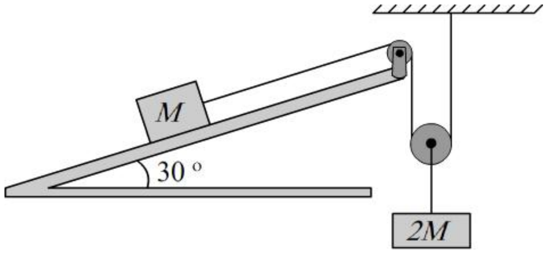
Objective : Further applications of Newton's laws of motion for deeper understanding

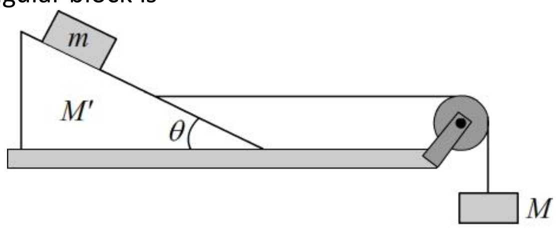
Only one option correct

1. In the given figure, if all the surfaces are assumed to be frictionless and strings and pulleys are assumed to be of negligible mass then, the acceleration of the body of mass M is



a) $g/3$ up the plane
b) $g/3$ down the plane
c) g up the plane
d) g down the plane

2. In the given figure, if all the surfaces are assumed to be frictionless and strings and pulleys are assumed to be negligible mass then, the value of M that will prevent the smaller block of mass m from slipping on the triangular block is



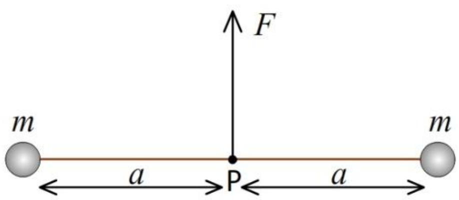
a) $\dfrac{M'}{\cot(\theta)-1}$

b) $\dfrac{m}{\cot(\theta)-1}$

c) $\dfrac{M'-m}{\cot(\theta)-1}$

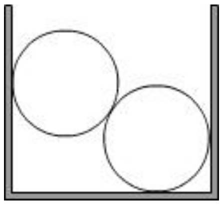
d) $\dfrac{M'+m}{\cot(\theta)-1}$

3. Two particles, each of mass m are tied at the ends of a light string of length $2a$. The whole system is kept on a frictional horizontal surface such that the string is tight and each mass is at a distance of a from the point P as shown in the figure. Now the midpoint of the string is pulled vertically up with a small but constant force F, as a result of which the particles begin to move closer. Magnitude of the acceleration when the distance of separation between them is $2x$ is



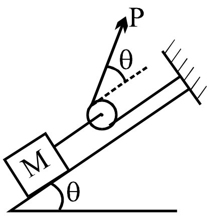
a) $\frac{F}{2m}\frac{a}{\sqrt{a^2 - x^2}}$ b) $\frac{F}{2m}\frac{x}{\sqrt{a^2 - x^2}}$ c) $\frac{F}{2m}\frac{x}{a}$ d) $\frac{F}{2m}\frac{\sqrt{a^2 - x^2}}{x}$

4. Two identical spheres of radius 10 cm each are placed between two rigid vertical walls as shown in the figure. The spacing between the walls is 36 cm. If the weight of each sphere is W, the contact force between them is



a) 1.67 W b) 1.25 W c) 1.33 W d) 0.75 W

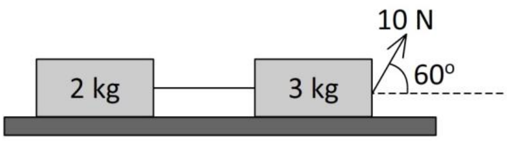
5. The minimum force P to be applied to the string so that block of mass M just begins to move up the frictionless plane is



a) Mg tan(θ)/2 b) Mg tan(θ)/2
c) Mg cos(θ)/(1 + sin(θ)) d) Zero

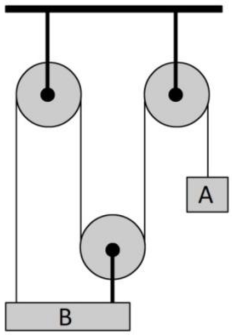
6. A particle moves in xy - plane under the influence of a force such that its linear momentum is $\boldsymbol{p}(t) = A\left[\cos(kt)\hat{i} - \sin(kt)\hat{j}\right]$, where A and k are constants. Angle between force and momentum is
a) 0^0 b) 30^0 c) 45^0 d) 90^0

7. If the contact between blocks and the ground is smooth then, tension in the string connecting the blocks shown in the figure below is



a) 2 N b) 3 N c) 5 N d) 10 N

8. In the arrangement shown in the figure below, if the acceleration of block B is a, then the acceleration of block A in magnitude will be



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

9. A body of mass 5 kg starts from the origin with an initial velocity $\vec{u} = 30\hat{i} + 40\hat{j}\, ms^{-1}$. If a constant force $\vec{F} = -(\hat{i} + 5\hat{j})\, N$ acts on the body, the time in which the y - component of the velocity becomes zero is

a) 5 s b) 20 s c) 40 s d) 80 s

10. Uniform force $\bar{F}_1$ acts for time interval t_1 on a particle initially at rest. The particle is then acted upon by uniform force $\bar{F}_2$ for time interval t_2 and it comes to rest. This is possible only if

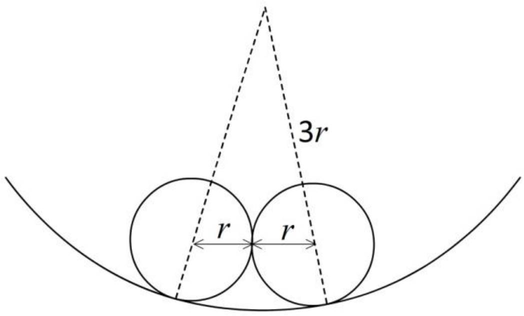
a) $\bar{F}_1 t_1 + \bar{F}_2 t_2 = 0$

b) $\vec{F}_1 t_1 + \vec{F}_2 t_2 \neq 0$ but $|\vec{F}_1| t_1 = |\vec{F}_2| t_2$

c) $\vec{F}_1 t_2 + \vec{F}_2 t_1 = 0$

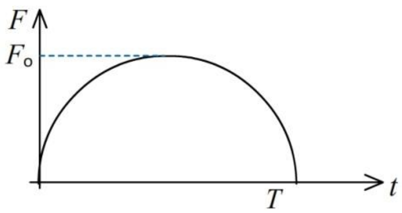
d) $\vec{F}_1 t_2 + \vec{F}_2 t_1 \neq 0$ but $|\vec{F}_1| t_2 = |\vec{F}_2| t_1$

11. Two equal heavy spheres, each of radius r, are in equilibrium within a smooth cup of radius $3r$. The ratio of reaction of cup on one of the spheres and reaction of one sphere on the other is



a) 1 b) 2 c) 3 d) None

12. A particle of mass m, initially at rest, is acted upon by a variable force F for a short interval of time T. Once the force is removed, the particle begins to move with a final velocity u. The variation of the force as a function of time is as shown in the graph (semicircular) . the Final velocity of the body is given by



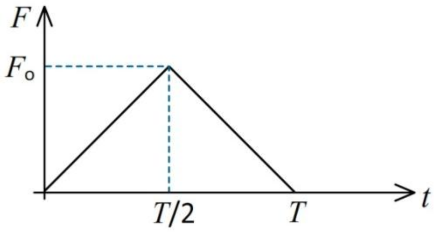
a) $\dfrac{\pi F_o^{\,2}}{2m}$

b) $\dfrac{\pi T^2}{8m}$

c) $\dfrac{\pi F_o T}{4m}$

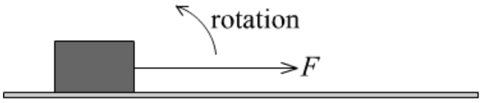
d) $\dfrac{F_o T}{2m}$

13. A particle of mass m, moving with velocity u makes an elastic one dimensional collision with a stationary particle of mass m. They are in contact for a brief interval of time T. The variation of their interaction force as a function of time is as shown in the graph. The maximum force of interaction F_o is given by



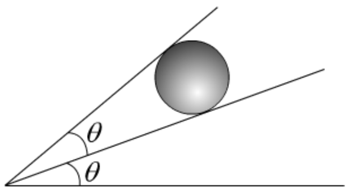
a) $\frac{mu}{T}$ b) $\frac{2mu}{T}$ c) $\frac{mu}{2T}$ d) $\frac{3mu}{\pi T}$

14. A force F of 40 N acts on a particle of mass 5 kg placed on a smooth horizontal surface. The force vector F is constant in magnitude but its direction is varied such that vector rotates in a vertical plane at an angular speed 2 rad s^{-1} If at $t = 0$, vector F is horizontal, velocity of block at $t = \pi/4\omega$ is



a) 2 b) $\sqrt{2}$ c) $\sqrt{3}$ d) $2\sqrt{2}$

15. A sphere of mass m is kept between two inclined walls, as shown in the figure. If the coefficient of friction between each wall and the sphere is zero, then the ratio of normal reaction (N_1 / N_2) offered by the walls 1 and 2 on the sphere will be

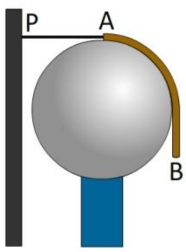


a) $2\tan(\theta)$ b) $\tan(2\theta)$ c) $2\cos(\theta)$ d) $\cos(2\theta)$

16. A ball of mass m is dropped from a height h on a smooth horizontal rigid plane. It makes an elastic collision and rises to the same height. Average force exerted by ball on the plane over a sufficiently long interval of time is

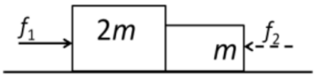
a) Zero b) mg c) Infinite d) $2mg$

17. A chain of length 1.5 m and linear density λ rests on a smooth sphere of radius $2/\pi$ such that the end A of the chain is at the top surface and the other end hangs freely. The chain held stationary by a horizontal thread. The tension in the thread is



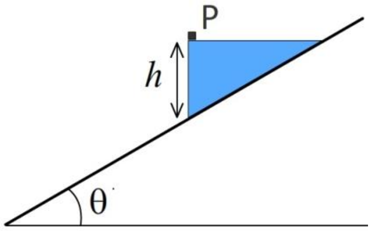
a) $\lambda g\left[\frac{1}{2}+\frac{2}{\pi}\right]$ b) $\lambda g\left[\frac{\pi}{2}+\frac{2}{\pi}\right]$ c) $\lambda g\left[\frac{2}{\pi}\right]$ d) Zero

18. Two blocks of masses m and $2m$ are placed on a smooth horizontal surface as shown. In the first case only a force f_1 is applied from left. Later on only a force f_2 is applied from right. If the force acting at the interface of the two blocks in the two cases is the same, then $f_1 : f_2$ is



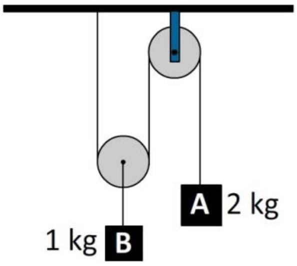
a) 1:1 b) 1:2 c) 2:1 d) 1:3

19. A wedge of height h has a particle P placed on it as shown in the figure. When released, the wedge slides down along the inclined plane. If all surfaces are smooth then the time taken for the particle to come in contact with the inclined plane is



a) $\sqrt{\frac{2h}{g\sin^2(\theta)}}$ b) $\sqrt{\frac{h}{g\sin(\theta)}}$ c) $\sqrt{\frac{2h}{g\cos(\theta)}}$ d) $\sqrt{\frac{h}{g\cos^2(\theta)}}$

20. Two blocks A and B are connected by a light inextensible string as shown in the figure. Choose the correct statements from the following



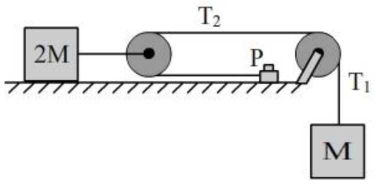
a) Acceleration of the block A is $\frac{2}{3}g$ downward

b) Acceleration of the block A is $\frac{1}{3}g$ downward

c) Acceleration of the block B is $\frac{2}{3}g$ upwards

d) Acceleration of the block B is $\frac{4}{3}g$ upwards

21. Consider the situation as shown in the figure. The pulleys and the strings are assumed to be of negligible mass and the surfaces in contact are assumed to be frictionless. P is a rigid support. Choose the correct statements from the following



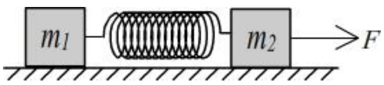
a) Acceleration of the body of mass M is $\frac{1}{3}g$

b) Tension in the string T_1 is $\frac{2Mg}{3}$

c) Tension in the string T_2 is $\frac{3Mg}{2}$

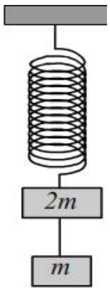
d) Force exerted by the clamp on the pulley A is $\frac{\sqrt{2}Mg}{3}$

22. Two blocks are connected by a spring, assumed to be of negligible weight, as shown in the figure. The spring has a force constant k and is initially in an un-stretched state of length l_o. A constant force F is applied on one of the blocks. (the contact between the blocks and the ground is assumed to be smooth)



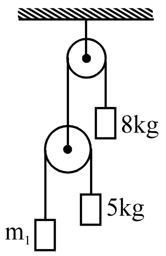
a) If $m_1 = m_2 = m$ then the elongation of the spring is $F/2k$
b) If $m_1 = m_2$ then the elongation of the spring is 0
c) If $m_1 = m_2 = m$ and the direction of force is reversed, the compression in the spring is 2 F/k
d) The elongation of the spring when, if m_1 in not equal to m_2, is $\frac{F}{k(m_1+m_2)}$

23. The system shown in the adjacent figure is in equilibrium and at rest. The spring and the string are assumed to be negligible mass. Acceleration of masses $2m$ and m , respectively, at the instant when the string is cut off is



a) $g/2$ upwards and g downwards
b) g upwards and $g/2$ downwards
c) g upwards and $2g$ downwards
d) $2g$ upwards and g downwards

24. At what value of m_1 will 8 kg mass be at rest.



a) 3 kg b) 10/3 kg c) 3/2 kg d) 13/2 kg

25. A heavy block is placed on a smooth horizontal floor (as shown in the figure below) . It is pulled on either side by two identical ropes, each of mass m. At the instant of time, t = 0, the force on the left rope is withdrawn keeping the force acting on the right rope same. Let F_1 and F_2 be the forces exerted by the right and the left ropes respectively on the block. In this case

a) $F_1 = F_2 = F$ for $t < 0$
b) $F_1 = F_2 = F + mg$ for $t < 0$
c) $F_1 = F, F_2 = F$ for t > 0
d) $F_1 < F_2 , F_2 = F$ for $t > 0$

Answers

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