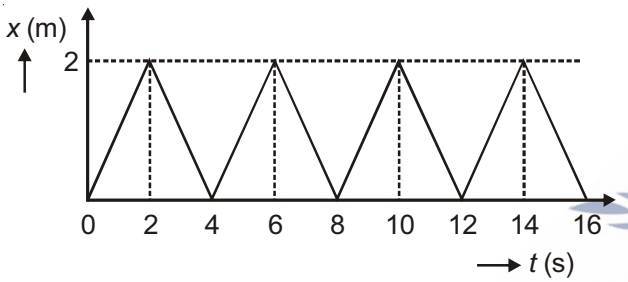
Laws of Motion

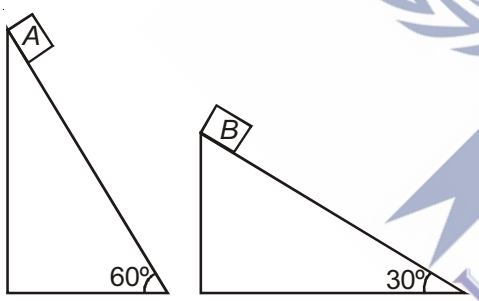
1. The figure shows the position–time (x-t) graph of one-dimensional motion of a body of mass 0.4 kg. The magnitude of each impulse is **[AIEEE-2010]**



(1) 0.2 Ns (2) 0.4 Ns

(3) 0.8 Ns (4) 1.6 Ns

2. Two fixed frictionless inclined planes making an angle 30° and 60° with the vertical are shown in the figure. Two blocks A and B are placed on the two planes. What is the relative vertical acceleration of A with respect to B? **[AIEEE-2010]**



(1) 4.9 ms^{-2} in vertical direction

(2) 4.9 ms^{-2} in horizontal direction

(3) 9.8 ms^{-2} in vertical direction

(4) Zero

3. The minimum force required to start pushing a body up a rough (frictional coefficient μ) inclined plane is F_1 while the minimum force needed to prevent it from sliding down is F_2. If the inclined plane makes an angle θ from the horizontal such that $\tan\theta = 2\mu$, then the ratio $\frac{F_1}{F_2}$ is **[AIEEE-2011]**

(1) 3 (2) 4

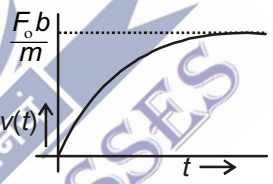
(3) 1 (4) 2

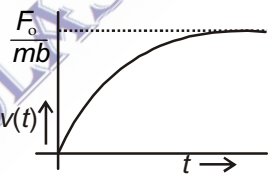
4. If a spring of stiffness k is cut into two parts 'A' and 'B' of length $l_A : l_B = 2 : 3$, then the stiffness of spring 'A' is given by **[AIEEE-2011]**

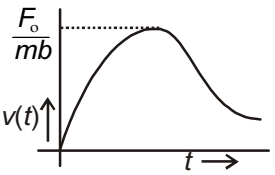
(1) k (2) $\frac{5}{2}k$

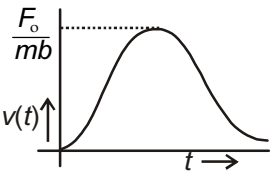
(3) $\frac{3k}{5}$ (4) $\frac{2k}{5}$

5. A particle of mass m is at rest at the origin at time $t = 0$. It is subjected to a force $F(t) = F_o e^{-bt}$ in the x direction. Its speed $v(t)$ is depicted by which of the following curves? **[AIEEE-2012]**

(1) 

(2) 

(3) 

(4) 

6. Two cars of masses m_1 and m_2 are moving in circles of radii r_1 and r_2, respectively. Their speeds are such that they make complete circles in the same time t. The ratio of their centripetal acceleration is **[AIEEE-2012]**

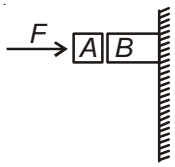
(1) $m_1 : m_2$ (2) $r_1 : r_2$

(3) 1 : 1 (4) $m_1 r_1 : m_2 r_2$

7. A block of mass m is placed on a surface with a vertical cross-section given by $y = \frac{x^3}{6}$. If the coefficient of friction is 0.5, the maximum height above the ground at which the block can be placed without slipping is **[JEE (Main)-2014]**

(1) $\frac{1}{6}$ m (2) $\frac{2}{3}$ m

(3) $\frac{1}{3}$ m (4) $\frac{1}{2}$ m

8. 

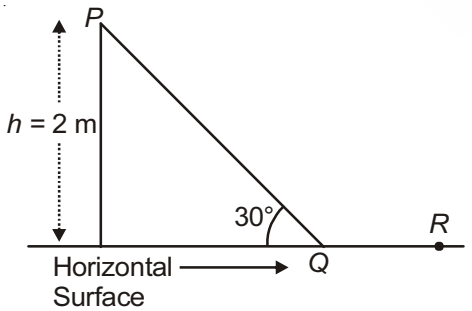
Given in the figure are two blocks A and B of weight 20 N and 100 N, respectively. These are being pressed against a wall by a force F as shown. If the coefficient of friction between the blocks is 0.1 and between block B and the wall is 0.15, the frictional force applied by the wall on block B is **[JEE (Main)-2015]**

(1) 100 N (2) 80 N

(3) 120 N (4) 150 N

9. A point particle of mass m, moves along the uniformly rough track PQR as shown in the figure. The coefficient of friction, between the particle and the rough track equals μ. The particle is released, from rest from the point P and it comes to rest at a point R. The energies, lost by the ball, over the parts, PQ and QR, of the track, are equal to each other, and no energy is lost when particle changes direction from PQ to QR.

The values of the coefficient of friction μ and the distance $x(= QR)$, are, respectively close to **[JEE (Main)-2016]**



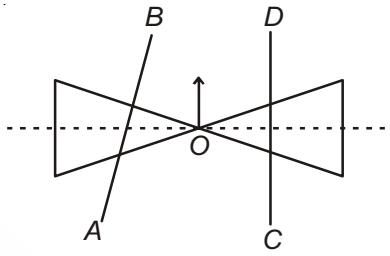
(1) 0.2 and 3.5 m

(2) 0.29 and 3.5 m

(3) 0.29 and 6.5 m

(4) 0.2 and 6.5 m

10. A roller is made by joining together two cones at their vertices O. It is kept on two rails AB and CD which are placed asymmetrically (see figure), with its axis perpendicular to CD and its centre O at the centre of line joining AB and CD (see figure). It is given a light push so that it starts rolling with its centre O moving parallel to CD in the direction shown. As it moves, the roller will tend to **[JEE (Main)-2016]**



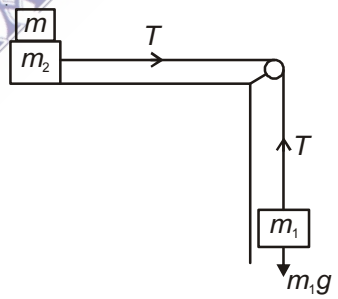
(1) Turn right

(2) Go straight

(3) Turn left and right alternately

(4) Turn left

11. Two masses m_1 = 5 kg and m_2 = 10 kg, connected by an inextensible string over a frictionless pulley, are moving as shown in the figure. The coefficient of friction of horizontal surface is 0.15. The minimum weight m that should be put on top of m_2 to stop the motion is **[JEE (Main)-2018]**



(1) 18.3 kg (2) 27.3 kg

(3) 43.3 kg (4) 10.3 kg

12. A particle is moving with a uniform speed in a circular orbit of radius R in a central force inversely proportional to the n^{th} power of R. If the period of rotation of the particle is T, then **[JEE (Main)-2018]**

(1) $T \propto R^{3/2}$ for any n

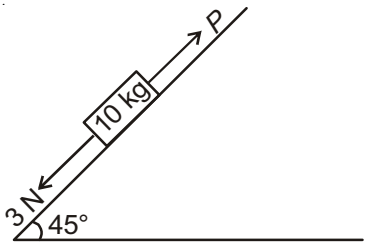
(2) $T \propto R^{\frac{n}{2}+1}$

(3) $T \propto R^{(n+1)/2}$

(4) $T \propto R^{n/2}$

13. A block of mass 10 kg is kept on a rough inclined plane as shown in the figure. A force of 3 N is applied on the block. The coefficient of static friction between the plane and the block is 0.6. What should be the minimum value of force P, such that the block doesnot move downward?

(take g = 10 ms^{-2}) **[JEE (Main)-2019]**



(1) 25 N (2) 32 N

(3) 18 N (4) 23 N

14. A mass of 10 kg is suspended vertically by a rope from the roof. When a horizontal force is applied on the roof at some point, the rope deviated at an angle of 45° at the roof point. If the suspended mass is at equilibrium, the magnitude of the force applied is (g = 10 ms^{-2}) **[JEE (Main)-2019]**

(1) 100 N (2) 200 N

(3) 70 N (4) 140 N

15. To mop-clean a floor, a cleaning machine presses a circular mop of radius R vertically down with a total force F and rotates it with a constant angular speed about its axis. If the force F is distributed uniformly over the mop and if coefficient of friction between the mop and the floor is μ, the torque, applied by the machine on the mop is

[JEE (Main)-2019]

(1) $\frac{\mu FR}{2}$ (2) $\frac{\mu FR}{3}$

(3) $\frac{\mu FR}{6}$ (4) $\frac{2}{3}\mu FR$

16. A body is projected at t = 0 with a velocity 10 ms^{-1} at an angle of 60° with the horizontal. The radius of curvature of its trajectory at t = 1 s is R. Neglecting air resistance and taking acceleration due to gravity g = 10 ms^{-2}, the value of R is

[JEE (Main)-2019]

(1) 5.1 m (2) 2.5 m

(3) 2.8 m (4) 10.3 m

17. A particle of mass m is moving in a straight line with momentum p. Starting at time t = 0, a force $F = kt$ acts in the same direction on the moving particle during time interval T so that its momentum changes from p to $3p$. Here k is a constant. The value of T is **[JEE (Main)-2019]**

(1) $\sqrt{\frac{2k}{p}}$ (2) $2\sqrt{\frac{p}{k}}$

(3) $\sqrt{\frac{2p}{k}}$ (4) $2\sqrt{\frac{k}{p}}$

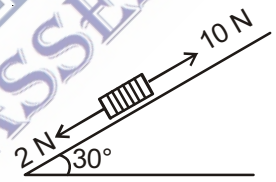
18. A particle moves from the point $\left(2.0\hat{i}+4.0\hat{j}\right)$ m, at t = 0, with an initial velocity $\left(5.0\hat{i}+4.0\hat{j}\right)$ ms^{-1}. It is acted upon by a constant force which produces a constant acceleration $\left(4.0\hat{i}+4.0\hat{j}\right)$ ms^{-2}. What is the distance of the particle from the origin at time 2 s? **[JEE (Main)-2019]**

(1) $20\sqrt{2}$ m (2) 15 m

(3) $10\sqrt{2}$ m (4) 5 m

19. A block kept on a rough inclined plane, as shown in the figure, remains at rest upto a maximum force 2 N down the inclined plane. The maximum external force up the inclined plane that does not move the block is 10 N. The coefficient of static friction between the block and the plane is

[Take g = 10 m/s^2] **[JEE (Main)-2019]**



(1) $\frac{1}{2}$ (2) $\frac{\sqrt{3}}{2}$

(3) $\frac{\sqrt{3}}{4}$ (4) $\frac{2}{3}$

20. A ball is thrown upward with an initial velocity V_0 from the surface of the earth. The motion of the ball is affected by a drag force equal to $m\gamma v^2$ (where m is mass of the ball, v is its instantaneous velocity and γ is a constant). Time taken by the ball to rise to its zenith is : **[JEE (Main)-2019]**

(1) $\frac{1}{\sqrt{\gamma g}}\sin^{-1}\left(\sqrt{\frac{\gamma}{g}}V_0\right)$

(2) $\frac{1}{\sqrt{\gamma g}}\ln\left(1+\sqrt{\frac{\gamma}{g}}V_0\right)$

(3) $\frac{1}{\sqrt{\gamma g}}\tan^{-1}\left(\sqrt{\frac{\gamma}{g}}V_0\right)$

(4) $\frac{1}{\sqrt{2\gamma g}}\tan^{-1}\left(\sqrt{\frac{2\gamma}{g}}V_0\right)$

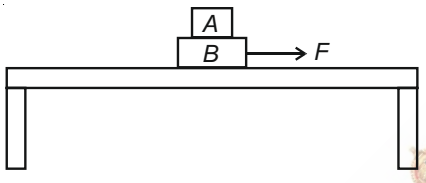
21. A bullet of mass 20 g has an initial speed of 1 ms^{-1}, just before it starts penetrating a mud wall of thickness 20 cm. If the wall offers a mean resistance of 2.5×10^{-2} N, the speed of the bullet after emerging from the other side of the wall is close to : **[JEE (Main)-2019]**

(1) 0.4 ms^{-1} (2) 0.7 ms^{-1}

(3) 0.3 ms^{-1} (4) 0.1 ms^{-1}

22. Two blocks *A* and *B* of masses m_A = 1 kg and m_B = 3 kg are kept on the table as shown in figure. The coefficient of friction between *A* and *B* is 0.2 and between *B* and the surface of the table is also 0.2. The maximum force *F* that can be applied on *B* horizontally, so that the block *A* does not slide over the block *B* is:

[Take g = 10 m/s^2] **[JEE (Main)-2019]**

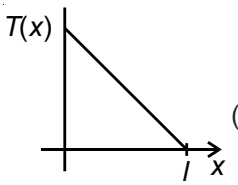


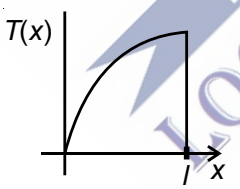
(1) 40 N (2) 12 N

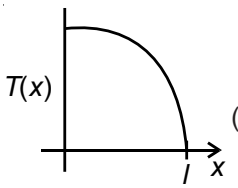
(3) 16 N (4) 8 N

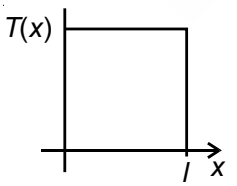
23. A uniform rod of length *l* is being rotated in a horizontal plane with a constant angular speed about an axis passing through one of its ends. If the tension generated in the rod due to rotation is $T(x)$ at a distance x from the axis, then which of the following graphs depicts it most closely?

[JEE (Main)-2019]

(1) 

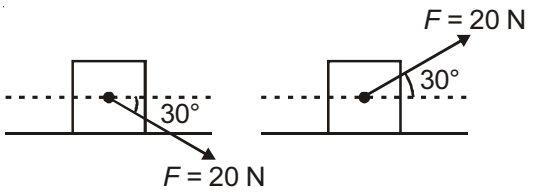
(2) 

(3) 

(4) 

24. A block of mass 5 kg is (i) pushed in case (A) and (ii) pulled in case (B), by a force F = 20 N, making an angle of 30° with the horizontal, as shown in the figures. The coefficient of friction between the block and floor is μ = 0.2. The difference between the accelerations of the block, in case (B) and case (A) will be :

(g = 10 ms^{-2}) **[JEE (Main)-2019]**



(A) (B)

(1) 0.4 ms^{-2} (2) 3.2 ms^{-2}

(3) 0 ms^{-2} (4) 0.8 ms^{-2}

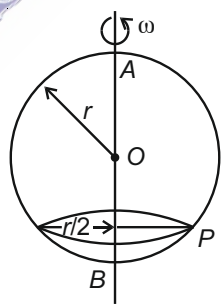
25. A spring whose unstretched length is *l* has a force constant *k*. The spring is cut into two pieces of unstretched lengths l_1 and l_2 where, $l_1 = nl_2$ and n is an integer. The ratio k_1/k_2 of the corresponding force constants, k_1 and k_2 will be

[JEE (Main)-2019]

(1) n^2 (2) $\frac{1}{n^2}$

(3) n (4) $\frac{1}{n}$

26. A smooth wire of length $2\pi r$ is bent into a circle and kept in a vertical plane. A bead can slide smoothly on the wire. When the circle is rotating with angular speed ω about the vertical diameter *AB*, as shown in figure, the bead is at rest with respect to the circular ring at position *P* as shown. Then the value of ω^2 is equal to **[JEE (Main)-2019]**



(1) $\frac{\left(g\sqrt{3}\right)}{r}$ (2) $\frac{2g}{r}$

(3) $\frac{2g}{\left(r\sqrt{3}\right)}$ (4) $\frac{\sqrt{3}g}{2r}$

27. A mass of 10 kg is suspended by a rope of length 4 m, from the ceiling. A force *F* is applied horizontally at the mid-point of the rope such that the top half of the rope makes an angle of 45° with the vertical. Then *F* equals (Take g = 10 ms^{-2} and the rope to be massless)

[JEE (Main)-2020]

(1) 75 N (2) 70 N

(3) 90 N (4) 100 N

28. A particle of mass m is fixed to one end of a light spring having force constant k and unstretched length l. The other end is fixed. The system is given an angular speed ω about the fixed end of the spring such that it rotates in a circle in gravity free space. Then the stretch in the spring is

[JEE (Main)-2020]

(1) $\frac{ml\omega^2}{k-\omega m}$ (2) $\frac{ml\omega^2}{k+m\omega^2}$

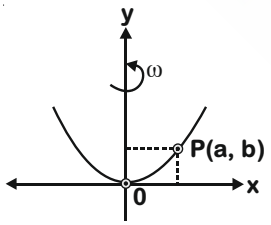
(3) $\frac{ml\omega^2}{k+m\omega}$ (4) $\frac{ml\omega^2}{k-m\omega^2}$

29. A spring mass system (mass m, spring constant k and natural length l) rests in equilibrium on a horizontal disc. The free end of the spring is fixed at the centre of the disc. If the disc together with spring mass system, rotates about it's axis with an angular velocity ω, ($k >> m\omega^2$) the relative change in the length of the spring is best given by the option **[JEE (Main)-2020]**

(1) $\sqrt{\frac{2}{3}}\left(\frac{m\omega^2}{k}\right)$ (2) $\frac{m\omega^2}{k}$

(3) $\frac{m\omega^2}{3k}$ (4) $\frac{2m\omega^2}{k}$

30. A bead of mass m stays at point $P(a, b)$ on a wire bent in the shape of a parabola $y = 4Cx^2$ and rotating with angular speed ω (see figure). The value of ω is (neglect friction) **[JEE (Main)-2020]**



(1) $2\sqrt{2gC}$ (2) $2\sqrt{gC}$

(3) $\sqrt{\frac{2g}{C}}$ (4) $\sqrt{\frac{2gC}{ab}}$

31. A small ball of mass m is thrown upward with velocity u from the ground. The ball experiences a resistive force mkv^2, where v is its speed. The maximum height attained by the ball is

[JEE (Main)-2020]

(1) $\frac{1}{2k}\tan^{-1}\frac{ku^2}{g}$ (2) $\frac{1}{k}\ln\left(1+\frac{ku^2}{2g}\right)$

(3) $\frac{1}{2k}\ln\left(1+\frac{ku^2}{g}\right)$ (4) $\frac{1}{k}\tan^{-1}\frac{ku^2}{2g}$

32. An insect is at the bottom of a hemispherical ditch of radius 1 m. It crawls up the ditch but starts slipping after it is at height h from the bottom. If the coefficient of friction between the ground and the insect is 0.75, then h is (g = 10 ms^{-2})

[JEE (Main)-2020]

(1) 0.45 m (2) 0.80 m

(3) 0.20 m (4) 0.60 m

33. A particle moving in the xy plane experiences a velocity dependent force $\vec{F} = k\left(v_y\hat{i} + v_x\hat{j}\right)$, where v_x and v_y are the x and y components of its velocity $\vec{v}$. If $\vec{a}$ is the acceleration of the particle, then which of the following statements is true for the particle? **[JEE (Main)-2020]**

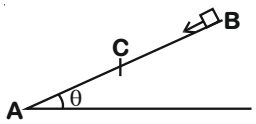
(1) Quantity $\vec{v}\cdot\vec{a}$ is constant in time

(2) Kinetic energy of particle is constant in time

(3) Quantity $\vec{v}\times\vec{a}$ is constant in time

(4) $\vec{F}$ arises due to a magnetic field

34. A small block starts slipping down from a point B on an inclined plane AB, which is making an



angle θ with the horizontal section BC is smooth and the remaining section CA is rough with a coefficient of friction μ. It is found that the block comes to rest as it reaches the bottom (point A) of the inclined plane. If $BC = 2AC$, the coefficient of friction is given by $\mu = k\tan\theta$. The value of k is _____. **[JEE (Main)-2020]**

❑ ❑ ❑