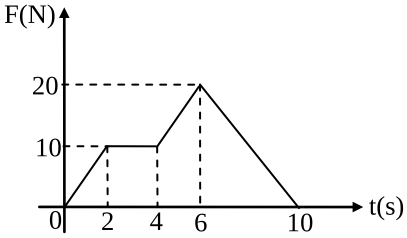
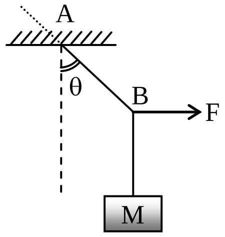
1. A particle of mass 2 kg is initially at rest. A force acts on it whose magnitude changes with time. The force time graph is shown below. The velocity of the particle after 10 s is –



(a) 20 m/s (b) 10 m/s (c) 75 m/s (d) 50 m/s

2. A mass M is suspended by a rope from a rigid support at A as shown in figure. Another rope is tied at the end B and it is pulled horizontally with a force F. If the rope AB makes an angle θ with the vertical, then the tension in the string AB is -



(a) F sin θ (b) F/sin θ (c) F cosθ (d) F/cosθ

3. A 60 kg man stands on a spring scale in a lift. At some instant he finds that the scale reading has changed from 60 kg to 50 kg for a while and then comes back to the original mark . What should he conclude?

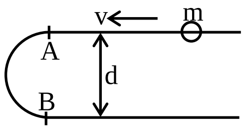
(a) The lift was in constant motion upwards

(b) The lift was in constant motion downwards

(c) The lift while in motion upwards, suddenly stopped

(d) The lift while in motion downwards, suddenly stopped

4. Figure shows a bead of mass m moving with uniform speed v through a U- shaped smooth wire. The wire has a semi-circular bending between A and B. The average force exerted by the bead on the part AB of the wire is -

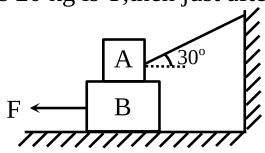


(a) 2 mv (b) $\frac{\pi d}{2}$ (c) $\frac{\pi d}{2v}$ (d) $\frac{4mv^2}{\pi d}$

5. A block of metal weighing 2 kg is resting on a frictionless plane. It is struck by a jet releasing water at a rate of 1 kg/sec and at a speed of 5 m/sec. The initial acceleration of the block will be -

(a) 2.5 m/s^2 (b) 5.0 m/s^2 (c) 10 m/s^2 (d) 25 m/s^2

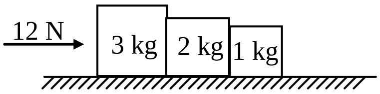
6. In the figure given below, if all surface are assumed to be smooth and the force F = 100 N. If acceleration of block B of mass 20 kg is 'a' and tension in string connecting block A of mass 20 kg is T,then just after when the force F is applied.



(a) T = 0 and a = $5m/s^2$ (b) T = 100 N and a = 0

(c) T = 200 N and a = 5 m/s^2 (d) None

7. Three blocks of masses 3 kg, 2 kg and 1 kg are placed side by side on a smooth surface as shown in figure. A horizontal force of 12N is applied to 3 kg block. The net force on 2 kg block is -

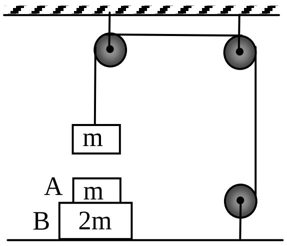


(a) 2 N (b) 4 N (c) 6 N (d) 12 N

8. A man weighing 80 kg is standing on a trolley weighing 320 kg. The trolley is resting on frictionless horizontal rails. If the man starts walking on the trolley along the rails at speed 1 m/s then after 4s his displacement relative to the ground will be -

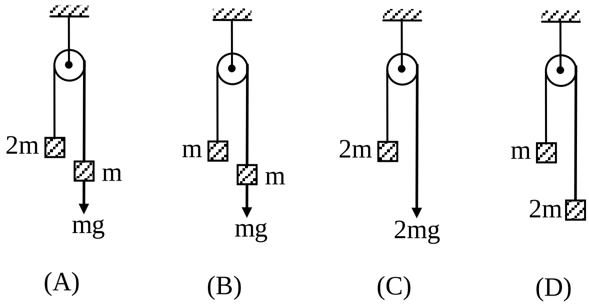
(a) 5 m (b) 4.8 m (c) 3.2 m (d) 3.0 m

9. In the arrangement shown in the figure, there is friction between the blocks of mass m and 2m. Block of mass 2m is kept on a smooth horizontal plane. The mass of the suspended block is m. If block A is stationary with respect to block B. The minimum value of coefficient of friction between m and 2m is:



(a) $\frac{1}{2}$ (b) $\frac{1}{\sqrt{2}}$ (c) $\frac{1}{4}$ (d) $\frac{1}{3}$

10. In the figure which of the systems are at rest.

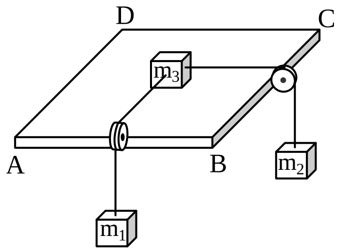


(a) A only (b) A and C only
(c) A, B and C only (d) C only

11. A block starts moving up a fixed inclined plane of inclination 60° with a velocity of 20 m/s and stops after 2 sec. The approximate value of coefficient of friction is (g = 10 m/s^2)

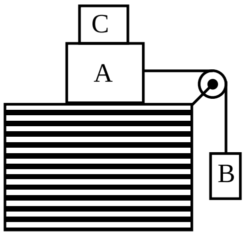
(a) 3 (b) 3.3 (c) 0.27 (d) 0.33

12. Three blocks are arranged as shown in which ABCD is a horizontal plane. Strings are massless and both pulley stands vertical while the strings connecting blocks m_1 and m_2 are also vertical and are perpendicular to faces AB and BC which are mutually perpendicular to each other. If m_1 and m_2 are 3 kg and 4 kg respectively. Coefficient of friction between the block m_3 = 10 kg and surface is μ = 0.6 then, frictional force on m_3 is -



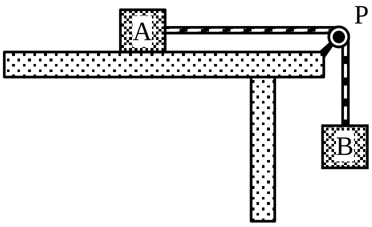
(a) 30 N (b) 40 N (c) 50 N (d) 60 N

13. Two masses A and B of 10 kg and 5 kg respectively, are connected with a string passing over a frictionless pulley fixed at the corner of a table as shown in figure. The coefficient of friction of A with the table is 0.2. The minimum mass of C that may be placed on A to prevent it from moving is –



(a) 15 kg (b) 5 kg (c) 10 kg (d) 0 kg

14. The block A and B are arranged as shown in the figure. The pulley is frictionless. The mass of A is 10 kg. The coefficient of friction of A with the horizontal surface is 0.20. The minimum mass of B to start the motion will be –

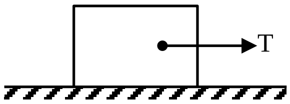


(a) 2 kg (b) 0.2 kg (c) 5 kg (d) 10 kg

15. A block of mass 1 kg is at rest on a horizontal table. The coefficient of static friction between the block and the table is 0.5. If g = 10 m s^{-2} , then the magnitude of the force acting upwards at an angle of 60° from the horizontal that will just start the block moving is -

(a) 5 N (b) 5.36 N (c) 74.6 N (d) 10 N

16. In figure a block of weight 10 N is shown resting on a horizontal surface. The coefficient of static friction between the block and surface is $\mu_s = 0.4$. A force of 3.5 N will keep the block in uniform motion once it has been set in motion. A horizontal force of 3 N is applied to the block. The block will then -



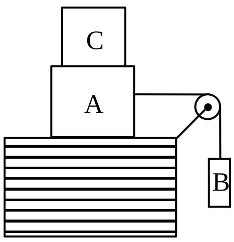
(a) Move over the surface with a constant velocity

(b) Move having accelerated motion over the surface

(c) Not move

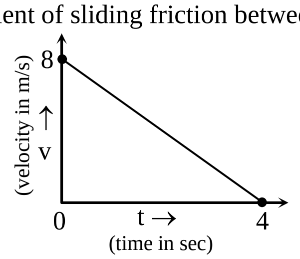
(d) First move with a constant velocity for sometime and then will have accelerated motion

17. Two masses A and B of 10 kg and 5 kg respectively, are connected with a string passing over a frictionless pulley fixed at the corner of a table as shown in figure. The coefficient of friction of A with the table is 0.2. The minimum mass of C that may be placed on A to prevent it from moving is –



(a) 15 kg (b) 5 kg (c) 10 kg (d) 0 kg

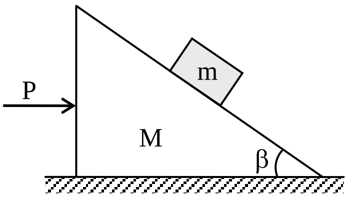
18. A block of mass 2 kg is given a push horizontally and then the block starts sliding over a horizontal plane. The graph shows the velocity-time graph of the motion. The coefficient of sliding friction between the plane and the block is -



(a) 0.3 (b) 0.20 (c) 0.5 (d) 0.40

19. A stone of mass 1000 g tied to a light string of length 10/3 m is whirling in a vertical circle. If the ratio of the maximum tension to minimum tension is 4 and g = 10 ms^{-2}, then speed of stone at the highest point of circle is
(a) 20 ms^{-1} (b) $10/\sqrt{3}$ ms^{-1} (c) $5\sqrt{3}ms^{-1}$ (d) 10 ms^{-1}

20. Two wooden blocks are moving on a smooth horizontal surface such that the mass 'm' remains stationary with respect to block of mass M as shown in figure. The magnitude of force P is –

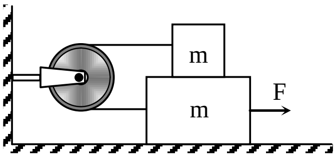


(a) (M + m)g tan β (b) g tan β
(c) mgcosβ (d) (M + m) g cosec β

21. A rope of length L is pulled with a constant force F. T is the tension in the rope at a point, distance x from the end where the force is applied. Then T is -
(a) FL/x (b) FL/(L – x)
(c) F (L – x)/L (d) (F – x)/(L – x)

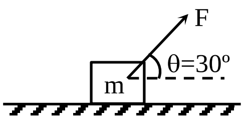
22. The horizontal acceleration that should be given to a smooth inclined plane of angle $\sin^{-1}(1/\ell)$ to keep an object stationary on the plane relative to the inclined plane is -
(a) $g/\sqrt{\ell^2-1}$ (b) $g\sqrt{\ell^2-1}$
(c) $\sqrt{\ell^2-1/g}$ (d) $g/\sqrt{\ell^2+1}$

23. For the arrangement shown in figure the coefficient of friction between the two blocks is μ. If both the block are identical, then the acceleration of each block is-



(a) $\frac{F}{2m}-2\mu g$ (b) $\frac{F}{2m}$ (c) $\frac{F}{2m}-\mu g$ (d) Zero

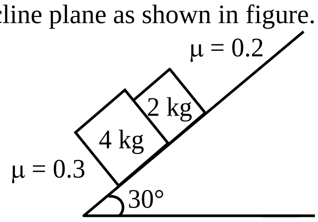
24. The acceleration of block which is placed on a horizontal smooth fixed surface when the force F = 4mg is applied on it in the direction shown in figure is -



(a) g (b) $2\sqrt{3}$ g (c) 2g (d) None of these

25. A piece of ice slides down a 45° incline in twice the time it takes to slide down a frictionless 45° incline. What is the coefficient of friction between the ice and incline?
(a) 0.25 (b) 0.50 (c) 0.75 (d) 0.40

26. Two blocks, 4 kg and 2 kg are sliding down an incline plane as shown in figure. The acceleration of 2 kg block is -



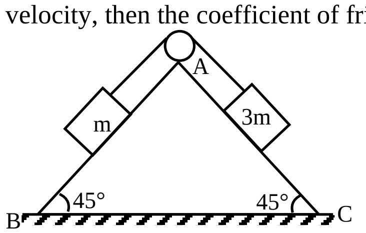
(a) 1.66 m/s^2 (b) 2.66 m/s^2
(c) 3.66 m/s^2 (d) 4.66 m/s^2

27. A marble block of mass 2 kg lying on ice when given a velocity of 6 m/s is stopped by friction in 10s. Then the coefficient of friction is -
(a) 0.01 (b) 0.02 (c) 0.03 (d) 0.06

28. A heavy uniform chain lies on a horizontal table top. If the coefficient of friction between the chain and the table is 0.25, then the maximum percentage of the length of the chain that can hang over one edge of the table is -
(a) 20 % (b) 25 % (c) 35 % (d) 15 %

29. A particle is placed at rest inside a hollow hemisphere of radius R. The coefficient of friction between the particle and the hemisphere is $\mu = \frac{1}{\sqrt{3}}$. The maximum height upto which the particle can remain stationary is-
(a) $\frac{R}{2}$ (b) $\left(1-\frac{\sqrt{3}}{2}\right)R$ (c) $\frac{\sqrt{3}}{2}R$ (d) $\frac{3R}{8}$

30. In the given figure the wedge is fixed, pulley is frictionless and string is light. Surface AB is frictionless whereas AC is rough. If the block of mass 3m slides down with constant velocity, then the coefficient of friction between surface AC and the block is:



(a) 1/3 (b) 2/3 `(c) ½ (d) 4/3

1. **(d)**

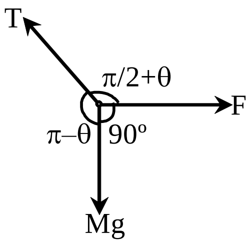
$\because$ Area bounded by the curve = ΔP

$\therefore \left(\frac{1}{2}\times 2\times 10\right) + (2\times 10) + \left(\frac{1}{2}\times 30\times 2\right) + \left(\frac{1}{2}\times 4\times 20\right)$

$= 2(v_2 - 0)$

$\Rightarrow v_2 = 50$ m/s

2. **(b)**



$$\frac{T}{\sin 90^0} = \frac{F}{\sin(\pi-\theta)} = \frac{Mg}{\sin\left(\frac{\pi}{2}+\theta\right)}$$

or $T = \frac{F}{\sin\theta} = \frac{Mg}{\cos\theta}$

3. **(c)**

When lift is moving in the upward direction with retardation, then apparent weight = M[g + (–a)]

i.e. apparent weight < Mg

and when lift is finally stopped then apparent weight = Mg.

4. **(d)**

Change in momentum = 2mv

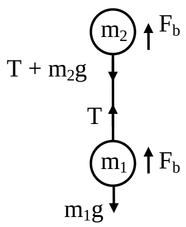
time = $\frac{\pi d/2}{v} = \frac{\pi d}{2v}$

Average force = $\frac{2mv}{\frac{\pi d}{2v}} = \frac{4mv^2}{\pi d}$

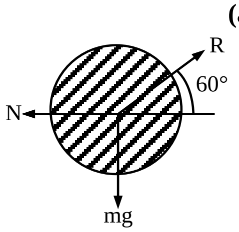
5. **(a)**

$F = \frac{dp}{dt}$ or $ma = \frac{dm}{dt}\times v$

or $2\times a = 1\times 5 \Rightarrow a = 2.5$ m/s



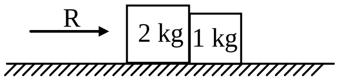
6. **(a)**



Conceptual

7. (c)

a = 2



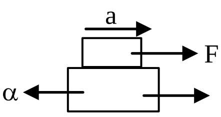
R = (3) (2) = 6N

8. (c)

$V = \frac{mu}{M+m} = \frac{80 \times 1}{400} = \frac{1}{5} m/s$

$\Delta S = \left(1 - \frac{1}{5}\right)t = \frac{4}{5} \times 4 = \frac{16}{5}$ m

9. (c)



mg = (4m)a

$g = 4 \times \mu g \Rightarrow \mu = \frac{1}{4}$

10. (b)

Conceptual

11. (c)

Retardation = g (sin θ + μ cos θ) = $5(\sqrt{3} + \mu)$

Now v = u – at

$\therefore$ a = $\frac{u}{t}$ as v = 0

$\therefore$ $5(\sqrt{3} + \mu) = 10 \Rightarrow \mu = 0.27$

12. (c)

Net force on m_3 = $\sqrt{(30)^2 + (40)^2}$ = 50 N

and limiting friction on m_3 = $\mu m_3 g$ = 60N

$\therefore$ System remain in equilibrium and friction on m_3 = 50 N

13. (a)

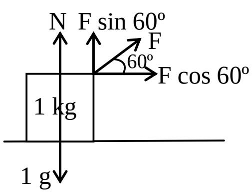
5g = 0.2(10 + m)g ⇒ m = 15 kg

14. (a)

$\mu M_A g = M_B g \Rightarrow M_B = \mu MA$

= . 2 × 10 = 2 kg

15. (b)



$F \cos 60^0 = f$ ...(i)

$f = \mu N = \mu (1\,g - F \sin 60^0)$ ...(ii)

16. (c)

$f_\ell = 0.4 \times 10 = 4N$

Force < f_ℓ so particle will not move.

17. (a)

Refer class notes

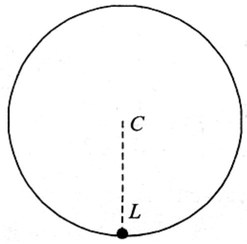
18. (b)

From the graph, retardation of block, $a = -2\ m/s^2$

$|\vec{a}| = \mu g, \Rightarrow \mu = \frac{2}{10} = 0.2$

19. (d)

$T_{max} = \frac{mv_l^2}{L} + mg$



and $T_{min} = \frac{mv_h^2}{L} - mg$

Then $\frac{T_{max}}{T_{min}} = \frac{\frac{mv_l^2}{L} + mg}{\frac{mv_h^2}{L} - mg}$

$= \frac{v_l^2 + gL}{v_h^2 - gL}$ .... (i)

Using $v^2 - u^2 = 2aS$, we get

$v_h^2 - v_l^2 = -2g(2L) = -4gL$

or $v_l^2 = v_h^2 + 4gL$

Then from (i) $\frac{T_{max}}{T_{min}} = \frac{v_h^2 + 4gL + gL}{v_l^2 - gL}$ or

$4 = \frac{v_h^2 + 5 \times 10 \times \frac{10}{3}}{v_h^2 - 10 \times \frac{10}{3}}$

or $3v_h^2 = 300$ = or $v_h = 10\ ms^{-1}$

20. (a)

As we have discussed in class room, acceleration required to stop the incline plane is

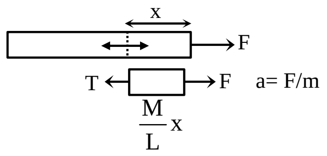
$a = g \tan \beta$

$\therefore$ Total force to move the system,

$P = (M + m)a$

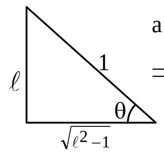
$= (M + m)\, g \tan \beta$

21. (c)



$$F - T = \left(\frac{M}{L}x\right)F/m$$

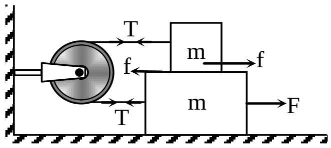
22. (a)



$a = g\tan\theta \Rightarrow$ given that $\theta = \sin^{-1}(1/\ell)$

$\Rightarrow \sin\theta = \frac{1}{\ell} \Rightarrow \therefore\ a = g\cdot\frac{1}{\sqrt{\ell^2-1}} = \frac{g}{\sqrt{\ell^2-1}}$

23. (c)



In fig, direction of friction is shown,

$F - T - \mu mg = ma$

$T - \mu mg = ma$

Solving the equations, $a = \frac{F - 2\mu mg}{2m}$

24. (d)

$F\sin\theta - mg = ma_y$ and $F\cos\theta = ma_x$

$a = \sqrt{a_x^2 + a_y^2}$

25. (c)

$\mu = \tan\theta\left(1 - \frac{1}{n^2}\right)$ [discussed in class room]

$= \tan 45\left(1 - \frac{1}{2^2}\right) = ¾$

26. (b)

$m_1g\sin\theta + m_2g\sin\theta - \mu_1m_1g\cos\theta - \mu_2m_2g\cos\theta = (m_1 + m_2)a$

$\Rightarrow\ a = n\theta -$

$\left(\frac{\mu_1m_1 + \mu_2m_2}{m_1 + m_2}\right)g\cos\theta$

$= g\left[\frac{1}{2} - \left(\frac{0.3\times4 + 0.2\times2}{4+2}\right)\times\frac{\sqrt{3}}{2}\right] = 2.66\,m/s^2$

27. (d)

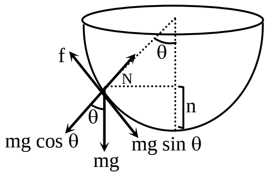
$v^2 = u^2 + 2as$

$0 = u^2 + (-2\mu g)\,s \Rightarrow\ \mu = \frac{u^2}{2gs}$

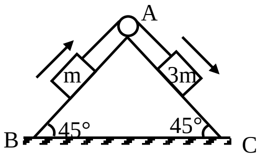
28. (a)

$\%\ length = \frac{\mu}{\mu H}\times100$

29. (b)



30. (b)



$3\,mg \sin\theta - T - \mu\,(3mg \cos\theta\,) = 0$

$T - mg \sin\theta = 0$

$\mu = \frac{2}{3}$