Level - II

Chapter 5

Laws of Motion

Solutions

SECTION - A

Objective Type Questions

(Newton's Second Law of Motion)

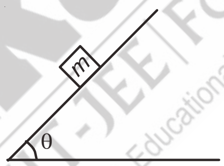
1. A block of weight 1 N rests on an inclined plane of inclination θ with the horizontal. The coefficient of friction between the block and the inclined plane is μ. The minimum force that has to be applied parallel to the inclined plane to make the body just move up the plane is

   (1) $\mu \sin\theta$ (2) $\mu \cos\theta$ (3) $\mu \cos\theta - \sin\theta$ (4) $\mu \cos\theta + \sin\theta$

Sol. Answer (4)

Given mg = 1 N

To just move the body up



F = friction force + gravitation force

$= \mu\, mg \cos\theta + mg \sin\theta$

$= \mu \cos\theta + \sin\theta$

2. If a pushing force making an angle α with horizontal is applied on a block of mass m placed on horizontal table and angle of friction is β, then minimum magnitude of force required to move the block is

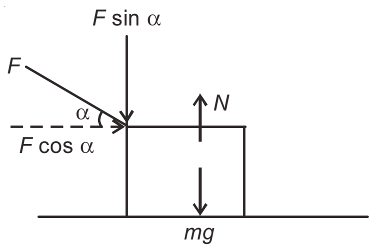
   (1) $\dfrac{mg\sin\beta}{\cos[\alpha-\beta]}$ (2) $\dfrac{mg\sin\beta}{\cos[\alpha+\beta]}$ (3) $\dfrac{mg\sin\beta}{\sin[\alpha+\beta]}$ (4) $\dfrac{mg\cos\beta}{\cos[\alpha-\beta]}$

Sol. Answer (2)

Angle of friction is β

$\Rightarrow \mu = \tan\beta$

$N = mg + F\sin\alpha$



To just move the block

$F\cos\alpha = \mu N$

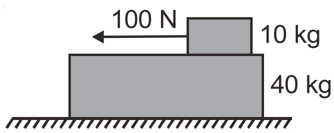
$F\cos\alpha = \tan\beta\,(mg + F\sin\alpha)$

$F(\cos\alpha - \tan\beta\sin\alpha) = mg\tan\beta$

$F(\cos\alpha\cos\beta - \sin\alpha\sin\beta) = mg\sin\beta$

$F = \dfrac{mg\sin\beta}{\cos(\alpha+\beta)}$

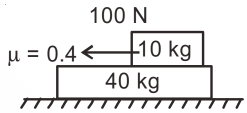
3. A 40 kg slab rests on a frictionless floor. A 10 kg block rests on top of the slab. The coefficient of friction between the block and the slab is 0.40. The 10 kg block is acted upon by a horizontal force of 100 N. If g = 10 m/s^2, the resulting acceleration of the slab will be



(1) 1.0 m/s^2 (2) 1.47 m/s^2 (3) 1.52 m/s^2 (4) 6.1 m/s^2

Sol. Answer (1)

Maximum external force when blocks move together = $\dfrac{f_{max}}{40}(40+10) = 50$ N



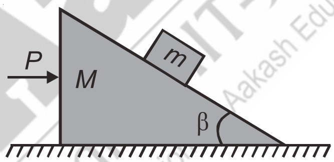
Now since external force is 100 N (which is > 50 N)

$\Rightarrow$ blocks will not move together. Hence net force acting on 40 kg will be only friction force

So using $F_{net} = ma$

$40 = (40a) \Rightarrow a = 1$ m/s^2

4. A block of mass m, is kept on a wedge of mass M, as shown in figure such that mass m remains stationary w.r.t. wedge. The magnitude of force P is



(1) $g\tan\beta$ (2) $mg\tan\beta$

(3) $(m+M)g\tan\beta$ (4) $mg\cot\beta$

Sol. Answer (3)

If acceleration of the system is a then $P = (M+m)a$

from the reference frame of wedge

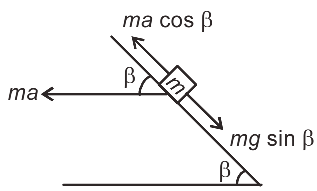
Component of ma along the inclined will be $ma\cos\beta$

for the block to be in equilibrium w.r.t. wedge

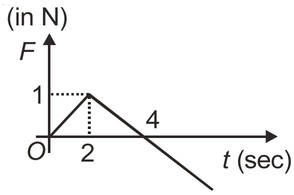
$ma\cos\beta = mg\sin\beta$

$a = g\tan\beta$

hence $P = (M+m)g\tan\beta$

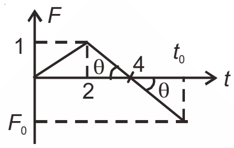


5. Force acting on a body varies with time as shown below. If initial momentum of the body is $\vec{p}$, then the time taken by the body to retain its momentum $\vec{p}$ again is



(1) 8 s (2) $(4+2\sqrt{2})$ s (3) 6 s (4) Can never obtain

Sol. Answer (2)



$$\tan\theta = \frac{1}{2} = \frac{F_0}{t_0-4}$$

$$\Rightarrow \quad F_0 = \frac{t_0-4}{2}$$

Total change in momentum should be zero, then only it will retain its initial momentum.

So, positive area of $F - t$ curve should be equal to negative area of $F - t$ curve till time t_0.

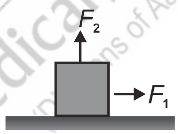
$$\frac{1}{2}(4)(1) = \frac{1}{2}(t_0-4)\,F_0$$

$$8 = \frac{(t_0-4)}{2}\cdot\frac{(t_0-4)}{2}$$

$$(t_0-4)^2 = 32$$

$$t_0 = 4+2\sqrt{2}$$

6. In the figure shown, horizontal force F_1 is applied on a block but the block does not slide. Then as the magnitude of vertical force F_2 is increased from zero the block begins to slide; the correct statement is



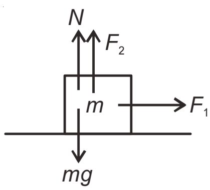
(1) The magnitude of normal reaction on block increases

(2) Static frictional force acting on the block increases

(3) Maximum value of static frictional force decreases

(4) All of these

Sol. Answer (3)



$N + F_2 = mg$

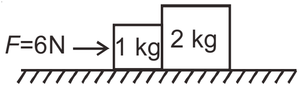
$N = mg - F_2$

As F_2 increases N will decrease

Static friction $f_s = \mu_s N = \mu_s (mg - F_2)$

$\Rightarrow$ By increasing F_2, f_s will decrease hence the block will slide

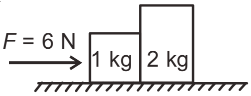
7. Arrangement of two block system is as shown. The net force acting on 1 kg and 2 kg blocks are (assuming the surfaces to be frictionless) respectively



(1) 4 N, 8 N (2) 1 N, 2 N (3) 2 N, 4 N (4) 3 N, 6 N

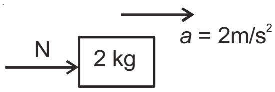
Sol. Answer (3)

Acceleration of the system $= \dfrac{F_{ext}}{M_{Total}}$



$= \dfrac{6}{3} = 2 \text{ m/s}^2$

for 2 kg block



$N = 2(2) = 4\text{N}$

for 1 kg block

$F_{net} = 6 - 4 = 2$ N

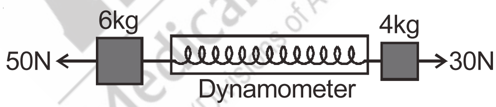
8. An open carriage in a goods train is moving with a uniform velocity of 10 m/s. If the rain adds water with zero velocity at the rate of 5 kg/s, then the additional force required by the engine to maintain the same velocity of the train is

(1) 0.5 N (2) 20 N (3) 50 N (4) Zero

Sol. Answer (3)

$F_{(additional)} = \dfrac{vdm}{dt} = (10) \times 5 = 50$ N

9. A dynamometer D is attached to two blocks of masses 6 kg and 4 kg as shown in the figure. The reading of the dynamometer is



(1) 18 N (2) 28 N (3) 38 N (4) 48 N

Sol. Answer (3)

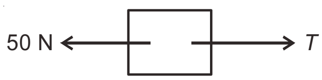
The tension in the spring will be the reading of dynamometer

$F)_{ext} = Ma$

$50–30 = 10(a)$

$a = 2 \text{ m/s}^2$

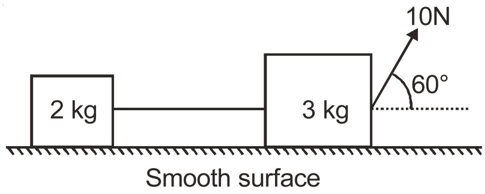
for 6 kg block



$50 - T = 6\ (2)$

$T = 38$ N

10. Figure shows two blocks connected by a light inextensible string as shown in figure. A force of 10 N is applied on the bigger block at 60° with horizontal, then the tension in the string connecting the two masses is



(1) 5 N (2) 2 N (3) 1 N (4) 3 N

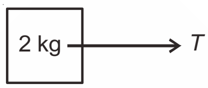
Sol. Answer (2)

$F_{net} = Ma$

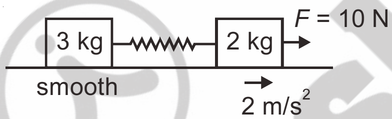
$(10 \cos 60°) = (3 + 2)\, a$

$a = 1 \text{ m/s}^2$

$T = 2(1) = 2 \text{ N}$



11. What is the acceleration of 3 kg mass when acceleration of 2 kg mass is 2 m/s^2 as shown?



(1) 3 m/s^2 (2) 2 m/s^2 (3) 0.5 m/s^2 (4) Zero

Sol. Answer (2)

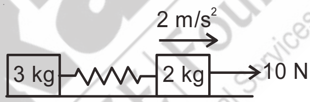
For 2 kg $10 - T = 2(2)$

$T = 10 - 4 = 6 \text{ N}$

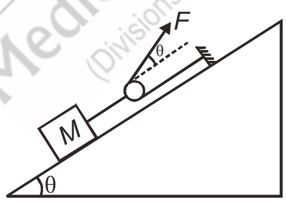
For 3 kg $T = 3(a)$

$6 = 3a$

$a = 2 \text{ m/s}^2$



12. What is the minimum value of F needed so that block begins to move upward on frictionless incline plane as shown?

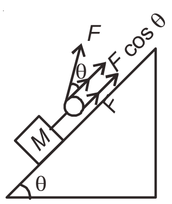


(1) $Mg\tan\left(\frac{\theta}{2}\right)$ (2) $Mg\cot\left(\frac{\theta}{2}\right)$ (3) $\frac{Mg\sin\theta}{(1+\sin\theta)}$ (4) $Mg\sin\left(\frac{\theta}{2}\right)$

Sol. Answer (1)

$F + F\cos\theta = mg\sin\theta$

$F = \frac{mg\sin\theta}{1+\cos\theta}$



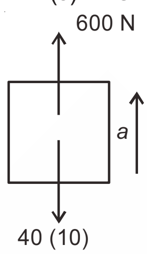
$$F = \frac{mg\ 2\sin\frac{\theta}{2}\cos\frac{\theta}{2}}{2\cos^2\frac{\theta}{2}} \qquad \left(\because \sin\theta = 2\sin\frac{\theta}{2}.\cos\frac{\theta}{2} \text{ and } 1+\cos\theta = 2\cos^2\frac{\theta}{2}\right)$$

$$= mg\tan\frac{\theta}{2}$$

13. A monkey of mass 40 kg climbs up a rope, of breaking load 600 N hanging from a ceiling. If it climbs up the rope with the maximum possible acceleration, then the time taken by monkey to climb up is [Length of rope is 10 m]

(1) 2 s (2) 1 s (3) 4 s (4) 3 s

Sol. Answer (1)



$600 - 400 = 40a$

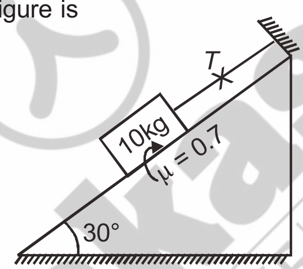
$$a = \frac{200}{40} = 5\ \text{m/s}^2$$

$$S = ut + \frac{1}{2}at^2$$

$$10 = \frac{1}{2}(5)t^2$$

$\Rightarrow$ $t = 2$ second

14. The tension T in the string shown in figure is



(1) Zero (2) 50 N (3) $35\sqrt{3}$ N (4) $(\sqrt{3}-1)\ 50$ N

Sol. Answer (1)

$mg\sin\theta = 10\ (10)\sin 30° = 50$ N

Frictional force = $\mu\, mg\cos\theta = (0.7)\ (10)\ (10)\ \frac{\sqrt{3}}{2} = 35\sqrt{3}$ N

Frictional force is sufficient to oppose gravitational force. Tension will be zero.

15. An object of mass 2 kg at rest at origin starts moving under the action of a force

$\vec{F} = (3t^2\hat{i} + 4t\hat{j})$ N

The velocity of the object at $t = 2$ s will be

(1) $(3\hat{i} + 2\hat{j})$m/s (2) $(2\hat{i} + 4\hat{j})$m/s (3) $(4\hat{i} + 4\hat{j})$m/s (4) $(3\hat{i} - 4\hat{j})$m/s

Sol. Answer (3)

$\vec{F} = 3t^2\hat{i} + 4t\hat{j}$

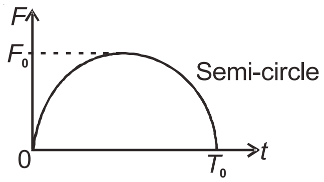
$$P_2 - P_1 = \frac{3t^3}{3}\hat{i} + \frac{4t^2}{2}\hat{j}$$

$P_1 = 0$

$(2)v = (2)^3\hat{i} + 2(2)^2\hat{j}$

$v = 4\hat{i} + 4\hat{j}$

16. The magnitude of force acting on a particle moving along x-axis varies with time (t) as shown in figure. If at $t = 0$ the velocity of particle is v_0, then its velocity at $t = T_0$ will be



(1) $v_0 + \frac{\pi F_0 T_0}{4m}$ (2) $v_0 + \frac{\pi F_0}{2m}$ (3) $v_0 + \frac{\pi T_0^2}{4m}$ (4) $v_0 + \frac{\pi F_0 T_0}{m}$

Sol. Answer (1)

$\int F dt = m\Delta v$

$\int F dt$ is area under F–t curve

$m\Delta v = \pi\left(\frac{F_0}{2}\right).\left(\frac{T_0}{2}\right)$ [area = $\frac{\pi ab}{2}$]

$v - v_0 = \frac{\pi F_0 T_0}{4m}$

$v = v_0 + \frac{\pi F_0 T_0}{4m}$

17. Three forces $\vec{F}_1 = (2\hat{i} + 4\hat{j})$ N ; $\vec{F}_2 = (2\hat{j} - \hat{k})$ N and $\vec{F}_3 = (\hat{k} - 4\hat{i} - 2\hat{j})$ N are applied on an object of mass 1 kg at rest at origin. The position of the object at $t = 2s$ will be

(1) (–2 m, –6 m) (2) (–4 m, 8 m) (3) (3 m, 6 m) (4) (2 m, –3 m)

Sol. Answer (2)

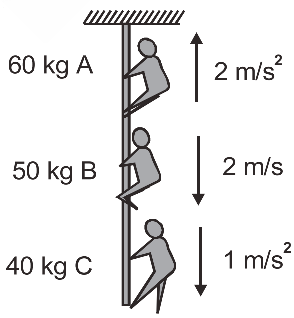
$\vec{a} = \frac{\vec{F}_1 + \vec{F}_2 + \vec{F}_3}{1} = -2\hat{i} + 4\hat{j}$

$S = \frac{1}{2} at^2$

$= \frac{1}{2}(-2\hat{i} + 4\hat{j})(2)^2$

$= -4\hat{i} + 8\hat{j}$

18. Tension in the rope at the rigid support is ($g = 10$ m/s^2)



(1) 760 N (2) 1360 N

(3) 1580 N (4) 1620 N

Sol. Answer (3)

For 40 kg, $400 - T_1 = 40$ (1)

$\Rightarrow T_1 = 360$ N

For 50 kg, $500 + T_1 - T_2 = 50$ (2)

$\Rightarrow T_2 = 760$ N

For 60 kg $\Rightarrow T_3 - 600 - T_2 = 60$ (3)

$T_3 = 1580$ N

T_3 will be the tension at the topmost point on the rigid support.

19. A rocket of mass 5700 kg ejects mass at a constant rate of 15 kg/s with constant speed of 12 km/s. The acceleration of the rocket 1 minute after the blast is (g = 10 m/s^2)

(1) 34.9 m/s^2 (2) 27.5 m/s^2 (3) 3.50 m/s^2 (4) 13.5 m/s^2

Sol. Answer (2)

$$F = \frac{vdm}{dt} - mg \quad \ldots(i)$$

where m is mass of the rocket after 1 minute

So m = [5700 – 15 (60)] = 4800 kg

in (i)

$$F = (12 \times 10^3)(15) - (4800)\,g$$

$$= (12000)(15) - 48000$$

$$a = \frac{F}{m} = \frac{12000(15) - 48000}{4800}$$

$$= 27.5 \text{ m/s}^2$$

20. A cracker rocket is ejecting gases at a rate of 0.05 kg/s with a velocity 400 m/s. The accelerating force on the rocket is

(1) 20 dyne (2) 20 N (3) 200 N (4) Zero

Sol. Answer (2)

For a variable mass system

$$F = \frac{vdm}{dt}$$

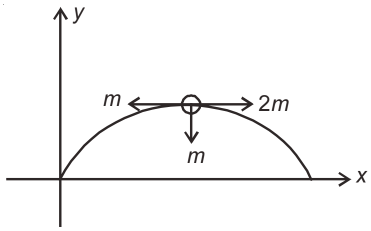
$$= 400 \times 0.05 = 20 \text{ N}$$

(Newton's Third Law of Motion Conservation of Momentum)

21. A projectile is fired with velocity u at an angle θ with horizontal. At the highest point of its trajectory it splits up into three segments of masses m, m and 2 m. First part falls vertically downward with zero initial velocity and second part returns via same path to the point of projection. The velocity of third part of mass 2 m just after explosion will be

(1) $u\cos\theta$ (2) $\frac{3}{2}u\cos\theta$ (3) $2u\cos\theta$ (4) $\frac{5}{2}u\cos\theta$

Sol. Answer (4)



along x-axis no internal force exists, hence momentum will be conserved along x-axis

$$(P_i)_x = (P_f)_x$$

$(m + m + 2m) \cos\theta = -mu \cos\theta + 0 + 2mV$

$\Rightarrow$ $2mv = 5\ mu \cos\theta$

$$v = \frac{5}{2} u \cos\theta$$

and along y direction $\left.P_i\right)_y = 0$ So $\left.P_f\right)_y = 0$

22. A bomb of mass 9 kg explodes into two pieces of masses 3 kg and 6 kg. The velocity of mass 3 kg is 16 m/s. The kinetic energy of mass 6 kg in joule is

(1) 196 (2) 320 (3) 192 (4) 620

Sol. Answer (3)

Using momentum conservation

$$o = m_1 v_1 + m_2 v_2$$

$$V_2 = -\frac{3 \times 16}{6}$$

$$= -8 \text{ m/s}$$

$$\text{K.E.} = \frac{1}{2} mv^2 = \frac{1}{2} (6)(8)^2 = 192 \text{ J}$$

23. A 6000 kg rocket is set for firing. If the exhaust speed is 1000 m/s, how much gas must be ejected each second to supply the thrust needed to overcome the weight of the rocket?

(1) 30 kg (2) 40 kg (3) 50 kg (4) 60 kg

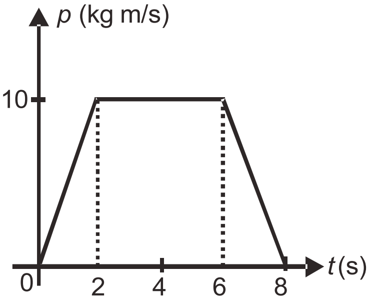
Sol. Answer (4)

$$F = v\frac{dm}{dt} = mg$$

$$1000\left(\frac{dm}{dt}\right) = 60000$$

$$\frac{dm}{dt} = 60 \text{ kg}$$

24. The momentum p of an object varies with time (t) as shown in figure. The corresponding force (F)-time (t) graph is



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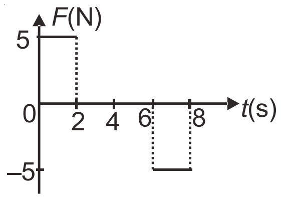

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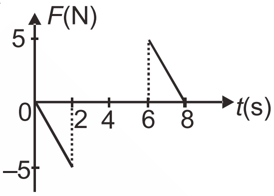

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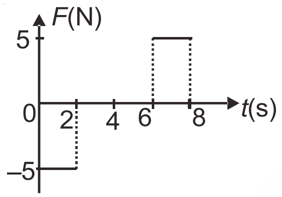

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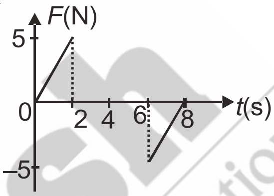


Sol. Answer (1)

$F = \dfrac{dp}{dt}$ = slope of P–t curve

From t = 0 to t = 2 second slope is constant and positive

From t = 2 to t = 6 second slope is zero

From t = 6 to t = 8 second slope is constant and negative

(Common Forces in Mechanics)

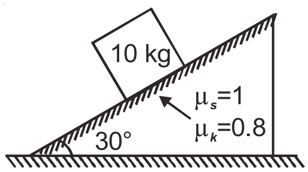
25. Which of the following is self adjusting force?

(1) Sliding friction (2) Dynamic friction (3) Static friction (4) Limiting friction

Sol. Answer (3)

Static friction

26. A block of 10 kg mass is placed on a rough inclined surface as shown in figure. The acceleration of the block will be



(1) Zero (2) g (3) $\dfrac{g}{2}$ (4) $\dfrac{\sqrt{3}g}{2}$

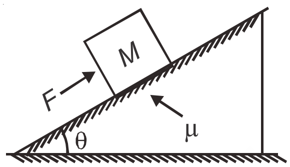
Sol. Answer (1)

$$F_L = \mu_s mg \cos\theta = (1)\ (100)\ \frac{\sqrt{3}}{2} = 50\sqrt{3}$$

Gravitational force = $mg \sin\theta = 50$ N

$f_L > mg \sin\theta \Rightarrow$ block will not move

27. A block (mass = M kg) is placed on a rough inclined plane. A force F is applied parallel to the inclined (as shown in figure) such that it just starts moving upward. The value of F is



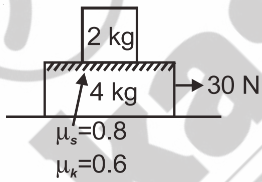
(1) $Mg\sin\theta - \mu Mg\cos\theta$ (2) $Mg\sin\theta + \mu Mg\cos\theta$ (3) $Mg\sin\theta$ (4) $\mu Mg\cos\theta$

Sol. Answer (2)

F will oppose friction force and gravitation force

$F = mg\sin\theta + \mu\, mg\cos\theta$

28. Figure shows two block system, 4 kg block rests on a smooth horizontal surface, upper surface of 4 kg is rough. A block of mass 2 kg is placed on its upper surface. The acceleration of upper block with respect to earth when 4 kg mass is pulled by a force of 30 N, is



(1) 6 m/s^2 (2) 5 m/s^2 (3) 8 m/s^2 (4) 2 m/s^2

Sol. Answer (2)

It both move together

$$a = \frac{30}{(4+2)} = 5\ \text{m/s}^2$$

2 kg will move due to frictional force

$F = ma \Rightarrow f = 2(5) = 10$ N

and limiting friction $f_L = (0.8)\ (2g) = 16$ N

$\Rightarrow$ Friction is sufficient to move both block together hence $a = 5$ m/s^2

29. A car accelerates on a horizontal road due to force exerted by

(1) The engine of the car

(2) The driver of the car

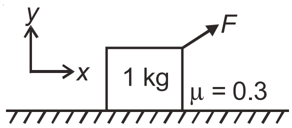
(3) The earth as weight of the car

(4) The road

Sol. Answer (4)

Due to frictional force by the road.

30. A force $\vec{F} = \hat{i} + 4\hat{j}$ acts on the block shown. The force of friction acting on the block is



(1) $-\hat{i}$ (2) $-18\hat{i}$ (3) $-2.4\hat{i}$ (4) $-3\hat{i}$

Sol. Answer (1)

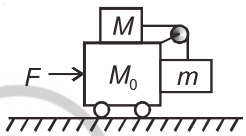
Limiting friction F_L = (0.3) (1) (g)

= 3 N

x-component or horizontal component of force is = 1 N

hence this much of magnitude will act in backward direction due to friction.

31. Two blocks of mass M and m are kept on the trolley whose all surfaces are smooth select the correct statement



(1) If F = 0 blocks cannot remain stationary with respect to trolley

(2) For one unique value of F, blocks will be stationary with respect to trolley

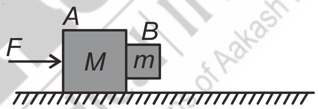
(3) Blocks cannot be stationary with respect to trolley for any value of F because all surfaces are smooth

(4) Both (1) & (2)

Sol. Answer (4)

As all the surfaces are smooth, block can be at rest only due to Pseduo force

32. Coefficient of friction between A and B is μ. The minimum force F with which A will be pushed such that B will not slip down is



(1) $\frac{Mg}{\mu}$ (2) $\frac{mg}{\mu}$ (3) $\frac{(M+m)g}{\mu}$ (4) $\frac{(M-m)g}{\mu}$

Sol. Answer (3)

From the reference frame of A

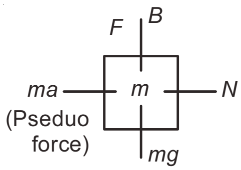
$$\mu N = mg$$

$$N = ma$$

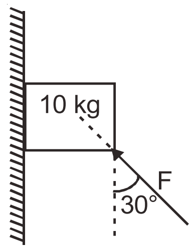
$$N = m\left(\frac{F}{M+m}\right)$$

$$\mu m\left(\frac{F}{M+m}\right) = mg$$

$$F = \left(\frac{M+m}{\mu}\right) g$$



33. A block of mass 10 kg is held at rest against a rough vertical wall [μ = 0.5] under the action a force F as shown in figure. The minimum value of F required for it is (g = 10 m/s^2)



(1) 162.6 N (2) 89.7 N (3) 42.7 N (4) 95.2 N

Sol. Answer (2)

$N = F\sin 30° = F/2$

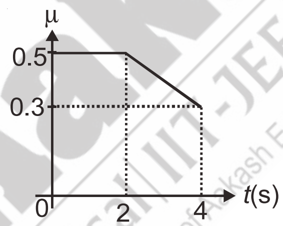
$F\cos 30° + \mu N = (10)g$

$$\frac{F\sqrt{3}}{2} + 0.5\left(\frac{F}{2}\right) = 100$$

$$F\left(\frac{2\sqrt{3}+1}{4}\right) = 100$$

$F \simeq 89.7$ N

34. A block is projected with speed 20 m/s on a rough horizontal surface. The coefficient of friction (μ) between the surfaces varies with time (t) as shown in figure. The speed of body at the end of 4 second will be (g = 10 m/s^2)



(1) 2 m/s (2) 5 m/s (3) 7.2 m/s (4) 9.5 m/s

Sol. Answer (1)

Retardation

$$\frac{dv}{dt} = -\mu g$$

$$\int dv = -\int \mu g\, dt$$

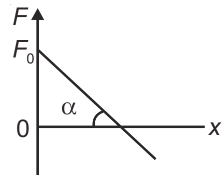
$$\Delta v = -g\int \mu\, dt$$

$\int \mu\, dt$ is area under $\mu - t$ curve

$$v - 20 = -10\left(2\frac{1}{2} + \frac{1}{2}(2)(0.2) + (2)(0.3)\right)$$

$v = 20 - 18 = 2$ m/s

35. An object starts from rest and is acted upon by a variable force F as shown in figure. If F_0 is the initial value of the force, then the position of the object, where it again comes to rest will be



(1) $\frac{2F_0}{\tan\alpha}$ (2) $\frac{F_0}{\sin\alpha}$ (3) $\frac{2F_0}{\cot\alpha}$ (4) $\frac{F_0}{2\cos\alpha}$

Sol. Answer (1)

F-x curve is straight line. Equation of F in terms of x can be written as

$$F = F_0 - x\tan\alpha$$

$$a = \frac{vdv}{dx} = \frac{F}{m} = \frac{F_0}{m} - \frac{x\tan\alpha}{m}$$

or, $vdv = \frac{F_0}{m}dx - \frac{\tan\alpha}{m}xdx$

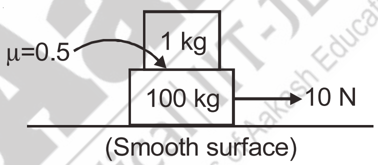
Integrating both sides

$$\frac{v^2 - u^2}{2} = \frac{F_0 x}{m} - \frac{x^2\tan\alpha}{2} = 0$$

$$\Rightarrow \frac{x\tan\alpha}{2} = F_0$$

$$x = \frac{2F_0}{\tan\alpha}$$

36. The frictional force acting on 1 kg block is



(1) 0.1 N (2) 2 N (3) 0.5 N (4) 5 N

Sol. Answer (1)

If both move together $a = \frac{10}{101} \simeq 0.1$ m/s^2

Now, $F_{net} = 1\,(0.1) = 0.1$N

$f_L = (0.5)\,(1)\,(g) = 5$ N

So, $f = 0.1$N

37. A block of mass m is at rest on a rough inclined plane of angle of inclination θ. If coefficient of friction between the block and the inclined plane is μ, then the minimum value of force along the plane required to move the block on the plane is $(\tan\theta < \mu)$

(1) $mg[\mu\cos\theta - \sin\theta]$ (2) $mg[\sin\theta + \mu\cos\theta]$ (3) $mg[\mu\cos\theta + \sin\theta]$ (4) $mg[\sin\theta - \mu\cos\theta]$

Sol. Answer (1)

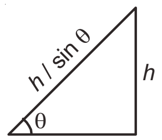
$F_{min} = mg[\mu\cos\theta - \sin\theta]$

38. A block of mass m takes time t to slide down on a smooth inclined plane of angle of inclination θ and height h. If same block slide down on a rough inclined plane of same angle of inclination and same height and takes time n times of initial value, then coefficient friction between block and inclined plane is

(1) $[1 + n^2] \tan \theta$ (2) $\left[1-\frac{1}{n^2}\right]\tan\theta$ (3) $[1 - n^2] \tan \theta$ (4) $\left[1+\frac{1}{n^2}\right]\tan\theta$

Sol. Answer (2)

$$t_1 = \sqrt{\frac{2}{g}\left(\frac{h}{\sin^2\theta}\right)} = \frac{1}{\sin\theta}\sqrt{\frac{2h}{g}}$$



$$t_2 = \sqrt{\frac{2h}{g\sin\theta(\sin\theta-\mu\cos\theta}}$$

According to problem

$$\frac{n}{\sin\theta}\sqrt{\frac{2h}{g}} = \sqrt{\frac{2h}{g\sin\theta(\sin\theta-\mu\cos\theta)}}$$

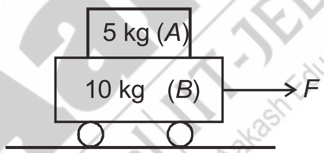
$$\frac{n^2}{\sin^2\theta} = \frac{1}{\sin^2\theta-\mu\sin\theta\cos\theta}$$

$n^2\sin^2\theta -$ $n^2\mu\sin\theta\cos\theta = \sin^2\theta$

$$n^2\left[1-\frac{\mu}{\tan\theta}\right] = 1$$

$$\mu = \left[1-\frac{1}{n^2}\right]\tan\theta$$

39. If acceleration of A is 2 m/s^2 which is smaller than acceleration of B then the value of frictional force applied by B on A is

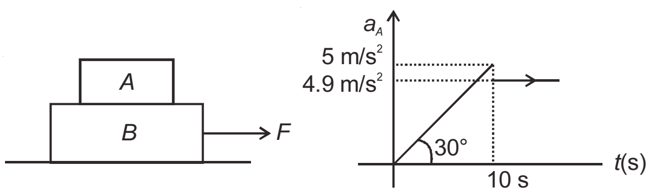


(1) 50 N (2) 20 N (3) 10 N (4) None of these

Sol. Answer (3)

Acceleration at block A is less than acceleration of B means there is relative slipping between A & B. So $f_A = 5 \times 2 = 10$ N.

40. Acceleration of block A varies with time as shown in figure the value of coefficient of kinetic friction between block A and B is

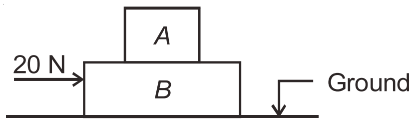


the value of coefficient of kinetic friction between block A and B is

(1) 0.5 (2) 0.6 (3) 0.4 (4) None of these

Sol. Answer (1)

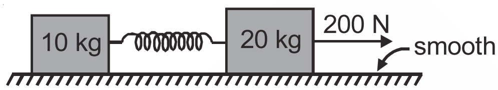
41. Blocks shown in figure moves with constant velocity 10 m/s towards right. All surfaces in contact are rough. The friction force applied by B on A is



(1) 0 N (2) 20 N (3) 10 N (4) Insufficient data

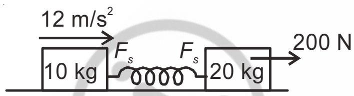
Sol. Answer (1)

42. Two masses of 10 kg and 20 kg respectively are connected by a massless spring as shown in fig. A force of 200 N acts on the 20 kg mass. At the instant shown the 10 kg mass has acceleration 12 m/s² towards right. The acceleration of 20 kg mass at this instant is



(1) 12 m/s² (2) 4 m/s² (3) 10 m/s² (4) Zero

Sol. Answer (2)



F_s is spring force

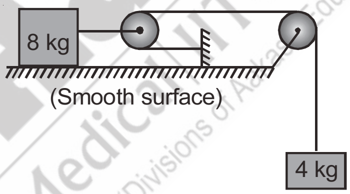
$F_s = 10 \times 12 = 120$ N

for 20 kg block

$200 - 120 = 20a$

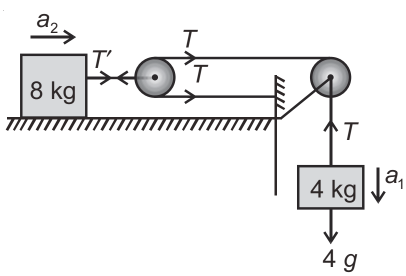
$a = \frac{80}{20} = 4$ m/s²

43. If pulleys shown in the diagram are smooth and massless and a_1 and a_2 are acceleration of blocks of mass 4 kg and 8 kg respectively, then



(1) $a_1 = a_2$ (2) $a_1 = 2a_2$ (3) $2a_1 = a_2$ (4) $a_1 = 4a_2$

Sol. Answer (2)



For 8 kg $T' = 8a_1$ ...(i)

for 4 kg

$4g - T = 4a_2$ ...(ii)

for pulley

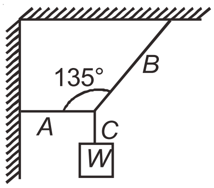
$T^1 = 2T$ ...(iii)

Using (i), (ii) and (iii)

$a_2 = \frac{a_1}{2}$

(Equilibrium of a Particle Frame of Reference)

44. A block of weight W is supported by three strings as shown in figure. Which of the following relations is true for tension in the strings? (Here T_1, T_2 and T_3 are the tension in the strings A, B and C respectively)



(1) $T_1 = T_2$ (2) $T_1 = T_3$ (3) $T_2 = T_3$ (4) $T_1 = T_2 = T_3$

Sol. Answer (2)

Tension will be same in A & C hence $T_1 = T_3$

45. Which of the following quantity/quantities are dependent on the choice of orientation of the co-ordinate axes?

(a) $\vec{a} + \vec{b}$

(b) $3a_x + 2b_y$

(c) $(\vec{a} + \vec{b} - \vec{c})$

(1) Only (b) (2) Both (a) & (b) (3) Both (a) & (c) (4) Both (b) & (c)

Sol. Answer (1)

46. Two blocks of masses 2 kg and 4 kg are hanging with the help of massless string passing over an ideal pulley inside an elevator. The elevator is moving upward with an acceleration $\frac{g}{2}$. The tension in the string connected between the blocks will be (Take g = 10 m/s^2).

(1) 40 N (2) 60 N (3) 80 N (4) 20 N

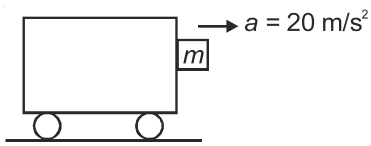
Sol. Answer (1)

47. A man of mass m is standing in an elevator moving downward with an acceleration $\frac{g}{4}$. The force exerted by the bottom surface of the elevator on the man will be

(1) $\frac{3mg}{4}$ (2) $\frac{mg}{4}$ (3) $\frac{5mg}{4}$ (4) $\frac{7mg}{4}$

Sol. Answer (1)

48. A vehicle is moving on a road with an acceleration a = 20 m/s^2 as shown in figure. The frictional coefficient between the block of mass (m) and the vehicle so that block is does not fall downward is (g = 10 m/s^2)

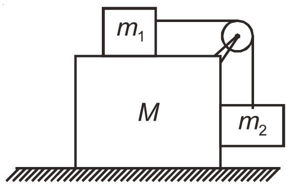


(1) 0.5 (2) 0.4

(3) 2 (4) 0.7

Sol. Answer (1)

49. In the given arrangement all surfaces are smooth. What acceleration should be given to the system, for which the block m_2 doesn't slide down?



(1) $\frac{m_2 g}{m_1}$ (2) $\frac{m_1 g}{m_2}$

(3) g (4) $\frac{m_2 g}{m_1 + m_2}$

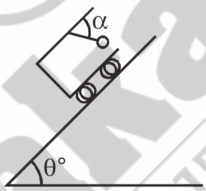
Sol. Answer (1)

50. A block of mass m kg is kept on a weighing machine in an elevator. If the elevator is retarding upward by a ms^{-2}, the reading of weighing machine is (in kgf)

(1) mg (2) $m(g - a)$ (3) $m\left(1 - \frac{a}{g}\right)$ (4) $m(g + a)$

Sol. Answer (3)

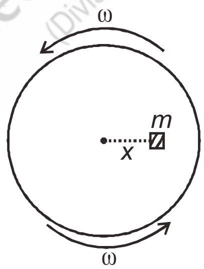
51. A trolley is falling freely on inclined plane as shown in the figure. The angle of string of pendulum with the ceiling of trolley is (α) equal to



(1) θ° (2) 90° – θ° (3) 90° (4) 0°

Sol. Answer (3)

52. A block of mass m is kept on horizontal turn table at x distance from the centre. If coefficient of friction between block and surface of turn table is μ, then maximum angular speed of the table so that block does not slip is

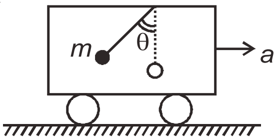


(1) $\sqrt{\frac{\mu g}{x^2}}$ (2) $\sqrt{\frac{\mu g}{x}}$

(3) $\sqrt{\frac{\mu g}{2x}}$ (4) $\sqrt{\frac{\mu x^2}{g}}$

Sol. Answer (2)

53. If trolley accelerates horizontally with acceleration a then bob is displaced backward from its initial vertical position. The angular deflection of the bob in equilibrium is



(1) $\theta = \cos^{-1}\left(\frac{a}{g}\right)$ (2) $\theta = \sin^{-1}\left(\frac{a}{g}\right)$ (3) $\theta = \cot^{-1}\left(\frac{a}{g}\right)$ (4) $\theta = \tan^{-1}\left(\frac{a}{g}\right)$

Sol. Answer (4)

54. Select correct statement regarding pseudo force

(1) It is electromagnetic in origin

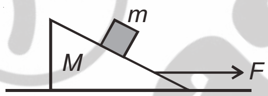
(2) Newton's 3rd law is applicable for it

(3) It is a fundamental force

(4) It is used to make Newton's law applicable in noninertial frame

Sol. Answer (4)

55. What force should be applied on the wedge so that block over it does not move? (All surfaces are smooth)



(1) $F = (M + m)\, g \cot\theta$

(2) $F = (M + m)\, g \tan\theta$

(3) $F = (M + m)\, g \sin\theta$

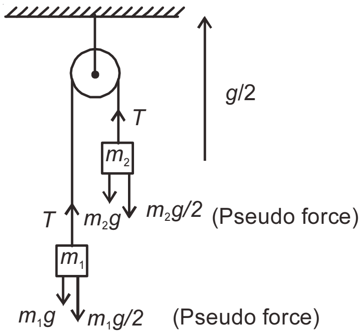
(4) $F = (M + m)\, g \cos\theta$

Sol. Answer (2)

56. Two bodies of masses m_1 and m_2 are connected by a light string which passes over a frictionless, massless pulley. If the pulley is moving upward with uniform acceleration $\frac{g}{2}$, then tension in the string will be

(1) $\frac{3m_1m_2}{m_1+m_2}g$ (2) $\frac{m_1+m_2}{4m_1m_2}g$ (3) $\frac{2m_1m_2}{m_1+m_2}g$ (4) $\frac{m_1m_2}{m_1+m_2}g$

Sol. Answer (1)



Writing equation from the reference frame of pulley

$$\frac{3m_1 g}{2} - T = m_1 a \qquad \ldots(i)$$

$$T - \frac{3m_2 g}{2} = m_2 a \qquad \ldots(ii)$$

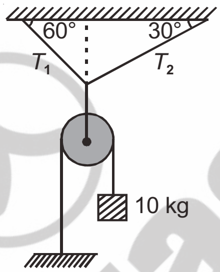
Add (i) and (ii)

$$\frac{3g}{2}\left(\frac{m_1 - m_2}{m_1 + m_2}\right) = a$$

Use a in eq. (i) or (ii)

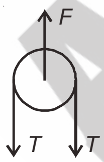
Solving $T = \dfrac{3m_1 m_2}{m_1 + m_2} g$

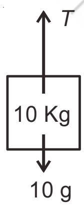
57. In the arrangement as shown, tension T_2 is (g = 10 m/s^2)

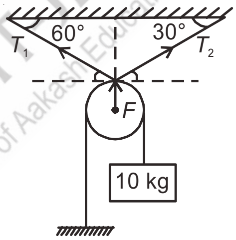


(1) 50 N (2) 100 N (3) $50\sqrt{3}$ N (4) $100\sqrt{3}$ N

Sol. Answer (2)







For pulley

$F = 2T$

for block

$T = 10\ g = 100$ N

$F = 200$ N

For horizontal equilibrium

$T_1 \cos 60° = T_2 \cos 30°$

$$T_1 = 2T_2 \frac{\sqrt{3}}{2} = \sqrt{3}\ T_2 \qquad \ldots(i)$$

For vertical equilibrium

$T_1 = \sin 60° + T_2 \sin 30° = 200 \qquad \ldots(ii)$

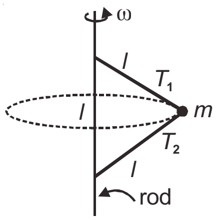
Using (i) and (ii) solve for T_2

$2T_2 = 200$

$T_2 = 100$ N

(Circular Motion Solving Problems in Mechanics)

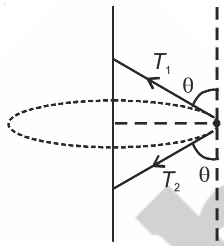
58. In the figure, a ball of mass m is tied with two strings of equal length as shown. If the rod is rotated with angular velocity ω, then



(1) $T_1 > T_2$ (2) $T_2 > T_1$ (3) $T_1 = T_2$ (4) $T_1 = \frac{T_2}{6}$

Sol. Answer (1)

For vertical equilibrium



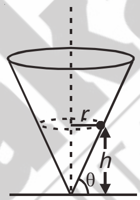
$T_1 \cos\theta = mg + T_2 \cos\theta$

$T_1 = \frac{mg}{\cos\theta} + T_2$

$\theta < 90°$ so $\cos\theta > 0$

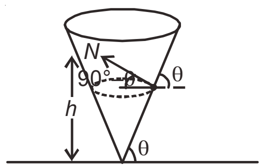
$\Rightarrow\ T_1 > T_2$

59. A particle describes a horizontal circle of radius r on the smooth surface of an inverted cone as shown. The height of plane of circle above vertex is h. The speed of particle should be



(1) $\sqrt{rg}$ (2) $\sqrt{2rg}$ (3) $\sqrt{gh}$ (4) $\sqrt{2gh}$

Sol. Answer (3)



$N\cos(90° - \theta) = \frac{mv^2}{r}$

$N\sin(90° - \theta) = mg$

$N = \frac{mg}{\cos\theta}$ ...(i)

and $N\sin\theta = \frac{mv^2}{r}$ ...(ii)

dividing (ii) and (i)

$mg\tan\theta = \frac{mv^2}{r}$

$g\left(\frac{h}{r}\right) = \frac{v^2}{r} \Rightarrow v = \sqrt{gh}$

60. If the string of a conical pendulum makes an angle θ with horizontal, then square of its time period is proportional to

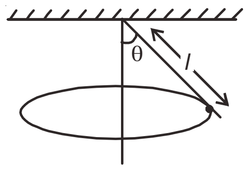
(1) sinθ (2) cosθ (3) tanθ (4) cotθ

Sol. Answer (1)

For conical pendulum we know that

$$T = 2\pi\sqrt{\frac{l\cos\theta}{g}}$$

where θ is the angle from vertical but in question θ is given from horizontal



hence $T = 2\pi\sqrt{\frac{l\sin\theta}{g}}$

$T^2 \propto \sin\theta$

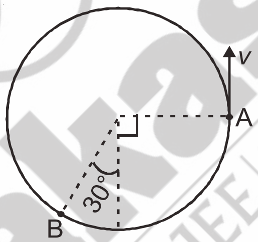
61. The acceleration vector of a particle in uniform circular motion averaged over the cycle is a null vector. This statement is

(1) True (2) False (3) May be true (4) May be false

Sol. Answer (1)

Acceleration will be towards centre at every instant.

62. A particle of mass *m* moves with constant speed *v* on a circular path of radius *r* as shown in figure. The average force on it during its motion from *A* to *B* is



(1) $\frac{\sqrt{3}mv^2}{2\pi r}$ (2) $\frac{mv^2}{r}$ (3) $\frac{2\sqrt{3}mv^2}{\pi r}$ (4) $\frac{3\sqrt{3}mv^2}{4\pi r}$

Sol. Answer (4)

$$F = ma = \frac{m\Delta v}{\Delta t} = \left[\frac{2v^2\sin\theta/2}{r\theta}\right]$$

$$= m\left[\frac{2v^2\sin(2\pi - 2\pi/3)}{r.\left(\frac{4\pi}{3}\right)}\right] = \frac{3\sqrt{3}\ mv^2}{4\pi r}$$

63. A person stands in contact against the inner wall of a rotor of radius *r*. The coefficient of friction between the wall and the clothing is μ and the rotor is rotating about vertical axis. The minimum angular speed of the rotor so that the person does not slip downward is

(1) $\sqrt{\frac{\mu g}{r}}$ (2) $\sqrt{\frac{\mu r}{g}}$ (3) $\sqrt{\frac{g}{\mu r}}$ (4) $\sqrt{\mu rg}$

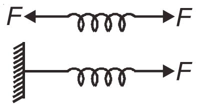
Sol. Answer (3)

$$N = \frac{mv^2}{r}$$

$$f_L = \mu N = \mu\left[\frac{mv^2}{r}\right] = mg$$

$$v = \sqrt{\frac{gr}{\mu}}$$

64. Figure shows two cases. In first case a spring (spring constant K) is pulled slowly by two equal and opposite forces F at both ends and in second case is pulled by a force F at one end. Extensions (x) in the springs will be



(1) In both cases $x = \frac{2F}{K}$
(2) In both cases $x = \frac{F}{K}$
(3) In first case $x = \frac{2F}{K}$, in second case $x = \frac{F}{K}$
(4) In first case $x = \frac{F}{K}$, in second case $x = \frac{2F}{K}$

Sol. Answer (2)

Figure (2) is F.B.D. of figure (1)

at equilibrium $F = Kx$

$x = F/K$

SECTION - B

Previous Years Questions

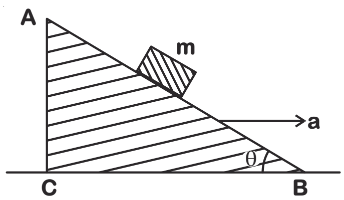
1. Which one of the following statements is incorrect? **[NEET-2018]**
   (1) Rolling friction is smaller than sliding friction.
   (2) Limiting value of static friction is directly proportional to normal reaction.
   (3) Coefficient of sliding friction has dimensions of length.
   (4) Frictional force opposes the relative motion.

Sol. Answer (3)

Coefficient of sliding friction has no dimension

$f = \mu_s N \Rightarrow \mu_s = \frac{f}{N}$

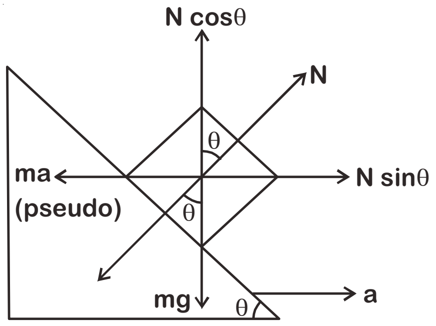
2. A block of mass m is placed on a smooth inclined wedge ABC of inclination θ as shown in the figure. The wedge is given an acceleration a towards the right. The relation between a and θ for the block to remain stationary on the wedge is



[NEET-2018]

(1) $a = \frac{g}{\text{cosec}\,\theta}$
(2) $a = \frac{g}{\sin\theta}$
(3) $a = g\tan\theta$
(4) $a = g\cos\theta$

Sol. Answer (3)



In non-inertial frame,

$N \sin\theta = ma$ ...(i)

$N \cos\theta = mg$ ...(ii)

$$\tan\theta = \frac{a}{g}$$

$a = g \tan \theta$

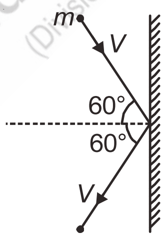
3. One end of string of length l is connected to a particle of mass 'm' and the other end is connected to a small peg on a smooth horizontal table. If the particle moves in circle with speed 'v', the net force on the particle (directed towards center) will be (T represents the tension in the string) **[NEET-2017]**

(1) T (2) $T + \frac{mv^2}{l}$ (3) $T - \frac{mv^2}{l}$ (4) Zero

Sol. Answer (1)

Centripetal force $\left(\frac{mv^2}{l}\right)$ is provided by tension so the net force will be equal to tension *i.e.*, T.

4. A rigid ball of mass m strikes a rigid wall at 60° and gets reflected without loss of speed as shown in the figure below. The value of impulse imparted by the wall on the ball will be **[NEET (Phase-2) 2016]**



(1) mV (2) $2mV$

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

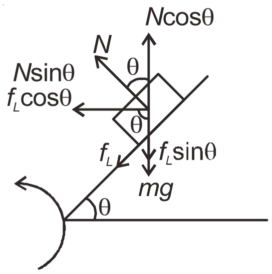
Sol. Answer (1)

$|\vec{J}| = |\vec{P}_2 - \vec{P}_1| = 2mV \cos\theta = mV$

5. A car is negotiating a curved road of radius R. The road is banked at an angle θ. The coefficient of friction between the tyres of the car and the road is μ_s. The maximum safe velocity on this road is **[NEET-2016]**

(1) $\sqrt{\frac{g}{R^2}\frac{\mu_s+\tan\theta}{1-\mu_s\tan\theta}}$ (2) $\sqrt{gR^2\frac{\mu_s+\tan\theta}{1-\mu_s\tan\theta}}$ (3) $\sqrt{gR\frac{\mu_s+\tan\theta}{1-\mu_s\tan\theta}}$ (4) $\sqrt{\frac{g}{R}\frac{\mu_s+\tan\theta}{1-\mu_s\tan\theta}}$

Sol. Answer (3)



Vertical equilibrium

$N\cos\theta = mg + f_L\sin\theta$

$\Rightarrow \; mg = N\cos\theta - f_L\sin\theta \qquad \ldots(1)$

Horizontal equilirbium

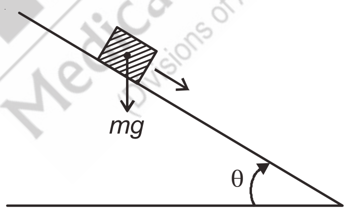
$N\sin\theta + f_L\cos\theta = \frac{mv^2}{R} \qquad \ldots(2)$

$\frac{Eqn(2)}{Eqn(1)} \qquad \frac{v^2}{Rg} = \frac{\sin\theta+\mu_s\cos\theta}{\cos\theta-\mu_s\sin\theta}$

$\Rightarrow \; v = \sqrt{Rg\frac{\sin\theta+\mu_s\cos\theta}{\cos\theta-\mu_s\sin\theta}}$

$= \sqrt{Rg\frac{\tan\theta+\mu_s}{1-\mu_s\tan\theta}}$

6. A plank with a box on it at one end is gradually raised about the other end. As the angle of inclination with the horizontal reaches 30º, the box starts to slip and slides 4.0 m down the plank in 4.0 s. The coefficients of static and kinetic friction between the box and the plank will be, respectively **[Re-AIPMT-2015]**



(1) 0.4 and 0.3 (2) 0.6 and 0.6 (3) 0.6 and 0.5 (4) 0.5 and 0.6

Sol. Answer (3)

Static coefficient of friction, $\mu_s = \tan 30°$

$\mu_s = \frac{1}{\sqrt{3}} = \frac{1}{1.7} \Rightarrow \mu_s = 0.6$

For kinetic friction, $a = \frac{2s}{t^2} = g\sin 30° - \mu_k\cos 30°$

$\mu_k = 0.5$

7. Two stones of masses m and 2 m are whirled in horizontal circles, the heavier one in a radius $\frac{r}{2}$ and lighter one in radius r. The tangential speed of lighter stone is n times that of the value of heavier stone when they experience same centripetal forces. The value of n is **[Re-AIPMT-2015]**

(1) 1 (2) 2 (3) 3 (4) 4

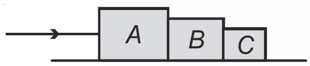
Sol. Answer (2)

$$F = \frac{m(nv)^2}{r} = \frac{2mv^2}{\frac{r}{2}}$$

$n^2 = 4$

$n = 2$

8. Three blocks A, B and C of masses 4 kg, 2 kg and 1 kg respectively, are in contact on a frictionless surface, as shown. If a force of 14 N is applied on the 4 kg block, then the contact force between A and B is **[AIPMT-2015]**



(1) 18 N (2) 2 N

(3) 6 N (4) 8 N

Sol. Answer (3)

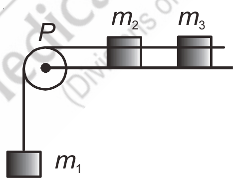
9. A block A of mass m_1 rests on a horizontal table. A light string connected to it passes over a frictionless pulley at the edge of table and from its other end another block B of mass m_2 is suspended. The coefficient of kinetic friction between the block and table is μ_k. When the block A is sliding on the table, the tension in the string is **[AIPMT-2015]**

(1) $\frac{m_1 m_2 (1-\mu_k)g}{(m_1+m_2)}$ (2) $\frac{(m_2+\mu_k m_1)g}{(m_1+m_2)}$

(3) $\frac{(m_2-\mu_k m_1)g}{(m_1+m_2)}$ (4) $\frac{m_1 m_2 (1+\mu_k)g}{(m_1+m_2)}$

Sol. Answer (4)

10. A system consists of three masses m_1, m_2 and m_3 connected by a string passig over a pulley P. The mass m_1 hangs freely and m_2 and m_3 are on a rough horizontal table (The coefficient of friction $= \mu$). The pulley is frictionless and of negligible mass. The downward acceleration of mass m_1 is: (Assume $m_1 = m_2 = m_3 = m$) **[AIPMT-2014]**



(1) $\frac{g(1-g\mu)}{9}$ (2) $\frac{2g\mu}{3}$

(3) $\frac{g(1-2\mu)}{3}$ (4) $\frac{g(1-2\mu)}{2}$

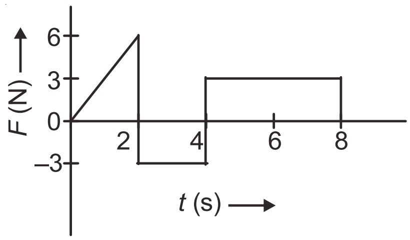
Sol. Answer (3)

$m_1 g - T = m_1 a$ ...(i)

$T - \mu(m_2 + m_3)g = (m_2 + m_3)a$ ...(ii)

Solve (i) & (ii) for a

11. The force F acting on a particle of mass m is indicated by the force-time graph shown below. The change in momentum of the particle over the time interval from 0 s to 8 s is **[AIPMT-2014]**



(1) 24 Ns (2) 20 Ns (3) 12 Ns (4) 6 Ns

Sol. Answer (3)

$$\Delta P = \int_0^8 F dt$$

So area of $F - t$ curve will give change in momentum.

$$\Delta P = \frac{1}{2} \times 2 \times 6 - (2 \times 3) + 4 \times 3 = 12 \text{ Ns}$$

12. A balloon with m is descending down with an acceleration a (where $a < g$). How much mass should be removed from it so that it starts moving up with an acceleration a? **[AIPMT-2014]**

(1) $\frac{2ma}{g+a}$ (2) $\frac{2ma}{g-a}$ (3) $\frac{ma}{g+a}$ (4) $\frac{ma}{g-a}$

Sol. Answer (1)

13. The upper half of an inclined plane of inclination θ is perfectly smooth while lower half is rough. A block starting from rest at the top of the plane will again come to rest at the bottom, if the coefficient of friction between the block and lower half of the plane is given by **[NEET-2013]**

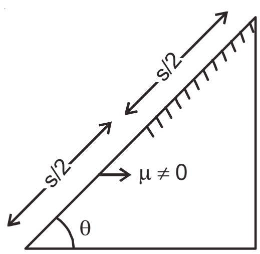
(1) $\mu = \frac{2}{\tan\theta}$ (2) $\mu = 2\tan\theta$

(3) $\mu = \tan\theta$ (4) $\mu = \frac{1}{\tan\theta}$

Sol. Answer (2)

For first half

$$v = \sqrt{2g\sin\theta\left(\frac{s}{2}\right)} = \sqrt{sg\sin\theta}$$



for second half

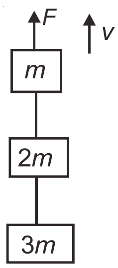
$$\frac{s}{2} = \frac{V^2}{2a} \text{ (a is retardation)}$$

Or, $$\frac{s}{2} = \frac{sg\sin\theta}{2(g\sin\theta - \mu g\cos\theta)}$$

Solving this

$$\mu = 2\tan\theta$$

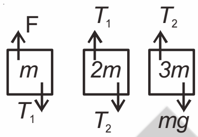
14. Three blocks with masses m, $2m$ and $3m$ are connected by strings, as shown in the figure. After an upward force F is applied on block m, the masses move upward at constant speed v. What is the net force on the block of mass $2m$? (g is the acceleration due to gravity) **[NEET-2013]**



(1) $2mg$ (2) $3mg$ (3) $6mg$ (4) Zero

Sol. Answer (4)

$a = 0$



Using $F_{net} = M_{total}a$

$F - (m + 2m + 3m) = 0$

$F = 6\ m$

$T_1 = F$, $T_2 = T_1$ since $a = 0$

Hence net force on $2m$ will be $T_1 - T_2 = 0$

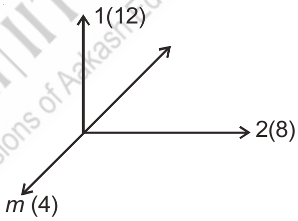
15. An explosion breaks a rock into three parts in a horizontal plane. Two of them go off at right angles to each other. the first part of mass 1 kg moves with a speed of 12 ms^{-1} and the second part of mass 2 kg moves with 8 ms^{-1} speed. If the third part flies off with 4 ms^{-1} speed, then its mass is **[NEET-2013]**

(1) 5 kg (2) 7 kg

(3) 17 kg (4) 3 kg

Sol. Answer (1)

Using momentum conservation



$$m(4) = \sqrt{(12)^2 + (16)^2}$$

$4m = 20$

$m = 5$ kg

16. A car of mass 1000 kg negotiates a banked curve of radius 90 m on a frictionless road. If the banking angle is 45°, the speed of the car is **[AIPMT (Prelims)-2012]**

(1) 5 ms^{-1} (2) 10 ms^{-1}

(3) 20 ms^{-1} (4) 30 ms^{-1}

Sol. Answer (4)

$$\tan\theta = \frac{v^2}{rg}$$

$$\tan 45° = \frac{v^2}{90(10)}$$

$v = 30$ m/s

17. A car of mass m is moving on a level circular track of radius R. If μ_s represents the static friction between the road and tyres of the car, the maximum speed of the car in circular motion is given by

[AIPMT (Mains)-2012]

(1) $\sqrt{\mu_s mRg}$ (2) $\sqrt{\frac{Rg}{\mu_s}}$ (3) $\sqrt{\frac{mRg}{\mu_s}}$ (4) $\sqrt{\mu_s Rg}$

Sol. Answer (4)

$$\tan\theta = \mu_s = \frac{v^2}{Rg}$$

$$\Rightarrow \quad v_{max.} = \sqrt{\mu_s Rg}$$

18. A person of mass 60 kg is inside a lift of mass 940 kg and presses the button on control panel. The lift starts moving upwards with an acceleration 1 m/s^2. If g = 10 ms^{-2}, the tension in the supporting cable is

[AIPMT (Prelims)-2011]

(1) 1200 N (2) 8600 N (3) 9680 N (4) 11000 N

Sol. Answer (4)

$$T = mg + ma$$
$$= m(g + a)$$
$$= 1000\,(10 + 1) = 11000 \text{ N}$$

19. A body of mass M hits normally a rigid wall with velocity v and bounces back with the same velocity. The impulse experienced by the body is **[AIPMT (Prelims)-2011]**

(1) Zero (2) Mv (3) $1.5Mv$ (4) $2Mv$

Sol. Answer (4)

Impulse = change in momentum

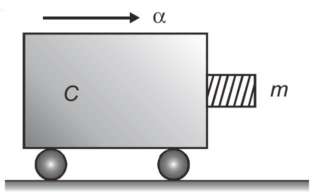
$$= Mv - (-Mv) = 2Mv$$

20. A radioactive nucleus of mass M emits a photon of frequency ν and the nucleus recoils. The recoil energy will be: **[AIPMT (Prelims)-2011]**

(1) $h\nu$ (2) $Mc^2 - h\nu$ (3) $\frac{h^2\nu^2}{2Mc^2}$ (4) Zero

Sol. Answer (3)

21. A block of mass m is in contact with the cart C as shown in the figure.



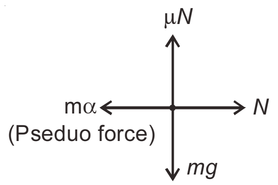
The coefficient of static friction between the block and the cart is μ. The acceleration α of the cart that will prevent the block from falling satisfies: **[AIPMT (Prelims)-2010]**

(1) $\alpha > \frac{mg}{\mu}$ (2) $\alpha > \frac{g}{\mu m}$ (3) $\alpha \geq \frac{g}{\mu}$ (4) $\alpha < \frac{g}{\mu}$

Sol. Answer (3)

$\Rightarrow \quad mg \leq \mu(m\alpha)$

$\alpha \geq \dfrac{g}{\mu}$



22. A gramophone record is revolving with an angular velocity ω. A coin is placed at a distance r from the centre of the record. The static coefficient of friction is μ. The coin will revolve with the record if: **[AIPMT (Prelims)-2010]**

(1) $r = \mu g \omega^2$ (2) $r < \dfrac{\omega^2}{\mu g}$ (3) $r < \dfrac{\mu g}{\omega^2}$ (4) $r \geq \dfrac{\mu g}{\omega^2}$

Sol. Answer (3)

23. A body, under the action of a force $\vec{F} = 6\hat{i} - 8\hat{j} + 10\hat{k}$, acquires an acceleration of 1 m/s^2. The mass of this body must be: **[AIPMT (Prelims)-2009]**

(1) 10 kg (2) 20 kg (3) $10\sqrt{2}$ kg (4) $2\sqrt{10}$ kg

Sol. Answer (3)

24. The mass of a lift is 2000 kg. When the tension in the supporting cable is 28000 N, then its acceleration is: **[AIPMT (Prelims)-2009]**

(1) 4 ms^{-2} upwards (2) 4 ms^{-2} downwards (3) 14 ms^{-2} upwards (4) 30 ms^{-2} downwards

Sol. Answer (1)

$F_{net} = ma$

$28000 - 2000\,g = 2000\,a$

$\Rightarrow a = \dfrac{8000}{2000} = 4 \text{ m/s}^2$ upwards

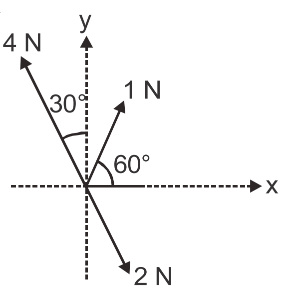
25. Sand is being dropped on a conveyor belt at the rate of M kg/s. The force necessary to keep the belt moving with a constant velocity of v m/s will be **[AIPMT (Prelims)-2008]**

(1) Zero (2) Mv newton (3) $2Mv$ newton (4) $\dfrac{Mv}{2}$ newton

Sol. Answer (2)

$F = \dfrac{vdM}{dt} = vM$

26. Three forces acting on a body are shown in the figure. To have the resultant force only along the y-direction, the magnitude of the minimum additional force needed is **[AIPMT (Prelims)-2008]**



(1) $\sqrt{3}$ N (2) 0.5 N (3) 1.5 N (4) $\dfrac{\sqrt{3}}{4}$ N

Sol. Answer (2)

To have the resultant force only along the *y*-direction

$\Rightarrow$ Component of forces along *x*-axis should be zero

$4 \sin 30° - 1 \cos 60° - 2 \cos 60° = x$

$x = 0.5$ N

27. A roller coaster is designed such that riders experience "weightlessness" as they go round the top of a hill whose radius of curvature is 20 m. The speed of the car at the top of the hill is between

[AIPMT (Prelims)-2008]

(1) 13 m/s and 14 m/s (2) 14 m/s and 15 m/s (3) 15 m/s and 16 m/s (4) 16 m/s and 17 m/s

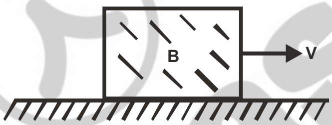
Sol. Answer (2)

$$\frac{mv^2}{r} = mg$$

$$\Rightarrow v = \sqrt{20 \times 10}$$

$$= 10\sqrt{2} \cong 14.1 \text{ m/s}$$

28. A block *B* is pushed momentarily along a horizontal surface with an initial velocity *v*. If μ is the coefficient of sliding friction between *B* and the surface, block *B* will come to rest after a time **[AIPMT (Prelims)-2007]**



(1) $\frac{v^2}{g\mu}$ (2) $\frac{v}{\mu g}$ (3) $\frac{g\mu}{v}$ (4) $\frac{g}{v}$

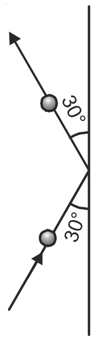
Sol. Answer (2)

$v = u - at$

$v = 0$

$t = \frac{v}{\mu g}$

29. A 0.5 kg ball moving with a speed of 12 m/s strikes a hard wall at an angle of 30° with the wall. It is reflected with the same speed and at the same angle. If the ball is in contact with the wall for 0.25 s, the average force acting on the wall is: **[AIPMT (Prelims)-2006]**



(1) 48 N (2) 24 N (3) 12 N (4) 96 N

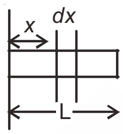
Sol. Answer (2)

30. A tube of length L is filled completely with an incompressible liquid of mass M and closed at both the ends. The tube is then rotated in a horizontal plane about one of its ends with a uniform angular velocity ω. The force exerted by the liquid at the other end is : **[AIPMT (Prelims)-2006]**

(1) $\dfrac{ML\omega^2}{2}$ (2) $\dfrac{ML^2\omega}{2}$

(3) $ML\omega^2$ (4) $\dfrac{ML^2\omega^2}{2}$

Sol. Answer (1)



$$dm = \frac{M}{L}dx$$

$$\int dF = \int_0^L dM\,\omega^2 x \qquad [\because F = M\omega^2 r]$$

$$F = \frac{M\omega^2}{L}\int_0^L x\,dx$$

$$= \frac{M\omega^2}{L}\left(\frac{L^2}{2}\right)$$

$$= \frac{M\omega^2 L}{2}$$

31. A conveyor belt is moving at a constant speed of 2 m/s. A box is gently dropped on it. The coefficient of friction between them is $\mu = 0.5$. The distance that the box will move relative to belt before coming to rest on it, taking $g = 10\ \text{ms}^{-2}$, is **[AIPMT (Mains)-2011]**

(1) Zero (2) 0.4 m (3) 1.2 m (4) 0.6 m

Sol. Answer (2)

$$v^2 - u^2 = 2as$$

$$(2)^2 - 0 = 2\,(0.5 \times 10)s$$

$$\Rightarrow s = \frac{4}{10} = 0.4\ \text{m}$$

32. A stone is dropped from a height h. It hits the ground with a certain momentum P. If the same stone is dropped from a height 100% more than the previous height, the momentum when it hits the ground will change by

(1) 68% (2) 41%

(3) 200% (4) 100%

Sol. Answer (2)

$$\frac{h' - h}{h}\times 100 = 100 \Rightarrow h' = 2h$$

$$mv_1 = m\sqrt{2gh}$$

$$mv_2 = m\sqrt{2g(2h)} = \sqrt{2}\,mv_1$$

$$\text{change\%} = \frac{\sqrt{2}\,mv_1 - mv_1}{mv_1}\times 100 = 41\%$$

33. A mass m moving horizontally (along the x-axis) with velocity v collides and sticks to a mass of $3m$ moving vertically upward (along the y-axis) with velocity $2v$. The final velocity of the combination is

(1) $\frac{2}{3}v\hat{i}+\frac{1}{3}v\hat{j}$ (2) $\frac{3}{2}v\hat{i}+\frac{1}{4}v\hat{j}$ (3) $\frac{1}{4}v\hat{i}+\frac{3}{2}v\hat{j}$ (4) $\frac{1}{3}v\hat{i}+\frac{2}{3}v\hat{j}$

Sol. Answer (3)

Using momentum conservation, $mv\hat{i}+3m(2v)\hat{j} = 4m\vec{v}$

$$\vec{v} = \frac{1}{4}v\hat{i}+\frac{3}{2}v\hat{j}$$

34. An object is moving on a plane surface uniform velocity 10 ms^{-1} in presence of a force 10 N. The frictional force between the object and the surface is

(1) 1 N (2) –10 N (3) 10 N (4) 100 N

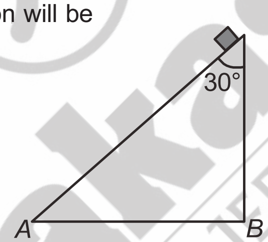
Sol. Answer (2)

$F_{net} = 0$ to move with constant velocity

$F + F = 0$

$F = -10$ N

35. A body of mass M starts sliding down on the inclined plane where the critical angle is $\angle ACB = 30°$ as shown in figure. The coefficient of kinetic friction will be



(1) $\frac{Mg}{\sqrt{3}}$ (2) $\sqrt{3}Mg$ (3) $\sqrt{3}$ (4) None of these

Sol. Answer (3)

$mg\sin\theta = \mu mg\cos\theta$

where $\theta = 90 - 30° = 60°$

$\tan\theta = \mu$

$\mu = \sqrt{3}$

36. In non-inertial frame, the second law of motion is written as

(1) $\vec{F}=m\vec{a}$ (2) $\vec{F}=m\vec{a}+\vec{F}_p$ (3) $\vec{F}=m\vec{a}-\vec{F}_p$ (4) $\vec{F}=2m\vec{a}$

where $\vec{F}_p$ is a pseudo-force while $\vec{a}$ is the acceleration of the body relative to non-inertial frame.

Sol. Answer (3)

$F = ma - F_p$

where F_p is pseudo force

37. A person holding a rifle (mass of person and rifle together is 100 kg) stands on a smooth surface and fires 10 shots horizontally, in 5 s. Each bullet has a mass of 10 g with a muzzle velocity of 800 ms^{-1}. The final velocity acquired by the person and the average force exerted on the person are

(1) $-1.6\ ms^{-1}$; 8 N (2) $-0.08\ ms^{-1}$; 16 N (3) $-0.8\ ms^{-1}$; 16 N (4) $-1.6\ ms^{-1}$; 16 N

Sol. Answer (3)

Bullet shots per second = $\frac{10}{5} = 2$

Using momentum conservation

$$0 = 10 \times \frac{10}{1000}(800) + 100\ V \Rightarrow V = -0.8 \text{ m/s}$$

$$F = n\ mV$$

$$= 2 \times \frac{(10)}{1000} \times 800 = 16 \text{ N}$$

38. In a rocket, fuel burns at the rate of 1 kg/s. This fuel is ejected from the rocket with a velocity of 60 km/s. This exerts a force on the rocket equal to

(1) 6000 N (2) 60000 N (3) 60 N (4) 600 N

Sol. Answer (2)

$$F = \frac{vdm}{dt}$$

$$= 60 \times 10^3 \times (1)$$

$$= 60000 \text{ N}$$

39. A satellite in force-free space sweeps stationary interplanetary dust at a rate of $dM/dt = \alpha v$, where M is mass and v is the speed of satellite and α is a constant. The tangential acceleration of satellite is

(1) $\frac{-\alpha v^2}{2M}$ (2) $-\alpha v^2$ (3) $\frac{-2\alpha v^2}{M}$ (4) $\frac{-\alpha v^2}{M}$

Sol. Answer (4)

$$a = \frac{F}{M} = \frac{-\alpha\ v.v}{M} = \frac{-\alpha\ v^2}{M}$$

40. A man fires a bullet of mass 200 gm at a speed of 5 m/s. The gun is of one kg mass. By what velocity the gun rebounds backward?

(1) 1 m/s (2) 0.01 m/s (3) 0.1 m/s (4) 10 m/s

Sol. Answer (1)

Using momentum conservation

$$v = \frac{(0.2)5}{1} = 1 \text{ m/s}$$

41. A 10 N force is applied on a body produces in it an acceleration of 1 m/s^2. The mass of the body is

(1) 15 kg (2) 20 kg (3) 10 kg (4) 5 kg

Sol. Answer (3)

$$m = \frac{F}{a} = \frac{10}{1} = 10 \text{ kg}$$

42. A force of 6 N acts on a body at rest and of mass 1 kg. During this time, the body attains a velocity of 30 m/s. The time for which the force acts on the body is

(1) 7 second (2) 5 second (3) 10 second (4) 8 second

Sol. Answer (2)

$$a = \frac{6}{1} = 6 \text{ m/s}^2$$

$$v = at$$

$$\Rightarrow t = \frac{v}{a} = \frac{30}{6} = 5 \text{ s}$$

43. A shell, in flight, explodes into four unequal parts. Which of the following is conserved?

(1) Potential energy (2) Momentum (3) Kinetic energy (4) Both (1) & (3)

Sol. Answer (2)

44. A 5000 kg rocket is set for vertical firing. The exhaust speed is 800 ms^{-1}. To give an initial upward acceleration of 20 ms^{-2}, the amount of gas ejected per second to supply the needed thrust will be (g = 10 ms^{-2})

(1) 185.5 kg s^{-1} (2) 187.5 kg s^{-1} (3) 127.5 kg s^{-1} (4) 137.5 kg s^{-1}

Sol. Answer (2)

m = 5000 kg v = 800 m/s a = 20 m/s^2

$$a = \frac{v\frac{dm}{dt} - mg}{m} = \frac{800\left(\frac{dm}{dt}\right) - 50000}{5000} = 2$$

$$\Rightarrow \frac{dm}{dt} = 187.5 \text{ kg/s}$$

45. A bullet is fired from a gun. The force on the bullet is given by $F = 600 - 2 \times 10^5 t$, where F is in newton and t in second. The force on the bullet becomes zero as soon as it leaves the barrel. What is the impulse imparted to the bullet?

(1) 9 Ns (2) Zero (3) 1.8 Ns (4) 0.9 Ns

Sol. Answer (4)

When bullet leaves the barrel, force becomes zero

$$F = 600 - 2 \times 10^5 t = 0$$

$$t = \frac{600}{2\times10^5} = 3 \times 10^{-3} \text{ s}$$

$$I = \int F dt = \int_0^{3\times10^{-3}} (600 - 2\times10^5 t)\ dt$$

$$\left[600t - 2\times\frac{10^5 t^2}{2}\right]_0^{3\times10^{-3}} = 1.8 - 0.9 = 0.9 \text{ N.s}$$

46. A ball of mass 0.25 kg attached to the end of a string of length 1.96 m is moving in a horizontal circle. The string will break if the tension is more than 25 N. What is the maximum speed with which the ball can be moved?

(1) 5 m/s (2) 3 m/s (3) 14 m/s (4) 3.92 m/s

Sol. Answer (3)

$$T_{max.} = 25 = \frac{mv_{max.}^2}{R}$$

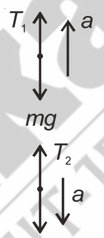
$$v_{max.}^2 = 196$$

$$v_{max.} = 14 \text{ m/s}$$

47. A mass of 1 kg is suspended by a thread. It is (i) lifted up with an acceleration 4.9 m/s^2, (ii) lowered with an acceleration 4.9 m/s^2. The ratio of the tensions is

(1) 1 : 3 (2) 1 : 2 (3) 3 : 1 (4) 2 : 1

Sol. Answer (3)



$T_1 = mg + ma$

$T_2 = mg - ma$

$$\frac{T_1}{T_2} = \frac{9.8+4.9}{9.8-4.9} = \frac{3}{1}$$

48. If the force on a rocket, that releases the exhaust gases with a velocity of 300 m/s is 210 N, then the rate of combustion of the fuel is

(1) 0.07 kg/s (2) 1.4 kg/s (3) 0.7 kg/s (4) 10.7 kg/s

Sol. Answer (3)

$$F = \frac{vdm}{dt}$$

$$\frac{dm}{dt} = \frac{F}{v} = \frac{210}{300} = 0.7 \text{ kg/s}$$

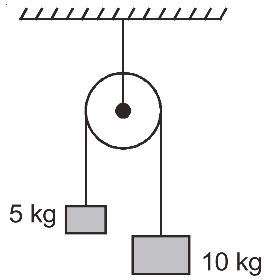
49. A 500 kg car takes a round turn of radius 50 m with a velocity of 36 km/h. The centripetal force is

(1) 1000 N (2) 750 N (3) 250 N (4) 1200 N

Sol. Answer (1)

$$F_c = \frac{mv^2}{r} = \frac{500(10)^2}{50} = 1000 \text{ N}$$

50. Two masses as shown are suspended from a massless pulley. Calculate the acceleration of the 10 kg mass when masses are left free



(1) $\frac{2g}{3}$ (2) $\frac{g}{3}$ (3) $\frac{g}{9}$ (4) $\frac{g}{7}$

Sol. Answer (2)

$$a = \left(\frac{m_1 - m_2}{m_1 + m_2}\right) g = \frac{g}{3}$$

51. A mass of 1 kg is thrown up with a velocity of 100 m/s. After 5 second, it explodes into two parts. One part of mass 400 g moves down with a velocity 25 m/s. Calculate the velocity of other part just after the explosion. (g = 10 ms^{-2})

(1) 40 m/s ↑ (2) 40 m/s ↓ (3) 100 m/s ↑ (4) 60 m/s ↑

Sol. Answer (3)

$$v = u - g(t) = 50 \text{ m/s}$$

So, $1\,(50) = \frac{400}{1000}\,(25) + \frac{600}{1000}v$

$$v = 100 \text{ m/s} \uparrow$$

52. A man is slipping on a frictionless inclined plane and a bag falls down from the same height. Then the velocity of both is related as (V_B = velocity of bag and V_m = velocity of man)

(1) $V_B > V_m$ (2) $V_B < V_m$

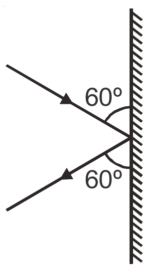
(3) $V_B = V_m$ (4) V_B and V_m can't be related

Sol. Answer (3)

Height is same and friction is absent so using mechanical energy conservation both will reach with the same speed.

$$mgh = \frac{1}{2}mv^2$$

53. A body of mass 3 kg moving with velocity 10 m/s hits a wall at an angle of 60° and returns at the same angle. The impact time was 0.2 s. Calculate the force exerted on the wall.



(1) $150\sqrt{3}$ N (2) $50\sqrt{3}$ N (3) 100 N (4) 75 N

Sol. Answer (1)

$$F = \frac{\Delta p}{\Delta t} = \frac{2(3)(10)\sin 60^\circ}{0.2} = 300\frac{\sqrt{3}}{2} = 150\sqrt{3}\ \text{N}$$

54. A cricketer catches a ball of mass 150 g in 0.1 s moving with speed 20 m/s, then he experiences force of

(1) 300 N (2) 30 N (3) 3 N (4) 0.3 N

Sol. Answer (2)

$$F = \frac{\Delta p}{\Delta t} = \frac{0-\frac{150}{1000}(20)}{0.1} = 30\ \text{N}$$

55. On the horizontal surface of a truck, a block of mass 1 kg is placed (μ = 0.6) and truck is moving with acceleration 5 m/s^2 then the frictional force on the block will be

(1) 5 N (2) 6 N (3) 5.88 N (4) 8 N

Sol. Answer (1)

f_L = 0.6 × 1 g = 6 N

Now, F_{net} = 1 (5) = 5 N

$\Rightarrow$ Only static friction is acting on it.

56. An object of mass 3 kg is at rest. Now a force $\vec{F} = 6t^2\hat{i} + 4t\hat{j}$ is applied on the object then velocity of object at t = 3s is

(1) $18\hat{i} + 3\hat{j}$ (2) $18\hat{i} + 6\hat{j}$

(3) $3\hat{i} + 18\hat{j}$ (4) $18\hat{i} + 4\hat{j}$

Sol. Answer (2)

$\vec{F} = 6t^2\,\hat{i} + 4t\,\hat{j}$

$\frac{mdv}{dt} = 6t^2\,\hat{i} + 4\hat{t}\,\hat{j}$

$mdv = 6t^2\,dt\,\hat{i} + 4tdt.\,\hat{j}$

Integrating both sides

$m(v-u) = \left[2t^3\hat{i} + 2t^2\hat{j}\right]_{t=0}^{t=3}$

given u = 0, m = 3 kg

$v = 18\hat{i} + 6\hat{j}$

57. A block of mass 10 kg placed on rough horizontal surface having coefficient of friction μ = 0.5, if a horizontal force of 100 N is acting on it then acceleration of the block will be (g = 10 ms^{-2})

(1) 10 m/s^2 (2) 5 m/s^2 (3) 15 m/s^2 (4) 0.5 m/s^2

Sol. Answer (2)

$$a = \frac{F-f_k}{m} = \frac{100-(0.5)(10)(10)}{10} = \frac{50}{10} = 5\ \text{m/s}^2$$

58. A lift of mass 1000 kg is moving with acceleration of 1 m/s^2 in upward direction, then the tension developed in string which is connected to lift is

(1) 9800 N (2) 10,800 N (3) 11,000 N (4) 10,000 N

Sol. Answer (2)

$T = m(g + a)$

$= 1000\ (9.8 + 1)$

$= 10800$ N

59. A monkey of mass 20 kg is holding a vertical rope. The rope will not break when a mass of 25 kg is suspended from it but will break if the mass exceeds 25 kg. What is the maximum acceleration with which the monkey can climb up along the rope? (g = 10 m/s^2)

(1) 5 m/s^2 (2) 10 m/s^2 (3) 25 m/s^2 (4) 2.5 m/s^2

Sol. Answer (4)

$T_{max.} - mg = ma$

$250 - 20g = 20a$

$a = 2.5$ m/s^2

60. A man weighs 80 kg. He stands on a weighing scale in a lift which is moving upwards with a uniform acceleration of 5 m/s^2. What would be the reading on the scale? (g = 10 m/s^2)

(1) Zero (2) 400 N (3) 800 N (4) 1200 N

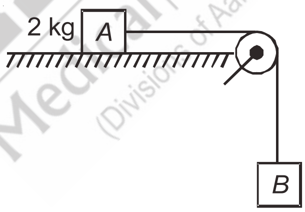
Sol. Answer (4)

$W_{app} = m(g + a)$

$= 80\ (10 + 5)$

$= 1200$ N

61. The coefficient of static function, (μ_s) between block A of mass 2 kg and the table as shown in the figure is 0.2. What would be the maximum mass value of block B so that the two blocks do not move? (The string and the pulley are assumed to be smooth and massless)



(1) 2.0 kg (2) 4.0 kg

(3) 0.2 kg (4) 0.4 kg

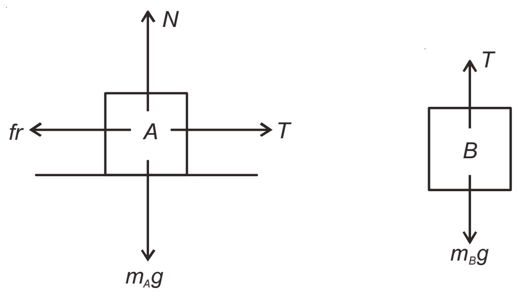
Sol. Answer (4)

$T < fr$

$M_B g < \mu_S\ (2)\ (g)$

$M_B < (0.2)\ (g)$

$M_B < 0.4$ kg

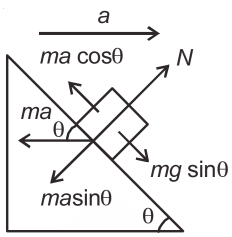


62. A block of mass m is placed on a smooth wedge of inclination θ. The whole system is accelerated horizontally so that the block does not slip on the wedge. The force exerted by the wedge on the block (g is acceleration due to gravity) will be

(1) $mg\cos\theta$ (2) $mg\sin\theta$

(3) mg (4) $mg/\cos\theta$

Sol. Answer (4)



$mg\sin\theta = ma\cos\theta$

$\Rightarrow a = g\tan\theta$

$N = ma\sin\theta + mg\cos\theta$

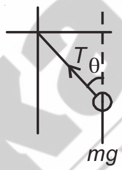
$$N = \frac{mg\sin^2\theta}{\cos\theta} + mg\cos\theta = \frac{mg}{\cos\theta}$$

63. A car is moving in a circular horizontal track of radius 10 m with a constant speed of 10 m/s. A bob is suspended from the roof of the car by a light wire of length 1.0 m. The angle made by the wire with the vertical is

(1) 0° (2) $\frac{\pi}{3}$

(3) $\frac{\pi}{6}$ (4) $\frac{\pi}{4}$

Sol. Answer (4)



$T\cos\theta = mg$

$$T\sin\theta = \frac{mv^2}{r}$$

Divide both equations, $\tan\theta = \frac{v^2}{rg} = \frac{10\times10}{10\times10} \Rightarrow \theta = 45°$

64. A man of 50 kg mass is standing in a gravity free space at a height of 10 m above the floor. He throws a stone of 0.5 kg mass downwards with a speed 2 m/s. When the stone reaches the floor, the distance of the man above the floor will be

(1) 20 m (2) 9.9 m (3) 10.1 m (4) 10 m

Sol. Answer (3)

Using momentum conservation, $0 = 0.5\,(2) + 50\,V \Rightarrow V = \frac{1}{50}$ m/s

Time taken by stone to reach the ground

$S = ut$

$10 = 2(t) \Rightarrow t = 5$ second

Distance covered by man upwards will be $S = \left(\frac{1}{50}\right)5 = 0.1$ m

Total height above the ground = 10 + 0.1 = 10.1 m

SECTION - C

Assertion-Reason Type Questions

1. A : Due to inertia an object is unable to change by itself its state of rest and uniform motion.
   R : An object cannot change its state unless acted upon by an unbalanced external force.

Sol. Answer (1)

2. A : Acceleration of an object in uniform motion is zero.
   R : No force is required to move an object uniformly

Sol. Answer (1)

3. A : Newton's second law of motion gives the measurement of force.
   R : According to second law of motion, force is directly proportional to the rate of change of momentum.

Sol. Answer (1)

4. A : According to Newton's third law of motion for every action, there is an equal and opposite reaction.
   R : There is no time lag between action and reaction.

Sol. Answer (2)

5. A : Inertia depends on the mass of an object.
   R : Greater the mass, larger is the force required to change its state of rest or of uniform motion.

Sol. Answer (1)

6. A : In case of free fall of a lift, the apparent weight of a man in it will be zero.
   R : In free fall, acceleration of lift is equal to acceleration due to gravity.

Sol. Answer (1)

7. A : Static friction force is a self adjusting force.
   R : The interatomic forces at the point of contact give rise to friction between the surfaces.

Sol. Answer (2)

8. A : The value of kinetic friction is less than the limiting friction.
   R : When motion of an object started, the inertia of rest has been overcome.

Sol. Answer (1)

9. A : During horizontal circular turn of a car, the centripetal force required should be less than the limiting friction between its tyres and road.
   R : The centripetal force to car is provided by the frictional force between its tyres and the road.

Sol. Answer (1)

10. A : A person on a frictionless surface can get away from it by blowing air out of his mouth.
    R : For every action there is an equal and opposite reaction.

Sol. Answer (1)

11. A : It is difficult to move a cycle along a road with its brakes on.
    R : Sliding friction is greater than rolling friction.

Sol. Answer (1)

12. A : It makes easier to walk on slippery muddy road if we throw some sand on it.
    R : On throwing sand, frictional force of the surface increases.

Sol. Answer (1)

13. A : Banking of roads reduces the wear and tear of the tyres of automobiles.

R : By banking of the roads, one component of the normal reaction on the automobile contributes to necessary centripetal force.

Sol. Answer (1)

14. A : The centripetal and centrifugal forces never cancel each other.

R : They are action and reaction forces.

Sol. Answer (3)

15. A : Work done by friction can increase the kinetic energy of the body.

R : Friction is a type of contact force and it always opposes the relative motion or tendency of relative motion.

Sol. Answer (2)