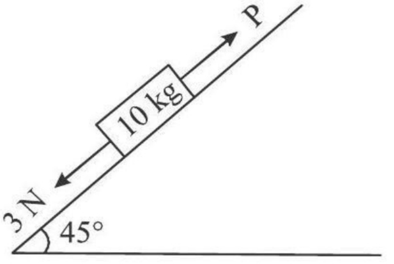
Laws of Motion

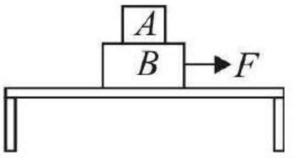
1. A block of mass 10 kg is kept on a rough inclined plane as shown in the figure. A force of 3 N is applied on the block. The coefficient of static friction between the plane and the block is 0.6. What should be the minimum value of force P (in newton), such that the block does not move downward? (Take $g = 10\ ms^{-2}$)



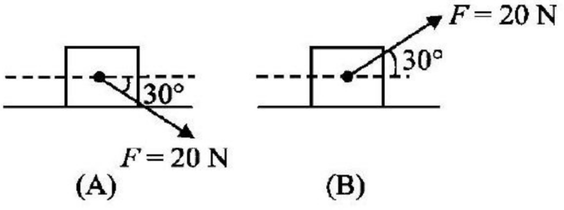
2. A mass of 10 kg is suspended vertically by a rope from the roof. When a horizontal force is applied on the rope at some point, the rope deviated at an angle of 45° at the roof point. If the suspended mass is at equilibrium, the magnitude of the force (in newton) applied is ($g = 10\ ms^{-2}$)

3. 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 (in m/s) of the bullet after emerging from the other side of the wall is close to :

4. Two blocks A and B 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 (in newton) that can be applied on B horizontally, so that the block A does not slide over the block B is : [Take $g = 10\ m/s^2$]



5. 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 $\mu = 0.2$. The difference between the accelerations (in m/s^2) of the block, in case (B) and case (A) will be : ($g = 10\ ms^{-2}$)



6. A body of mass 2 kg is moving with a velocity 8 m/s on a smooth surface. If it is to be brought to rest in 4 seconds, then the magnitude of force (in newton) to be applied in opposite direction of motion is

7. A force of 100 dynes acts on a mass of 5 gram for 10 sec. The velocity (incm/s) produced is

8. A body of mass 0.05 kg is observed to fall with an acceleration of 9.5 ms^{-2}. The opposing force (in newton) of air on the body is ($g = 9.8\ ms^{-2}$)

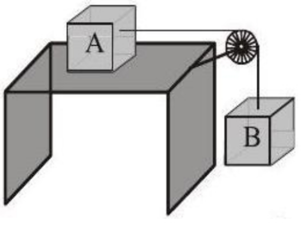
9. A car having a mass of 1000 kg is moving at a speed of 30 metres /sec. Brakes are applied to bring the car to rest. If the frictional force between the tyres and the road surface is 5000 newtons, the car will come to rest in seconds.

10. A ball of mass 150 g starts moving with an acceleration of 20 m/s^2. When hit by a force, which acts on it for 0.1 sec the impulsive force (in newton second) is

11. A body of mass 5 kg explodes at rest into three fragments with masses in the ratio 1: 1: 3. The fragments with equal masses fly in mutually perpendicular directions with speeds of 21 m/s. The velocity of heaviest fragment in m/s will be

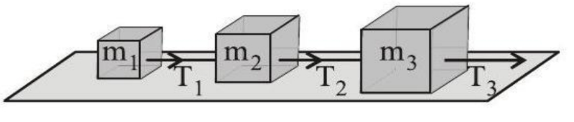
12. An elevator weighing 6000 kg is pulled upward by a cable with an acceleration of 5 ms^{-2}. Taking g to be 10 ms^{-2}, the tension (in newton) in the cable is

13. A block A of mass 7 kg is placed on a frictionless table. A thread tied to it passes over a frictionless pulley and carries a body B of mass 3 kg at the other end.

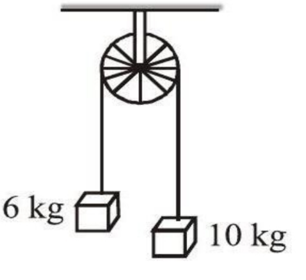


The acceleration (in m/s^2) of the system is (given $g = 10\ ms^{-2}$)

14. Three blocks of masses m_1, m_2 and m_3 are connected by massless strings as shown, on a frictionless table. They are pulled with a force $T_3 = 40$ N. If $m_1 = 10$ kg, $m_2 = 6$ kg and $m_3 = 4$ kg, the tension T_2 (in newton) will be

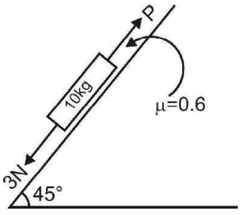


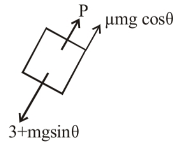
15. A light string passes over a frictionless pulley. To one of its ends a mass of 6 kg is attached. To its other end a mass of 10 kg is attached. The tension (in newton) in the thread will be [Take $g = 9.8\ m/s^2$]



SOLUTIONS

1. **(32)**





$$\text{mg}\sin 45^\circ = \frac{100}{\sqrt{2}} = 50\sqrt{2}$$

$$[\because \text{m} = 10\text{kg}, \text{g} = 9.8\,\text{m s}^{-2}]$$

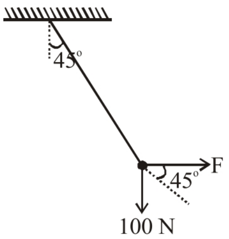
$$\mu\text{mg}\cos\theta = 0.6 \times \text{mg} \times \frac{1}{\sqrt{2}} = 0.6\,'\,50\sqrt{2}$$

$$3 + \text{mg}\sin\theta = \text{P} + \mu\text{mg}\cos\theta$$

$$3 + 50\sqrt{2} = \text{P} + 30\sqrt{2}$$

$$\therefore \text{P} = 31.28 = 32\,\text{N}$$

2. **(100)** At equilibrium,



$$\tan 45^\circ = \frac{\text{mg}}{\text{F}} = \frac{100}{\text{F}}$$

$$\therefore \text{F} = 100\,\text{N}$$

3. **(0.7)** From the third equation of motion

$$v^2 - u^2 = 2aS$$

But, $a = \frac{F}{m}$

$$\therefore v^2 = u^2 - 2\left(\frac{F}{m}\right)S$$

$$\Rightarrow v^2 = (1)^2 - (2)\left[\frac{2.5 \times 10^{-2}}{20 \times 10^{-3}}\right]\frac{20}{100}$$

$$\Rightarrow v^2 = 1 - \frac{1}{2}$$

$$\Rightarrow v = \frac{1}{\sqrt{2}}\,\text{m/s} = 0.7\,\text{m/s}$$

4. **(16)** Taking (A + B) as system

$$F - \mu(M + m)g$$
$$= (M + m)a$$

$$\Rightarrow a = \frac{F - \mu(M + m)g}{(M + m)}$$

$$a = \frac{F - (0.2)4 \times 10}{4} = \left(\frac{F - 8}{4}\right) \quad \text{...(i)}$$

But, $a_{max} = \mu g = 0.2 \times 10 = 2$

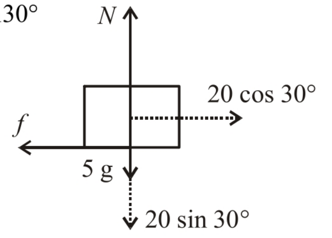
$$\therefore \frac{F - 8}{4} = 2$$

$$\Rightarrow F = 16\ \text{N}$$

5. **(0.8)** A : $N = 5g + 20 \sin 30°$

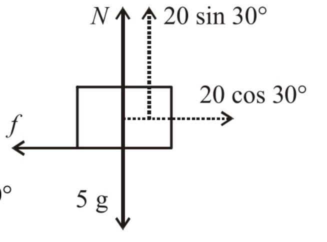
$= 50 + 20 \times \frac{1}{2}$

$= 60$ N



Accelaration, $a_1 = \frac{F - f}{m} = \frac{20\cos 30° - \mu N}{5}$

$= \left[\frac{20 \times \frac{\sqrt{3}}{2} - 0.2 \times 60}{5}\right]$



$= 1.06$ m/s^2

B : $N = 5g - 20 \sin 30°$

$= 50 - 20 \times \frac{1}{2} = 40$ N

$a_2 = \frac{F - f}{m} = \left[\frac{20\cos 30° - 0.2 \times 40}{5}\right]$

$= 1.86$ m/s^2

Now $a_2 - a_1 = 1.86 - 1.06$

$= 0.8$ m/s^2

6. **(4)** $|F| = \left|\frac{m(u-v)}{t}\right| = \left|\frac{2 \times (8-0)}{4}\right| = 4\,N$

7. **(20)** By Newton's 2nd law, $a = \frac{F}{m}$

$= \frac{100}{5} = 20\ cm/sec^2$.

$v = u + at = 0 + 20 \times 10 = 200$ cm/sec.

8. **(0.015)**

9. **(6)** $v = u - at \Rightarrow t = \frac{u}{a}$ [As $v = 0$]

$t = \frac{u \times m}{F} = \frac{30 \times 1000}{5000} = 6\,sec$

10. **(0.3)**

11. **(9.8)**

12. **(90,000)** $T = m(g + a) = 6000(10 + 5) = 90000\,N$

13. **(3)** $a = \frac{m_2}{m_1 + m_2} g = \frac{3}{7+3} \times 10 = 3\,m/s^2$

14. **(32)** $T_2 = (m_1 + m_2) \times \frac{T_3}{m_1 + m_2 + m_3}$

$= \frac{(10+6) \times 40}{20} = 32$ N

15. **(73.5)** $T = \frac{2m_1 m_2}{m_1 + m_2} g$

$= \frac{2 \times 10 \times 6}{10 + 6} \times 9.8 = 73.5\,N$