_2 - m_2 u_2)$$

$$\Rightarrow m_1 v_1 + m_2 v_2 = m_1 u_1 + m_2 u_2$$

$$\Rightarrow \text{Final momentum } (p_f) = \text{Initial momentum } (p_i).$$

Thus, we conclude that during the interaction between the two balls, momentum before collision is equal to total momentum after collision. Thus, the momentum of the system is conserved in the absence of external forces.

37. The moment of inertia of a body about a given axis is 1.2 kg m^2 . Initially, the body is at rest. In order to produce a rotational K.E. of 1500J , for how much duration, an acceleration of 25 rads^{-2} must be applied about that axis.

Answer:

Here,

$I = 1.2 \text{ kg m}^2$
rotational K.E. = $\frac{1}{2} I \omega^2 = 1500\text{J}$
 $\omega_0 = 0$
 $\alpha = 25 \text{ rads}^{-2}$
 $t = ?$

$\therefore \frac{1}{2} I \omega^2 = 1500 \text{ gives,}$

$$\omega = \sqrt{\frac{2 \times 1500}{1.2}} = \sqrt{\frac{30000}{12}}$$
$$= \sqrt{2500} = 50 \text{ rads}^{-1}$$

Using relation,

$\omega = \omega_0 + \alpha t, \text{ we get}$
$$t = \frac{\omega - \omega_0}{\alpha} = \frac{50 - 0}{25} = 2\text{s}.$$

(OR)

a. Using the expression of power and K.E. of rotational motion, derive the relation $\tau = I\alpha$.

Answer:

As we know that power is given by

Also, we know that,

$$\text{K.E.} = \frac{1}{2} I \omega^2 \dots\dots\dots\text{(ii)}$$

Now, the power of rotational motion is equal to time rate of work done during the rotational motion. Since the work done is stor in the form of kinetic energy,

$$p = \frac{d}{dt} (\text{K.E. of rotational motion})$$

Using the equations (i) and (ii), we have,

$$\begin{aligned} \tau(\omega) &= \frac{d}{dt} \left(\frac{1}{2} I (\omega)^2 \right) = \frac{1}{2} I \frac{d}{dt} (\omega^2) \\ &= \frac{1}{2} \times I \times 2\omega \frac{d\omega}{dt} \\ &= I\omega\alpha \quad \left(\because \frac{d\omega}{dt} = \alpha \right) \end{aligned} \quad \dots \text{ (iii)}$$

From (i) and (iii), we get:

$$\begin{aligned} \tau\omega &= I\omega\alpha \\ \tau &= I\alpha. \end{aligned}$$

b.What are the important features of angular momentum?

Answer:

The following are the important features of angular momentum-

1. The angular momentum of a particle with respect to a point provides an idea of the strength of its rotational tendency about the point.
2. The magnitude of the angular momentum can be defined in terms of mass and velocity of the particle and its distance from the reference point i.e. $L = mvr$.
3. The vector concept of angular momentum is important and useful. Its direction is the axial direction portrayed by the right-handed rule.

38. If the Earth has a mass 9 times and a radius twice of the planet Mars, calculate the minimum velocity required by a rocket to pull out of the gravitational force of Mars. Escape velocity on the surface of Earth is 11.2 km s^{-1} .

Answer:

Let M_m and R_m be the mass and radius of Mars,
and M_e, R_e = mass and radius of Earth.

Also, let v_e and v_m be the escape velocities from Earth and Mars respectively.

$$\begin{aligned}
 \therefore v_e &= \sqrt{\frac{2GM}{R}} \\
 \text{and } v_m &= \sqrt{\frac{2GM_m}{R_m}} \\
 \text{Now } M &= 9 M_m \\
 R &= 2 R_m \\
 v_e &= 11.2 \text{ kms}^{-1} \\
 \therefore 11.2 &= \sqrt{\frac{2 \times G \times 9M_m}{2R_m}} \\
 &= \frac{3}{\sqrt{2}} \sqrt{\frac{GM_m}{R_m}} = \frac{3}{\sqrt{2}} v_m \\
 \text{or } v_m &= \frac{11.2}{3} \times \sqrt{2} = \frac{11.2 \times 1.414}{3} \\
 &= 5.279 \text{ kms}^{-1}
 \end{aligned}$$

(OR)

a. Show that Kepler's Second law is the law of conservation of angular momentum.

Answer:

The second law states that the areal velocity is constant i.e. area covered by the radius vector is the same in equal intervals of time. If the velocity and radius at the time, t_1 is v_1 and r_1 while at another place these are v_2 and r_2 in the same time, then the area covered by the planet in these intervals are

$$\frac{1}{2} v_1 r_1 \text{ and } \frac{1}{2} v_2 r_2.$$

$$\therefore \frac{1}{2} m v_1 r_1 = \frac{1}{2} m v_2 r_2$$

$$(\text{Area of triangle} = \frac{1}{2} \text{ base} \times \text{height})$$

$$\text{So that, } \frac{1}{2} v_1 r_1 = \frac{1}{2} v_2 r_2$$

$$\text{or } m v_1 r_1 = m v_2 r_2$$

$$\text{or } L_1 = L_2$$

This shows that the law leads to the conservation of angular momentum law.

b. Why the atmosphere of Jupiter contains light gases (generally hydrogen) whereas the Earth's atmosphere has little hydrogen gas?

Answer:

The escape velocity of Jupiter is much larger than the escape velocity of Earth. So to escape from the surface of Jupiter, a very large velocity is required. Since the thermal velocity of hydrogen gas molecules is lesser than the escape velocity of Jupiter, therefore hydrogen can't escape from the surface of Jupiter.

SECTION-E

Momentum of a body is defined to be the product of its mass m and velocity v , and is denoted by p :

$$\mathbf{p} = \mathbf{m} \times \mathbf{v}$$

Momentum is clearly a vector quantity. SI unit is kg m/s . The following common experiences indicate the importance of this quantity for considering the effect of force on motion. Suppose a light-weight vehicle (say a small car) and a heavy weight vehicle (say a loaded truck) is parked on a horizontal road. We all know that a much greater force is needed to push the truck than the car to bring them to the same speed in same time. Similarly, a greater opposing force is needed to stop a heavy body than a light body in the same time, if they are moving with the same speed.

- If two stones, one light and the other heavy, are dropped from the top of a building, a person on the ground will find it easier to catch the light stone than the heavy stone. The mass of a body is thus an important parameter that determines the effect of force on its motion.
- Speed is another important parameter to consider. A bullet fired by a gun can easily pierce human tissue before it stops, resulting in casualty. The same bullet fired with moderate speed will not cause much damage. Thus for a given mass, the greater the speed, the greater is the opposing force needed to stop the body in a certain time. Taken together, the product of mass and velocity, that is momentum, is evidently a relevant variable of motion. The greater the change in the momentum in a given time, the greater is the force that needs to be applied.

1) SI unit of momentum is

- Kg m/s
- Kg m/s^2
- m/s^2
- None of these

2) Momentum is

- a) Scalar quantity
- b) Vector quantity

3) Define momentum. Give its SI unit.

4) Explain with example how mass of body is important for determining effect of force on its motion?

5) Explain with example how speed is important for determining effect of force on its motion?

Answers:

- 1. a
- 2) b

3) Momentum of a body is defined to be the product of its mass m and velocity v , and is denoted By p :

$$P = m \times v$$

Momentum is clearly a vector quantity. SI unit is kg m/s .

4) If two stones, one light and the other heavy, are dropped from the top of a building, a person on the ground will find it easier to catch the light stone than the heavy stone. The mass of a body is thus an important parameter that determines the effect of force on its motion.

5) Speed is important parameter to consider. A bullet fired by a gun can easily pierce human tissue before it stops, resulting in casualty. The same bullet fired with moderate speed will not cause much damage. Thus for a given mass, the greater the speed, the greater is the opposing force needed to stop the body in a certain time.

The centre of mass of a body or a system of bodies is the point which moves as though all of the mass were concentrated there and all external forces were applied to it. Hence, a point at which the entire mass of the body or system of bodies is supposed to be concentrated is known as the centre of mass.

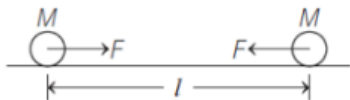
If a system consists of more than one particle (or bodies) and net external force on the system in a particular direction is zero with centre of mass at rest. Then, the centre of mass will not move along that direction. Even though some particles of the system may move along that direction.

(i) Two bodies of masses 1 kg and 2 kg are lying in xy-plane at (-1, 2) and (2, 4), respectively. What are the coordinates of the centre of mass?

- (a) $1, 10/3$
- (b) (1,0)
- (c) (0,1)
- (d) None of these

(i) Answer: (a)

(ii) Two balls of same masses start moving towards each other due to gravitational attraction, if the initial distance between them is L . Then, they meet at



- (a) $L/2$
- (b) L
- (c) $L/3$
- (d) $L/4$

Answer: (a)

(iii) The centre of mass of a system of two particles divides, the distance between them

- (a) in inverse ratio of square of masses of particles
- (b) in direct ratio of square of masses of particles
- (c) in inverse ratio of masses of particles
- (d) in direct ratio of masses of particles

Answer: (c)

(iv) Two particles A and B initially at rest move towards each other under a mutual force of attraction. At the instant, when the speed of A is v and the speed of B is $2v$, the speed of centre of mass of the system is

- (a) zero
- (b) v
- (c) $1.5 v$
- (d) $3v$

Answer: (a)

(v) All the particles of a body are situated at a distance R from the origin. The distance of centre of mass of the body from the origin is

(a) $= R$

(b) $\leq R$

(c) $> R$

(d) $\geq R$

Answer: (b)