

## Laws Of Motion

### Very Short Answer Type Questions

1. A girl riding a bicycle along a straight road with a speed of  $5 \text{ m s}^{-1}$  throws a stone of mass  $0.5 \text{ kg}$  which has a speed of  $15 \text{ m s}^{-1}$  with respect to the ground along her direction of motion. The mass of the girl and bicycle is  $50 \text{ kg}$ . Does the speed of the bicycle change after the stone is thrown? What is the change in speed, if so?
2. A person of mass  $50 \text{ kg}$  stands on a weighing scale on a lift. If the lift is descending with a downward acceleration of  $9 \text{ m s}^{-2}$ , what would be the reading of the weighing scale? ( $g = 10 \text{ m s}^{-2}$ )
3. The position time graph of a body of mass  $2 \text{ kg}$  is as given in Fig. 5.4. What is the impulse on the body at  $t = 0 \text{ s}$  and  $t = 4 \text{ s}$ .

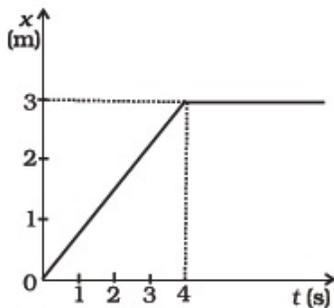


Fig. 5.4

4. A person driving a car suddenly applies the brakes on seeing a child on the road ahead. If he is not wearing seat belt, he falls forward and hits his head against the steering wheel. Why?
5. The velocity of a body of mass  $2 \text{ kg}$  as a function of  $t$  is given by  $\mathbf{v}(t) = 2t \hat{\mathbf{i}} + t^2 \hat{\mathbf{j}}$ . Find the momentum and the force acting on it, at time  $t = 2\text{s}$ .
6. A block placed on a rough horizontal surface is pulled by a horizontal force  $F$ . Let  $f$  be the force applied by the rough surface on the block. Plot a graph of  $f$  versus  $F$ .
7. Why are porcelain objects wrapped in paper or straw before packing for transportation?
8. Why does a child feel more pain when she falls down on a hard cement floor, than when

she falls on the soft muddy ground in the garden?

9. A woman throws an object of mass 500 g with a speed of  $25 \text{ m s}^{-1}$ .

- (a) What is the impulse imparted to the object?
- (b) If the object hits a wall and rebounds with half the original speed, what is the change in momentum of the object?

10. Why are mountain roads generally made winding upwards rather than going straight up?

### Short Answer Type Questions

1. A mass of 2 kg is suspended with thread AB (Fig. 5.5). Thread CD of the same type is attached to the other end of 2 kg mass. Lower thread is pulled gradually, harder and harder in the downward direction so as to apply force on AB. Which of the threads will break and why?

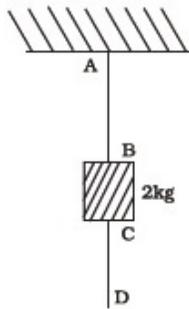


Fig. 5.5

2. In the above given problem if the lower thread is pulled with a jerk, what happens?
3. Two masses of 5 kg and 3 kg are suspended with help of massless inextensible strings as shown in Fig. 5.6. Calculate  $T_1$  and  $T_2$  when whole system is going upwards with acceleration =  $2 \text{ m s}^{-2}$  (use  $g = 9.8 \text{ m s}^{-2}$ ).

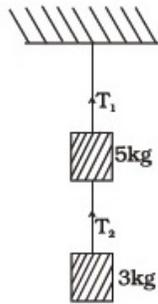


Fig. 5.6

4. Block A of weight 100 N rests on a frictionless inclined plane of slope angle  $30^\circ$  (Fig. 5.7). A flexible cord attached to A passes over a frictionless pulley and is connected to block B of weight  $W$ . Find the weight  $W$  for which the system is in equilibrium.

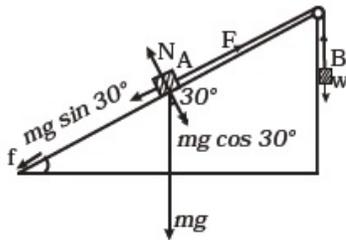


Fig. 5.7

5. A block of mass  $M$  is held against a rough vertical wall by pressing it with a finger. If the coefficient of friction between the block and the wall is  $\mu$  and the acceleration due to gravity is  $g$ , calculate the minimum force required to be applied by the finger to hold the block against the wall ?
6. A 100 kg gun fires a ball of 1kg horizontally from a cliff of height 500m. It falls on the ground at a distance of 400m from the bottom of the cliff. Find the recoil velocity of the gun. (acceleration due to gravity =  $10 \text{ m s}^{-2}$ )
7. Figure 5.8 shows  $(x, t)$ ,  $(y, t)$  diagram of a particle moving in 2-dimensions.

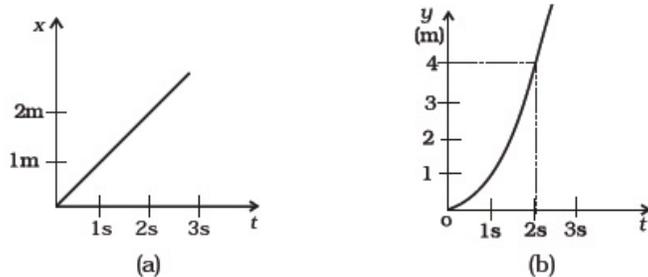


Fig. 5.8

8. If the particle has a mass of 500 g, find the force (direction and magnitude) acting on the particle.
9. A person in an elevator accelerating upwards with an acceleration of  $2 \text{ m s}^{-2}$ , tosses a coin vertically upwards with a speed of  $20 \text{ m s}^{-1}$ . After how much time will the coin fall back into his hand? ( $g = 10 \text{ m s}^{-2}$ )

### Long Answer Type Questions

1. There are three forces  $F_1$ ,  $F_2$  and  $F_3$  acting on a body, all acting on a point P on the body. The body is found to move with uniform speed.
  - (a) Show that the forces are coplanar.
  - (b) Show that the torque acting on the body about any point due to these three forces is zero
2. When a body slides down from rest along a smooth inclined plane making an angle of  $45^\circ$  with the horizontal, it takes time T. When the same body slides down from rest along a rough inclined plane making the same angle and through the same distance, it is seen to take time  $pT$ , where p is some number greater than 1. Calculate the co-efficient of friction between the body and the rough plane.
3. Figure 5.9 shows  $(v_x, t)$ , and  $(v_y, t)$  diagrams for a body of unit mass. Find the force as a function of time.

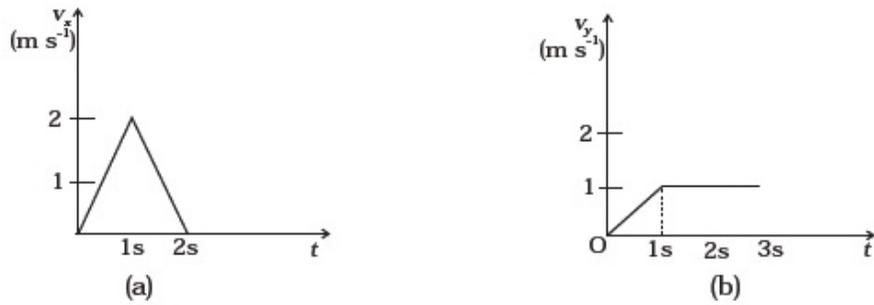


Fig. 5.9

4. A racing car travels on a track (without banking) ABCDEFA (Fig. 5.10). ABC is a circular arc of radius  $2R$ . CD and FA are straight paths of length  $R$  and DEF is a circular arc of radius  $R = 100$  m. The co-efficient of friction on the road is  $\mu = 0.1$ . The maximum speed of the car is  $50 \text{ m s}^{-1}$ . Find the minimum time for completing one round.

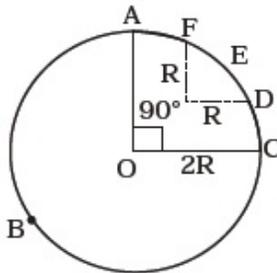


Fig. 5.10

The displacement vector of a particle of mass  $m$  is given by  $\mathbf{r}(t) = \hat{\mathbf{i}}A \cos \omega t + \hat{\mathbf{j}}B \sin \omega t$ .

5.  (a) Show that the trajectory is an ellipse.  
 (b) Show that  $F = -m\omega^2 r$ .
6. A cricket bowler releases the ball in two different ways  
 (a) giving it only horizontal velocity, and  
 (b) giving it horizontal velocity and a small downward velocity.

7. The speed  $v_s$  at the time of release is the same. Both are released at a height  $H$  from the ground. Which one will have greater speed when the ball hits the ground? Neglect air resistance.
8. There are four forces acting at a point  $P$  produced by strings as shown in Fig. 5.11, which is at rest. Find the forces  $F_1$  and  $F_2$  .

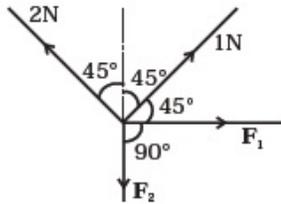


Fig. 5.11

9. A rectangular box lies on a rough inclined surface. The co-efficient of friction between the surface and the box is  $\mu$ . Let the mass of the box be  $m$ .
- (a) At what angle of inclination  $\theta$  of the plane to the horizontal will the box just start to slide down the plane?
  - (b) What is the force acting on the box down the plane, if the angle of inclination of the plane is increased to  $\alpha > \theta$  ?
  - (c) What is the force needed to be applied upwards along the plane to make the box either remain stationary or just move up with uniform speed?
  - (d) What is the force needed to be applied upwards along the plane to make the box move up the plane with acceleration  $a$ ?
10. A helicopter of mass 2000 kg rises with a vertical acceleration of  $15 \text{ m s}^{-2}$ . The total mass of the crew and passengers is 500 kg. Give the magnitude and direction of the ( $g = 10 \text{ m s}^{-2}$ )
- (a) force on the floor of the helicopter by the crew and passengers.
  - (b) action of the rotor of the helicopter on the surrounding air.
  - (c) force on the helicopter due to the surrounding air.