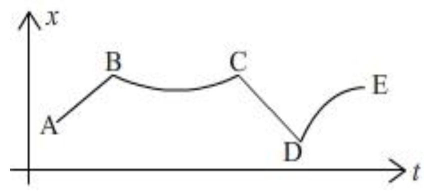
Laws of motion

Objective : Further applications of Newton's laws of motion for deeper understanding

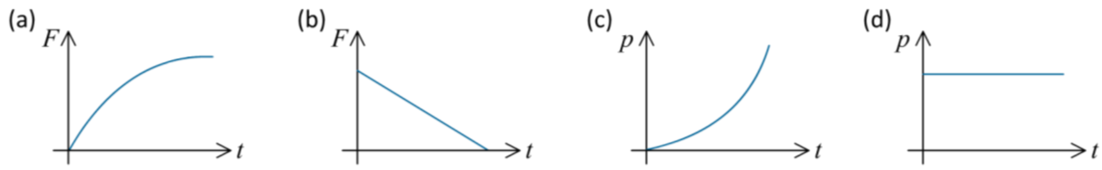
Only one option correct

1. Consider the plot of displacement of a particle (moving along the x-axis) as a function of time. The force acting on the particle is zero in the region(s)



a) AB & CD b) BC & DE
c) AB & DE d) DE

2. Which of the following statements is incorrect for the graphs given below?



a) Graphs (a) and (c) indicate an increasing force acting on the body
b) Momentum of the body decreases for the force given in graph (b)
c) Force acting on the body is zero for graph (d)
d) Momentum of the body increases in graphs (a), (b) and (c)

3. When forces $\overline{F_1}, \overline{F_2}, \overline{F_3}, \overline{F_4}...$ act on a particle the particle remains at rest in equilibrium. If $\overline{F_1}$ is removed the acceleration of the particle is

a) $\frac{\overline{F_1}}{m}$ b) $-\frac{\overline{F_1}}{m}$ c) $\frac{\overline{F_2}+\overline{F_3}...\overline{F_n}-\overline{F_1}}{m}$ d) $\frac{\overline{F_2}}{m}$

4. A single constant force acts along the x-axis on a stone initially at rest. The possible equation of motion of the stone is

a) $x = 5t - 3$ b) $x = -2t^2 + 6$ c) $x = 5t^2 + 3$ d) $x = 5t^2 + 4t - 3$

5. Three forces act on a particle causing it to move with a constant velocity given by $\vec{v} = (3\hat{i} - 4\hat{j})$ ms^{-1}. Two of the forces are $\vec{F_1} = (3\hat{i} + 2\hat{j} - 4\hat{k})$ N and $\vec{F_2} = (-5\hat{i} + 8\hat{j} - 3\hat{k})N$. The third force is

a) $\left(-2\hat{i} + 10\hat{j} - 7\hat{k}\right)N$ b) $\left(2\hat{i} - 10\hat{j} + 7\hat{k}\right)N$
c) $\left(7\hat{i} - 2k + 10\hat{j}\right)N$ d) zero

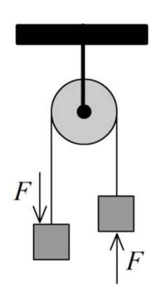
6. A person of mass 80 kg parachuting using a parachute of mass 5 kg. If his downward acceleration is 2.5ms^{-2}, upward force on the open parachute due to the air is (g = 10 ms^{-2})

a) 637.5 N b) 812.5 N c) 837.5 N d) 872.5 N

7. A block of mass m is pulled on the smooth horizontal surface with the help of two ropes, each of mass m, connected to the opposite faces of the block. The external forces applied at the free end of the ropes are F and $2F$. The net force on the block is

a) F b) $2F$ c) $F/3$ d) $3F/2$

8. Two blocks, each of mass M are connected by a massless string, which passes over a smooth massless pulley. External forces act on the blocks as shown in the figure. The tension in the string is

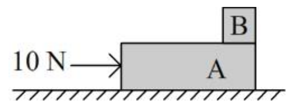


a) Mg b) $2\,Mg$ c) $Mg+F$ d) None of these

9. A uniform rope of mass M and length L, lying on a smooth table is pulled by a constant force F. Tension in the string at a point which is at a distance of l from the point of application of force is

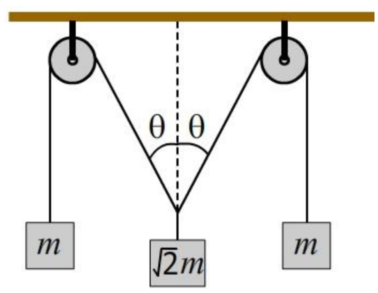
a) $F\left(1-\frac{L}{l}\right)$ b) $\left(F-\frac{l}{L}\right)$ c) $F\left(1-\frac{l}{L}\right)$ d) $F(L-l)$

10. A small block B is placed on another block A of mass 5 kg and length 20 cm. Initially block B in near the right end of block A. A constant horizontal force of 10 N is applied block A. If all surfaces are assumed to be frictionless, the time elapsed before block B separates from block A is (nearly)



a) 0.45 s b) 0.3 s c) 0.5 s d) Infinite

11. In the given figure, the pulleys and strings are assumed to be smooth and of negligible mass. For the system to be in equilibrium the value of θ should be



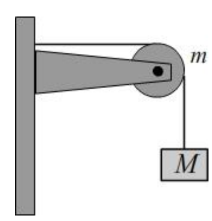
a) 0˚ b) 30˚ c) 45˚ d) 60˚

12. A car is moving along a circular horizontal track of radius 10 m with a constant speed of 10 ms^{-1} . A bob is suspended from the roof of the car using a light rigid rod. Angle made by the rod w.r.t. the vertical is

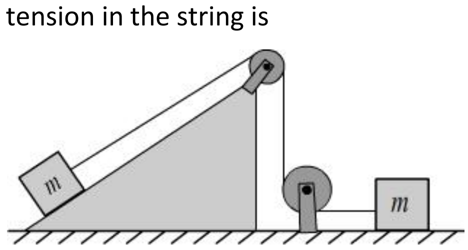
(g = 10 ms^{-2})
a) 0˚ b) 30˚ c) 45˚ d) 60˚

13. A body of mass M is connected to a rigid support using a string of negligible mass as shown in the figure. If the mass of the pulley is m, then the force exerted on the pulley by the clamp is

a) $\sqrt{2}Mg$
b) $\sqrt{2}mg$
c) $\left[\sqrt{(M+m)^2+m^2}\right]g$
d) $\left[\sqrt{(M+m)^2+M^2}\right]g$



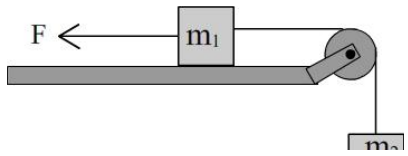
14. Consider two identical blocks connected through a string and a pulley (assumed to be of negligible mass) as shown in the figure. If the surfaces are assumed to be frictionless, and angle of inclined plane w.r.t. ground is θ then tension in the string is



a) $\frac{2}{3}mg\sin(\theta)$ b) $\frac{1}{3}mg\sin(\theta)$ c) $\frac{1}{2}mg\sin(\theta)$ d) $mg\sin(\theta)$

15. A lift is descending with an acceleration of 2 ms$^{-b)}$ A block B of mass 2.5 kg in placed on the floor of the lift and another block A of mass 0.5 kg is placed on the block B. Force exerted by A on B is (g = 10 ms^{-2})
a) 3 N b) 4 N c) 5 N d) 6 N

16. A constant force of magnitude $m_2\, g\,/2$ is applied on the block m_1 as shown in the figure. The string and the pulley are light and the surfaces in contact are assumed to be smooth. Acceleration of m_1 is



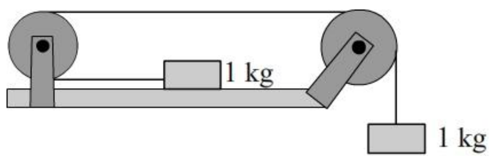
a) $\frac{m_2 g}{2(m_1+m_2)}$ towards right

b) $\frac{m_2 g}{2(m_1+m_2)}$ towards left

c) $\frac{m_1 g}{2(m_1+m_2)}$ towards right

d) $\frac{m_1 g}{2(m_1+m_2)}$ towards left

17. In the figure given below, if the pulley and the string are assumed to be of negligible mass and the surfaces in contact are frictionless, then the tension in the string is (g = 10 ms^{-2})



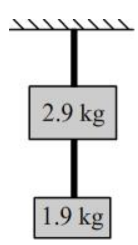
a) 2.5 N b) 5 N c) 7.5 N d) 10 N

18. Buoyant force exerted by the atmosphere on the balloon is B in the upward direction and remains constant. Force of air resistance on the balloon acts opposite to the direction of velocity and is proportional to it. The mass connected to the balloon is M. The balloon falls towards the surface of the earth with a constant velocity. To make the balloon move up with the same velocity, the mass to be removed from it is

a) $2\left(M-\frac{g}{B}\right)$ b) $\frac{1}{2}\left(M-\frac{B}{g}\right)$ c) $2\left(M-\frac{B}{g}\right)$ d) $\frac{1}{2}\left(M-\frac{g}{B}\right)$

19. A pendulum of mass 50 g is suspended from the ceiling of an elevator using a string. Consider the following statements and choose the correct options
   a) The tension in the string will be more than 0.49N if the elevator is moving up with an acceleration or moving down with deceleration
   b) The tension in the string will be less than 0.49N if the elevator is moving up with an acceleration or moving down with deceleration
   c) The tension in the string will be less than 0.49N if the elevator is moving up or down with deceleration
   d) The tension in the string will be less than 0.49N if the elevator is moving up or down with acceleration

20. Two blocks of mass 2.9 kg and 1.9 kg are suspended from a rigid support S by two inextensible wires, each of length 1m. The upper wire is assumed to be of negligible mass and the lower wire has a uniform mass of 0.2 kg per meter. The entire system is accelerated upwards with 0.2 ms$^{-b)}$ If g = 9.8 ms^{-2} then

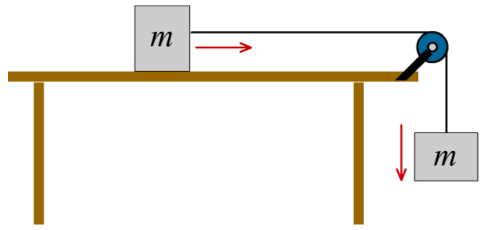


a) The tension at the midpoint of the lower wire is 20 N
b) The tension in the midpoint of the upper wire is 40 N
c) The tension at the lowest end of the lower wire is 30 N
d) The tension in the lowest of the upper wire is 20 N

21. A person is standing on a weighing machine placed on the floor of an elevator. The elevator accelerates up, moves with constant velocity for some time and decelerates to finally come to rest. The maximum and minimum weights recorded are 72 kgwt and 60 kgwt. Assuming that the magnitudes of acceleration and decelerations are same (g = 10 ms^{-2})
a) The true weight of the person is 70 kgwt
b) The magnitude of acceleration is nearly 1.9 ms^{-2}
c) Weight of the person when the lift was moving up with constant velocity is 66 kgwt

d) Weight of the person when the lift was moving up with constant velocity is zero

22. Both the blocks shown here are of mass m and are moving with constant velocity in direction shown in a resistive medium which exerts equal constant force on both blocks in direction opposite to the velocity. Tension in the string connecting the bodies is

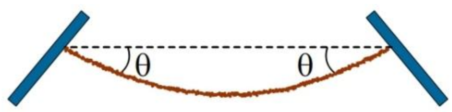


a) mg b) $mg/2$ c) $mg/3$ d) $mg/4$

23. A long carpet is laid on the ground. One end of the carpet is bent and pulled backwards with a constant velocity of 16 $ms^{-a)}$ If the mass per unit length of the carpet is 1 kg m^{-1}, the minimum force required to pull the moving part is

a) 4 N b) 8 N c) 16 N d) 128 N

24. A flexible chain of mass m hangs between two rigid supports A and B which are at the same level. The inclination of the chain w.r.t. the horizontal at the point of suspension is θ. Tension at the midpoint of the chain is



a) $\dfrac{mg}{\tan(\theta)}$ b) $\dfrac{mg}{2\tan(\theta)}$ c) zero d) $\dfrac{mg[\sin(\theta)+\cos(\theta)]}{2}$

25. A rope of mass 5 kg, held vertically, is subjected to an upward force of 100 N acting at the upper end and a downward force of 70 N acting at the lower end. Tension at midpoint of the rope is

a) 10 N b) 85 N c) 75N d) 105 N

Answers

1. a
2. b
3. b
4. c
5. b
6. a
7. c
8. a
9. c
10. a
11. c
12. c
13. d
14. c
15. b
16. a
17. b
18. c
19. a
20. a
21. c
22. b
23. d
24. b
25. b