Physicsaholics

DPP – 4 (NLM)

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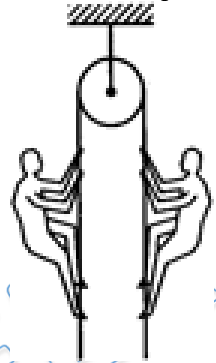
Q 1. Two men of unequal masses hold on to the two sections of a light rope passing over a smooth light pulley. Which of the following are possible?



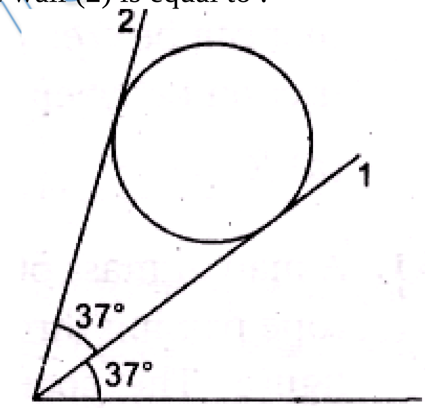
(a) The lighter man is stationary while the heavier man moves down with some acceleration

(b) The heavier man is stationary while the lighter man moves up with some acceleration

(c) The two men move with the same acceleration in the same direction.

(d) The two men move with accelerations of the same magnitude in opposite directions.

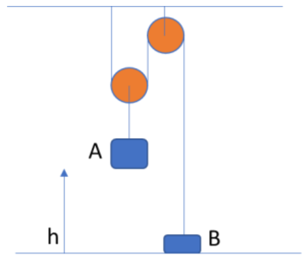
Q 2. A sphere of mass m is held between two smooth inclined walls. For sin 37° = 3/5, the normal reaction of the wall (2) is equal to :



(a) mg (b) mg sin 74°

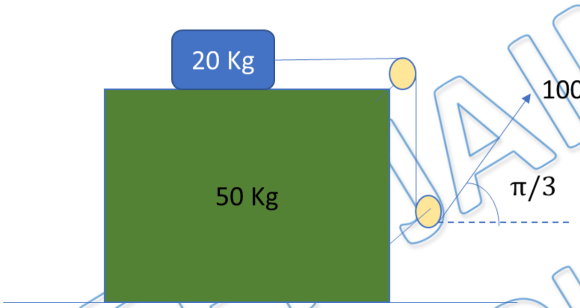
(c) mg cos 74° (d) none of the above

Q 3. In the arrangement mass of A is 4 times that of B . After setting free block A hits the ground and do not rebound. Find maximum height gained by B ?



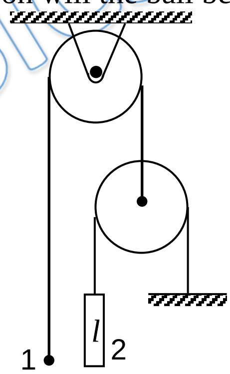
(a) h
(b) 2h
(c) 3h
(d) 4h

(a) A 20 Kg block is placed on 50 Kg wedge as shown in figure. All surfaces are smooth. Pulleys and string are massless . Find relative acceleration of block and wedge in m/Sec^2 ?



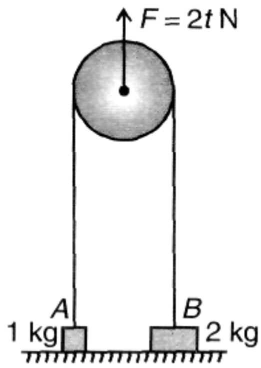
(a) 5
(b) 6
(c) 4
(d) 3

Q 5. In the arrangement shown in the figure, the mass of ball 1 is η = 1.8 times as great as rod 2. The length of the latter is l = 100 cm. The mass of the pulley and the threads, as well as the friction, is negligible. The ball is set on the same level as the lower end of rod and then released. How soon will the ball be opposite the upper end of the rod?



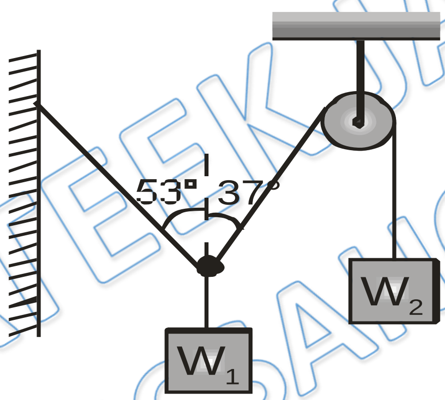
(a) 1 sec
(b) 2 sec
(c) 1.4 sec
(d) 2.4 sec

Q 6. Two blocks A and B of masses 1 kg and 2 kg respectively are placed on a smooth horizontal surface. They are connected by a massless inextensible string going over a pulley as shown. The pulley is being acted upon by a vertical force of magnitude varying with time as F= 2tN. Find acceleration of pulley at t = 30 sec



(a) 10 m/Sec^2
(b) 15 m/Sec^2
(c) 12.5 m/Sec^2
(d) 20 m/Sec^2

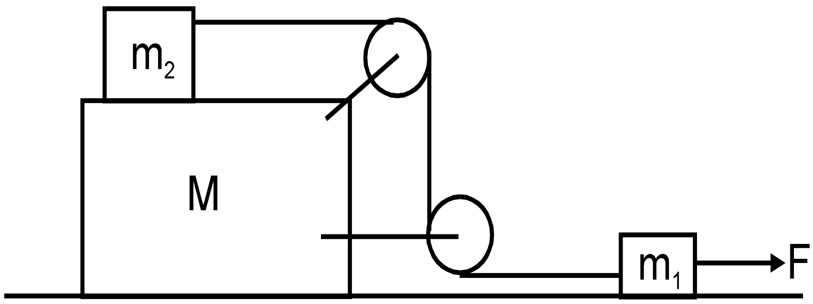
Q 7. Two weights W_1 & W_2 in equilibrium and at rest, are suspended as shown in figure. Then the ratio $\frac{W_1}{W_2}$ is :



(a) 5/4 (b) 4/5
(c) 8/5 (d) none of these

Q 8. **Match the following:**

Three blocks of masses m_1, m_2 and M are arranged as shown in figure. All the surfaces are frictionless and string is inextensible. A constant force F is applied on block of mass m_1. Pulleys and string are light. Part of the string connecting both pulleys is vertical and part of the strings connecting pulleys with masses m_1 and m_2 are horizontal.



(P) Acceleration of mass m_1 (1) $\frac{F}{m_1}$

(Q) Acceleration of mass m_2 (2) $\frac{F}{m_1+m_2}$

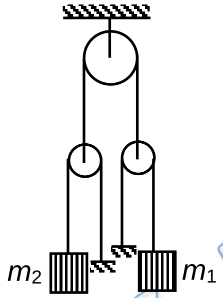
(R) Acceleration of mass M (3) zero

(S) Tension in the string (4) $\frac{m_2F}{m_1+m_2}$

(A) P-1, Q-1, R-1,S-3 (B) P-2, Q-2, R-3,S-4

(C) P-2, Q-4, R-3,S-1 (D) P-2, Q-2, R-3,S-3

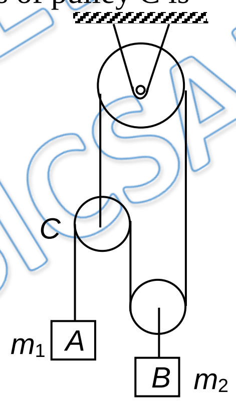
Q 9. In the given figure, all strings and pulleys are ideal and acceleration of m_1 is g/3 upward. Then find the ratio of m_1/m_2?



(a) 1/3 (b) 1

(c) 1/2 (d) ¼

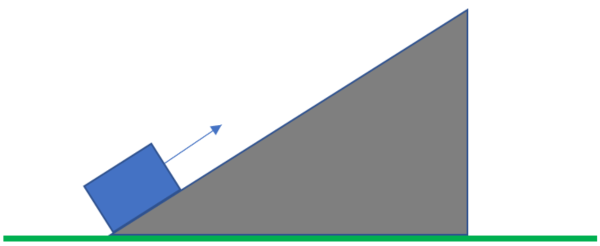
Q 10. In the arrangement shown in the figure neglect the masses of the pulley and string and also friction. The accelerations of pulley C is



(a) g (b) 2g

(c) 3g (d) 4g

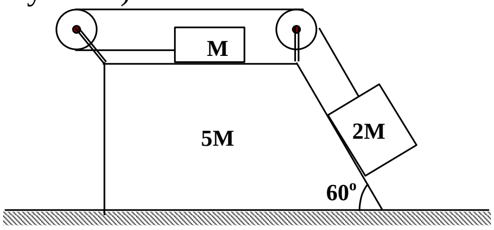
Q 11. A block is projected on a wedge as shown in figure. If friction is absent everywhere, path of block is



(a) Straight line
(b) circle

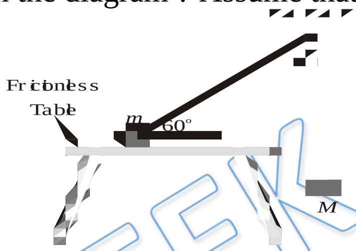
(c) parabola
(d) N.O.T.

Q 12. In the system shown, the acceleration of the wedge of mass 5M is (there is no friction anywhere)



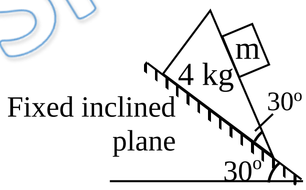
(a) 0
(b) g/2
(c) g/3
(d) g/4

Q 13. What is the minimum value of the mass *M* so that the block is lifted off the table at the instant shown in the diagram ? Assume that the blocks are initially at rest.



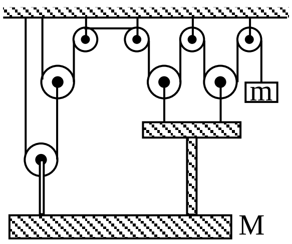
(a) $\frac{m}{\sin 60^o}$
(b) $\frac{m}{\tan 60^o}$
(c) m sin 60^o
(d) none of these

Q 14. For what value of m the wedge will remain in equilibrium? Friction is absent everywhere.



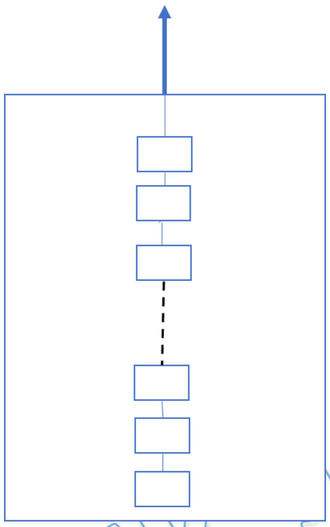
(a) 2Kg
(b) 4 Kg
(c) 8Kg
(d) none of these

Q 15. Find M/m so that both blocks remains unaccelerated



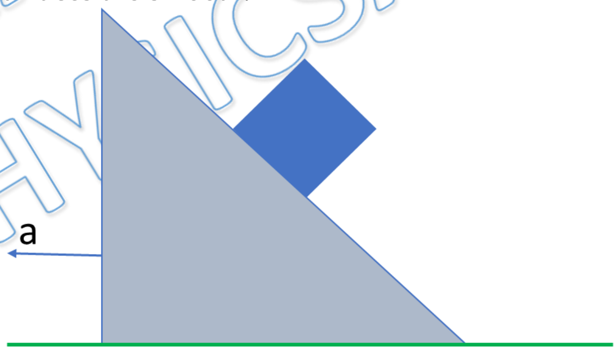
(a) 2
(b) 4
(c) 6
(d) 8

Q 16. 100 blocks are hanging in a lift of mass 950 kg as shown in figure tension in cable of lift is 9000g. From lowermost to uppermost each block has mass 1 kg greater than previous one. Mass of lowermost block is 1 kg. find net force on block of mass 50 kg ?



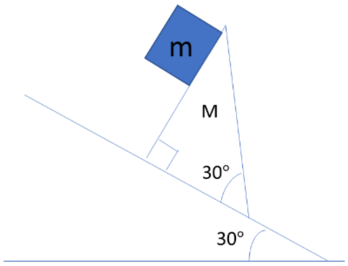
(a) 10g
(b) 25g
(c) 50g
(d) 100g

Q 17. A block is released on inclined surface of prism of equal mass. Angle of inclination is π/4. after releasing if prism moves with acceleration "a" find acceleration of block? All surfaces are smooth.



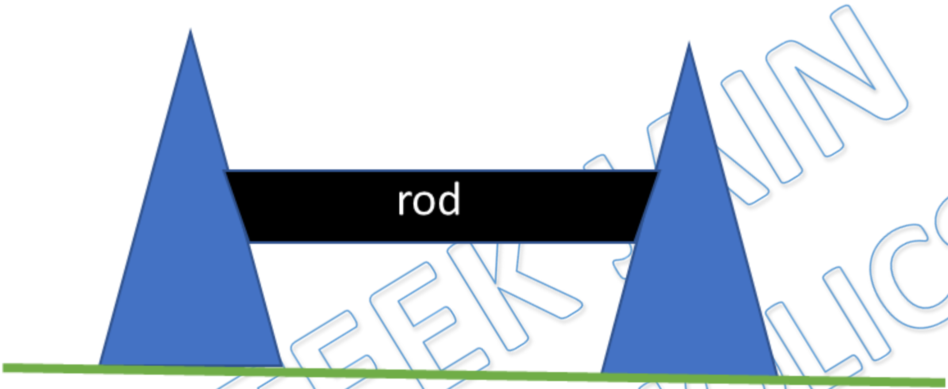
(a) a
(b) $2a\sqrt{2}$
(c) $a\sqrt{5}$
(d) $a/\sqrt{2}$

Q 18. In given figure all surfaces are smooth and incline is fixed. Prism is right angled. M = 5 kg , m = 1 kg.



(a) g/2 (b) g/5
(c) g/6 (d) g

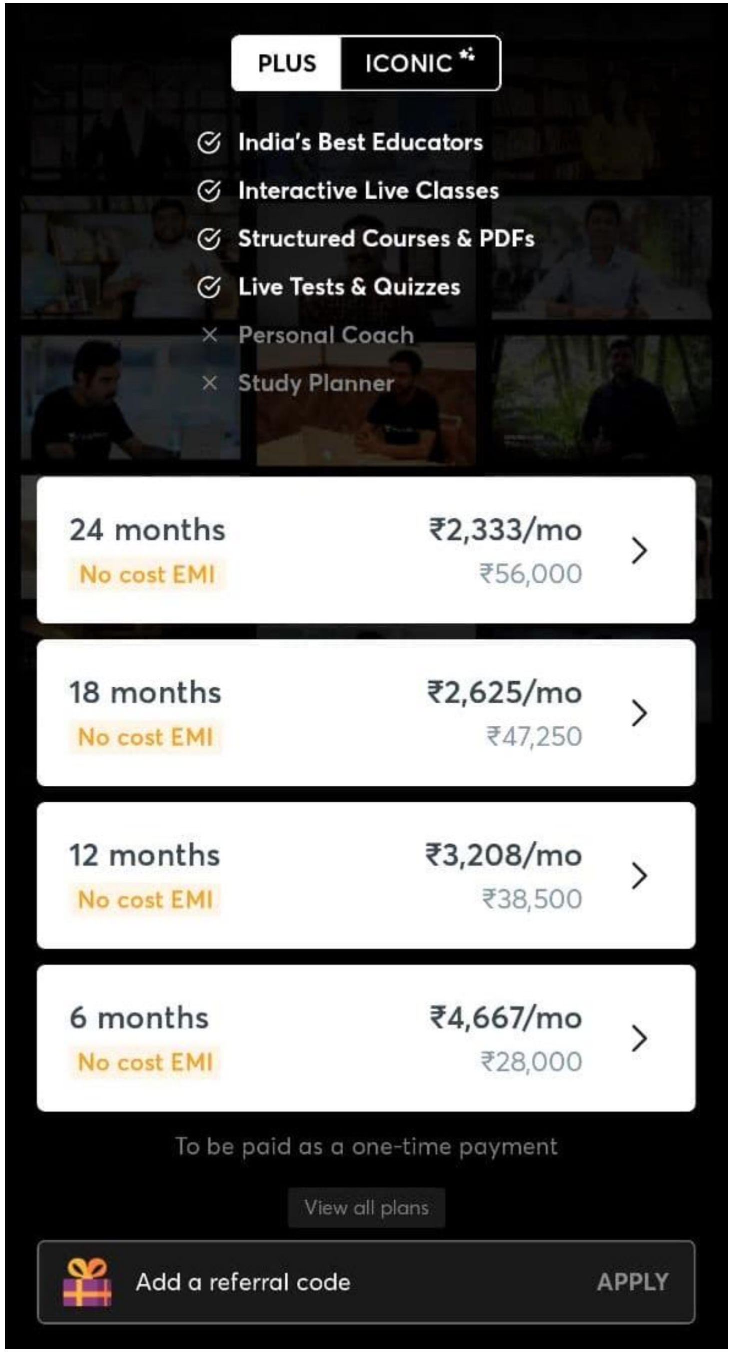
Q 19. A rod is placed on two equilateral prisms as shown in figure. All surfaces are smooth and all objects have equal mass .find acceleration of rod after releasing system? Rod always remains horizontal during motion.(g = 10 m/Sec^2)



(a) 2 m/Sec^2 (b) 4 m/Sec^2
(c) 6 m/Sec^2 (d) 8 m/Sec^2

Answer Key

Q.1 a,b,c	Q.2 a	Q.3 c	Q.4 b	Q.5 c
Q.6 c	Q.7 a	Q.8 b	Q.9	Q.10 c
Q.11 c	Q.12 a	Q.13 d	Q.14 c	Q.15 d
Q.16 b	Q.17 c	Q.18 d	Q.19 c	



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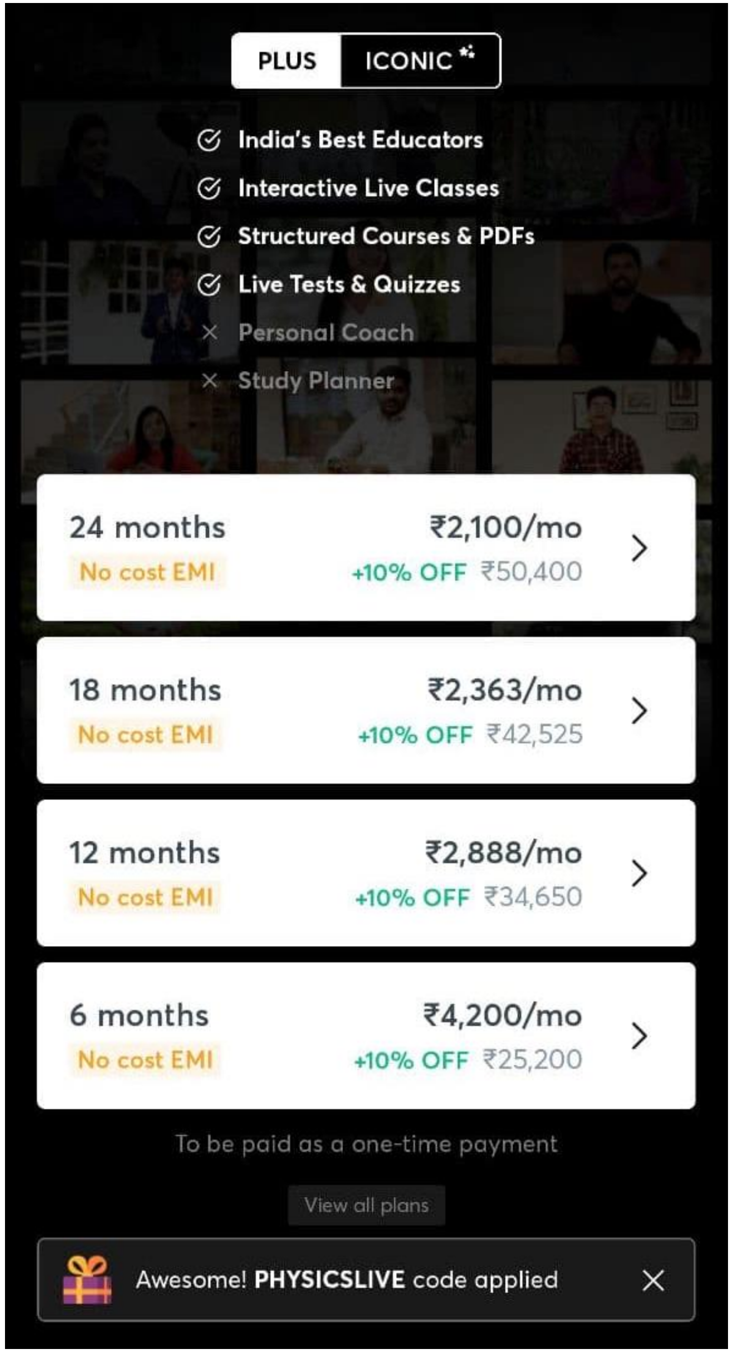

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Written Solution

DPP-4 NLM: Newton's 2nd Law

By Physicsaholics Team

Solution.1 Let $M > m$

If m is stationary $\Rightarrow T = mg$

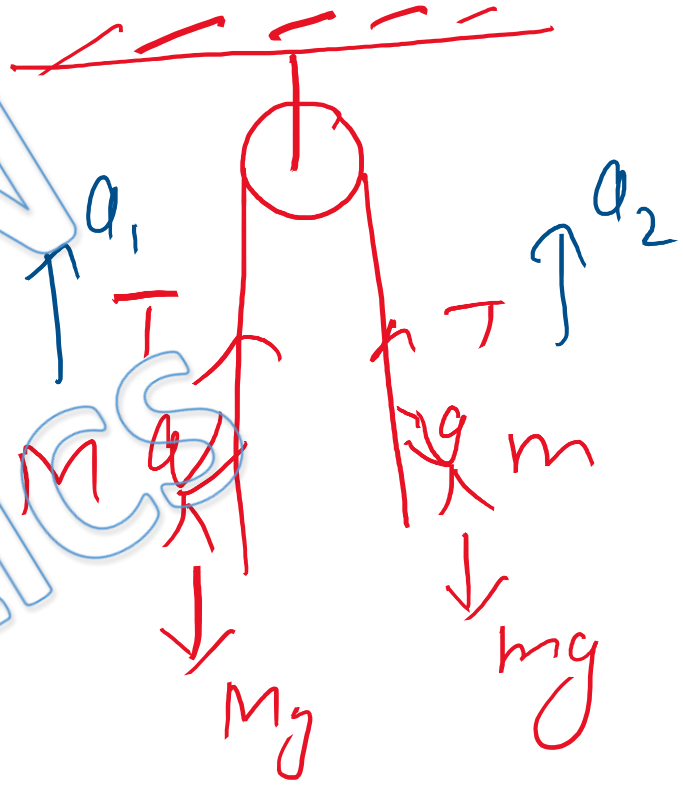
$\Rightarrow$ wt of M exceeds tension

$\Rightarrow$ M will accelerate downward.

If M is stationary $\Rightarrow T = Mg$

$\Rightarrow$ Tension exceeds wt of m

$\Rightarrow$ m will accelerate up.



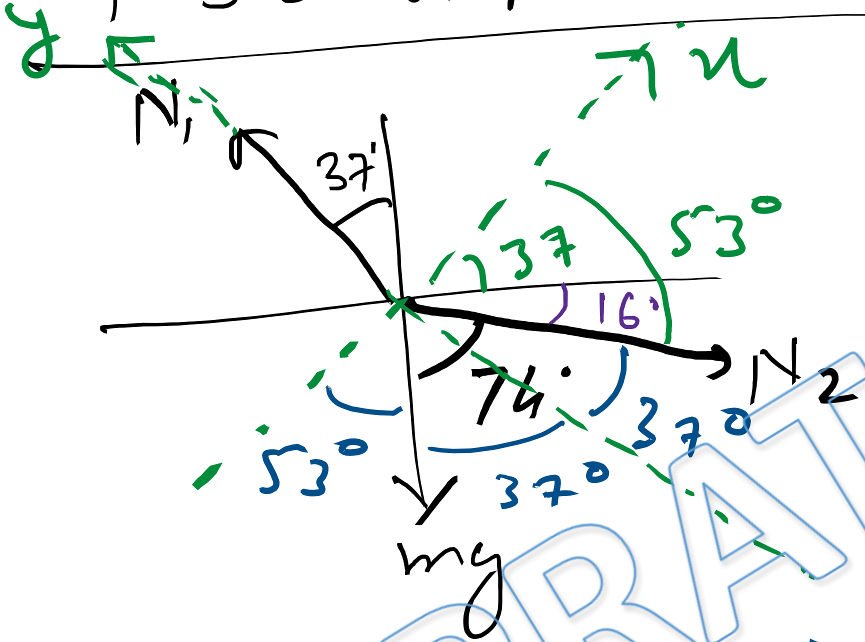
$a_1 = \frac{T - Mg}{M} = \frac{T}{M} - g$, $a_2 = \frac{T - mg}{m} = \frac{T}{m} - g$

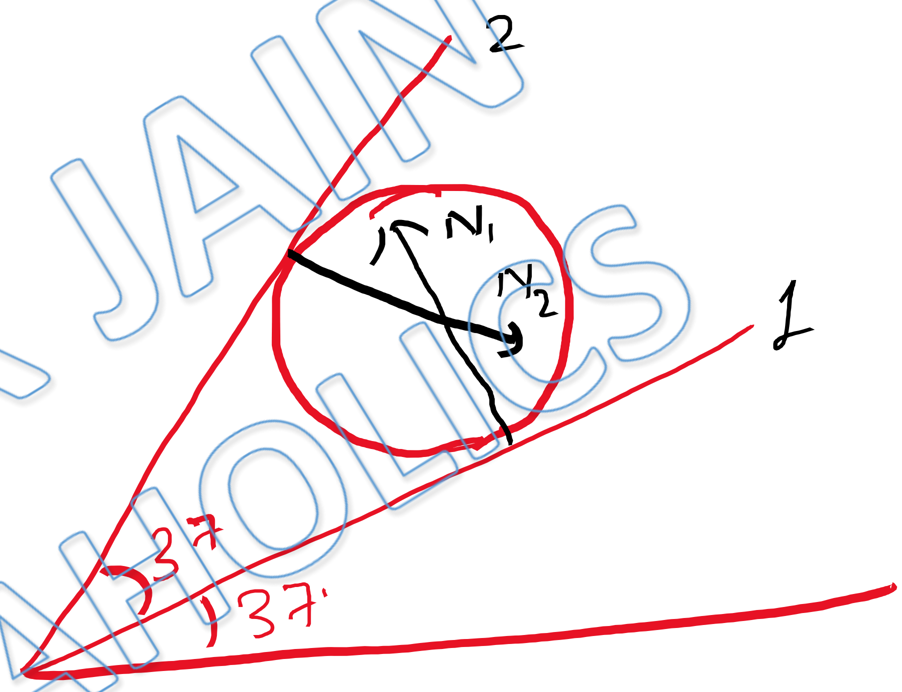
It is clear that $a_1 \neq a_2$ but a_1 may be equal to $-a_2$.

Ans. (A, B, D)

Solution.2

F.B.D of sphere



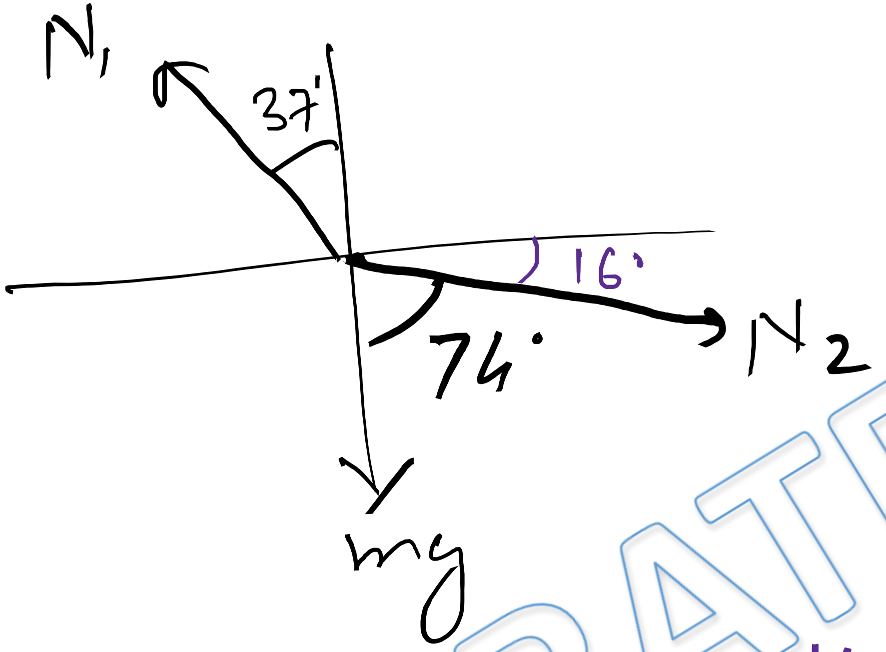


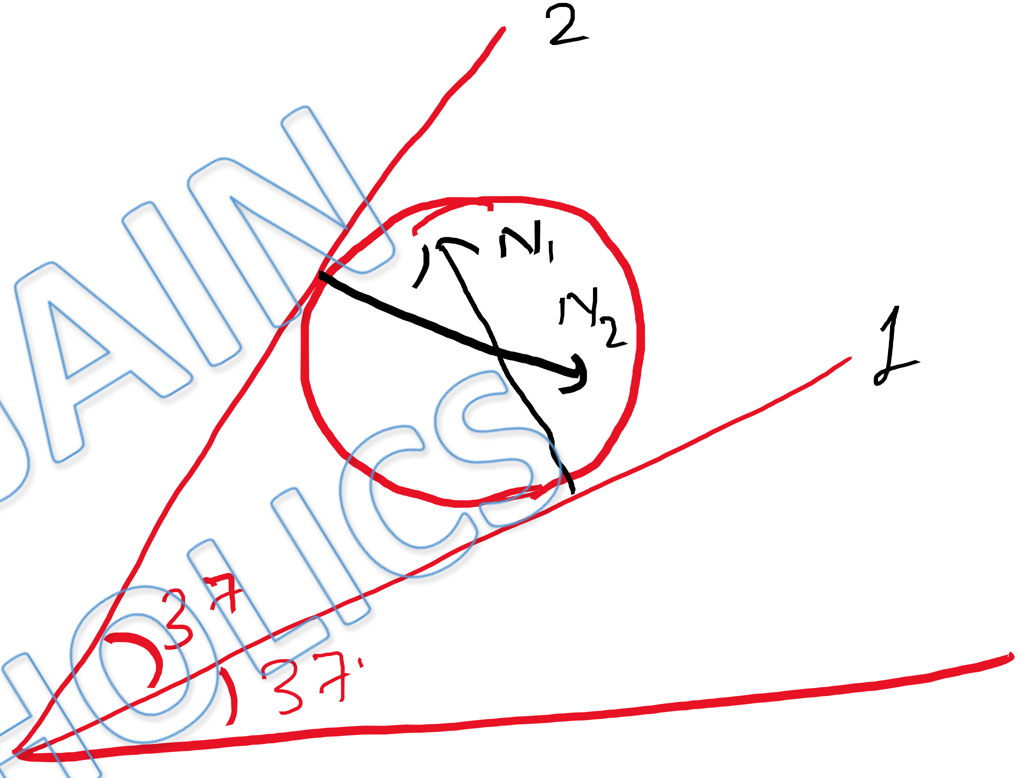
for Equilibrium; $\vec{F}_{net} = 0$

in x-direction ⇒ $N_2 \cos 53^\circ = mg \cos 53^\circ$ ⇒ $\boxed{N_2 = mg}$ Ans

Ans. (A)

F.B.D of Sphere OR





Using Lami's theorem

$$\frac{N_2}{\sin(180-37)} = \frac{mg}{\sin(90+53)}$$

$$\Rightarrow N_2 = \frac{mg \sin 37°}{\cos 53°}$$

$$= mg$$

Ans. (A)

Solution.4

from F.B.D of blocks

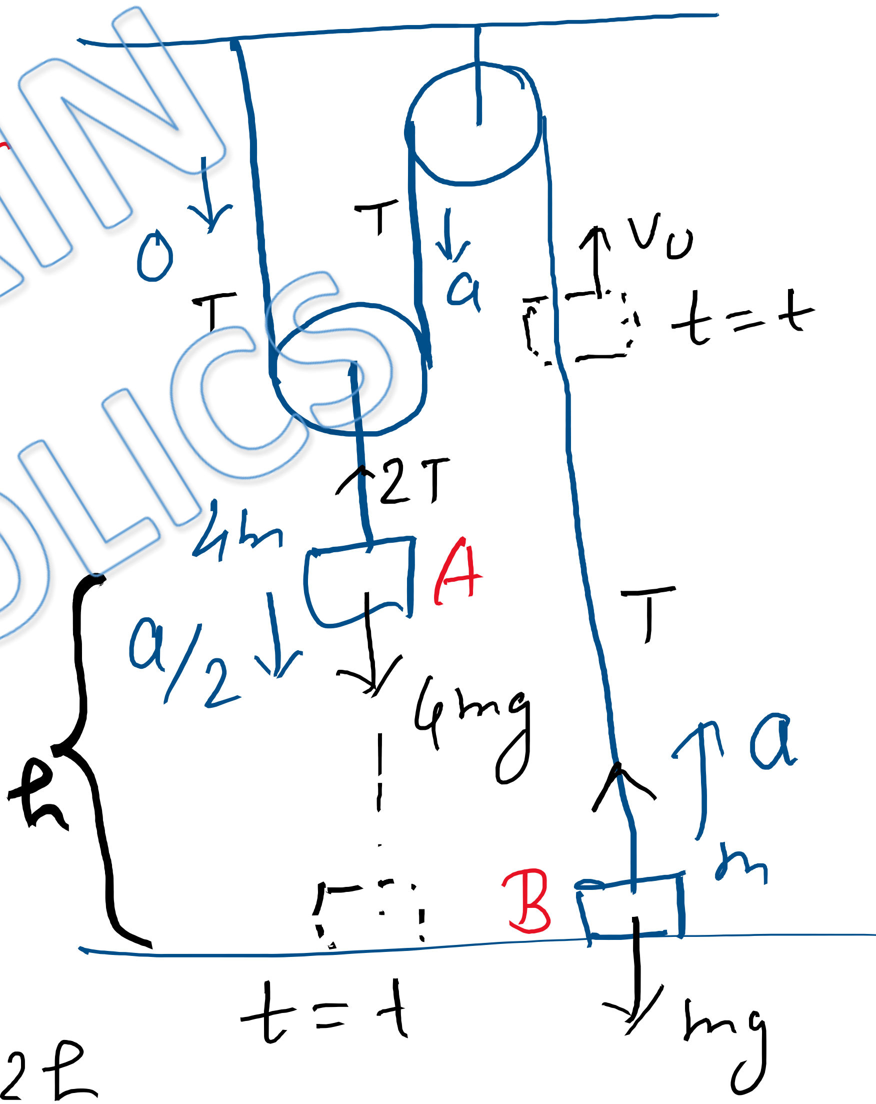
$T - mg = ma$, $\frac{4mg - 2T = 4m\frac{a}{2}}{2}$

$2mg - T = ma$

$mg = 2ma \Rightarrow a = g/2$

when A will move distance h down B will move 2h up. let velocity of B at height 2h is V_0.

$\Rightarrow V^2 = u^2 + 2ax \Rightarrow V_0^2 = 0 + \frac{2g \times 2h}{2}$



when B will reach at height 2h, Tension in strings will become zero & B will start free fall. maximum height of B above this point

$$= \frac{V_0^2}{2g} = \frac{2gh}{2g} = h.$$

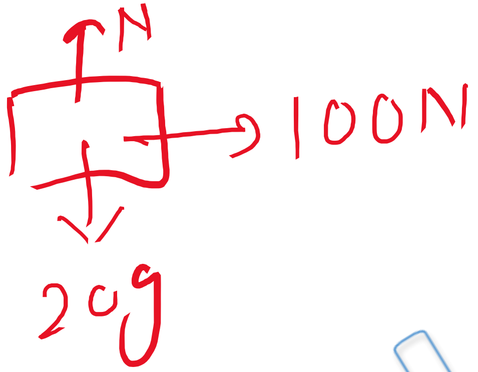
maximum height of B from ground

$$= 2h + h = 3h$$

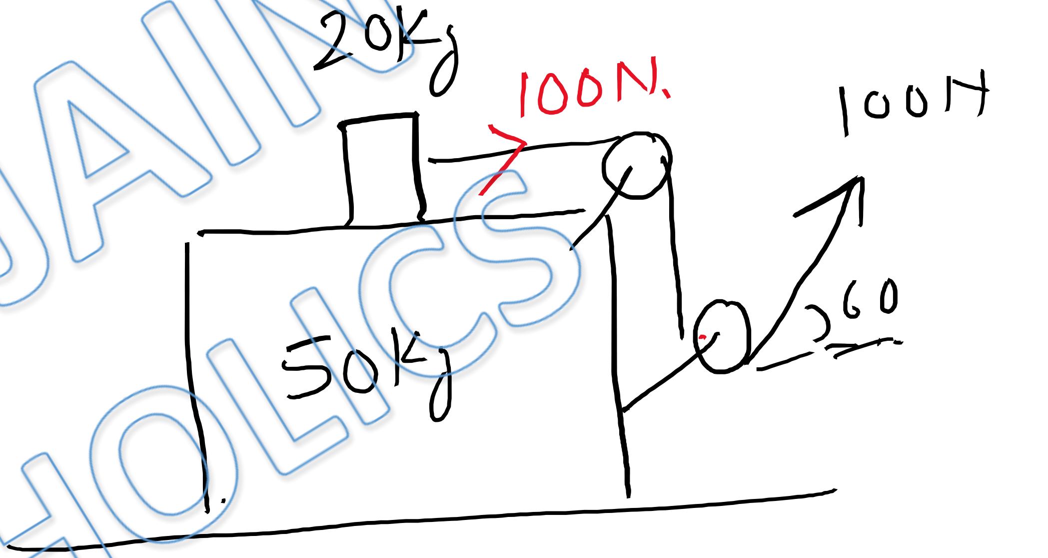
Ans.c

Solution.3

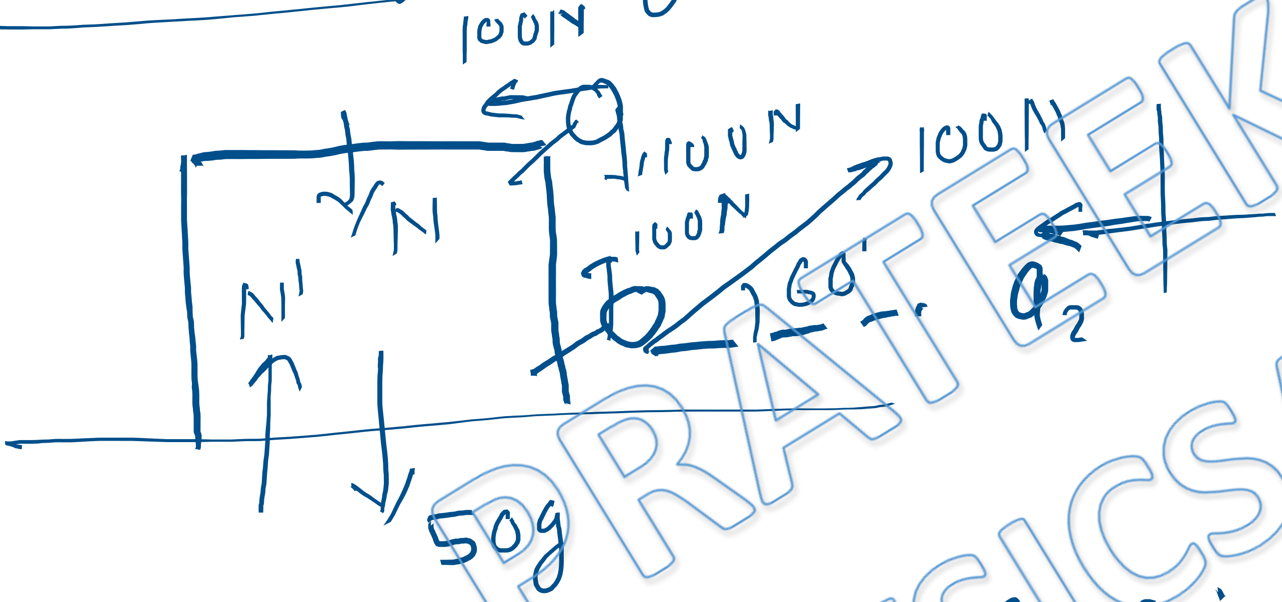
F.B.D of 20kg



$\rightarrow a_1 \Rightarrow a_1 = \frac{100}{20} = 5\ m/sec^2$



F.B.D of wedge



$100 - 100\cos 60° = 50 a_2 \Rightarrow 50 = 50 a_2$

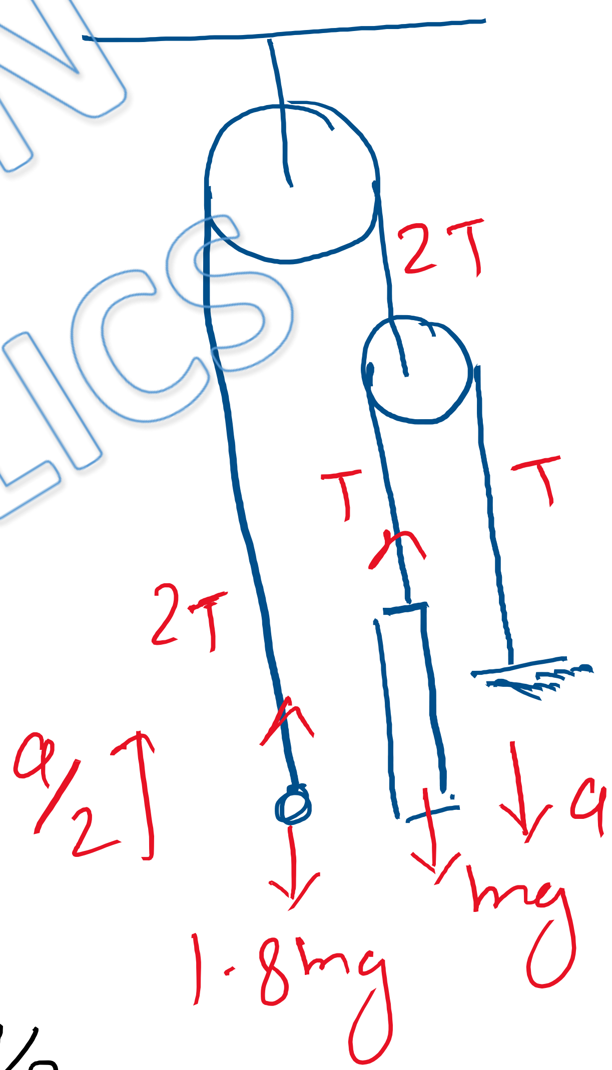
$\Rightarrow a_2 = 1 \Rightarrow$ rel. acceleration $= 6\ m/sec^2$

Ans. (b)

Solution.4

Let mass of Rod is m $\Rightarrow$ mass of ball is 1.8m.

from F.B.D $\rightarrow$



$$mg - T = ma \quad \times 2$$

$$2T - 1.8mg = 1.8m\frac{a}{2}$$

$$2mg - 2T = 2ma$$

$$0.2mg = 2.9ma$$

$$a = \frac{2g}{29}$$

acceleration of ball w.r.t. rod $= \frac{3a}{2}$

$$= \frac{3g}{29}$$

relative displacement = 1m.

$$x = ut + \frac{1}{2}at^2 \Rightarrow 1 = \frac{1}{2} \times \frac{3g}{29} t^2$$

$$t = \sqrt{\frac{58}{3g}} = 1.4 \text{ Sec}$$

Ans. (C)

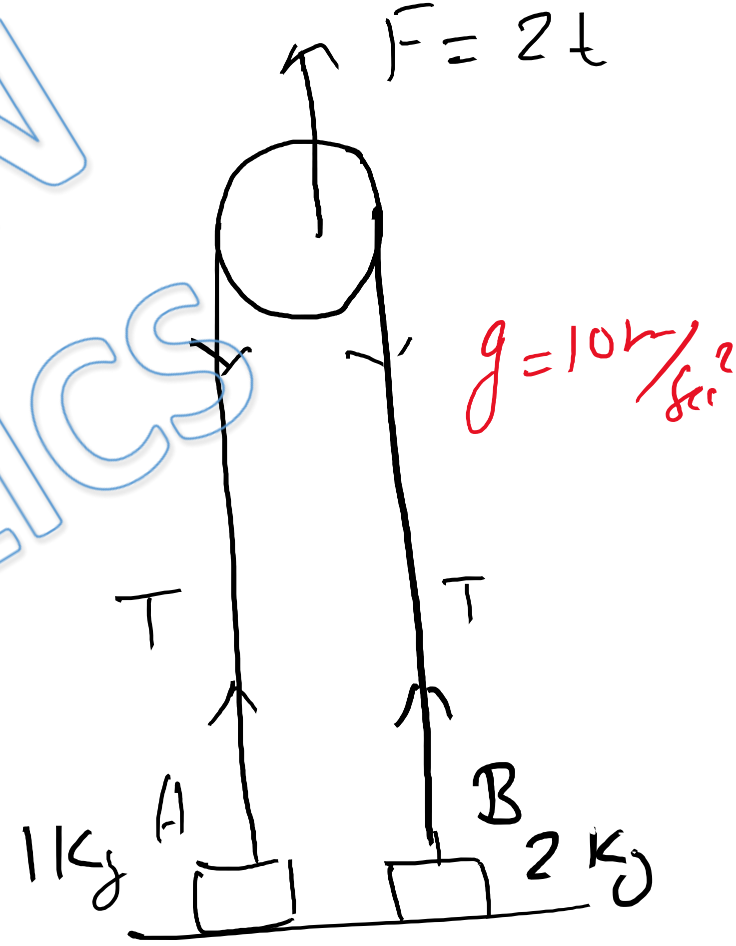
Solution.5

Since pulley is massless $F = 2T = 2t$

$\Rightarrow T = t$

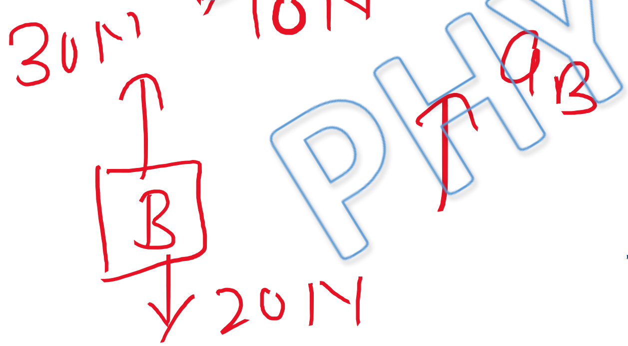
To lift A, $T > 10N$.

To lift B, $T > 20N$.



at $t = 30$ Sec, $T = 30N$.

$\Rightarrow a_A = 20 m/sec^2$



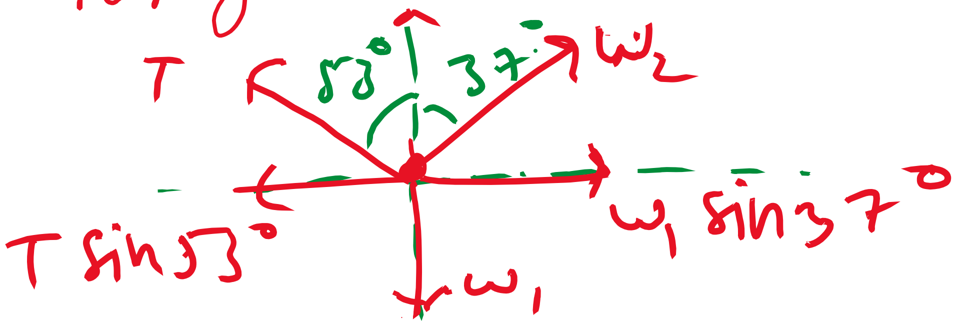
$\Rightarrow a_B = \frac{30-20}{2} = 5 m/sec^2$

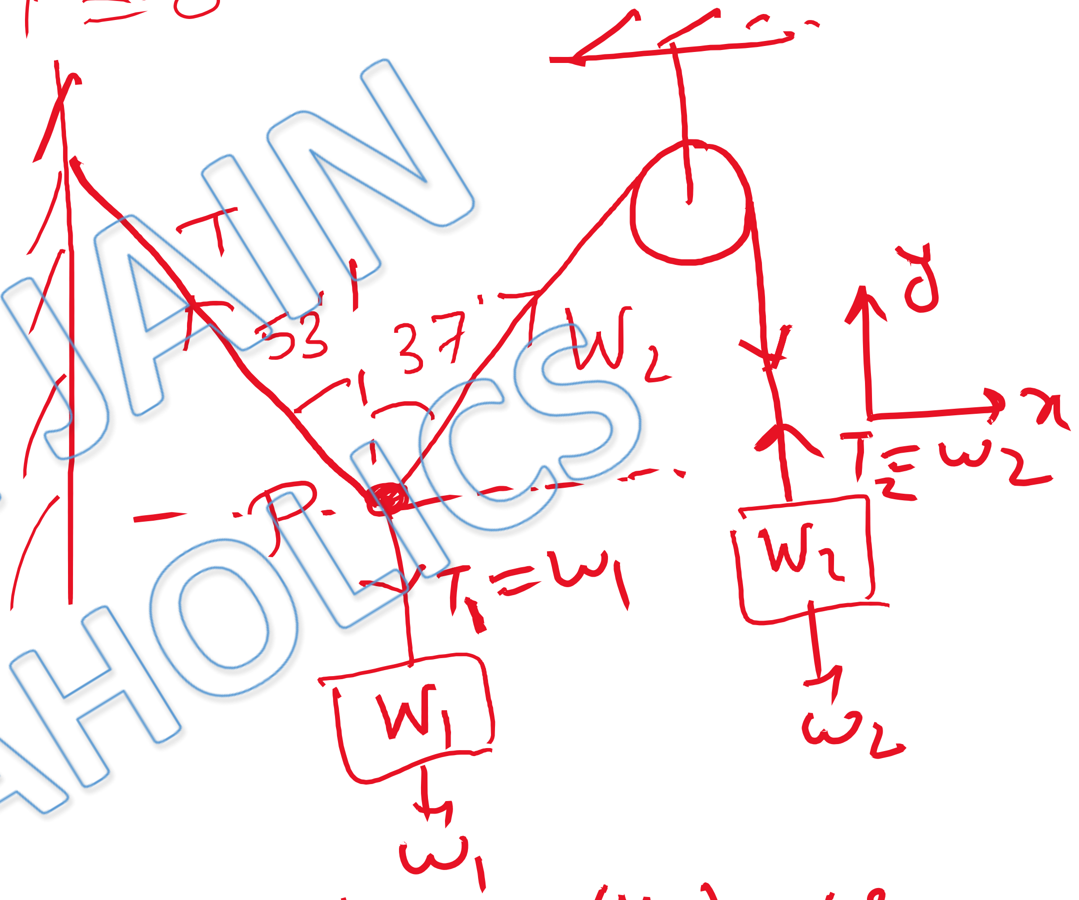
$\Rightarrow a_{pulley} = \frac{20+5}{2} = 12.5 m/sec^2$

Ans.c

Solution.6

net force on mass less point P = 0





in x-direction

$$T\sin 53^\circ = w_2 \sin 37^\circ$$

$$T\left(\frac{4}{5}\right) = w_2\left(\frac{3}{5}\right)$$

$$4T = 3w_2 \Rightarrow T = \frac{3w_2}{4}$$

in y-dirn:

$$T\cos 53^\circ + w_2 \cos 37^\circ = w_1$$

$$T\left(\frac{3}{5}\right) + w_2\left(\frac{4}{5}\right) = w_1$$

$$\Rightarrow \left(\frac{3w_2}{5}\right)\left(\frac{3}{4}\right) + w_2\left(\frac{4}{5}\right) = w_1$$

$$\frac{9w_2}{20} + \frac{16w_2}{20} = w_1$$

$$\frac{25}{20} w_2 = w_1$$

$$\Rightarrow \boxed{\frac{w_1}{w_2} = \frac{5}{4}}$$

ANS (A)

(OR)

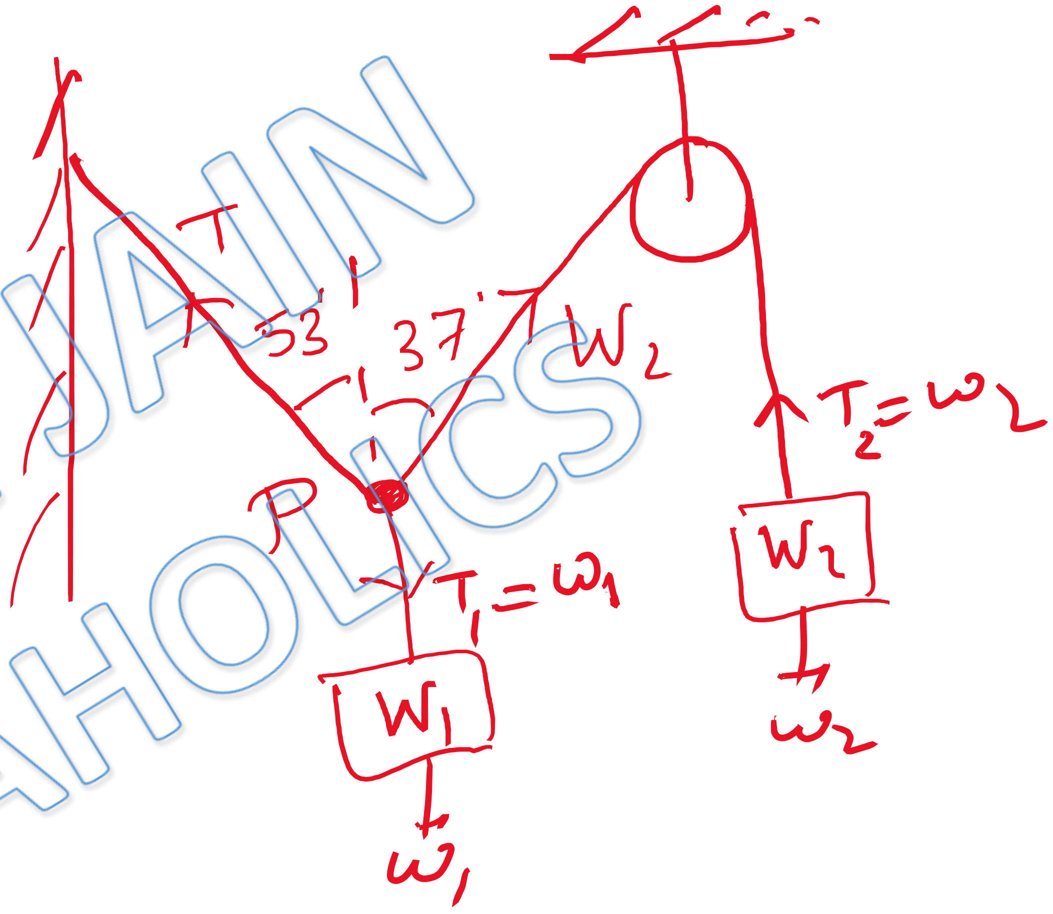
net force on massless point

$P = 0$

$\Rightarrow$ Using Lami's theorem

$$\frac{W_1}{\sin 90^\circ} = \frac{W_2}{\sin(180^\circ - 53^\circ)}$$

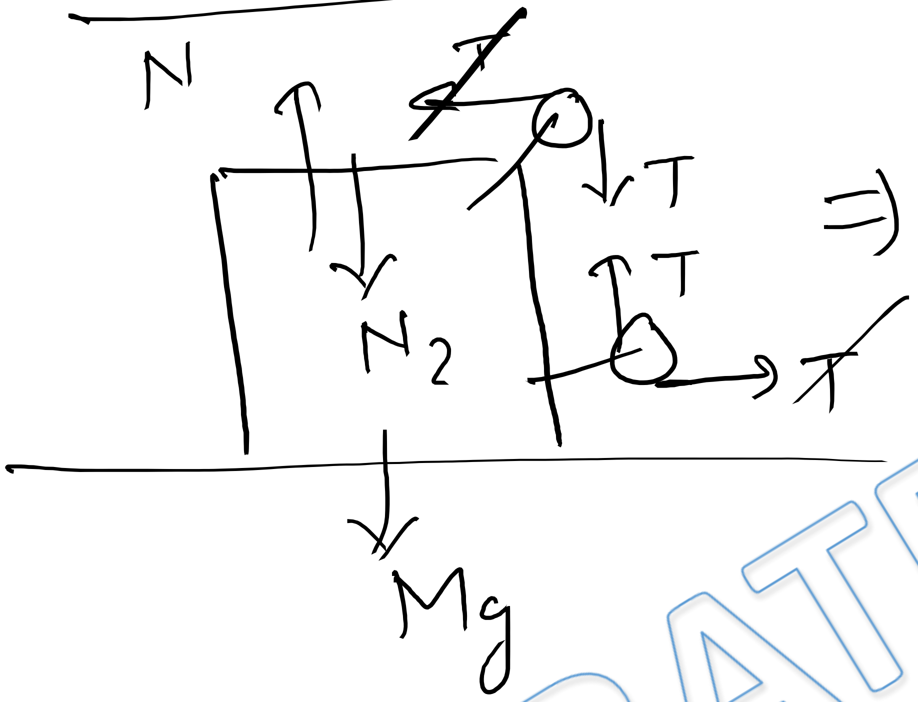
$$\Rightarrow \frac{W_1}{W_2} = \frac{1}{\sin 53^\circ} = \frac{5}{4}$$



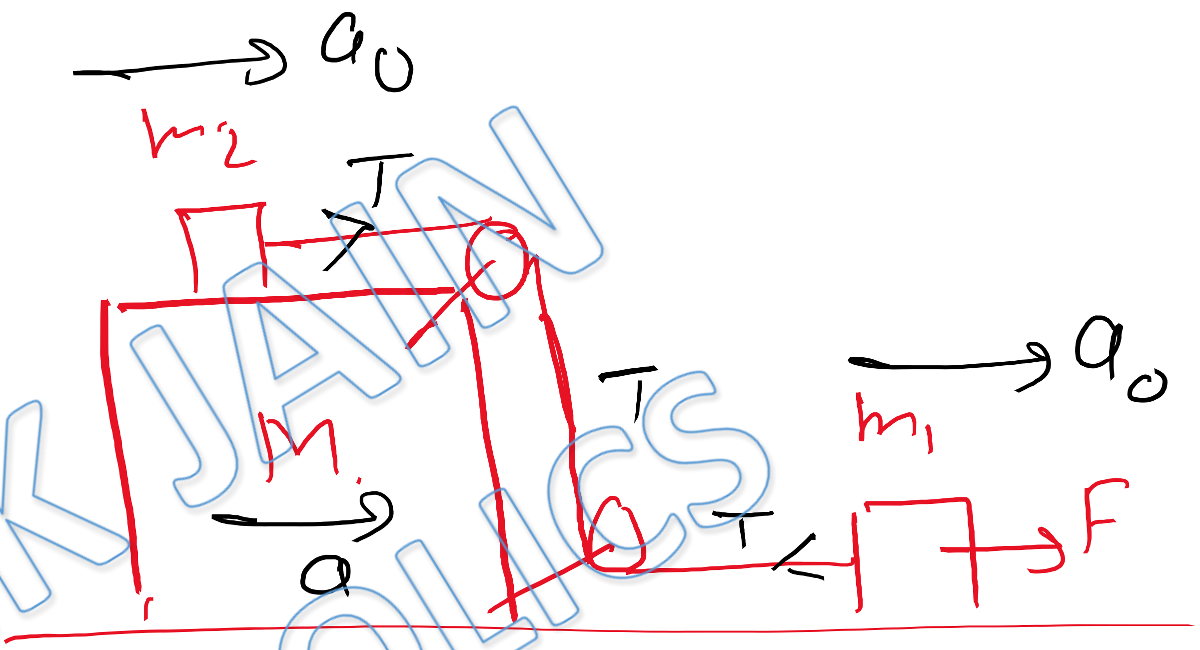
ANS (A)

Solution.7

F.B.D of M



$\Rightarrow a = 0$



for $m_1 \rightarrow$ $\quad F - T = m_1 a_0$

for $m_2 \rightarrow$ $\quad T = m_2 a_0$

$$\Rightarrow a_0 = \frac{F}{m_1 + m_2}$$

$$T = \frac{m_2 F}{m_1 + m_2}$$

ANS – (B)

Solution.8

Using power method →

$T \times g/3 - T a_2 = 0 \Rightarrow a_2 = g/3$

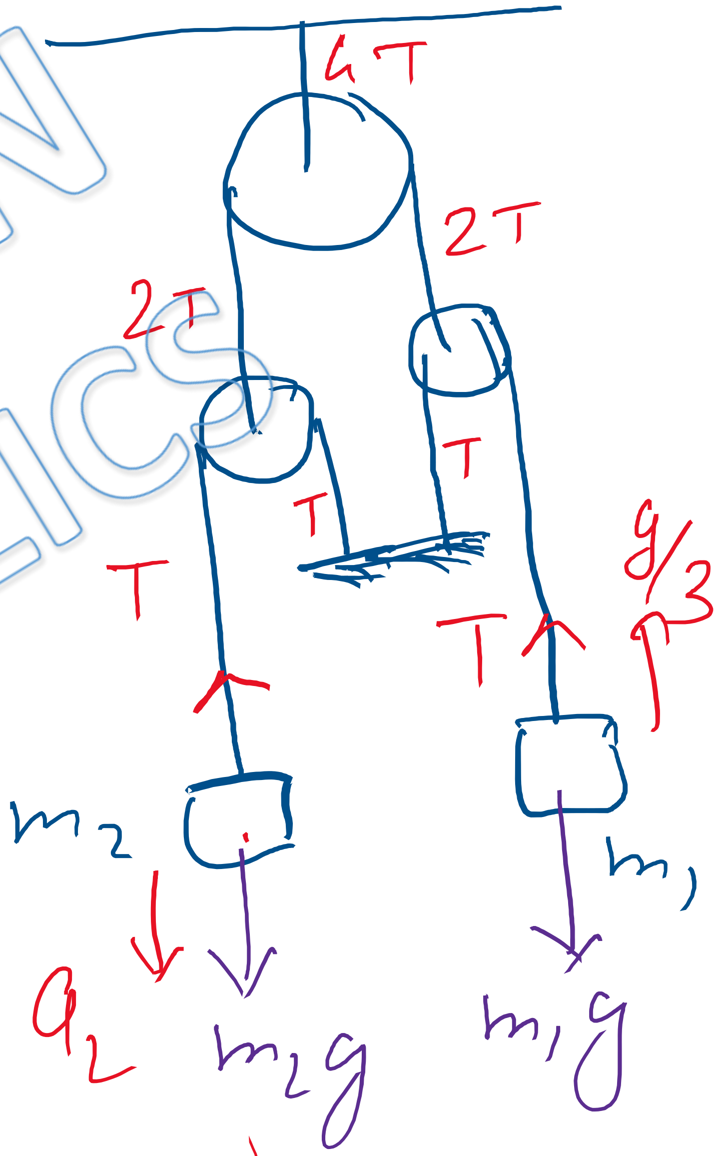
$T - m_1 g = m_1 g/3$

$\Rightarrow T = \frac{4}{3} m_1 g$

$m_2 g - T = m_2 g/3$

$T = \frac{2}{3} m_2 g$

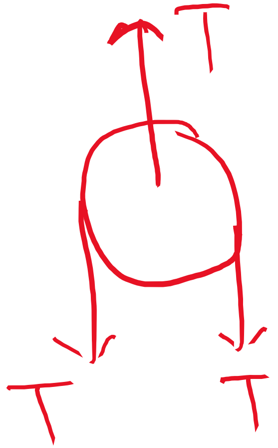
$\Rightarrow \frac{4}{3} m_1 g = \frac{2}{3} m_2 g \Rightarrow \frac{m_1}{m_2} = \frac{1}{2}$



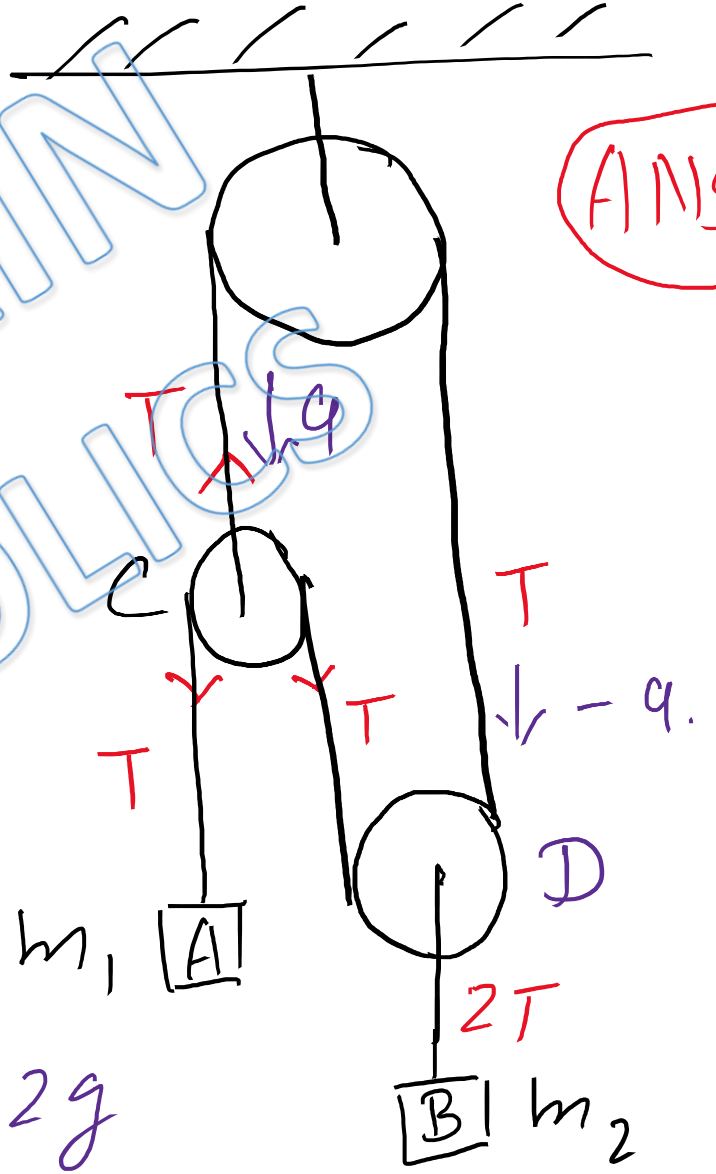
Ans. (C)

Solution.9

F.B.D of C →



⇒ net force $= T = 0$ (Since C is massless)



ANS-C

Since $T = 0 \Rightarrow m_1$ & m_2 starts free fall, $a_A = a_B = g \downarrow$

for pulley C

$a' + g = 2a$

$a' = 2a - g$

for pulley D

$a' - a = 2g$

$2a - g - a = 2g \Rightarrow a = 3g$

Solution.10 acceleration of block → a_0 is constant

but not parallel to v_0

⇒ path is parabolic.

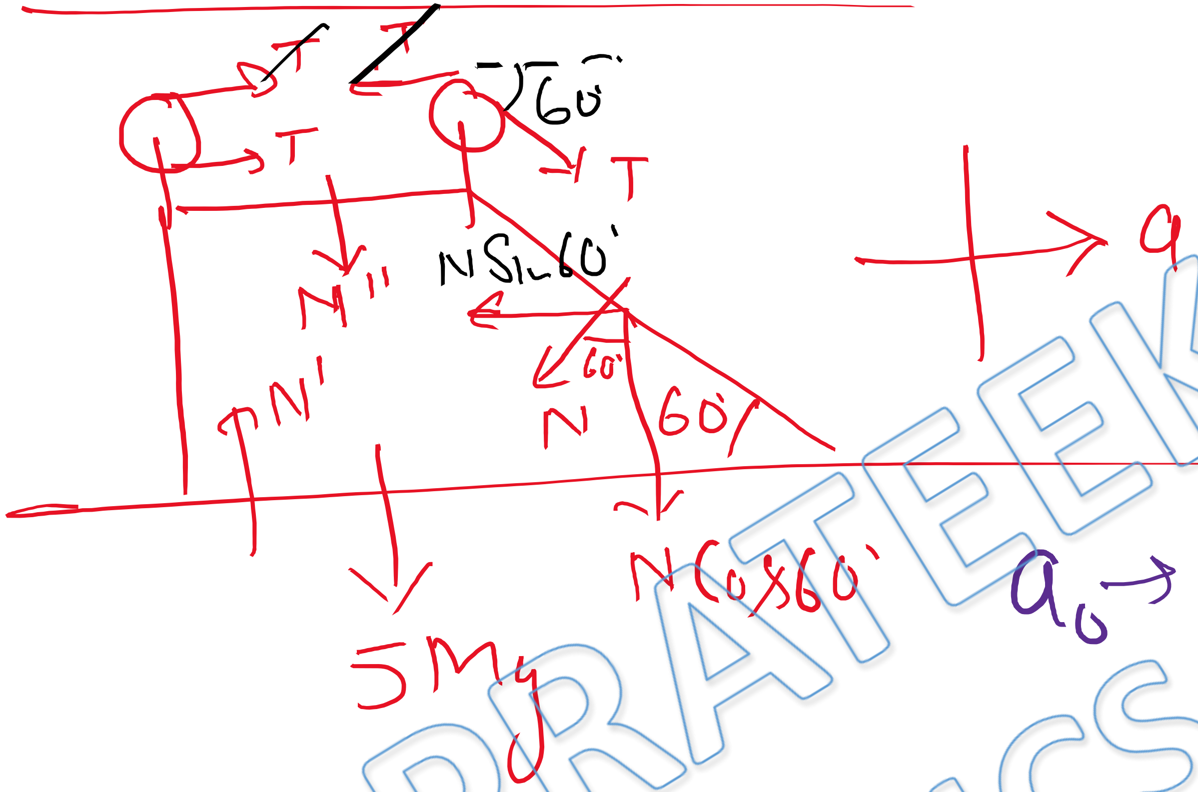
a_0 → acceleration of Prism

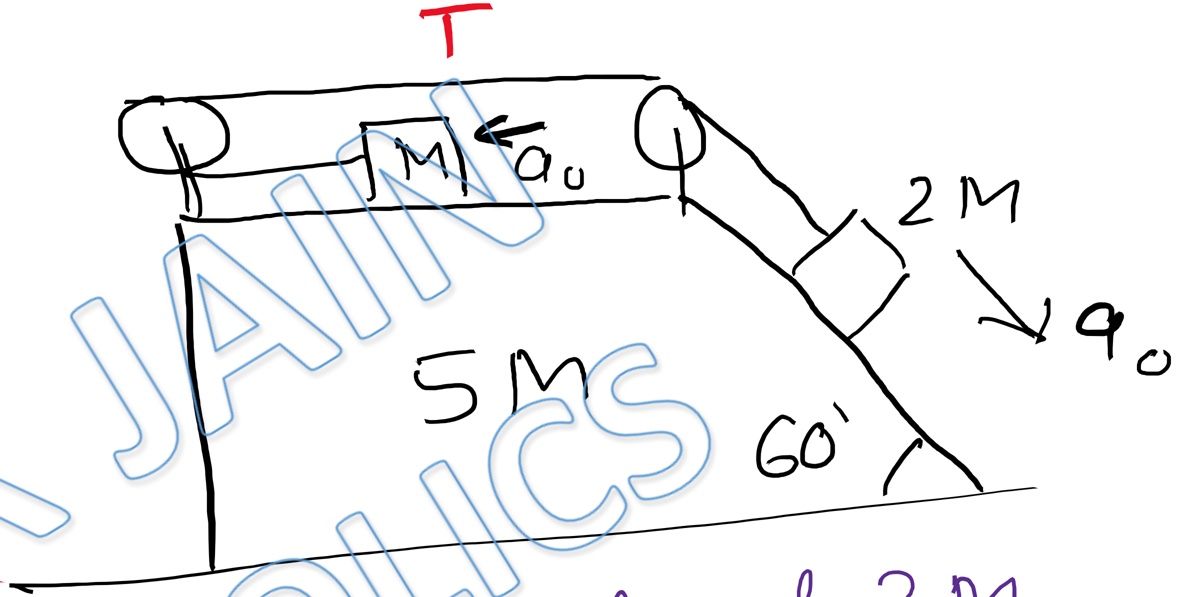
a → acceleration of block w.r.t. Prism.

Ans.c

Solution.11

F.B.D of 5M



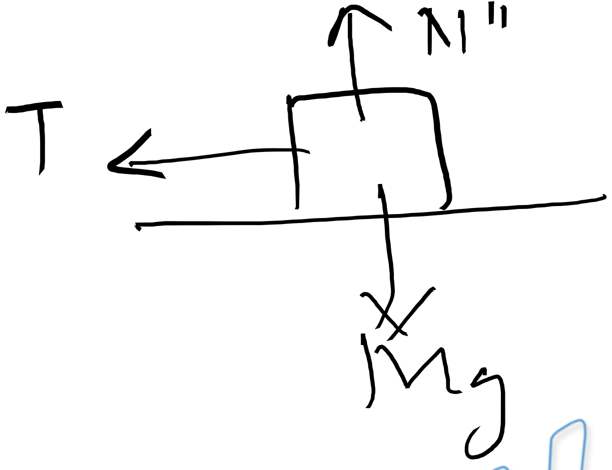


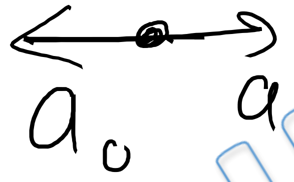
$a_0 \rightarrow$ acceleration of M & 2M w.r.t. 5M.

$$T + T\cos 60° - N\sin 60° = 5Ma$$

$$\frac{3T}{2} - \frac{N\sqrt{3}}{2} = 5Ma \quad \text{--- (1)}$$

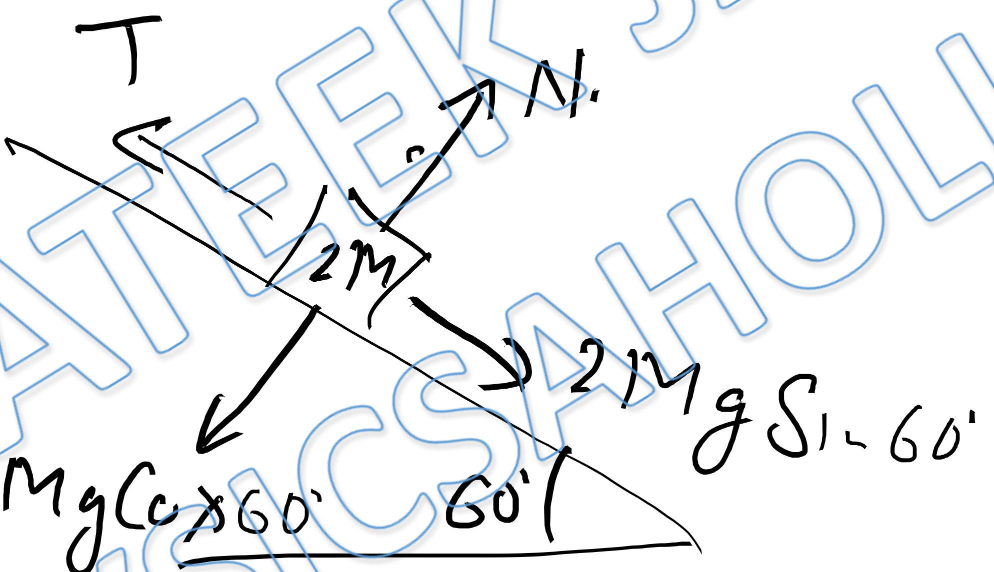
F.B.D of M

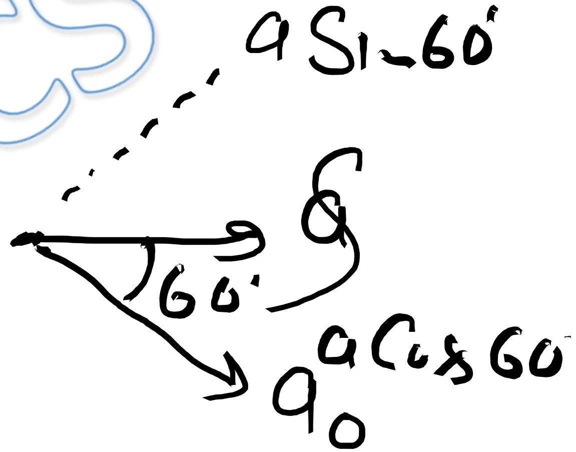




$$\Rightarrow T = M(a_0 - a) \quad \text{--- (II)}$$

F.B.D of 2M





$$2Mg\frac{\sqrt{3}}{2} - T = 2M\left(a_0 + \frac{a}{2}\right) \quad \text{--- (III)}$$

$$N - 2Mg \times \frac{1}{2} = 2Ma\frac{\sqrt{3}}{2} \quad \text{--- (IV)}$$

$$\frac{3T}{2} - N\frac{\sqrt{3}}{2} = 5Ma \quad \text{--- (I)}$$

$$T = Ma_0 - Ma \quad \text{--- (II)}$$

$$Mg\sqrt{3} - T = 2Ma_0 + Ma \quad \text{--- (III)}$$

$$N - Mg = Ma\sqrt{3} \quad \text{--- (IV)}$$

On adding Equation (II) & (III)

$$Mg\sqrt{3} = 3Ma_0$$

$$a_0 = g/\sqrt{3}$$

On adding Eq (I) to $\frac{\sqrt{3}}{2} \times$ (IV)

$$\frac{3T}{2} - \frac{\sqrt{3}Mg}{2} = \frac{3Ma}{2}$$

$$\Rightarrow 3Ma_0 - 3Ma - \sqrt{3}Mg = 3Ma$$

$$6Ma = 3Ma_0 - \sqrt{3}Mg$$

$$= 3Mg/\sqrt{3} - \sqrt{3}Mg = 0$$

$$\Rightarrow \boxed{a = 0}$$

Ans.a

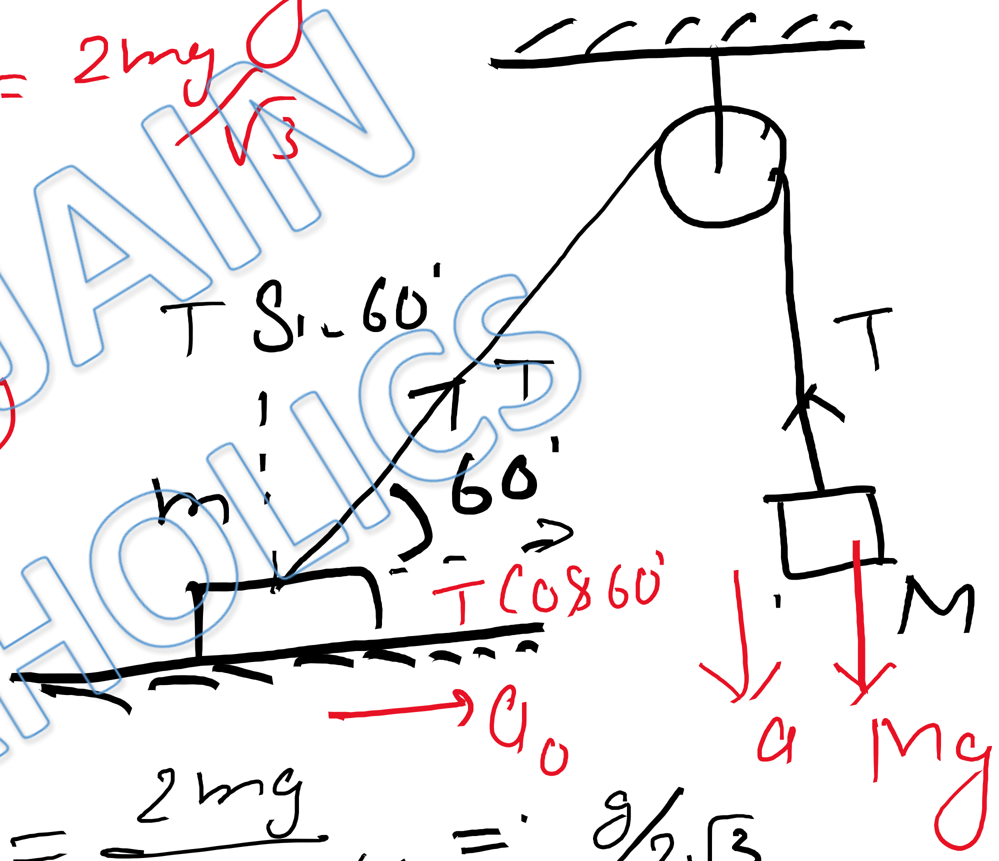
Solution.12

To just lift m, $T\sin 60° = mg$ ---(i) $\Rightarrow T = \frac{2mg}{\sqrt{3}}$

Using Power Method

$$T\cos 60° \cdot a_0 - T a = 0$$

$$\Rightarrow a = a_0/2 \quad \text{---(ii)}$$



from F.B.D of m →

$$T\cos 60° = m a_0 \Rightarrow \frac{T}{2} = 2ma$$

$$\Rightarrow T = 4ma \quad \text{---(iii)} \Rightarrow a = \frac{2mg}{\sqrt{3} \times 4m} = g/2\sqrt{3}$$

from F.B.D of M →

$$Mg - T = Ma \Rightarrow Mg - \frac{2mg}{\sqrt{3}} = \frac{Mg}{2\sqrt{3}}$$

Ans.d

Solution.13

$$2\sqrt{3}M - 4m = M$$

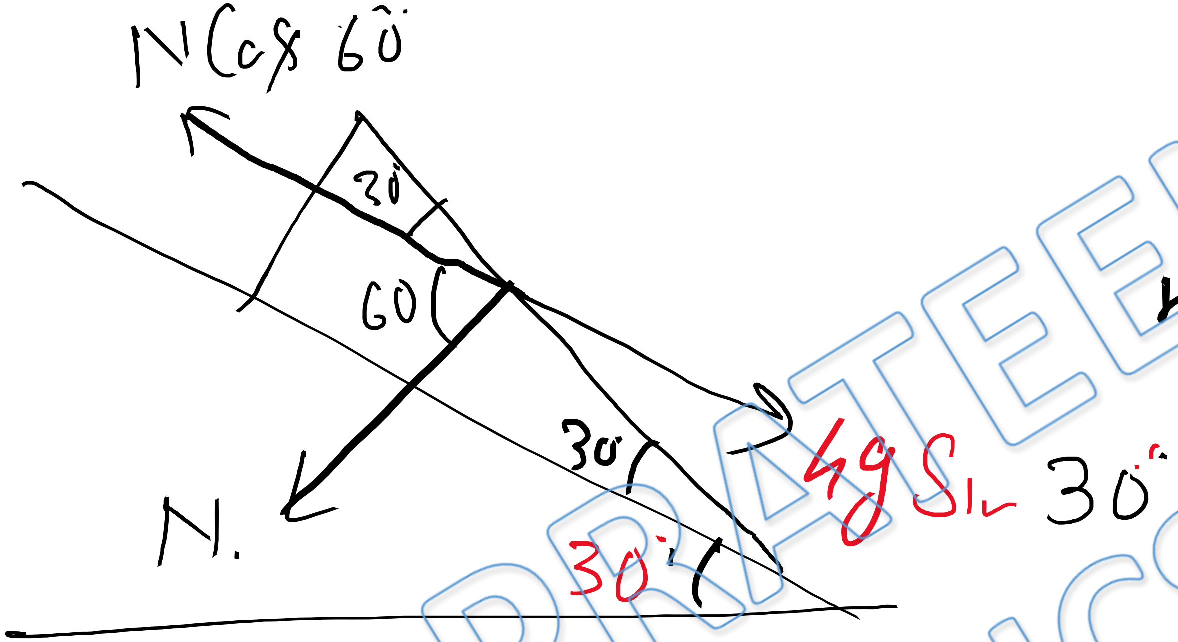
$$M(2\sqrt{3} - 1) = 4m$$

$$M = \frac{4m}{2\sqrt{3} - 1}$$

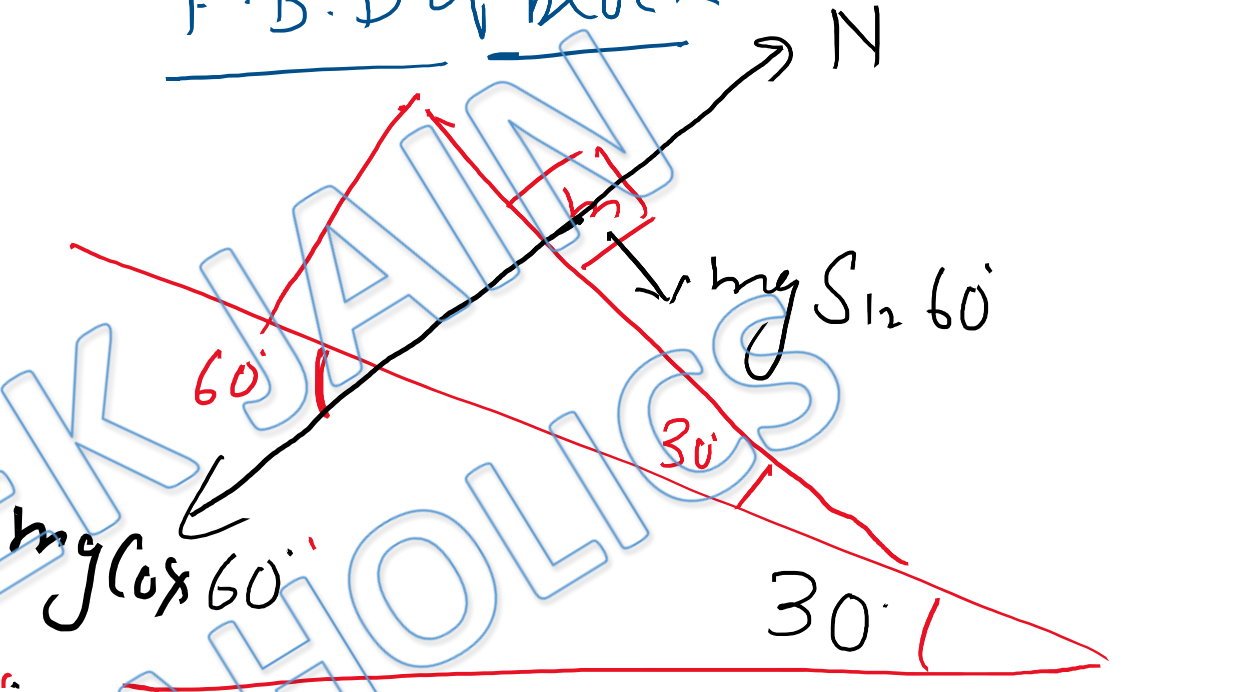
ANS – (D)

Solution.14

F.B.D of 4Kg



F.B.D of block



$N = mg\cos 60°$

$N\cos 60 = 4g\sin 30$

$\Rightarrow mg\frac{1}{2} = 4g$

$m = 8\ Kg$

Ans : (C)

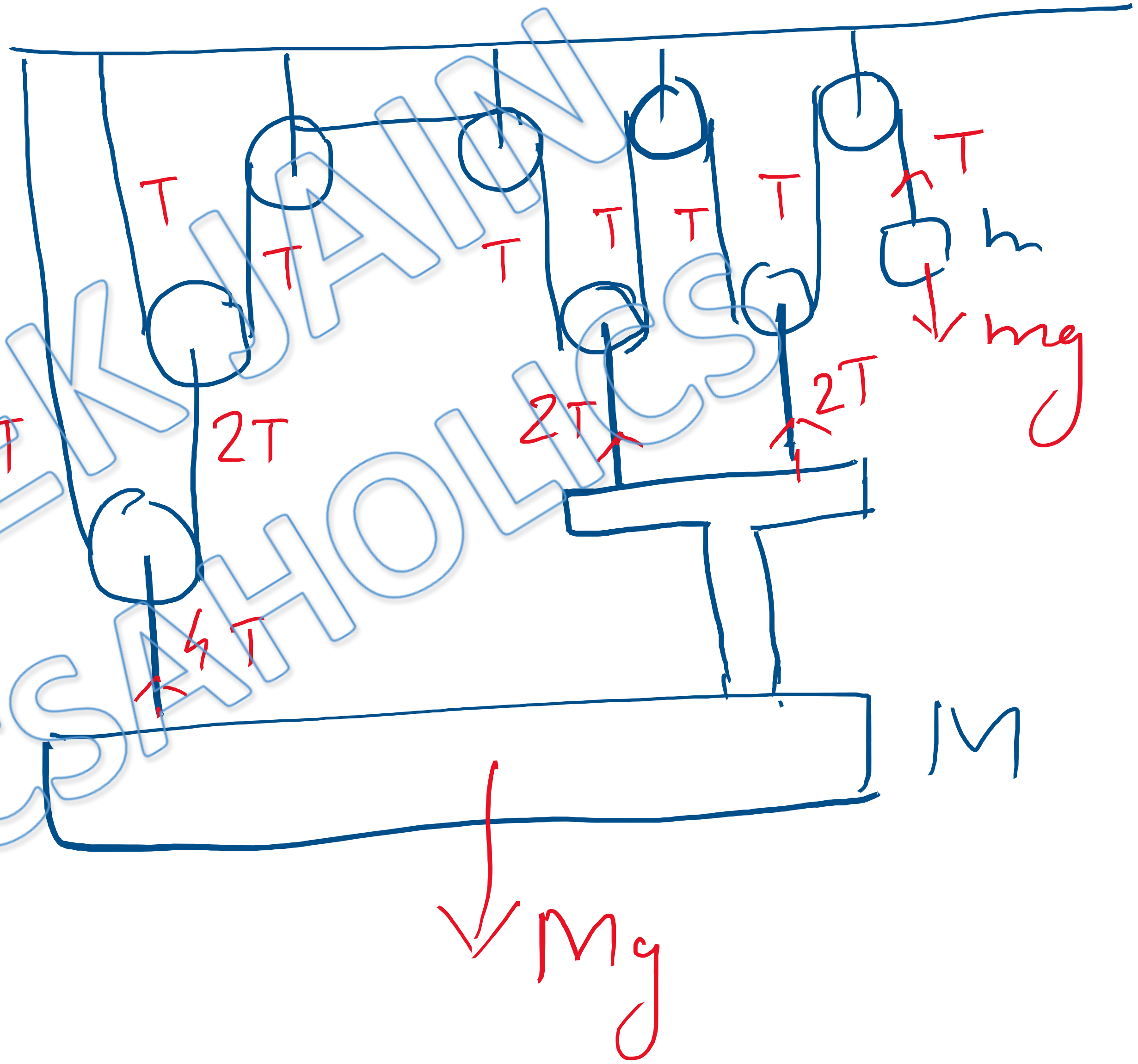
Solution.15

$T = mg$

$8T = Mg$

$8 = \frac{M}{m}$

ANS (D)



Ans.d

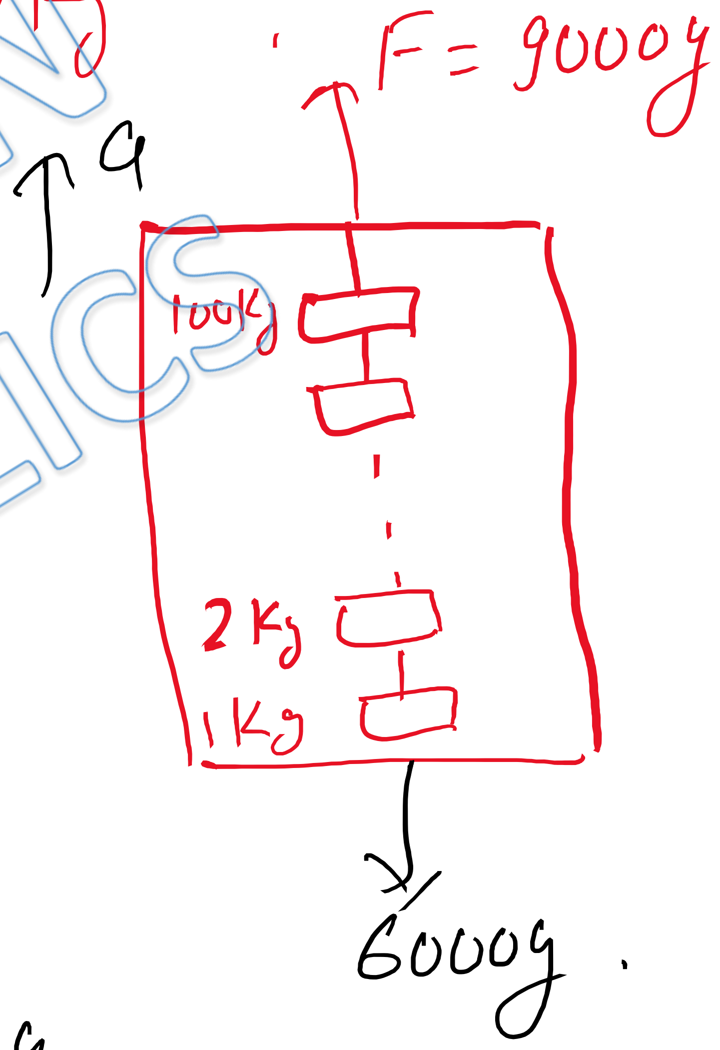
Solution.16

total mass of all blocks

$= 1 + 2 + \dots + 100 = 101 \times 50 = 5050\,kg$

mass of lift = 950 kg

total weight = 6000g



$9000g - 6000g = 6000a$

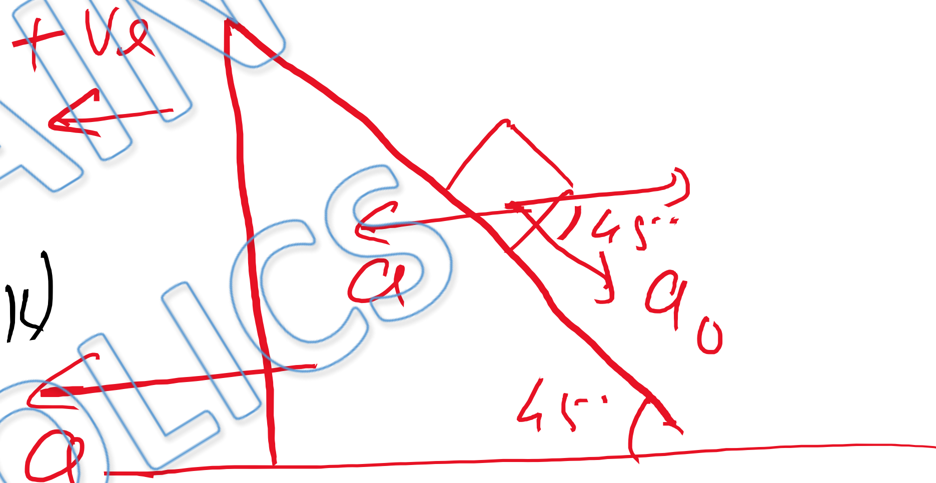
$\Rightarrow a = g/2$

net force = $m \times a$

net force on 50 kg $= 50 \times g/2 = 25g$

Ans. (b)

Solution.17 $a_0 \to$ acceleration of block w.r.t. prism.



net horizontal force on prism

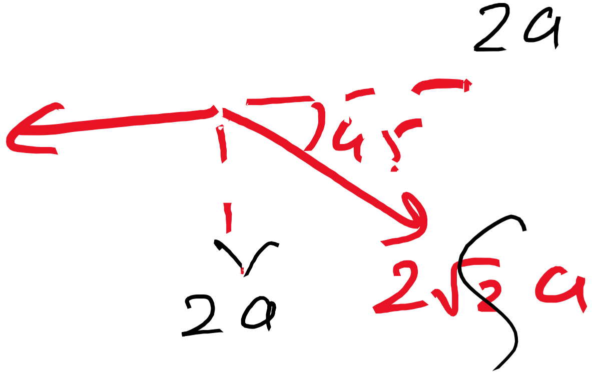
+ " " " " block

= net horizontal force on (prism + block)

$\Rightarrow \quad +ma + m(a - a_0\cos 45°) = 0$

$\Rightarrow \quad 2a = \frac{a_0}{\sqrt{2}} \Rightarrow a_0 = 2\sqrt{2}\,a$

acceleration of block =

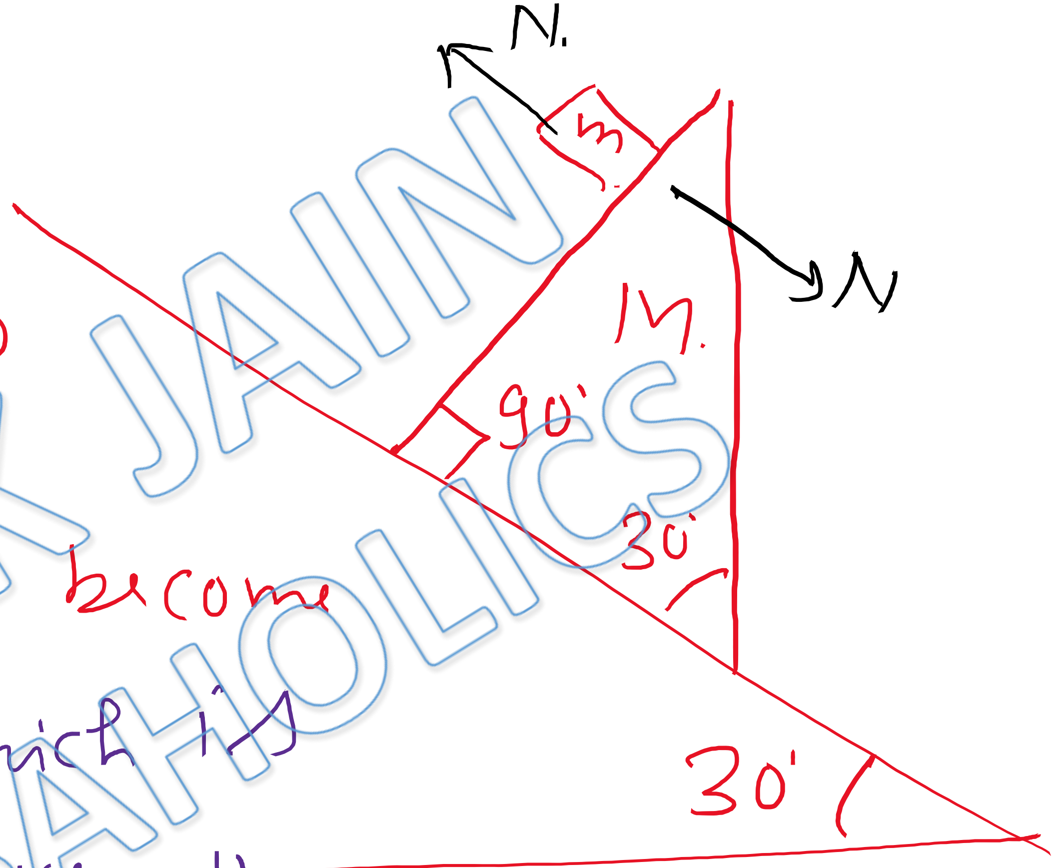


$= a\sqrt{5}$

Ans. (C)

Solution.18

Normal b/w prism & block will be zero since for nonzero normal acceleration of M along inclined will become greater than $g \sin 30°$, which is not possible because even in free fall acceleration of m along inclined plane can not be greater than $g \sin 30°$.



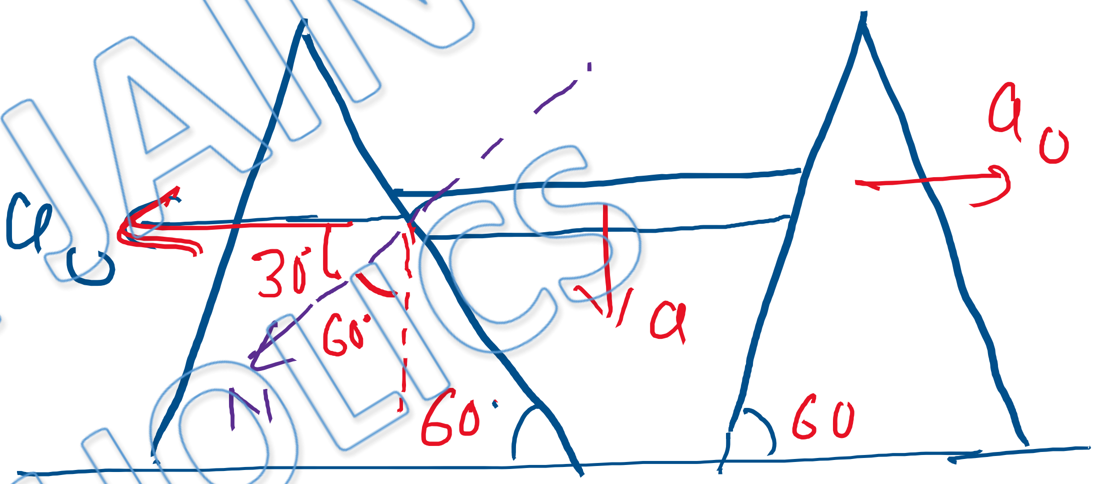
Since $N = 0 \Rightarrow$ m falls freely $\Rightarrow a_m = g$ Ans. (d)

Solution.19

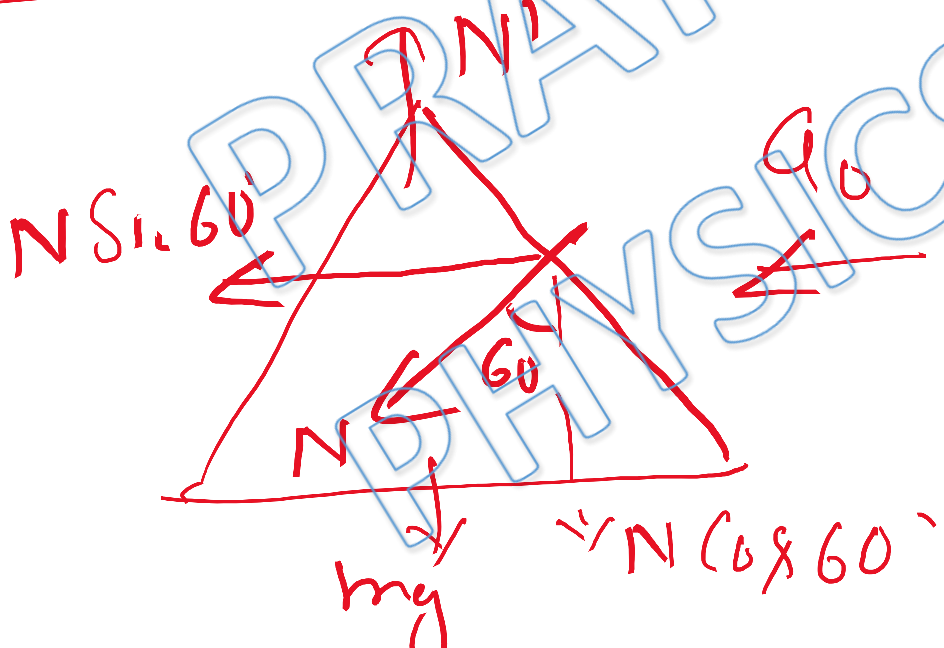
Using wedge Constraint

$$a_0 \cos 30^\circ = a \cos 60^\circ$$

$$\Rightarrow \quad a_0 \frac{\sqrt{3}}{2} = \frac{a}{2} \quad \text{—(i)}$$



F.B.D of Left Prism



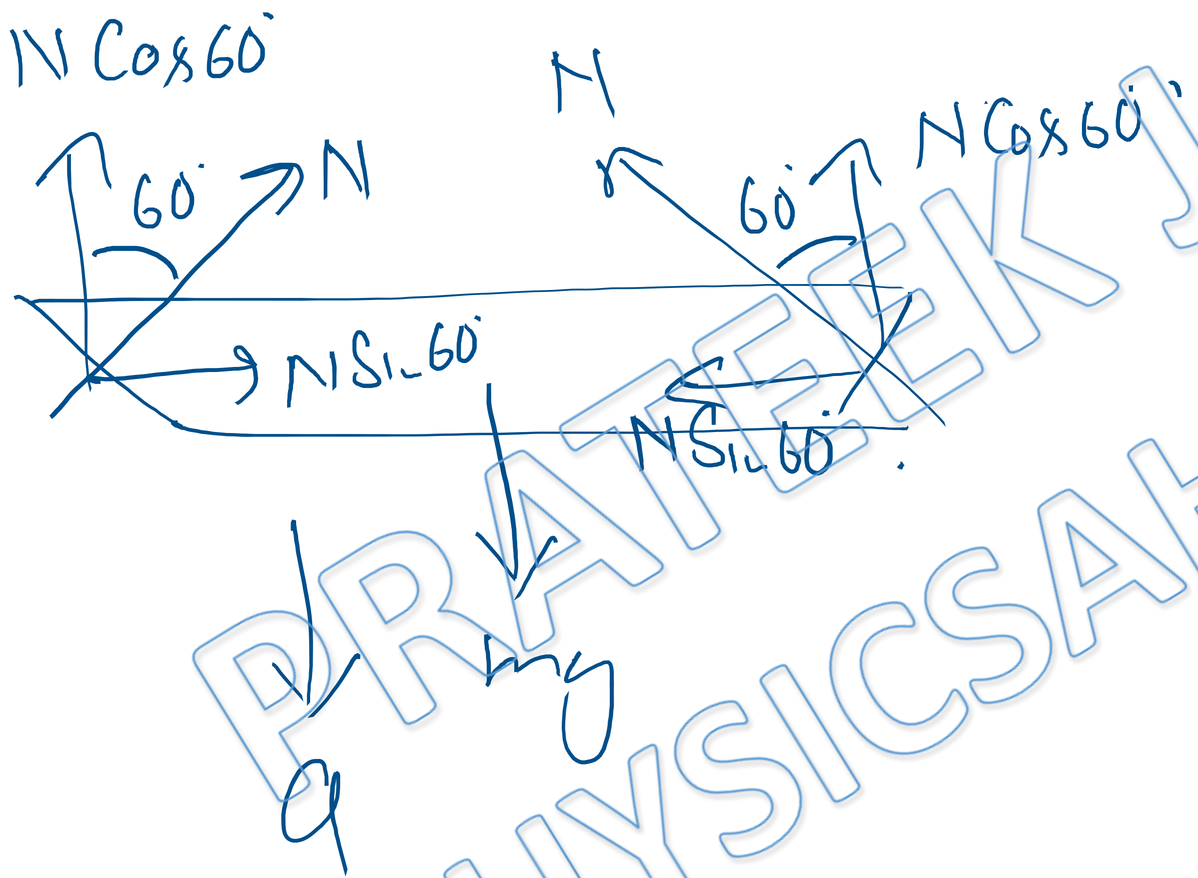
$$N \sin 60^\circ = m a_0$$

$$N \frac{\sqrt{3}}{2} = m \frac{a}{\sqrt{3}}$$

$$N = \frac{2ma}{3} \quad \text{—(ii)}$$

Ans.c

F.B.D of Rod



$mg - 2N\cos 60° = ma$

$mg - \frac{2ma}{3} = ma$

$g = \frac{5a}{3}$

$a = 3g/5$

$= 6\ m/sec^2$

Ans.c

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