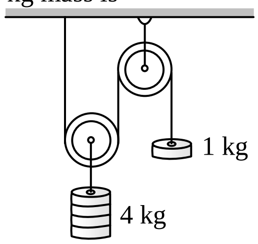
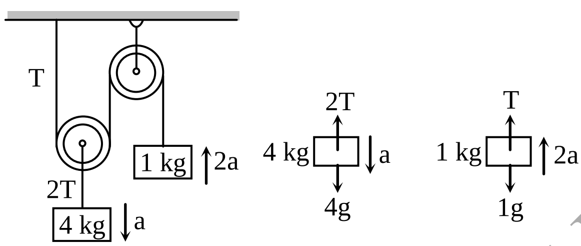
Q.1 In the system shown in figure, the acceleration of the 1 kg mass is -



(A) $\frac{g}{4}$ downward (B) $\frac{g}{4}$ upward

(C) $\frac{g}{2}$ downward (D) $\frac{g}{2}$ upward

Sol. **[D]**



$4g - 2T = 4(a)$ ... (1)

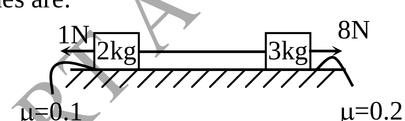
$T - 1(g) = 1\,(2a)$ ... (2)

Solving equation no. (1) and (2)

we get $a = \frac{g}{4}$

$\therefore$ Acceleration of 1 kg mass = $\frac{g}{2}$ upward

Q.2 In the shown arrangement if f_1, f_2 and T be the frictional forces on 2 kg block, 3kg block and tension in the string respectively, then their values are:



(A) 2N, 6N, 3.2 N

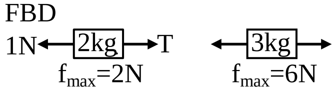
(B) 2N, 6N, 0N

(C) 1N, 6N, 2N

(D) Data insufficient to calculate the required values

[C]

Sol. FBD



Net force without friction on system is '7N' in right side so first maximum friction will come on 3 kg block

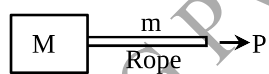
So $f_1 = 1N$, $f_2 = 6N$, $T = 2N$

Q.3 A block of mass M is pulled along a horizontal frictionless surface by a rope of mass m. If a force P is applied at the free end of the rope, the force exerted by the rope on the block is -

(A) $\frac{Pm}{M+m}$ (B) $\frac{Pm}{M-m}$

(C) P (D) $\frac{PM}{M+m}$ **[D]**

Sol.



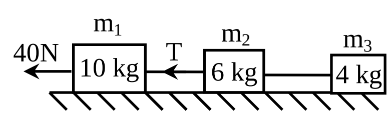
$P = (M + m)\,a$

$a = \frac{P}{(M+m)}$

$F = Ma = \frac{PM}{(M+m)}$

Q.4 Three blocks of masses m_1, m_2 and m_3 are placed on a horizontal frictionless surface. A force of 40 N pulls the system then calculate the value of T, if

$m_1 = 10kg$, $m_2 = 6$ kg, $m_3 = 4$ kg –



(A) 40 N (B) 20 N

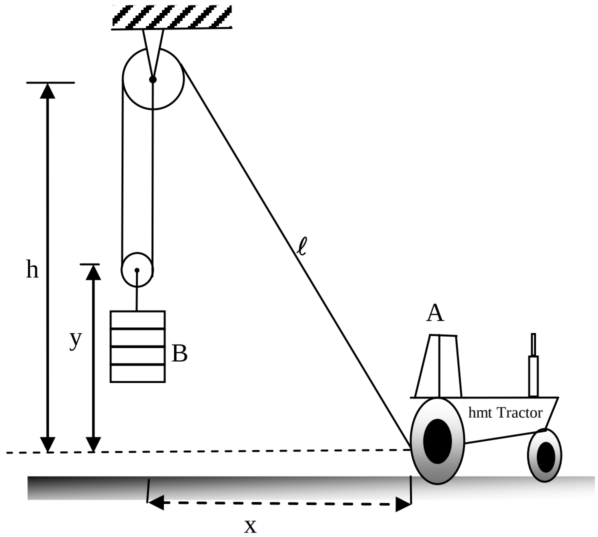
(C) 10 N (D) 5 N **[B]**

Sol. $a = \frac{F}{m_1 + m_2 + m_3} = \frac{40}{10+6+4} = 2m/s^2$

$40 - T = 10 \times 2$

$T = 20$ N

Q. 5 The tractor A is used to hoist the bale B with the pulley arrangement shown. If A has a forward velocity v_A, determine an expression for the upward velocity v_B of the bale in terms of x.



(A) $\frac{v_A x}{h}$ (B) $\frac{1}{2}\frac{v_A x}{\sqrt{h^2+x^2}}$

(C) $\frac{1}{2}\frac{v_A h}{\sqrt{h^2+x^2}}$ (D) $\frac{v_A h}{x}$ **[B]**

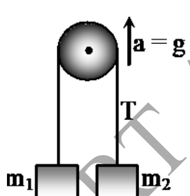
Q.6 Two weights w_1 and w_2 are suspended from the ends of a light string passing over a smooth fixed pulley. If the pulley is pulled up at an acceleration g , the tension in the string will be-

(A) $\frac{4w_1w_2}{w_1+w_2}$ (B) $\frac{2w_1w_2}{w_1+w_2}$

(C) $\frac{w_1-w_2}{w_1+w_2}$ (D) $\frac{w_1w_2}{2(w_1-w_2)}$

[A]

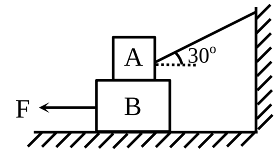
Sol.



$T=\frac{2m_1m_2(g+a)}{m_1+m_2}$,

$T = \frac{2\frac{w_1}{g}.\frac{w_2}{g}(g+g)}{\frac{w_1}{g}+\frac{w_2}{g}}$ $\Rightarrow T = \frac{4w_1w_2}{(w_1+w_2)}$

Q.7 In the figure given below, if all surface are assumed to be smooth and the force F = 100N. If acceleration of block B of mass 20kg 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

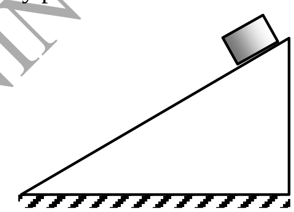
(C) T = 200 N and a = 5m/s^2 (D) None

Sol. **[A]**

As no force on A

$\therefore$ T = 0 & $a_B = \frac{F}{m_B}$

Q.8 A block of mass 'm' is slipping down a rough inclined plane with constant speed. The force on block by plane is -



(A) mg

(B) $\frac{mg}{2}$

(C) Depends upon coefficient of friction

(D) Depends upon angle of inclination **[D]**

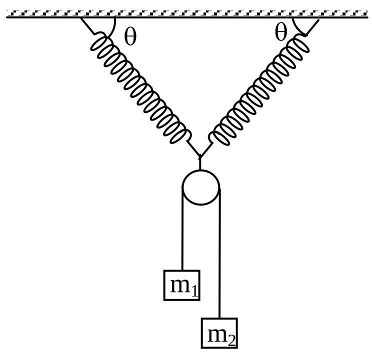
Sol. Net force on block $\vec{F}_{net} = m\vec{g} + \vec{F}_{BW}$

As block is slipping with constant speed $\vec{F}_{net}$ = 0

$\Rightarrow \vec{F}_{BW} = -m\vec{g}$

$\Rightarrow F_{BW} = mg$

Q. 9 Two identical ideal springs of spring constant 1000 N/m are connected by a pulley as shown in figure and this arrangement is established in the vertical plane. The pulley is ideal and string passing over pulley is massless. At equilibrium of pulley θ is 60º and the masses m_1 and m_2 are 2 kg and 3 kg respectively. Then the elongation in each spring when θ is 60º is –



(A) $1.6\sqrt{3}$ cm (B) 1.6 cm

(C) 4.8 cm (D) None of these

[A]

Sol. $2kx\cos 30^o = \left(\dfrac{4m_1m_2}{m_1+m_2}\right)g$

Q. 10 A light string passing over a smooth light pulley connects two blocks of masses m_1 and m_2 (vertically). If the acceleration of the system is g/8, then the ratio of the masses is -

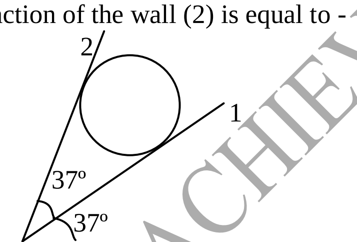
(A) 8 : 1 (B) 9 : 7

(C) 4 : 3 (D) 5 : 3

Sol. **[B]**

$a = \dfrac{m_2 - m_1}{m_1 + m_2} g = \dfrac{g}{8}$

Q.11 A sphere of mass m is held between two smooth inclined walls. For sin 37º = 3/5, the normal reaction of the wall (2) is equal to -

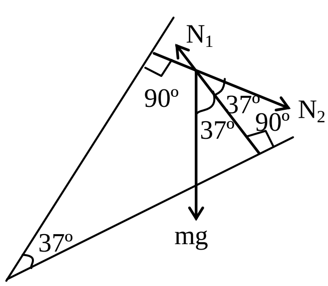


(A) mg (B) mg sin 74º

(C) mg cos 74º (D) None of these

[A]

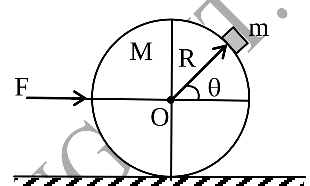
Sol.4[A] Using lami's theorem



$\dfrac{mg}{\sin(180^o - 37^o)} = \dfrac{N_2}{\sin(180^o - 37^o)}$

$\therefore N_2 = mg$

Q.12 A smooth sphere of radius R and mass M is placed on the smooth horizontal floor. Another smooth particle of mass m is placed on the sphere and a horizontal force F is applied on the sphere as shown. If the particle does not slip on the sphere then the value of force F is –



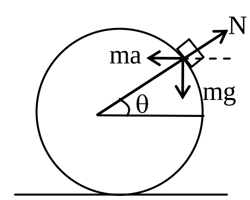
(A) F = mg cotθ

(B) F = Mg cotθ

(C) F=(m + M)g cotθ

(D) F =(m + M)g tanθ

Sol. **[C]**



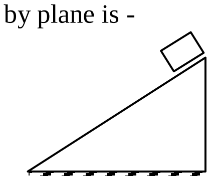
By F.B.D of m

N sinθ = mg and N cosθ = ma

$\therefore \tan\theta = \dfrac{g}{a} \Rightarrow a = g\cot\theta$

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

Q.13 A block of mass 'm' is slipping down a rough inclined plane with constant speed. The force on block by plane is -



(A) mg

(B) $\dfrac{mg}{2}$

(C) Depends upon coefficient of friction

(D) Depends upon angle of inclination **[D]**

Sol. Net force on block $\vec{F}_{net} = \overrightarrow{mg} + \vec{F}_{BW}$

As block is slipping with constant speed

$\vec{F}_{net} = 0$

$\Rightarrow \vec{F}_{BW} = -\overrightarrow{mg}$

$\Rightarrow \quad F_{BW} = mg$

Q.14 If $\vec{F} = F_x\hat{i} + F_y\hat{j} + F_z\hat{k}$ is a conservative force then.

(A) $\frac{\partial F_x}{\partial y} = \frac{\partial F_y}{\partial x}, \frac{\partial F_y}{\partial z} = \frac{\partial F_z}{\partial y}, \frac{\partial F_z}{\partial x} = \frac{\partial F_x}{\partial z}$

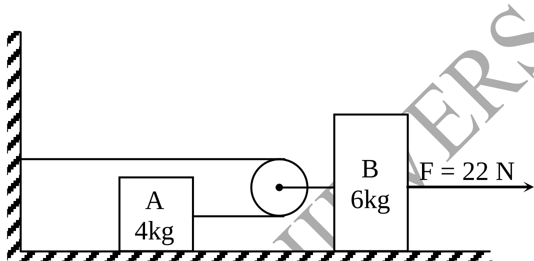
(B) $\frac{\partial F_x}{\partial y} - \frac{\partial F_y}{\partial x} = \frac{\partial F_z}{\partial z}$

(C) $\frac{\partial F_x}{\partial y} + \frac{\partial F_y}{\partial x} = \frac{\partial F_z}{\partial z}$

(D) All of these

Sol. **[A]** Conceptual

Q.15 Two blocks are connected by a massless string through an ideal pulley as shown. A force of 22N is applied on block B when initially the blocks are at rest. Then speed of centre of mass of block A and block B, 2 sec, after the application of force is (masses of A and B are 4 kg and 6 kg respectively and surfaces are smooth) –



(A) 1.4 m/s^2 (B) 1 m/s^2

(C) 2 m/s^2 (D) None of these

Sol. **[A]**

F – 2T = 6a and T = 4 × 2a

$\therefore$ F – 16 a = 6a

$\Rightarrow a = \frac{F}{22} \Rightarrow a = 1 m/s^2$

$\therefore \quad a_{CM} = \frac{6\times1+4\times2}{10} = 1.4 m/s^2$

Q.16 A block of mass m is kept on a moving block of mass M in such a way that M moves but m remains at rest with respect to M. Then –

(A) momentum of m must not be zero in any frame

(B) kinetic energy of m must not be zero in any frame

(C) kinetic energy and momentum may be zero in a frame

(D) none of the above

Sol. **[C]**

Conceptual.

Q.17 A body in equilibrium will not have -

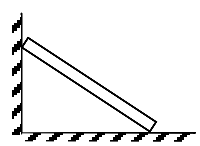
(A) velocity (B) momentum

(C) acceleration (D) All of the above

Sol. **[C]**

conceptual.

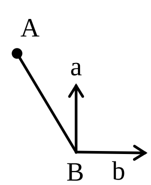
Q.18 A rod of length L is sliding such that one of its ends is always in contact with a vertical wall and its other end is always in contact with horizontal surface. Just after the rod is released from rest, the magnitude of acceleration of rod at this instant will be -



(A) $\frac{a+b}{\ell}$ (B) $\frac{\sqrt{|a^2-b^2|}}{\ell}$

(C) $\frac{\sqrt{a^2+b^2}}{\ell}$ (D) None of these

Sol. **[C]**



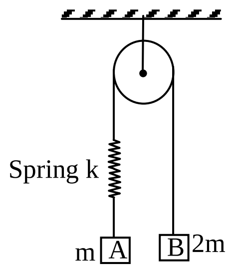
At the initial moment, angular velocity of rod is zero. Acceleration of end B of rod with respect to end A is shown in figure. Centripetal acceleration of point B with respect to A is zero ($\because \omega^2\ell = 0$)

So at the initial moment, acceleration of end B with respect to end A is perpendicular to the rod which is equal to $\sqrt{a^2+b^2}$

$a_{rel} = \ell\,\alpha$

$\frac{\sqrt{a^2+b^2}}{\ell} = \alpha$ where α is angular acceleration

Q.19 Two blocks A and B of masses m and 2m respectively are held at rest such that the string is in natural length. Find out the accelerations of both the blocks just after release.

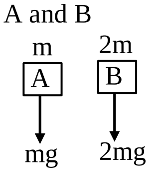


(A) $g\downarrow, g\downarrow$ (B) $\frac{g}{3}\downarrow, \frac{g}{3}\uparrow$

(C) 0, 0 (D) $g\downarrow$, 0

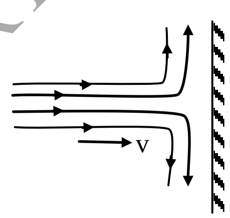
Sol. **[A]**

In this case spring force is zero initially F.B.D of A and B



$a_A = g$ $a_B = g$

Q.20 A stream of water of density d, cross-section A and speed v strikes a wall that is perpendicular to the stream as shown. The water then flows sideways along the wall. The force exerted by the stream on the wall is -



(A) dv^2A (B) dvA/2

(C) dghA (D) v^2A/d

Sol. **[A]**

The mass of water reaching the wall per second = v Ad.

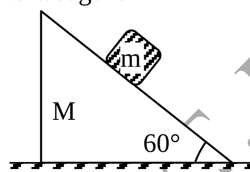
the momentum transferred per second = (vAd)v

$\Rightarrow \vec{p}$ per unit time = v^2 Ad.

The flow of water , tangential to the wall does not contribute to the force.

Therefore, force = rate of change of momentum = v^2 Ad.

Q.21 In the arrangement shown in figure wedge of mass M moves towards left with an acceleration a. All surfaces are smooth. The acceleration of mass m relative to wedge is –



(A) a/2 (B) $\frac{2Ma}{m}$

(C) $\frac{2(M+m)a}{m}$ (D) $\frac{(M+m)a}{m}$

Sol. **[C]**

Let acceleration of mass m relative to wedge down the plane is a_r. Its absolute acceleration in horizontal direction is $a_r \cos 60° - a$(towards right). Hence, let N be the normal reaction between the mass and the wedge. Then

$N \sin\theta = Ma = m(a_r \cos 60° - a)$

or $a_r = \frac{(M+m)a}{m\cos 60°} = \frac{2(M+m)a}{m}$

Q. 22 A block of mass m = 1kg moving on horizontal surface with speed u = 2m/s enters a rough horizontal patch ranging from x = 0.10 m to x = 2.00m. If the retarding force f_r on the block in this range is inversely proportional to x over this range i.e.

$f_r = \frac{-k}{x}$ $0.10 < x < 2.00$

$= 0$ for $x < 0.10$ and $x > 2.00$

If k = 0.5 J then the speed of this block as it crosses the patch is (use $\ell n\, 20 = 3$)

(A) 2.65 m/s (B) 1 m/s

(C) 1.5 m./s (D) 2 m/s

Sol. **[B]**

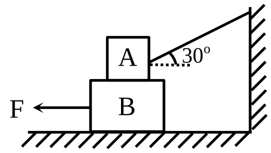
$W = \int f_r\,dx = -k \log_e \frac{2}{0.1} = -1.5$ J

$\therefore$ $W = \Delta K$

$\frac{1}{2} \times 1 \times v^2 - \frac{1}{2} \times 1 \times 4 = -1.5$

$\Rightarrow$ v = 1 m/s

Q.23 In the figure given below, all surfaces are assumed to be smooth and the force F = 100N. If acceleration of block B of mass 20kg 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 =5m/s^2 (D) None

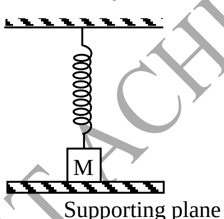
Sol. **[A]**

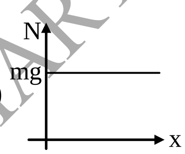
As there is no friction, horizontal force on B is therefore F = 100 N

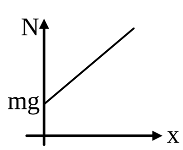
$\therefore$ a = $\frac{100}{20}$ = 5m/s^2

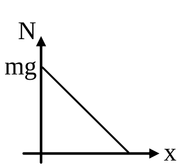
but no horizontal force on A acts therefore T = 0

Q. 24 A block of mass m is attached to an ideal spring and system lies in vertical plane as shown. Initially the supporting plane is placed so that spring remains in its natural length then the plane is moved very slowly downwards. The graph showing variation of normal reaction applied by mass on supporting plane with distance travelled by block is –



(A)


(B)


(C)


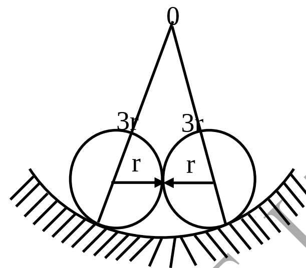
(D) None of these

Sol. **[C]**

as supporting plane is lowered slowly

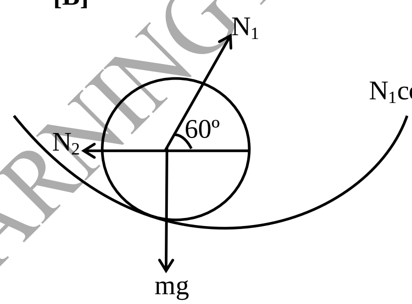
$\therefore$ N = mg – kx

Q.25 Two identical heavy spheres of equal mass are placed on smooth cup of radius 3r where r is radius of each sphere as shown. Then the ratio of reaction force between cup and any sphere to reaction force between two sphere is –



(A) 1
(B) 2
(C) 3
(D) none of these

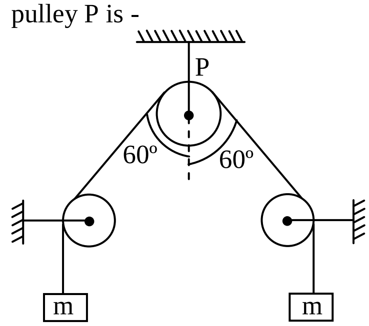
Sol. **[B]**



$N_1 \cos 60° = N_2$

$\frac{N_1}{N_2} = 2$

Q.26 The force exerted by the ideal string on the ideal pulley P is -



(A) mg (B) 2 mg

(C) $\sqrt{2}$ mg (D) 4 mg

Sol. **[A]**

As T = mg and for pulley P

$T_{Net} = \sqrt{T^2 + T^2 + 2.T.T.\cos 120°}$ = T = mg.

Q.27 In a cricket match the fielder draws his hands backward after receiving the ball in order to take a catch because -

(A) His hands will be saved from getting hurt

(B) He deceives the player

(C) It is a fashion

(D) He catches the ball firmly **[A]**

Q.28 A jet engine works on the principle of -

(A) conservation of mass

(B) conservation of energy

(C) conservation of linear momentum

(D) conservation of angular momentum **[C]**

Q.29 A boy sitting on the top most berth in the compartment of a train which is just going to stop on a railway station, drops an apple aiming at the open hand of his brother situated vertically below his hands at a distance of about 2m. The apple will fall -

(A) in the hand of his brother

(B) Slightly away from the hands of his brother in the direction of motion of the train

(C) Slightly away from the hands of his brother in the direction opposite to the direction of motion of the train

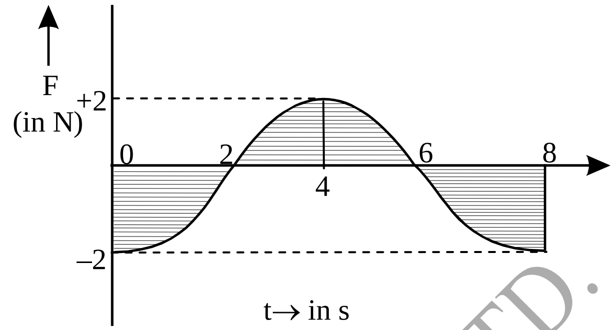
(D) none of the above **[B]**

Q.30 In a legend the hero kicked a body pig so that he is projected with a speed greater than that of his cry. If the weight of the body pig is assumed to be 5kg and the time of contact 0.01 sec., the force with which the hero kicked him was -
(Speed of cry = 330 m/s)

(A) 5×10^{-2} N (B) 2×10^{5} N

(C) 1.65×10^{5} N (D) 1.65×10^{3} N **[C]**

Q.31 A force - time graph for the motion of a body is shown in figure. Change in linear momentum between 0 and 8 s is –



(A) zero (B) 4 N-s

(C) 8 N-s (D) None **[A]**

Q.32 A force of 5 N acts on a body of weight of 10 N. What is the acceleration in m/s^2 ?

(A) 50 (B) 5

(C) 0.5 (D) 2 **[B]**

Q.33 A particle is acted upon by two mutually perpendicular forces of 3N and 4N. In order that the particle remains stationary, the magnitude of the third force that should be applied is -

(A) 12 N (B) 5 N

(C) 8 N (D) 7 N **[C]**

Q.34 Two objects A and B are thrown upward simultaneously with the same speed. The mass of A is greater than the mass of B. Suppose the air exerts a constant and equal force of resistance on the two bodies-

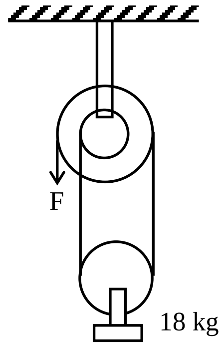
(A) The two bodies will reach the same height

(B) A will go higher than B

(C) B will go higher than A

(D) Any of the above three may happen depending on the speed with which the objects are thrown **[B]**

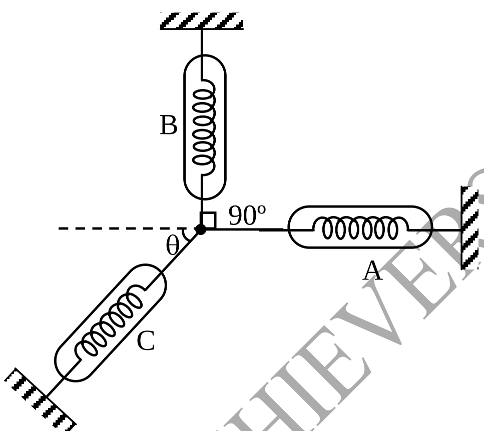
Q.35 In the figure at the free end a force F is applied to keep the suspended mass of 18 kg at rest . The value of F is-



(A) 180 N (B) 90 N

(C) 60 N (D) 30 N **[B]**

Q.36 Three spring balances are attached to the ring as shown in the figure. There is an angle of 90° between the balance A and balance B. There is a reading of 5 N on balance A and 12 N on the balance B –



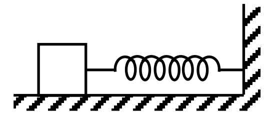
(A) Reading in the balance C is 13 N and angle θ is 67.4°

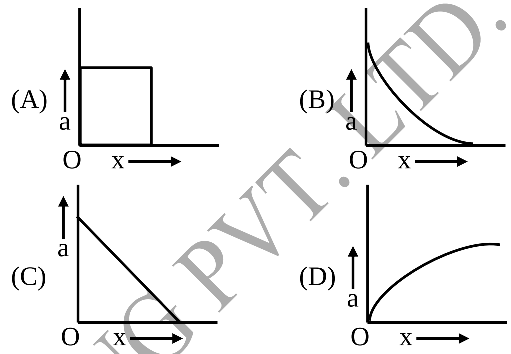
(B) Reading in the balance C is 13 N and angle θ is 22.6°

(C) Reading in the balance C is 5 N and angle θ is 67.4°

(D) Reading in the balance C is 5 N and angle θ is 22.6° **[A]**

Q.37 A light spring is compressed and placed horizontally between a vertical fixed wall and a block, free to slide over a smooth horizontal table top as shown in figure. If the system is released from rest, which of the graphs below represents the relation between the acceleration 'a' of the block and the distance 'x' travelled by it ?





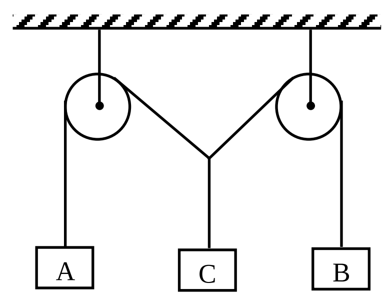
[C]

Q.38 A particle of small mass m is joined to a very heavy body by a light string passing over a light pulley. Both bodies are free to move. The total downward force on the pulley is –

(A) mg (B) 2 mg

(C) 4 mg (D) >> mg **[C]**

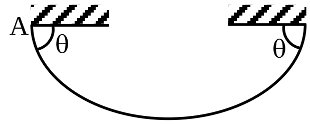
Q.39 Three blocks A, B and C are suspended as shown in figure. Mass of each of blocks A and B is m. If system is in equilibrium, and mass of C is M then –



(A) M = 2m (B) M < 2m

(C) M > 2m (D) M ≯ 2m **[B]**

Q.40 A flexible chain of weight w hangs between two fixed points A and B as shown in fig. at the same level. Then the vector force exerted by the chain on each end point, and the tension in the chain at the lowest point.



(A) 2w sin θ, 2w cot θ

(B) 2w cot θ, 2w sin θ

(C) w/2 sin θ, w/2 cot θ

(D) w/2 cos θ, w/2 tan θ **[C]**

Q.41 A man slides down a light rope whose breaking strength is η times his weight (η < 1). What should be his maximum acceleration so that the rope just breaks ?

(A) ηg (B) g(1 – η)

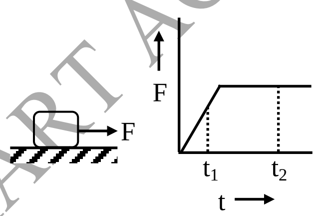
(C) $\frac{g}{1+\eta}$ (D) $\frac{g}{2-\eta}$ **[B]**

Q.42 An empty plastic box of mass m is found to accelerate up at the rate of g/6 when placed deep inside water. How much sand should be put inside the box so that it may accelerate down at the rate of g/6?

(A) 2 m/3 (B) 2 m/5

(C) m/5 (D) 6 m/7 **[B]**

Q.43 A particle is on a smooth horizontal plane. A force F is applied whose F-t graph is given. Then–



(A) at t_1 acceleration is constant

(B) initially body must be in rest

(C) at t_2, acceleration is constant

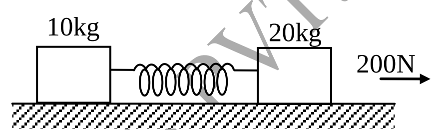
(D) Finally acceleration is zero **[C]**

Q.44 A stretching force of 1000 newton is applied at one end of a spring balance and an equal stretching force is applied at the other end at the same time. The reading of the balance will be -

(A) 2000 N (B) 0 N

(C) 1000 N (D) 500 N **[C]**

Q.45 The masses of 10 kg and 20 kg respectively are connected by massless spring as shown in the figure. A force of 200 N acts on the 20kg mass. At the instant shown, the 10 kg mass has acceleration of 12 m/s^2. What is the acceleration of 20 kg mass ?



(A) 12 m/s^2 (B) 4 m/s^2

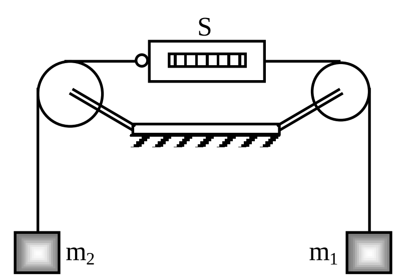
(C) 10 m/s^2 (D) zero **[B]**

Q.46 A spring toy of weight 1 kg rests on a weighing machine. The toy suddenly jumps and the balance reads 11 N. The acceleration of the toy just on jumping up is -

(A) 0.5 m/s^2 (B) 1 m/s^2

(C) 1.5 m/s^2 (D) 2 m/s^2 **[B]**

Q.47 In the arrangement shown, the pulleys are fixed and ideal, the strings are light, $m_1 > m_2$ and S is a spring balance which is itself massless. The reading of S (in units of mass) is –

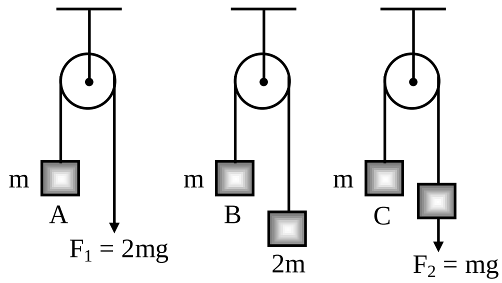


(A) $m_1 – m_2$ (B) $\frac{1}{2}$ $(m_1 + m_2)$

(C) $\frac{m_1 m_2}{m_1 + m_2}$ (D) $\frac{2m_1 m_2}{m_1 + m_2}$ **[D]**

Q.48 In the figure, the blocks A, B and C of mass m each have accelerations a_1, a_2 and a_3

respectively. F_1 and F_2 are external forces of magnitude 2mg and mg respectively.

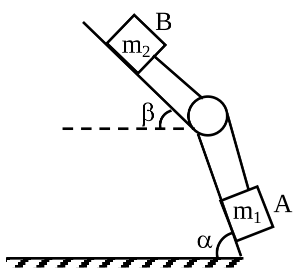


(A) $a_1 = a_2 = a_3$ (B) $a_1 > a_3 > a_2$

(C) $a_1 = a_2$, $a_2 > a_3$ (D) $a_1 > a_2$, $a_2 = a_3$

[B]

Q.49 Two blocks A and B of masses m_1 and m_2 are connected by an inextensible string rest on two smooth planes inclined at angle α and β as shown. The tension in string is-



(A) $(m_1 \sin\alpha - m_2 \sin\beta)\, g$

(B) $(m_1 + m_2)(\sin\alpha - \sin\beta)g$

(C) $\frac{m_1 m_2 g}{m_1 + m_2}(\sin\alpha + \sin\beta)$

(D) $\frac{m_1 m_2 g}{m_1 + m_2}(\sin\alpha - \sin\beta)$ **[D]**

Q.50 A chain of mass M and length L held vertical by fixing its upper end to a rigid support. The tension in the chain at a distance y from the rigid support is –

(A) mg (B) Mg(L – y)/L

(C) MgL / (L – y) (D) Mgy / L **[B]**