1 PUC - CHAPTER 05
LAWS OF MOTION

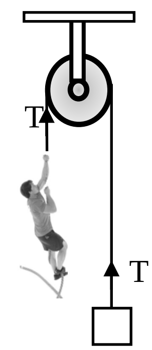
1. Three forces are acting on a particle of mass 'm' initially in equilibrium. If the first two forces (R_1 and R_2) are perpendicular to each other and suddenly the third force (R_3) is removed, then the acceleration of the particle is

(a) $\frac{R_3}{m}$ (b) $\frac{R_1+R_2}{m}$ (c) $\frac{R_1-R_2}{m}$ (d) $\frac{R_1}{m}$

2. 'n' balls each of mass 'm' impinge elastically each second on a surface with velocity u. The average force experienced by the surface will be

(a) mnu (b) $2mnu$ (c) $4mnu$ (d) $mnu/2$

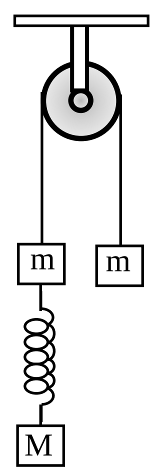
3. In order to raise a mass of 100 kg, a man of mass 60 kg fastens a rope to it and passes the rope over a smooth pulley. He climbs the rope with acceleration 5g/4 relative to the rope. The tension in the rope is (take $g=10\,ms^{-2}$)



(a) $\frac{4875}{8}N$ (b) $\frac{4875}{2}N$

(c) $\frac{4875}{4}N$ (d) $\frac{4875}{6}N$

4. The system shown in figure is released from rest. The spring gets elongated

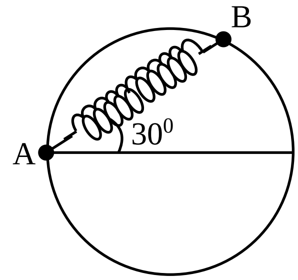


(a) If M > m
(b) If M > 2m
(c) If M > m/2
(d) For any value of M
(Neglect the friction and masses of pulley, string and spring)

5. A body A traveling at 5m/s collides with a body B at rest and sticks to it. If their common vel ocity after impact is 3m/s in the same direction. The ratio of masses of A and B is

(a) 3:2 (b) 2:3 (c) 5:3 (d) 3:5

6. A bead of mass m is attached to one end of a spring of natural length R and spring constant $K = \frac{(\sqrt{3}+1)mg}{R}$. The other end of the spring is fixed at a point A on a smooth vertical ring of radius R as shown in figure. The normal reaction at B just after it is released to move is



(a) $\frac{mg}{2}$ (b) $\sqrt{3}mg$

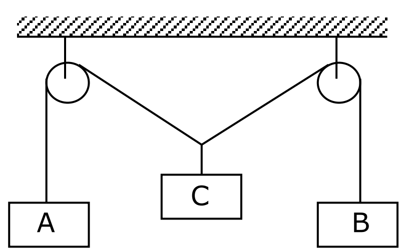
(c) $3\sqrt{3}mg$ (d) $\frac{3\sqrt{3}mg}{2}$

7. A shell of mass 40kg moving at 80m/s explodes into 2 pieces. The 32kg piece comes to rest. The velocity of the other piece is
(a) 400m/s (b) 64m/s (c) 800m/s (d) Zero

8. A uniform chain of length ℓ is lying on the table. If coefficient of friction between chain and table top is μ. What maximum length of the chain that can hang over the edge of the table without disturbing the rest of the chain on the table?
(a) $\frac{\mu\ell}{1+\mu}$ (b) $\frac{\ell}{1+\mu}$ (c) $\frac{\mu\ell}{1-\mu}$ (d) $\frac{\ell}{1-\mu}$

9. A particle of mass 2 kg moves with an initial velocity of $\vec{v} = 4\hat{i} + 4\hat{j}\,ms^{-1}$. A constant force of $\vec{F} = 20\hat{j}\,N$ is applied on the particle. Initially, the particle was at (0, 0). The x-coordinate of the particle when its y-coordinate again becomes zero is given by
(a) 1.2 m (b) 4.8 m (c) 6.0 m (d) 3.2 m

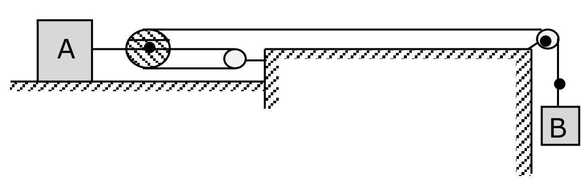
10. Three blocks A, B and C are suspended as shown in figure. Mass of each of blocks A and B is m. If the system is in equilibrium and mass of C is M, then



(a) $M > 2m$ (b) $M = 2m$

(c) $M < 2m$ (d) none of these

11. A block A has a velocity of $0.6\,ms^{-1}$ to the right. Determine the velocity of block B.



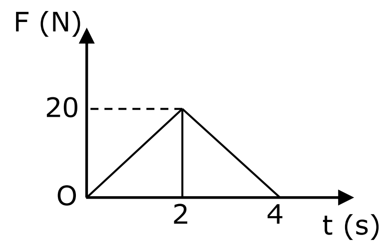
(a) $1.2\,ms^{-1}$ (b) $2.4\,ms^{-1}$

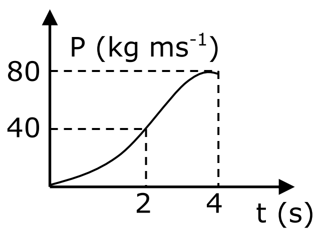
(c) $1.8\,ms^{-1}$ (d) $3.6\,ms^{-1}$

12. A car is moving along a straight horizontal road with the speed of v. If the coefficient of friction between the tyres and the road is μ, the shortest distance in which the car can be stopped is

(a) $\frac{v^2}{2\mu g}$ (b) $\frac{v^2}{\mu g}$ (c) $\left(\frac{v}{\mu g}\right)^2$ (d) $\frac{v^2}{\mu}$

13. Figure shows the variation of force acting on a body with time. Assuming the body to start from rest, the variation of its momentum with time is best represented by which plot?



(a)


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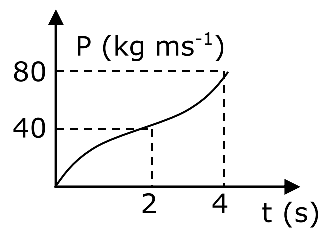
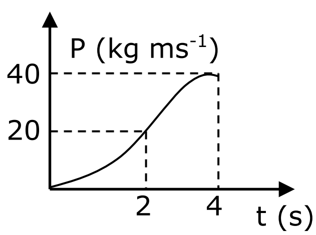
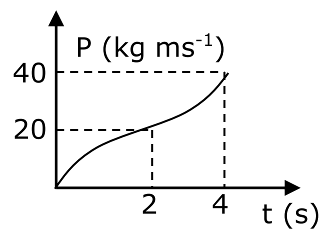


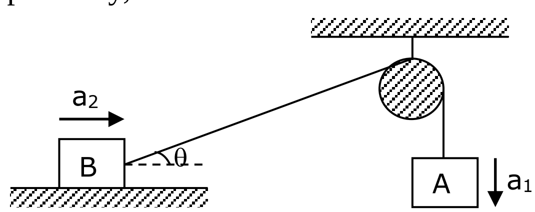
(c)


(d)


14. Figure shows two blocks, each of mass m. The system is released from rest. If the acceleration of blocks A and B at any instant (not initially) are a_1 and a_2 respectively, then

(a) $a_1 = a_2 \cos\theta$ (b) $a_2 = a_1 \cos\theta$

(c) $a_1 = a_2$ (d) none of these



15. A box of mass 8 kg is placed on a rough inclined plane of inclination θ. Its downward motion can be prevented by applying an upward pull F and it can be made to slide upwards by applying a force 2F. The coefficient of friction between the box and the inclined plane is

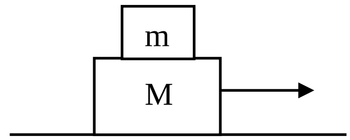
(a) $\frac{\tan\theta}{3}$ (b) $3\tan\theta$ (c) $\frac{\tan\theta}{2}$ (d) $2\tan\theta$

16. The upper half of an inclined plane with inclination ϕ is perfectly smooth while the lower half is rough. A body starting from rest at the top will again come to rest at the bottom if the coefficient of friction for the lower half is given by

(a) $2\tan\phi$ (b) $\tan\phi$ (c) $2\sin\phi$ (d) $2\cos\phi$

17. A block of mass m is placed on another block of mass M, which itself is lying on a horizontal surface. The coefficient of friction between two blocks is μ_1 and that between the block of mass M and horizontal surface is μ_2. What maximum horizontal force can be applied to the lower block so that the two blocks move without separation?

(a) $(M+m)(\mu_2-\mu_1)g$
(b) $(M-m)(\mu_2-\mu_1)g$
(c) $(M-m)(\mu_2+\mu_1)g$
(d) $(M+m)(\mu_2+\mu_1)g$



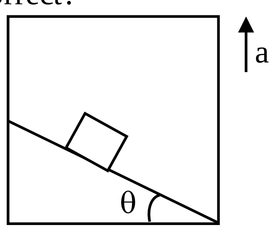
18. A wooden block of mass M resting on a rough horizontal floor is pulled with a force F at an angle ϕ with the horizontal. If μ is the coefficient of kinetic friction between the block and the surface, then the acceleration of the block is

(a) $\frac{F}{M}(\cos\phi-\mu\sin\phi)-\mu g$ (b) $\frac{\mu F}{M}\cos\phi$
(c) $\frac{F}{M}(\cos\phi+\mu\sin\phi)-\mu g$ (d) $\frac{F}{M}\sin\phi$

19. A given object takes n times to slide down 45° rough inclined plane it takes to slide down a perfectly smooth 45° incline. The coefficient of kinetic friction between the object and the incline is

(a) $\sqrt{\frac{1}{1-n^2}}$ (b) $\sqrt{1-\frac{1}{n^2}}$ (c) $1-\frac{1}{n^2}$ (d) $\sqrt{\frac{1}{2-n^2}}$

20. A block of mass m is at rest with respect to a rough incline kept in elevator moving up with acceleration a. Which of following statements is correct?

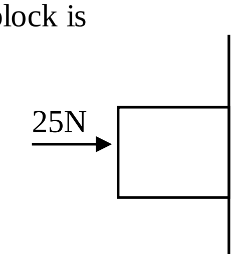


(a) The contact force between block and incline is parallel to the incline.
(b) The contact force between block and incline is of the magnitude $m(g+a)$.
(c) The contact force between block and incline is perpendicular to the incline.
(d) The contact force is of the magnitude $mg\cos\theta$

21. A horizontal force of 25 N necessary to just hold a block stationary against a wall. The coefficient of friction between the block and the wall is 0.4. The weight of the block is

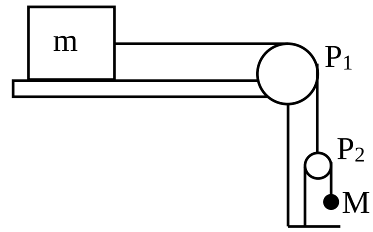
(a) 2.5 N (b) 20 N

(c) 10 N (d) 5 N



22. A circular road of radius 1000m has banking angle 45°. The maximum safe speed (in ms^{-1}) of a car having a mass 2000 kg will be (Coefficient of friction between tyre and road = 0.5) (g = 10 m/s^2)
(a) 173 (b) 124 (c) 99 (d) 86

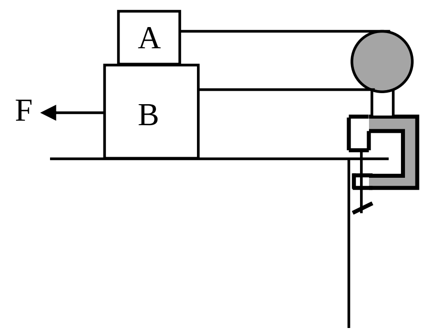
23. In the pulley arrangement shown in figure, the pulley P_2 is movable. Assuming the coefficient of friction between m and surface to be μ, the minimum value of M for which m is at rest is



(a) $M = \frac{\mu m}{2}$ (b) $m = \frac{\mu M}{2}$

(c) $M = \frac{m}{2\mu}$ (d) $m = \frac{M}{2\mu}$

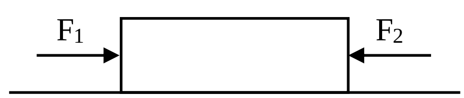
24. Block A, as shown in figure weighs, 2.0 N and block B weighs 6.0 N. The coefficient of kinetic friction between all surfaces is 0.25. Find the magnitude of the horizontal force necessary to drag block B to the left at constant speed if A and B are connected by a light, flexible cord passing around a fixed, frictionless pulley.



(a) 2 N (b) 3 N

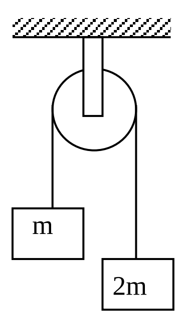
(c) 5 N (d) 6 N

25. Figure shows a wooden block at rest in equilibrium on a rough horizontal plane being acted upon by force $F_1 = 10\,N$, $F_2 = 2\,N$ as shown. If F_1 is removed, the resultant force acting on the block will be



(a) 2 N towards left
(b) 2N towards right
(c) 0 N
(d) cannot be determined.

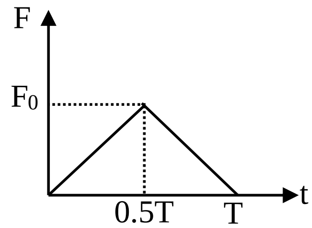
26. Two masses m and 2m are joined to each other by means string passing over a frictionless pulley as shown in figure. When the mass 2m is released, the mass m will ascend with an acceleration of



(a) $\frac{g}{3}$
(b) $\frac{g}{2}$
(c) g
(d) 2 g

27. A block of mass M is pulled along a horizontal frictionless surface by a rope of mass m. If a force F is applied at the free end of the rope, the net force exerted on the block will be
a) $\frac{FM}{(M+m)}$ b) $\frac{Fm}{(M+m)}$ c) $\frac{FM}{(M-m)}$ d) F

28. A ball of mass 'm' moving with a velocity 'u' rebounds from a wall. The collision is assumed to be elastic and the force of intersection between the ball and wall varies as shown in figure. Then the value of F_0 is

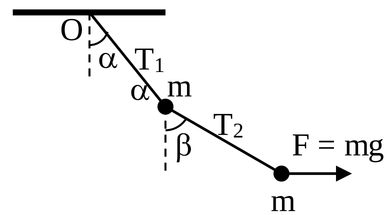


(a) $\frac{mu}{T}$ (b) $\frac{2mu}{T}$ (c) $\frac{4mu}{T}$ (d) $\frac{mu}{2T}$

29. Two particles A and B, each of mass m, are kept stationary by applying a horizontal force F = mg on particle B as shown in figure. If T_1 and T_2 are tension in the strings, then

(a) $2\tan\beta = \tan\alpha$ (b) $2T_1 = 5T_2$

(c) $T_1\sqrt{2} = T_2\sqrt{5}$ (d) none of these



30. A block is placed on the top of a smooth inclined plane of inclination θ kept on the floor of a lift. When the lift is descending with a retardation a, the block is released. The acceleration of the block relative to the incline is

(a) g sin θ (b) a sin θ (c) (g – a) sin θ (d) (g + a) sin θ

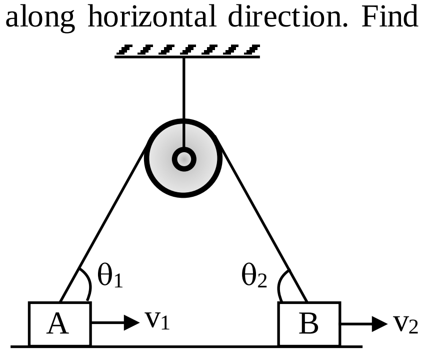
31. A balloon of mass M is descending at a constant acceleration α. When a mass m is released from the balloon, it starts rising with the same acceleration α. Assuming that its volumes does not change, what is the value of m?

(a) $\frac{\alpha}{\alpha+g}M$ (b) $\frac{2\alpha}{\alpha+g}M$ (c) $\frac{\alpha+g}{\alpha}M$ (d) $\frac{\alpha+g}{2\alpha}M$

32. A person is sitting facing the engine in a moving train. He tosses a coin. The coin falls behind him. This shows that the train is

(a) moving forward with a finite acceleration
(b) moving forward with a finite retardation
(c) moving backward with a uniform speed
(d) moving forward with a uniform speed.

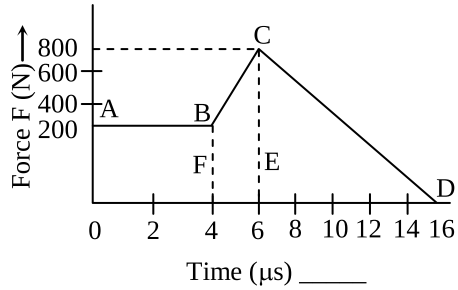
33. In figure, blocks A and B moves with velocities v_1 and v_2 along horizontal direction. Find the ratio of v_1/v_2.



(a) $\frac{\sin\theta_1}{\sin\theta_2}$ (b) $\frac{\sin\theta_2}{\sin\theta_1}$

(c) $\frac{\cos\theta_2}{\cos\theta_1}$ (d) $\frac{\cos\theta_1}{\cos\theta_2}$

34. The magnitude of the force (in Newtons) acting on a body varies with time t (in microseconds) as shown in fig. AB, BC, and CD are straight line segments. The magnitude of the total impulse of the force on the body from t = 4 μs to t = 16 μs is ....N-s.



(a) 5×10^{-4} N.s (b) 5×10^{-3} N.s (c) 5×10^{-5} N.s (d) 5×10^{-2} N.s

35. An aeroplane of mass M requires a speed v for take off. The length of the runway is s and the coefficient of friction between the tyres and the ground is μ. Assuming that the plane accelerates uniformly during the take-off, the minimum force required by the engine of the plane for take-off is given by

(a) $M\left(\frac{v^2}{2s} + \mu g\right)$ (b) $M\left(\frac{v^2}{2s} - \mu g\right)$ (c) $M\left(\frac{2v^2}{s} + 2\mu g\right)$ (d) $M\left(\frac{2v^2}{s} - 2\mu g\right)$

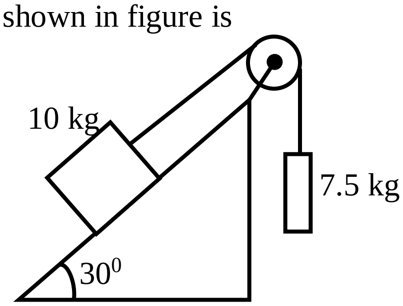
36. A car, moving at a speed of 54 km/h, is to go round a curved road of radius 30 m. If the curved road is not banked, what must be the coefficient of friction between the tyres and the road for the car to negotiate the curve? Take $g = 10\ m/s^2$.

(a) zero (b) 0.25 (c) 0.50 (d) 0.75

37. A rocket sanding vertically on a launch pad has to start moving up with practically zero velocity. If the initial mass of the rocket is $5 \times 10^5 kg$, then the rate of burning of the fuel should be [Take $g = 10\,ms^{-2}$ and velocity of exhaust gases = $10\,km\,s^{-1}$]

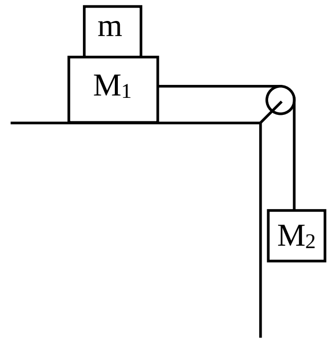
(a) $10\,kg\,s^{-1}$ (b) $50\,kg\,s^{-1}$ (c) $500\,kg\,s^{-1}$ (d) $5000\,kg\,s^{-1}$

38. The acceleration of the system shown in figure is



(a) $\frac{3.5}{17.5}g$ (b) $\frac{7.5}{17.5}g$ (c) $\frac{14.5}{17.5}g$ (d) $\frac{g}{7}$.

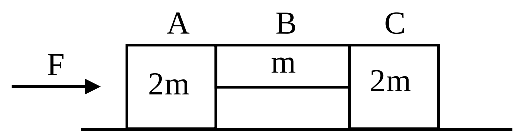
39. Two blocks of mass M_1 and M_2 are connected with a string passing over a pulley as shown in figure. The block M_1 lies on a horizontal surface. The coefficient of friction between the block M_1 and the horizontal surface is μ. The system accelerates, what additional mass m should be placed on the block M_1 so that the system does not accelerate?



(a) $\frac{M_2 - M_1}{\mu}$ (b) $\frac{M_2}{\mu} - M_1$

(c) $M_2 - \frac{M_1}{\mu}$ (d) $(M_2 - M_1)\mu$

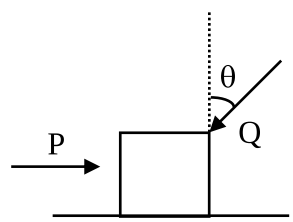
40. A system is pushed by a force F as shown in figure. All surfaces are smooth except between B and C. Friction coefficient between B and C is μ. Minimum value of F to prevent block B from downward slipping is



(a) $\left(\frac{3}{2\mu}\right)mg$ (b) $\left(\frac{5}{2\mu}\right)mg$

(c) $\left(\frac{5}{2}\right)\mu mg$ (d) $\left(\frac{3}{2}\right)\mu mg$

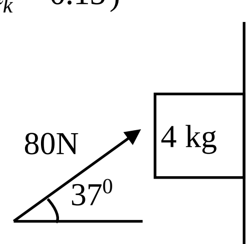
41. A block of mass m, lying on a horizontal plane, is acted upon by a horizontal force P and another force Q, inclined at an angle θ to the vertical. The block will remain in equilibrium if the coefficient of friction between it and the surface is (assume P > Q).



(a) $\frac{(P\sin\theta - Q)}{(mg - \cos\theta)}$ (b) $\frac{(P - Q\sin\theta)}{(mg + Q\cos\theta)}$

(c) $\frac{(P\cos\theta + Q)}{(mg - Q\cos\theta)}$ (d) $\frac{(P + Q\sin\theta)}{(mg + Q\cos\theta)}$

42. A block of mass 4kg is pressed against the wall by a force of 80 N as shown in figure. Determine the value of frictional force and block's acceleration (take $\mu_s = 0.2$, $\mu_k = 0.15$)



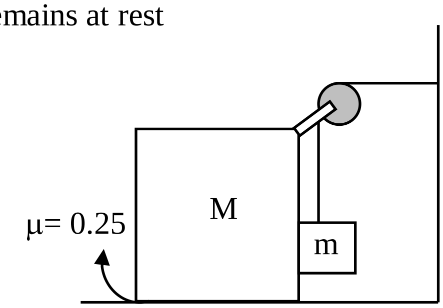
(a) 8 N, $0\,ms^{-2}$ (b) 32 N, $6\,ms^{-2}$

(c) 8 N, $6\,ms^{-2}$ (d) 32 N, $2\,ms^{-2}$

43. Two blocks (m and M) are arranged as in figure. There is friction between ground and M and other surfaces are frictionless. The coefficient of friction between ground and M is $\mu = 0.25$. The maximum ratio of m and M (m/M) so that the system remains at rest

(a) $\frac{1}{3}$ (b) $\frac{1}{4}$

(c) 3 (d) none of these



44. A truck moving at $\frac{250}{9} ms^{-1}$ carries steel girder which rests on its wooden floor. The minimum time in which the truck can come to a stop without the girder moving forward is: Given: $\mu_s = 0.5$.
(a) 3s (b) 4s (c) 5s (d) 5.7 s

45. A force vector applied on a mass is represented as $\vec{F} = 6\hat{i} - 8\hat{j} + 10\hat{k}$ and accelerates $1 ms^{-2}$. The mass of the body is (in kg)
(a) $2\sqrt{10}$ (b) $10\sqrt{2}$ (c) 10 Kg (d) 20 Kg

46. Which one of the following four statements is false?
(a) A body can have zero velocity and still be accelerated
(b) A body can have a constant speed and still have a varying velocity
(c) The direction of the velocity of a body can change when its acceleration is constant
(d) A body can have a constant velocity and still have a varying speed

47. Two boys weighing 40 kg and 50 kg stand facing each other on roller skates. The first boy is pushing away the second boy with a force of 10 N. the acceleration of the first and second boys are respectively (in ms^{-2})
(a) 0.25 and 0.25 (b) 0.2 and 0.2 (c) 0.25 and 0.2 (d) 0.2 and 0.25

48. A man weighing 70 kg is standing on a weighing scale in a lift at rest. If the lift moves upwards with an acceleration g, the reading on the scale is
(a) zero (b) 70 kg (c) 686 kg (d) 140 kg

49. A shell explodes into 3 pieces of equal masses. Two fragments fly off at right angles to each other with a speed of 9 and 12m/s respectively. The speed of the third fragments is
(a) 9m/s (b) 12m/s (c) 15m/s (d) 18m/s

50. Two billiard balls each of mass 50g moving in opposite directions each with a speed of 6m/s collide and rebound with the same speed. The impulse imparted to each ball due to the other is
(a) 0.3Ns (b) 0.6Ns (c) 0.9Ns (d) Zero