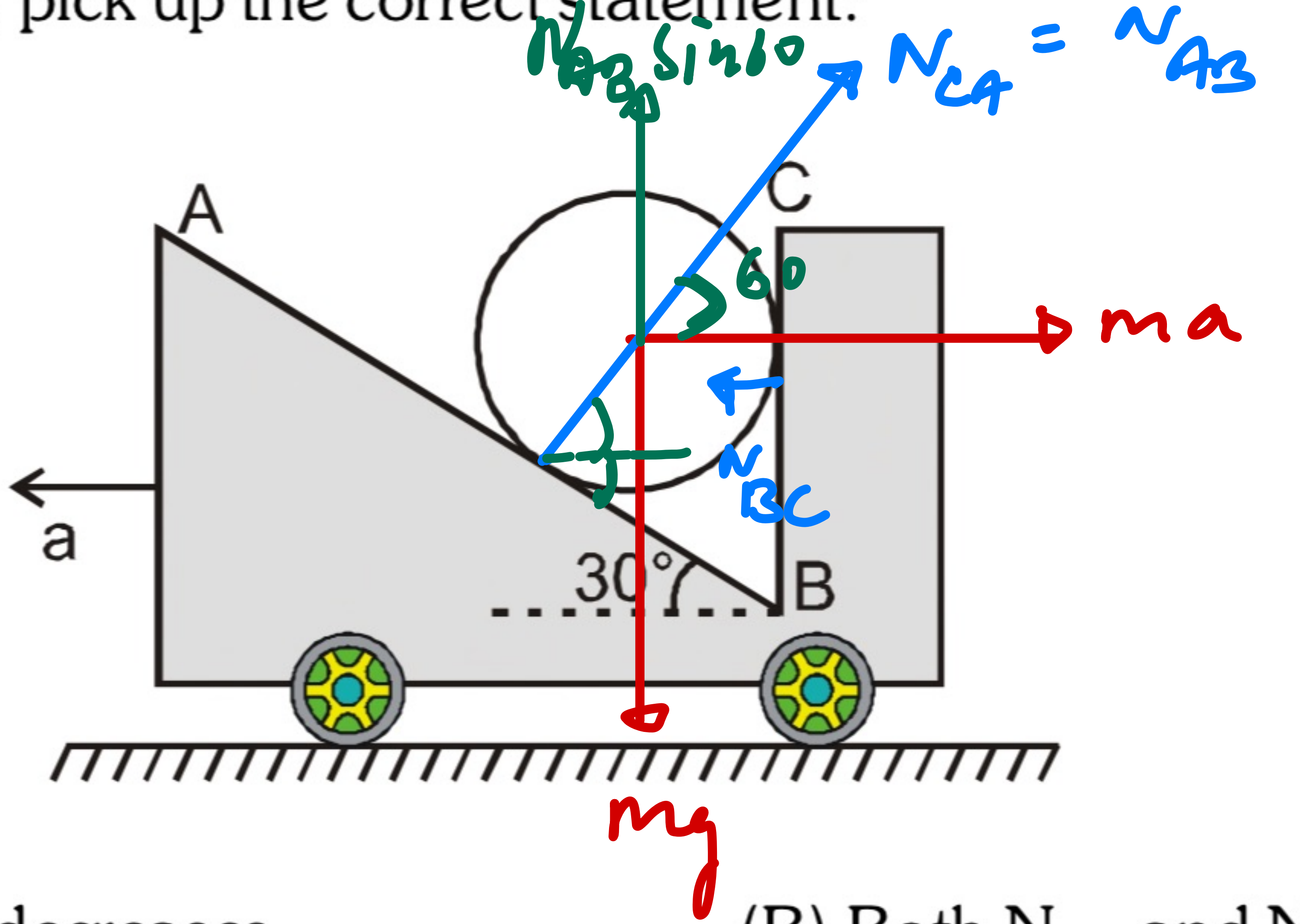
5. A cylinder rests in a supporting carriage as shown. The side AB of carriage makes an angle 30° with the horizontal and side BC is vertical. The carriage lies on a fixed horizontal surface and is being pulled towards left with an horizontal acceleration '*a*'. The magnitude of normal reactions exerted by sides AB and BC of carriage on the cylinder be N_{AB} and N_{BC} respectively. Neglect friction everywhere. Then as the magnitude of acceleration '*a*' of the carriage is increased, pick up the correct statement:



$N_{AB}\sin 60 = mg$

$\boxed{N_{AB} = \frac{2mg}{\sqrt{3}}}$ Unchanged

$N_{BC} = ma + N_{AB}\cos 60$

as $a \uparrow$ $N_{BC} \uparrow$

(A) N_{AB} increases and N_{BC} decreases.
(B) Both N_{AB} and N_{BC} increase.
(C) N_{AB} remains constant and N_{BC} increases.
(D) N_{AB} increases and N_{BC} remains constant.

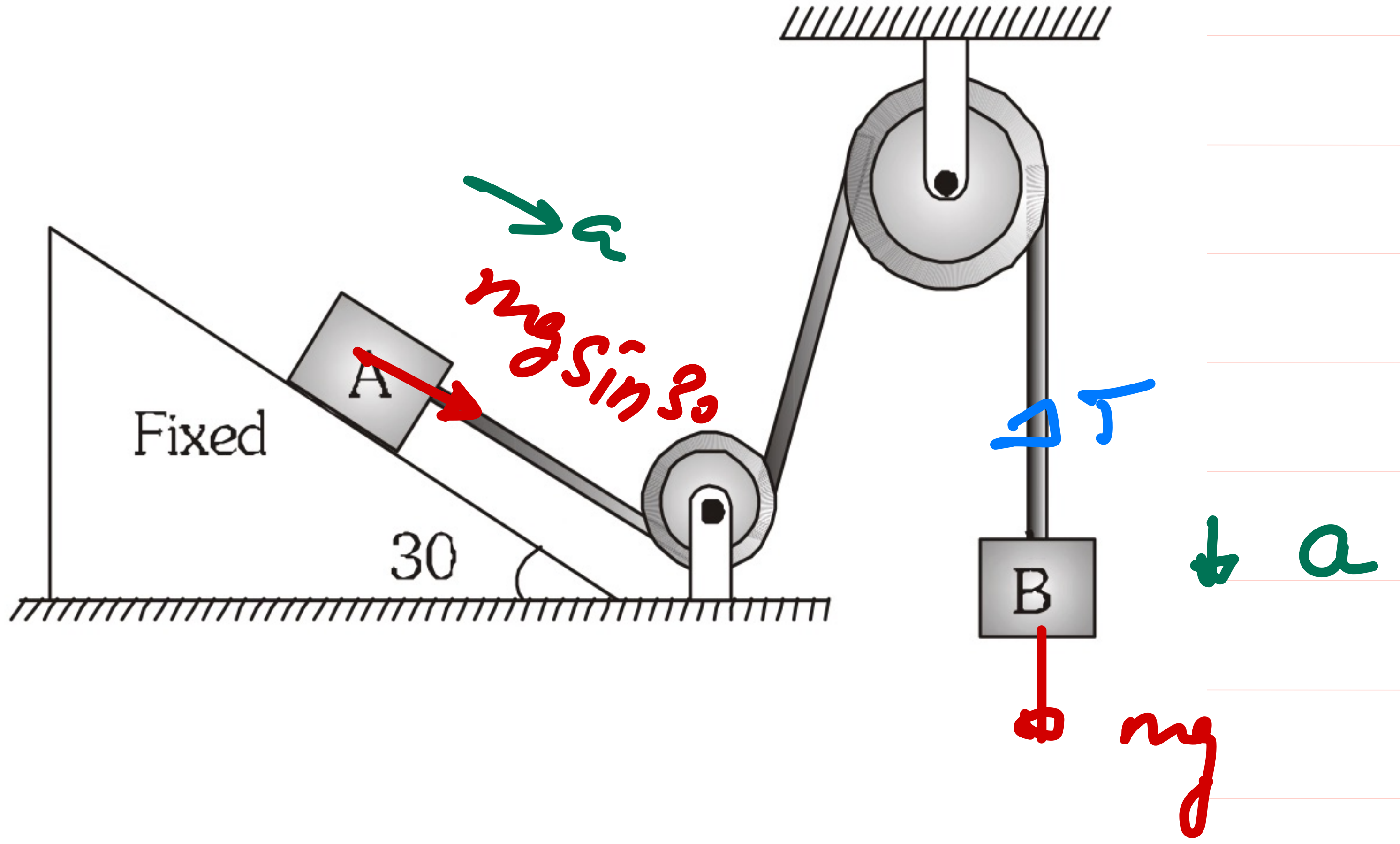
2. Two blocks A and B of equal mass m are connected through a massless string and arranged as shown in figure. Friction is absent everywhere. When the system is released from rest, then

(A) tension in string is $\frac{mg}{2}$

(B) tension in string is $\frac{mg}{4}$ ✓

(C) acceleration of A is $\frac{g}{2}$

(D) acceleration of A is $\frac{3}{4}g$ ✓



For B

$mg - T = ma$

$T = mg - ma$

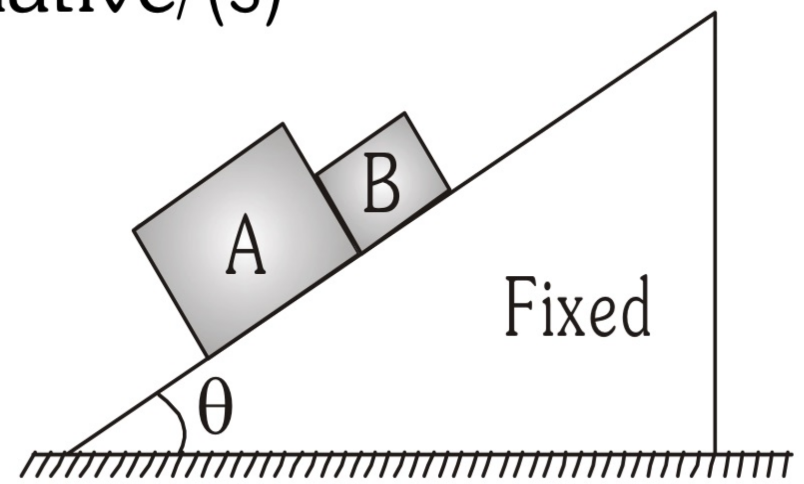
$= mg - \frac{3mg}{4}$

$\boxed{T = \frac{mg}{4}}$

$a = \frac{mg + mg\sin 30}{2m} = \frac{3mg}{2 \times 2m}$

$\boxed{a = \frac{3g}{4}}$

3. In the arrangement shown in figure all surfaces are smooth. Select the correct alternative/(s)



(A) for any value of θ acceleration of A and B are equal

(B) contact force between the two blocks is zero only if $\frac{m_A}{m_B} = \tan\theta$

(C) contact force between the two blocks is zero for any value of m_A or m_B

(D) normal reactions exerted by the wedge on the blocks are equal

$\cancel{m_B} g\sin\theta = \cancel{m_B} a_B$

$\boxed{a_B = g\sin\theta}$

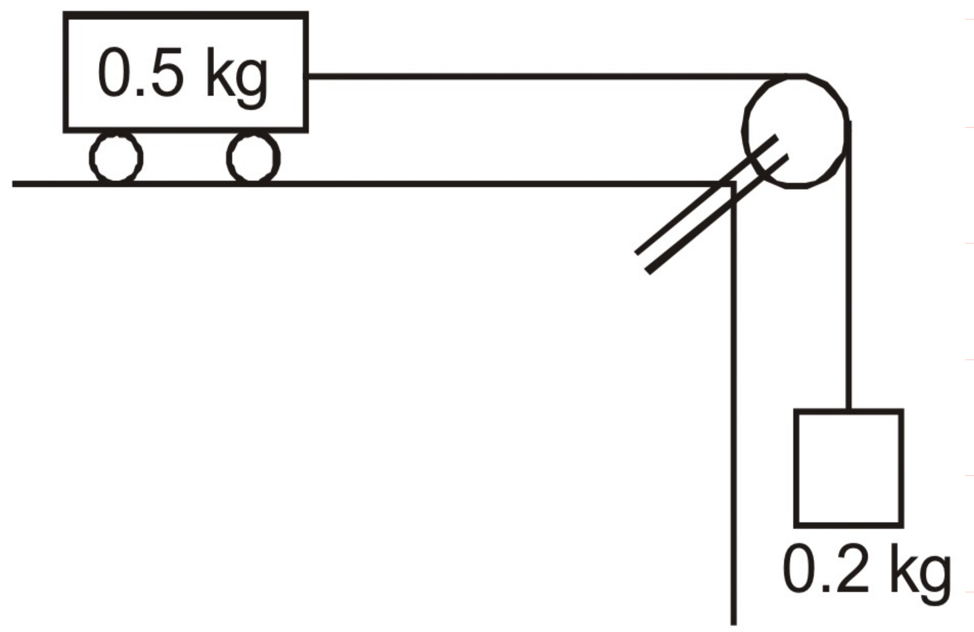
$\cancel{m_A} g\sin\theta = \cancel{m_A} a_A$

$\boxed{a_A = g\sin\theta}$

both will move with same velocity

there is no contact force

4*. A cart of mass 0.5 kg is placed on a smooth surface and is connected by a string to a block of mass 0.2 kg. At the initial moment the cart moves to the left along a horizontal plane at a speed of 7 m/s. (Use g = 9.8 m/s^2)

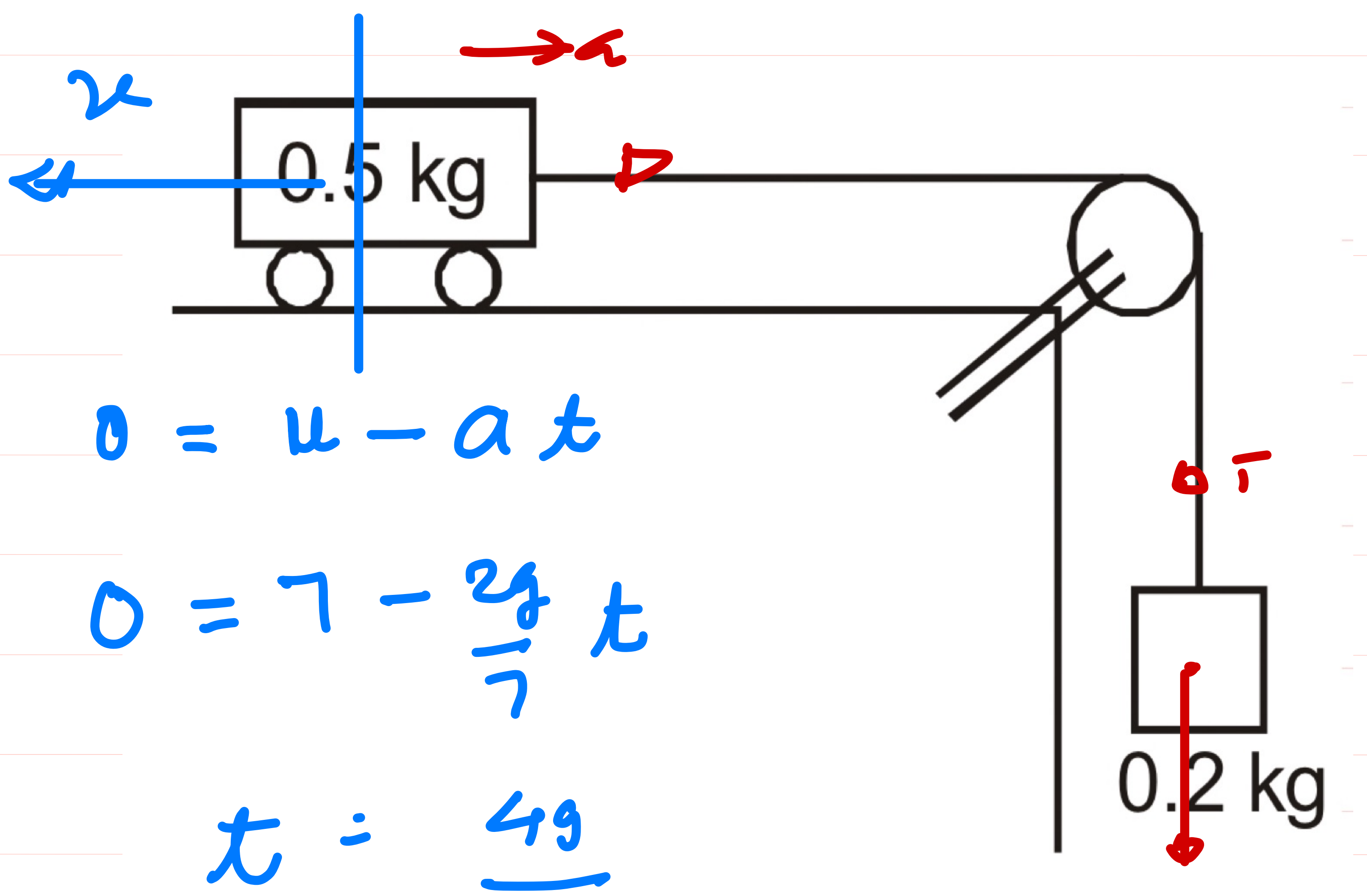


(A) The acceleration of the cart is $\frac{2g}{7}$ towards right.

(B) The cart comes to momentary rest after 2.5 s.

(C) The distance travelled by the cart in the first 5s is 17.5 m.

(D) The velocity of the cart after 5s will be same as initial velocity.



$0 = u - at$

$0 = 7 - \frac{2g}{7} t$

$t = \frac{49}{2 \times 9.8}$

$= \frac{49 \times 10}{2 \times 98} \Rightarrow t = 2.5\text{ sec}$

$a = \frac{0.2g}{0.7}$

$\boxed{a = \frac{2g}{7}}$

$d = 2s$

$= 2.5 \times \frac{49}{7} \times 0.5 \times 2$

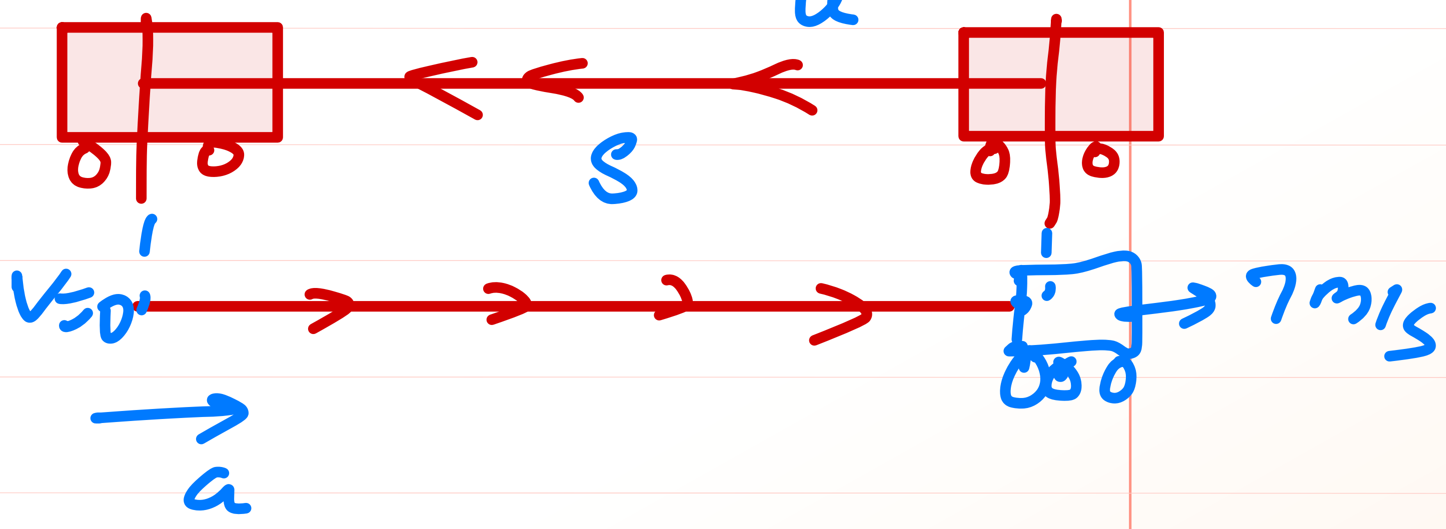
$= 2.5 \times 7$

$d = 17.5\text{ m}$

Cart

$u = 7$ m/s

$t = 2.5$ sec $\qquad t = 0$



$s = 7 \times 2.5 - \frac{1}{2} \times \frac{2g}{7} \times (2.5)^2$

$= 2.5\left[7 - \frac{9.8}{7} \times 2.5\right]$

$= \frac{2.5}{7}\left[49 - 49 \times 0.5\right]$

$s = 2.5 \times 49 \times 0.5 / 7$

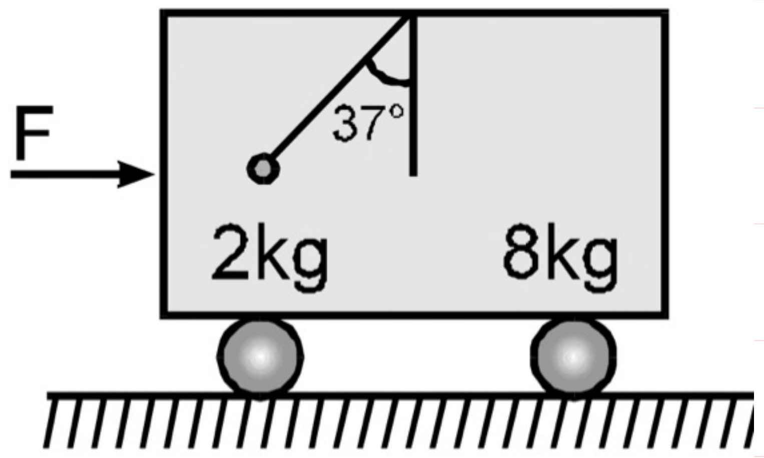
5. A trolley of mass 8 kg is standing on a frictionless surface inside which an object of mass 2 kg is suspended. A constant force F starts acting on the trolley as a result of which the string stood at an angle of 37^0 from the vertical. Then :

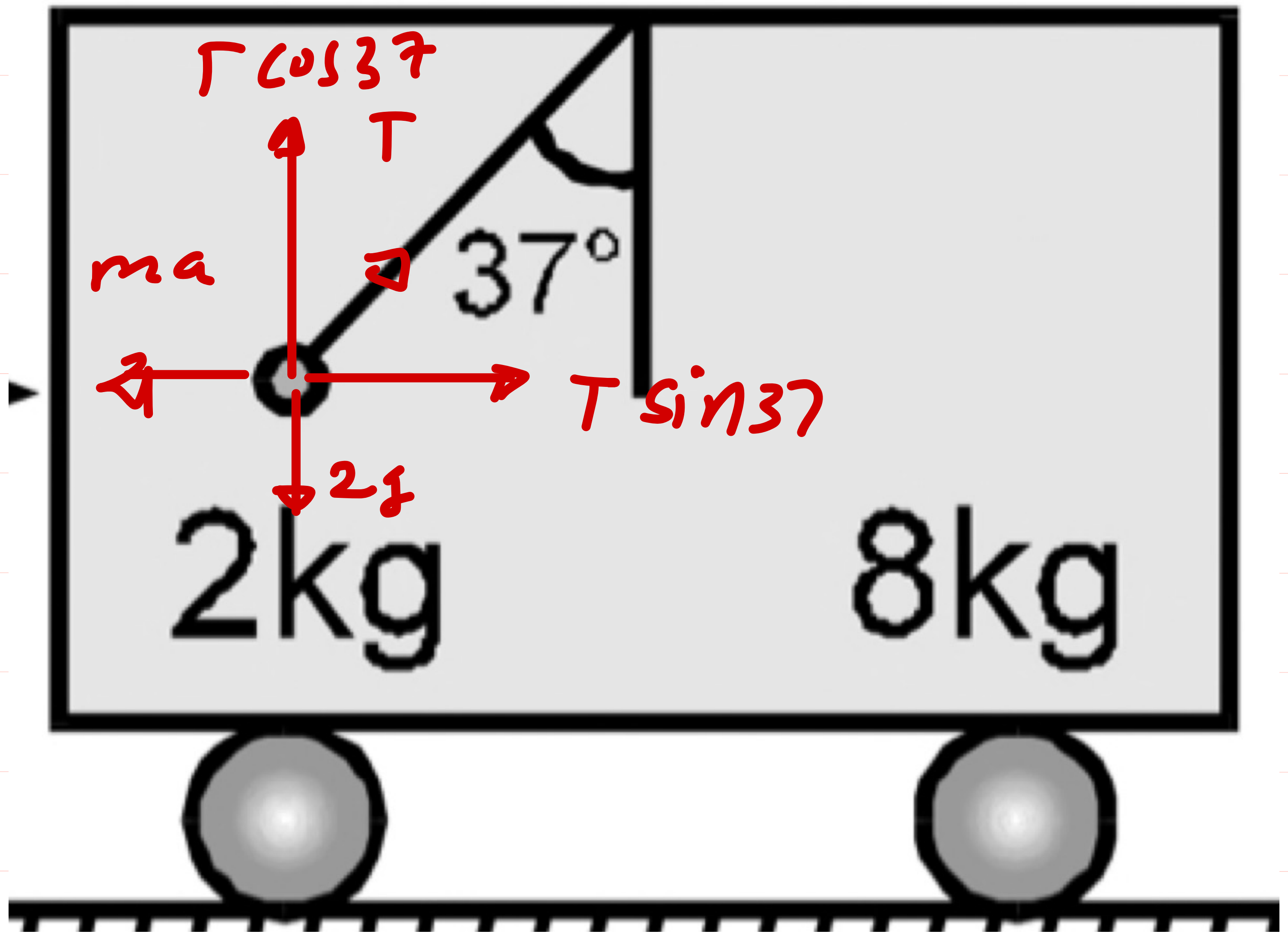
(A) acceleration of the trolley is 40/3 m/sec^2

(B) force applied in 60 N

(C) force applied is 75 N

(D) tension in the string is 25 N





$T \sin 37 = ma$

$T \cos 37 = mg$

$a = g \tan 37$

$= \frac{3}{4} g$

$\boxed{a = \frac{30}{4} m/s^2}$

$F = (2+8) \times a$

$F = 10a$

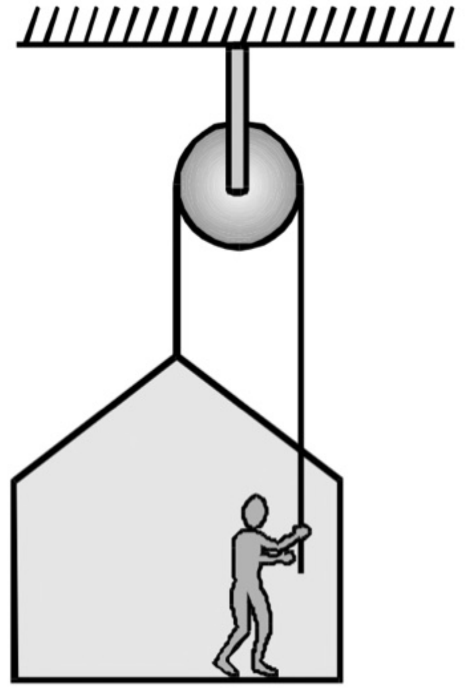
$F = \frac{300}{4} = 75 N$

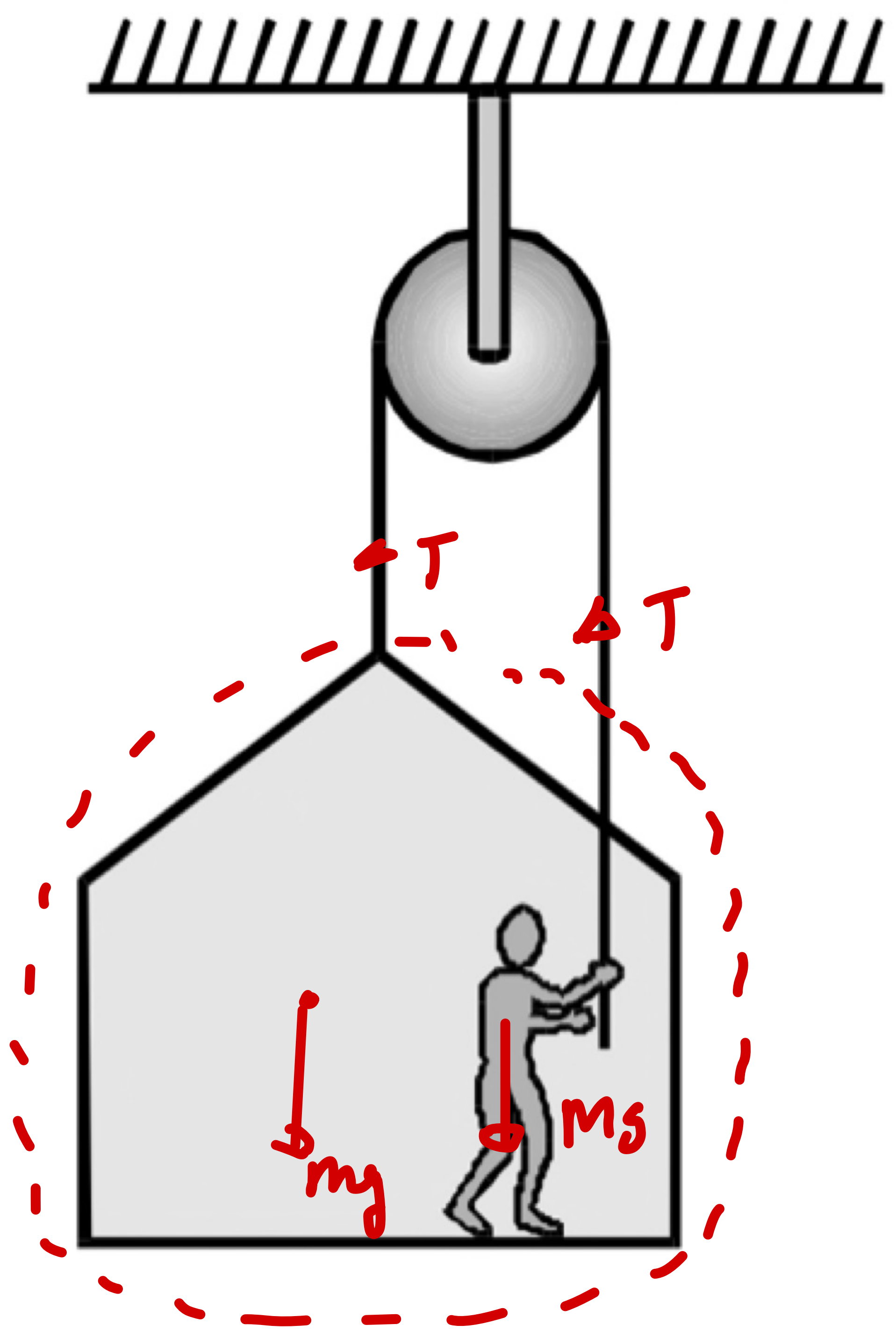
$T \times \frac{4}{5} = 20$

$\boxed{T = 25 N}$

6. A painter is applying force himself to raise him and the box with an acceleration of 5 m/s^2 by a massless rope and pulley arrangement as shown in figure. Mass of painter is 100 kg and that of box is 50 kg. If g = 10 m/s^2, then:

(A) tension in the rope is 1125 N
(B) tension in the rope is 2250 N
(C) force of contact between the painter and the floor is 375 N
(D) force of contact between the painter and the floor is 750 N





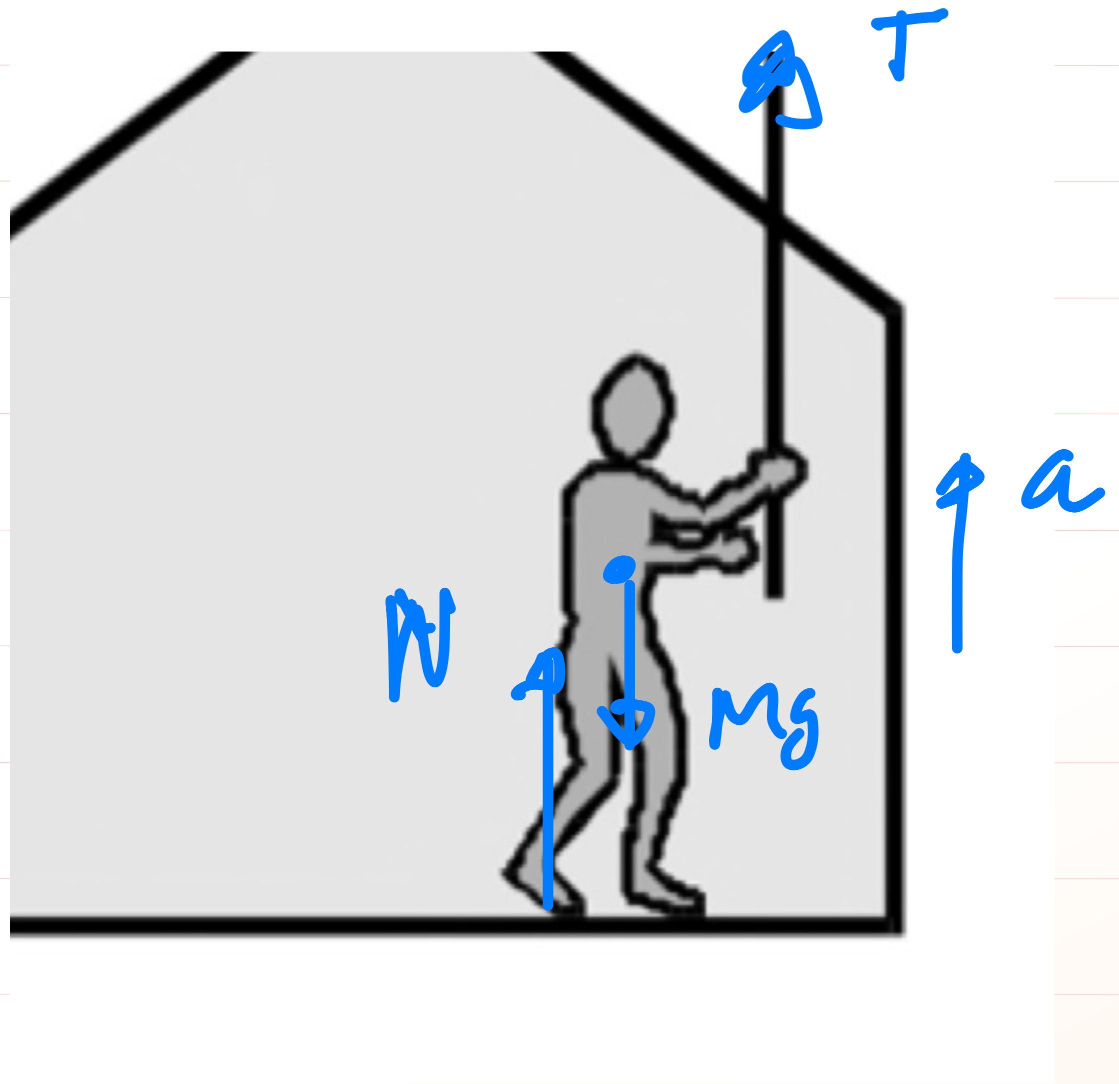
$$2T - (M+m)g = (M+m)a$$

$$2T - 1500 = 150 \times 5$$

$$2T = 1500 + 750$$

$$T = 750 + 375$$

$$\boxed{T = 1125\ N}$$



$$T + N - mg = ma$$

$$1125 + N - 1000 = 100 \times 5$$

$$N + 125 = 500$$

$$\boxed{N = 375\ \text{Newton}}$$

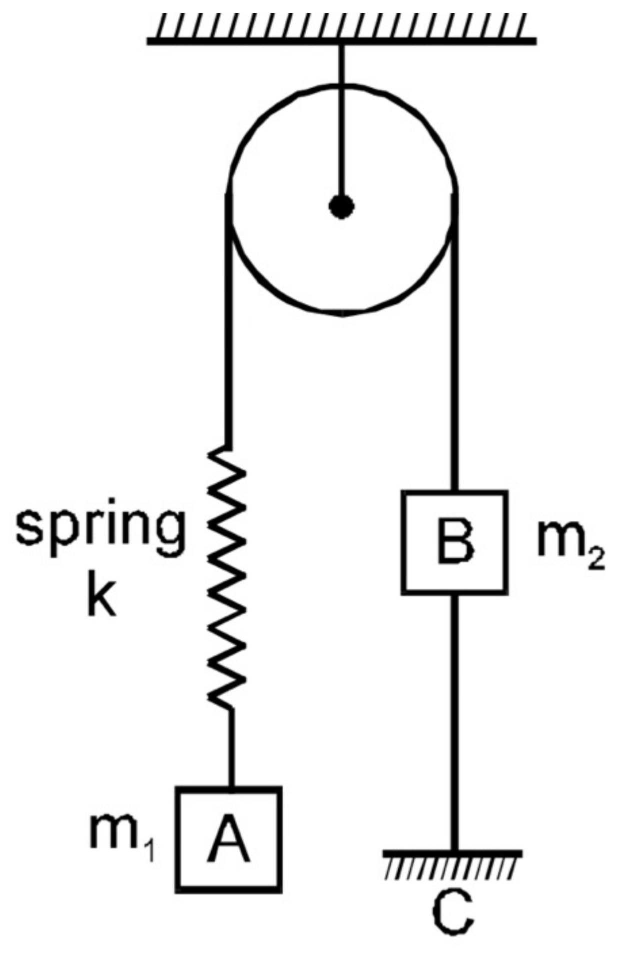
7. In the system shown in the figure $m_1 > m_2$. System is held at rest by thread BC. Just after the thread BC is burnt (neglect friction) :

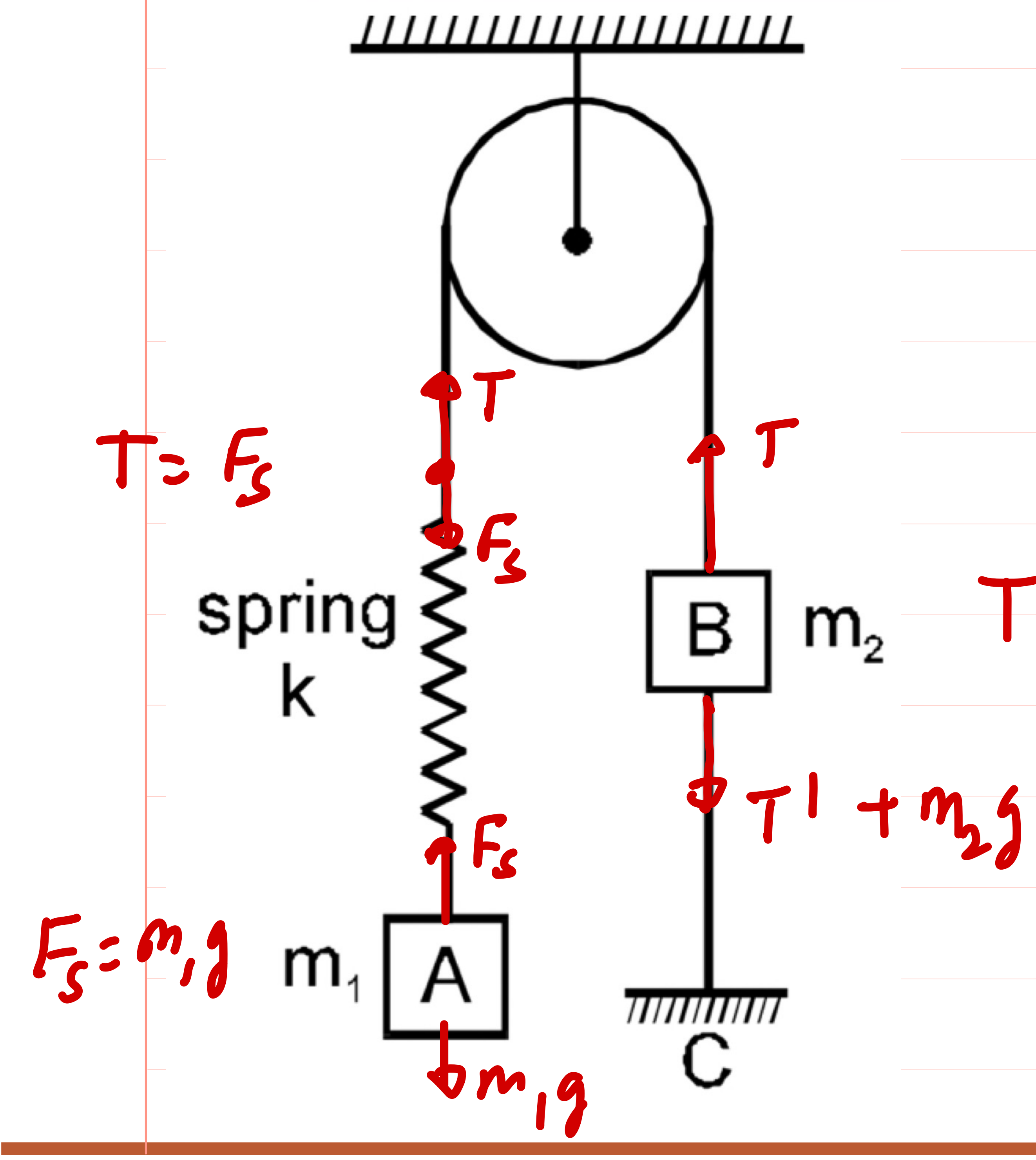
(A) acceleration of m_2 will be upwards

(B) magnitude of acceleration of both blocks will be equal to $\left(\frac{m_1 - m_2}{m_1 + m_2}\right) g$

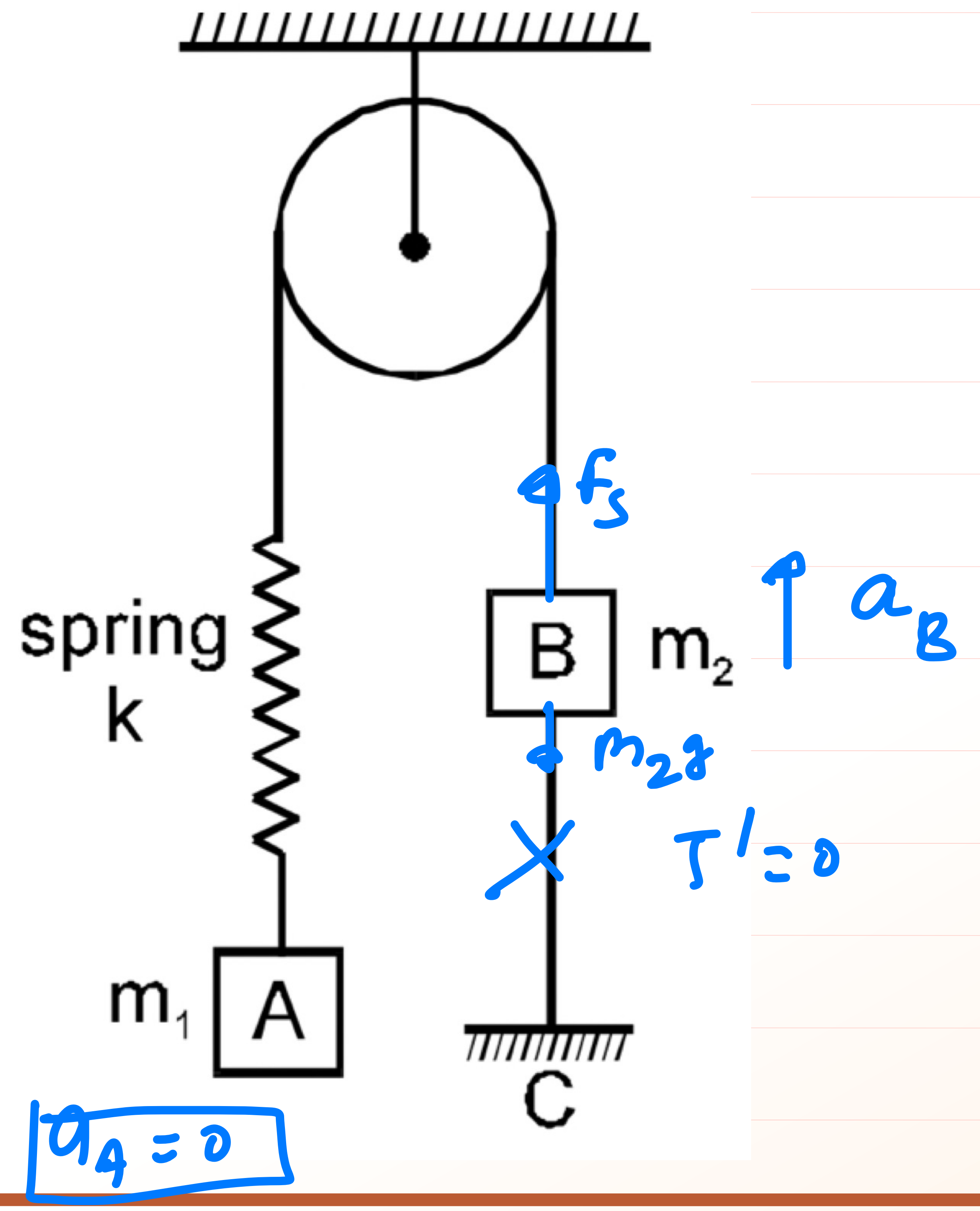
(C) acceleration of m_1 will be equal to zero

(D) magnitude of acceleration of two blocks will be non–zero and unequal.





$T = T' + m_2 g$

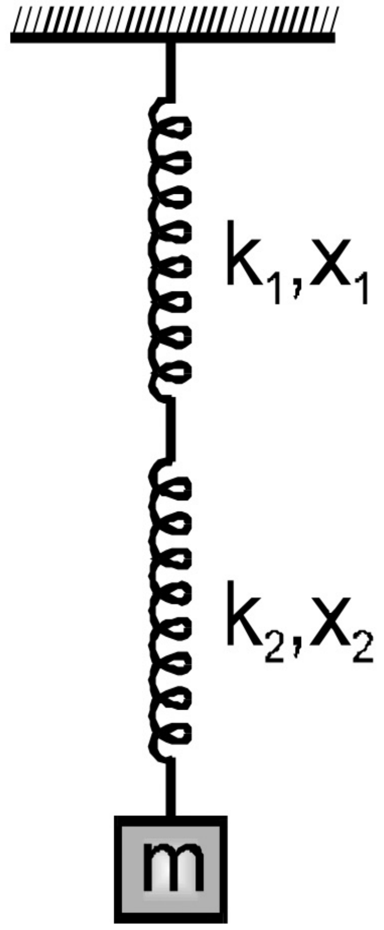


$\boxed{a_A = 0}$

$F_s - m_2 g = m_2 a_B$

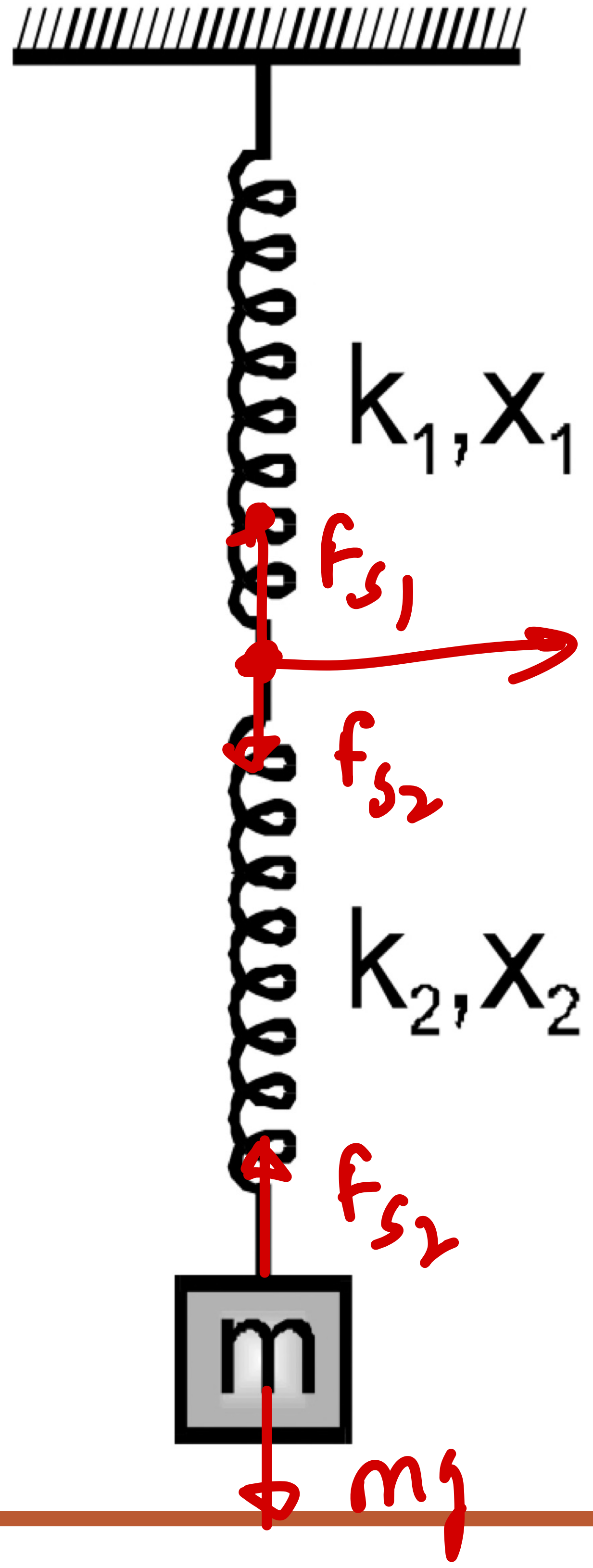
$\left(\frac{m_1 - m_2}{m_2}\right) g = a_B$ upward

8. Two springs are in a series combination and are attached to a block of mass 'm' which is in equilibrium. The spring constants and the extensions in the springs are as shown in the figure. Then the value of force exerted by the spring on the block is :



(A) $\frac{k_1 k_2}{k_1 + k_2}(x_1 + x_2)$ (B) $k_1x_1 + k_2x_2$

(C) k_1x_1 (D) None of these

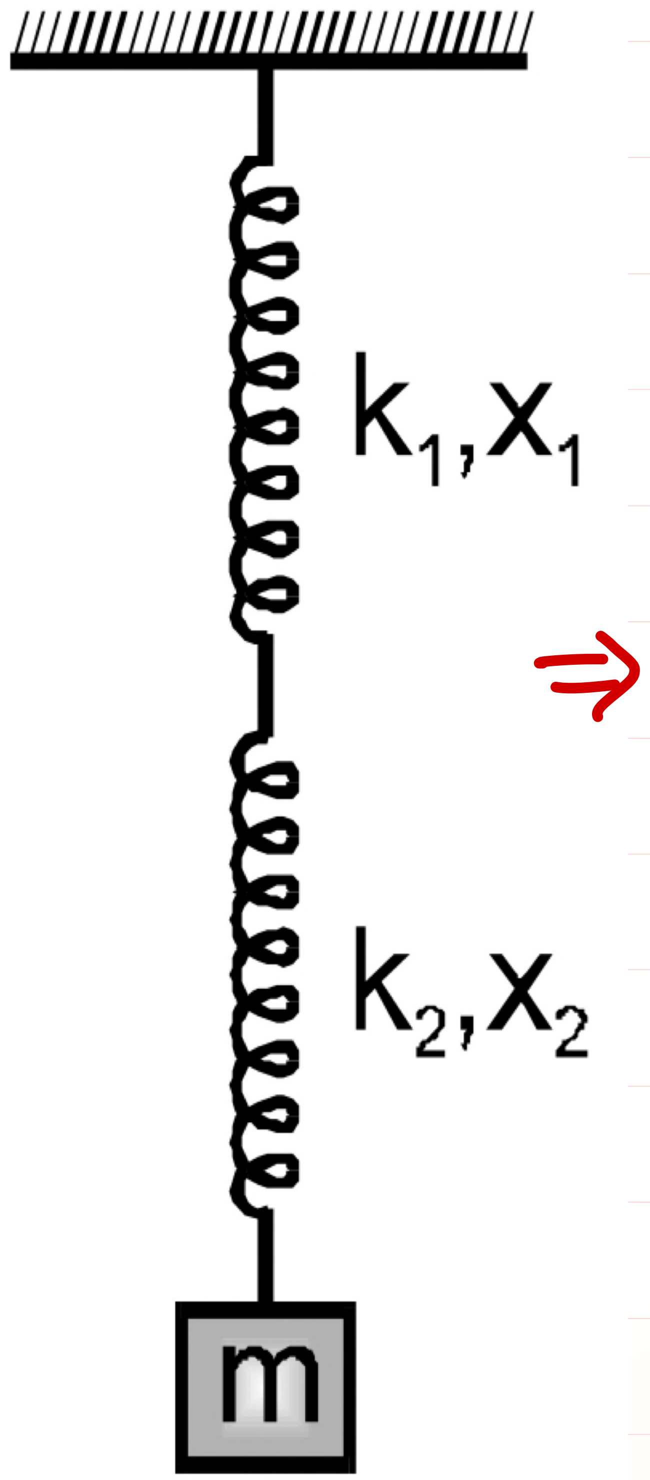


$F_{s_1} = k_1x_1 = mg$

$F_{s_1} = F_{s_2} = mg$

$F_{s_2} = k_2x_2 = mg$

$F_{s_2} = mg$



$\Rightarrow$

$k_s(x_1 + x_2) = F_s = mg$

$k_s = \frac{mg}{x_1 + x_2}$

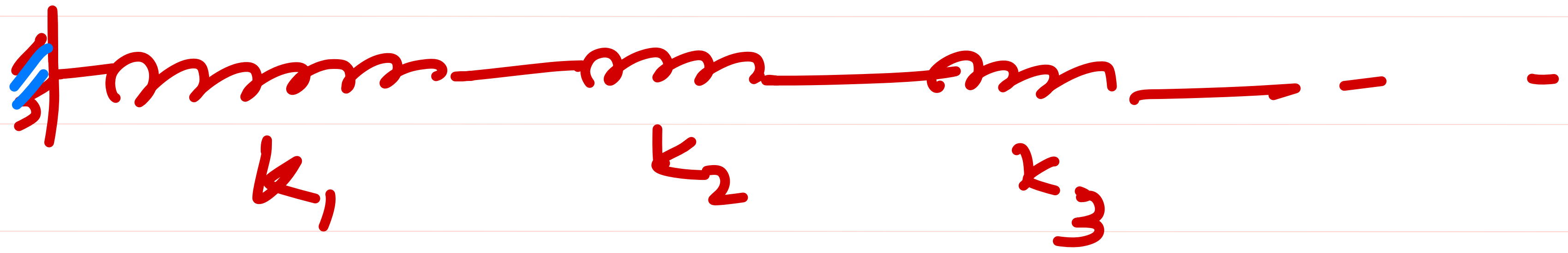
$= \frac{mg}{\frac{mg}{k_1} + \frac{mg}{k_2}}$

$k_s = \frac{1}{\frac{1}{k_1} + \frac{1}{k_2}}$

$k_s = \frac{k_1 k_2}{k_1 + k_2}$

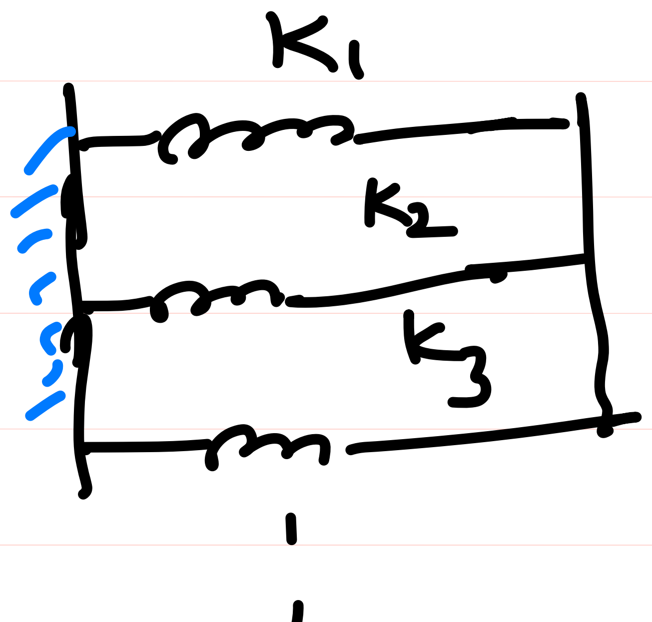
Spring connection :→

① series :



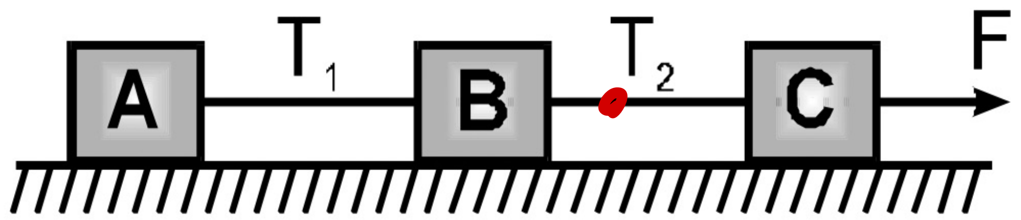
$$\boxed{\frac{1}{K_s} = \frac{1}{K_1} + \frac{1}{K_2} + \frac{1}{K_3} + \text{-----}}$$

② Parallel



$$\boxed{K_p = K_1 + K_2 + K_3 + \text{----}}$$

9. Three blocks are connected by strings as shown in figure and pulled by a force F = 60 N. If $m_A = 10$ kg, $m_B = 20$ kg and $m_C = 30$ kg, then :



(A) acceleration of the system is 2 m/s^2

(B) $T_1 = 10$ N

(C) $T_2 = 30$ N

(D) $T_1 = 20$ N & $T_2 = 40$ N

$$a = \frac{F}{m_A + m_B + m_C}$$

$$= \frac{60}{10+20+30}$$

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

$$T_1 = m_A a$$

$$= 10 \times 1$$

$$T_1 = 10 N$$

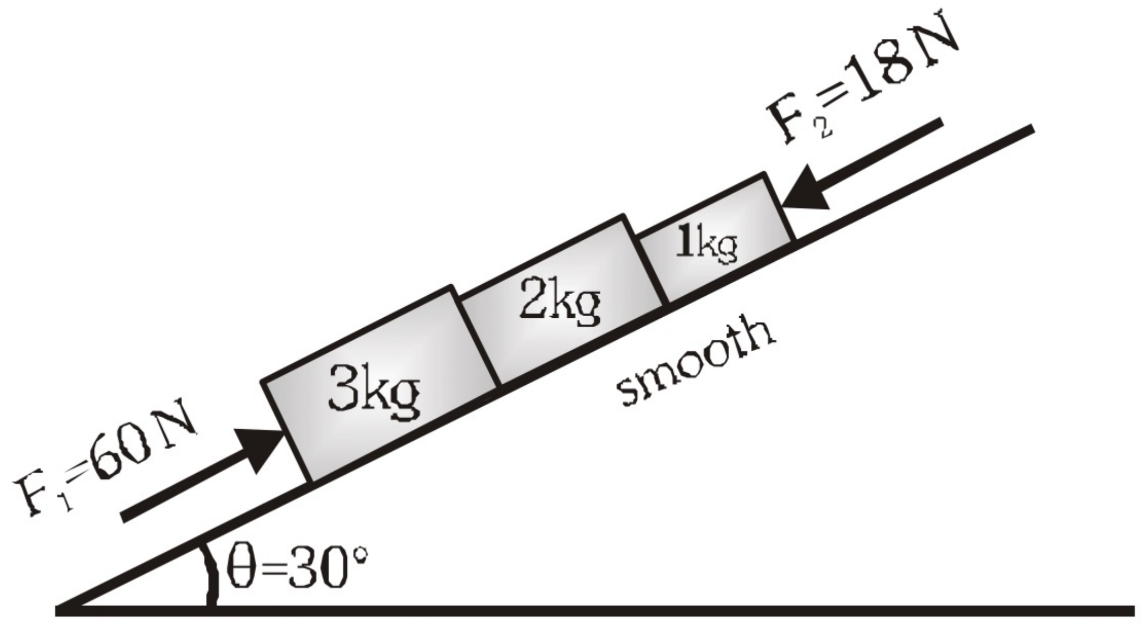
$$T_2 = (m_A + m_B)a$$

$$T_2 = (10+20) \times 1$$

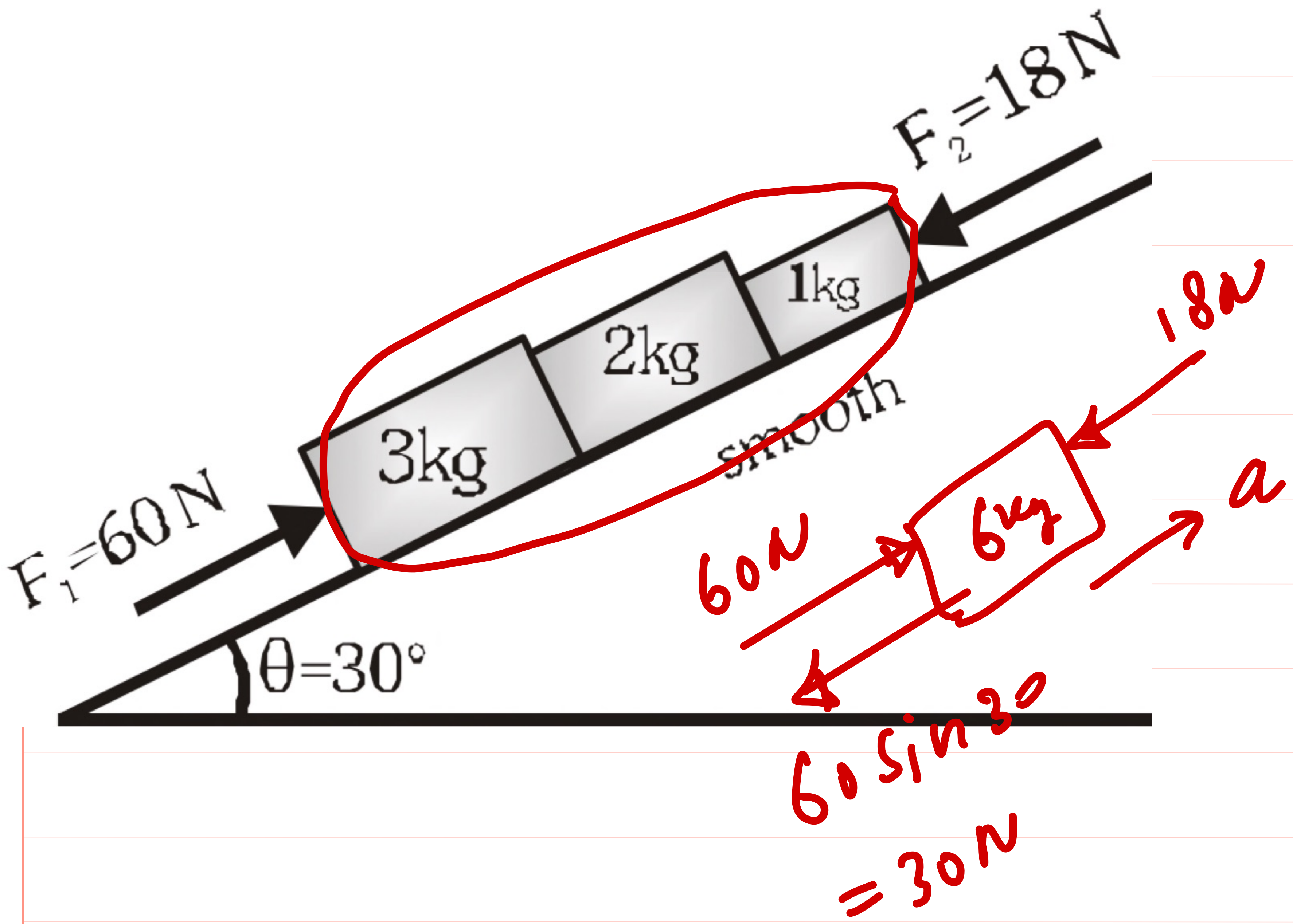
$$T_2 = 30 N$$

Match the column

11. In the diagram shown in figure $(g = 10\ m/s^2)$



Column I	**Column II**
r (A) Acceleration of 2kg block	(p) 8 SI unit
t (B) Net force on 3kg block	(q) 25 SI unit
q (C) Normal reaction between 2kg and 1kg	(r) 2 SI unit
s (D) Normal reaction between 3kg and 2kg	(s) 39 N
	(t) 6 N



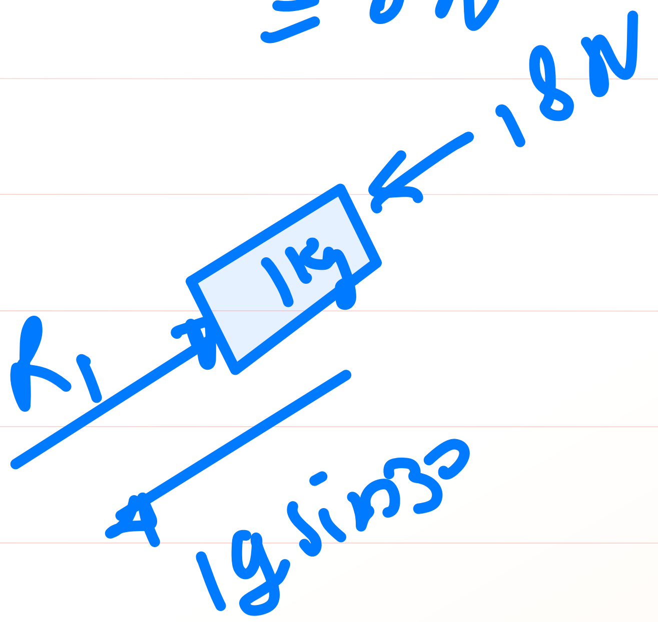
(A) $a = \frac{60-30-18}{6}$

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

(B) $F_{net} = 3 \times a$

$= 6N$

(C)

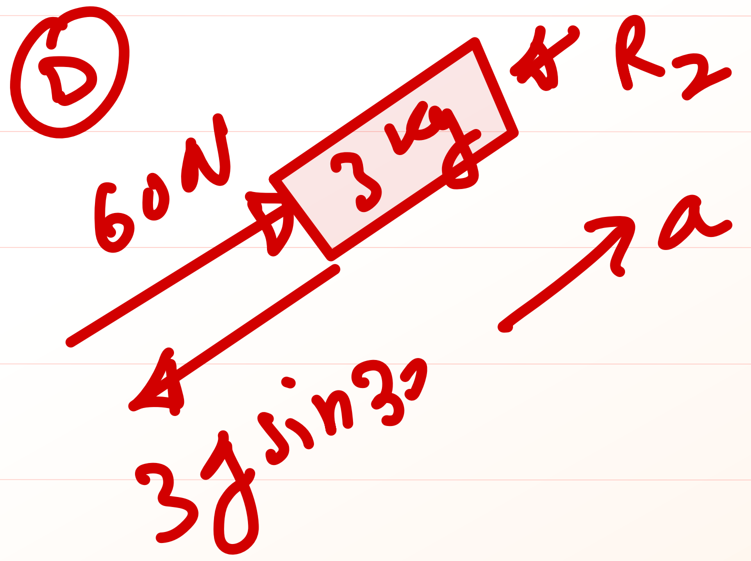


$R_1 - 18 - g\sin 30 = 1 \times a$

$R_1 - 18 - 5 = 2$

$\boxed{R_1 = 25\ N}$

(D)



$60 - 3g\sin 30 - R_2 = 3 \times a$

$60 - 15 - R_2 = 6$

$45 - R_2 = 6$

$\boxed{R_2 = 39\ N}$

12. Velocity of three particles A, B and C varies with time t as, $\vec{v}_A = (2t\hat{i} + 6\hat{j})$ m/s $\vec{v}_B = (3\hat{i} + 4\hat{j})$ m/s and $\vec{v}_C = (6\hat{i} - 4t\hat{j})$ m/s. Regarding the pseudo force match the following table :

Column I	**Column II**
t (A) On A as observed by B	(p) Along positive x–direction
r (B) On B as observed by C	(q) Along negative x–direction
r (C) On A as observed by C	(r) Along positive y–direction
q (D) On C as observed by A	(s) Along negative y–direction
	(t) Zero

A

$\vec{v}_A = 2t\hat{i} + 6\hat{j}$

$\vec{a}_A = 2\hat{i}$

B

$\vec{v}_B = 3\hat{i} + 4\hat{j}$

$\vec{a}_B = 0$ m/s^2

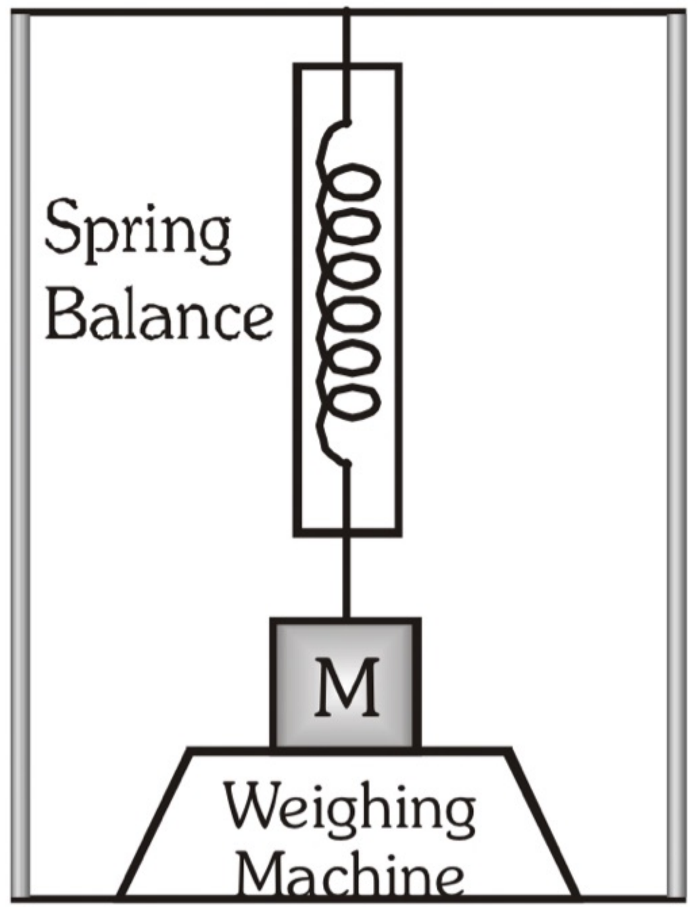
C

$\vec{v}_C = 6\hat{i} - 4t\hat{j}$

$\vec{a}_C = -4\hat{j}$

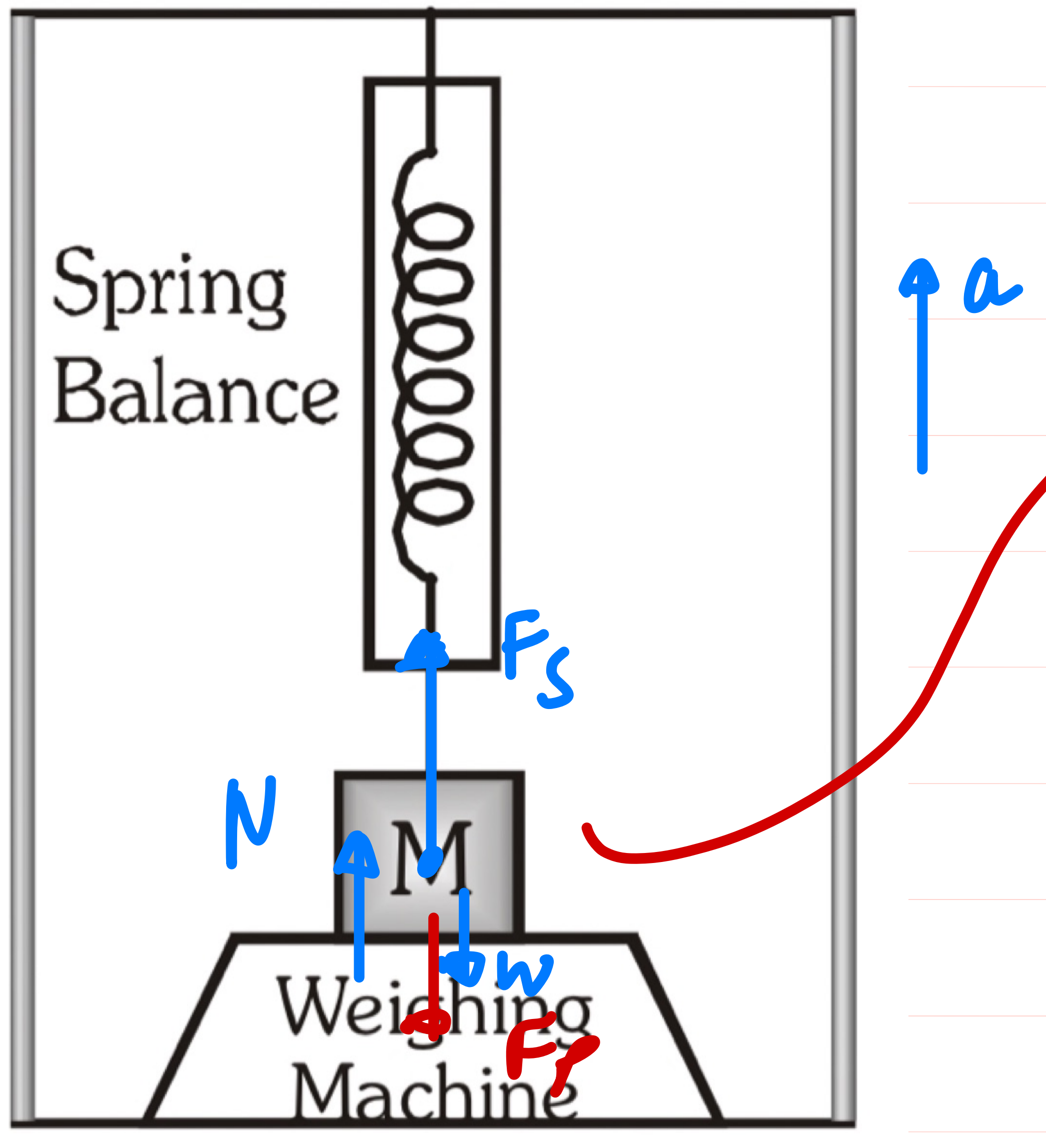
Figure shows a weighing machine kept in a lift. Lift is moving upwards with acceleration of 5 m/s^2. A block is kept on the weighing machine. Upper surface of block is attached with a spring balance. Reading shown by weighing machine and spring balance is 15 kg and 45 kg respectively.

Answer the following questions. Asume that the weighing machine can measure weight by having negligible deformation due to block, while the spring balance requires larger expansion :(take g = 10 m/s^2)



15. Mass of the object in kg is :

(A) 60 kg　　(B) 40 kg　　(C) 80 kg　　(D) 10 kg



$F_s + N = W + F_p$

$450 + 150 = mg + ma$

$600 = m(10+5)$

$\boxed{m = 40\text{ kg}}$

16. In the above situation normal acting on the block as seen by an observer in the lift.

(A) 450 N (B) 150 N (C) 400 N (D) zero

17. If lift is stopped and equilibrium is reached. Reading of weighing machine will be :

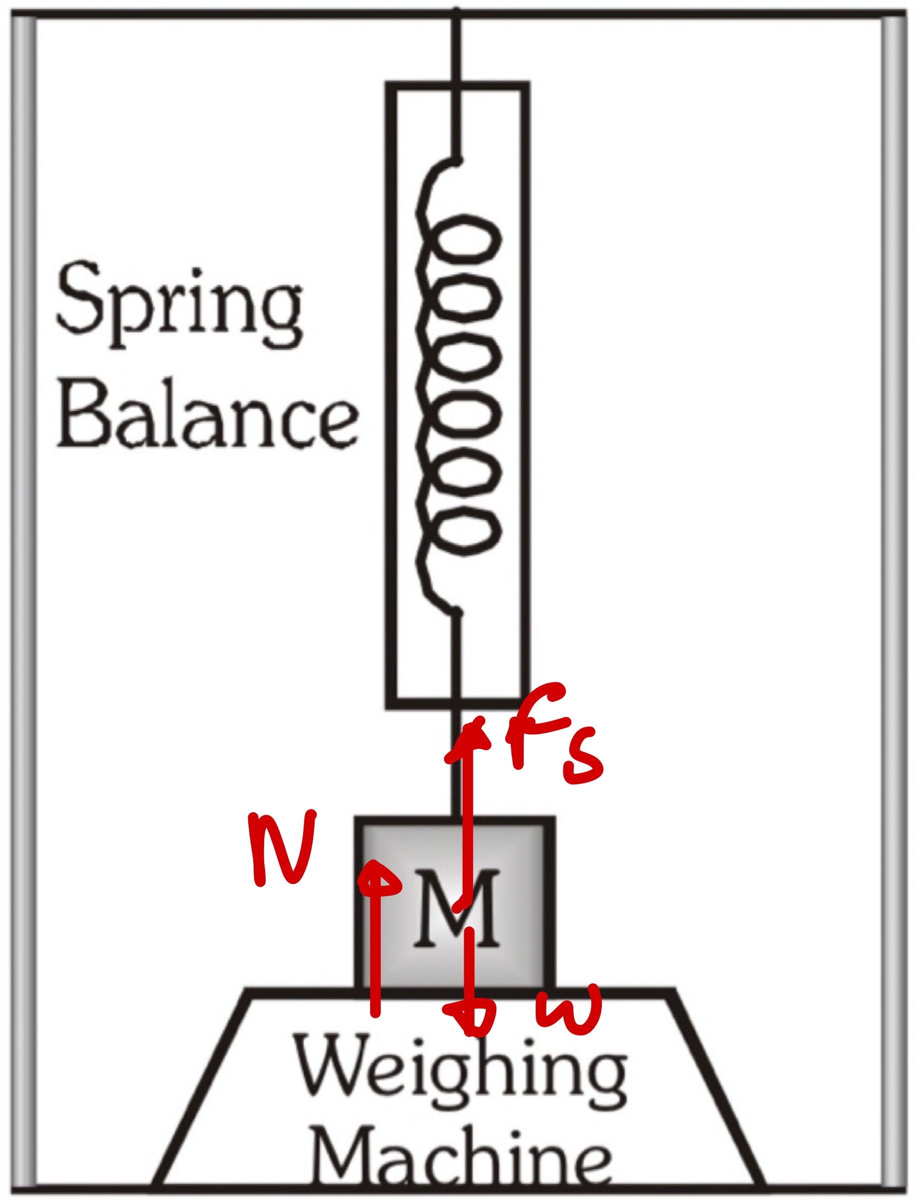
(A) 40 kg (B) 10 kg (C) 20 kg (D) zero

18. If lift is stopped and equilibrium is again reached. Reading of spring balance will be :

(A) zero (B) 20 kg (C) 10 kg (D) 40 kg

19. Find the acceleration of the lift such that the weighing machine shows its true weight.

(A) $\frac{45}{4}$ m/s^2 (B) $\frac{85}{4}$ m/s^2 (C) $\frac{11}{2}$ m/s^2 (D) 15 m/s^2



$\uparrow a = 0$

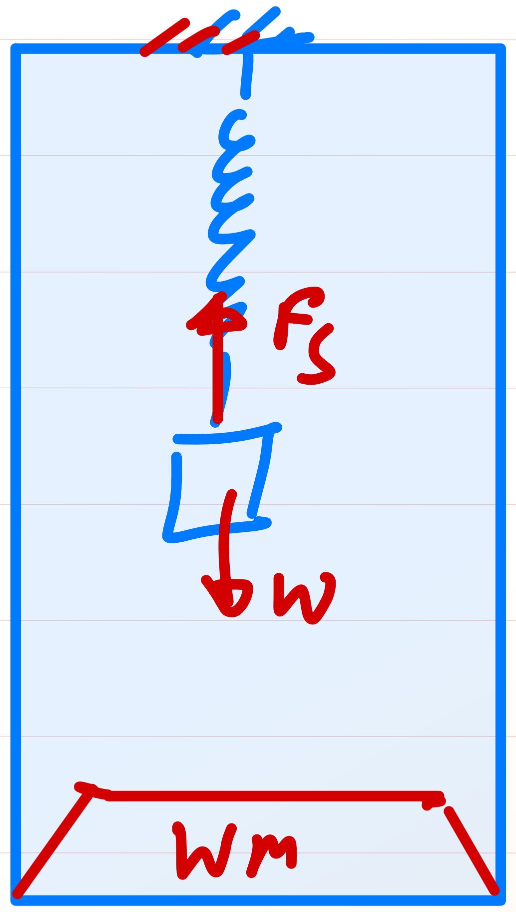
$F_s + N = W$

$450 + N = 400$

$N = -50$ N

Means block is not in contact with W.M.

18

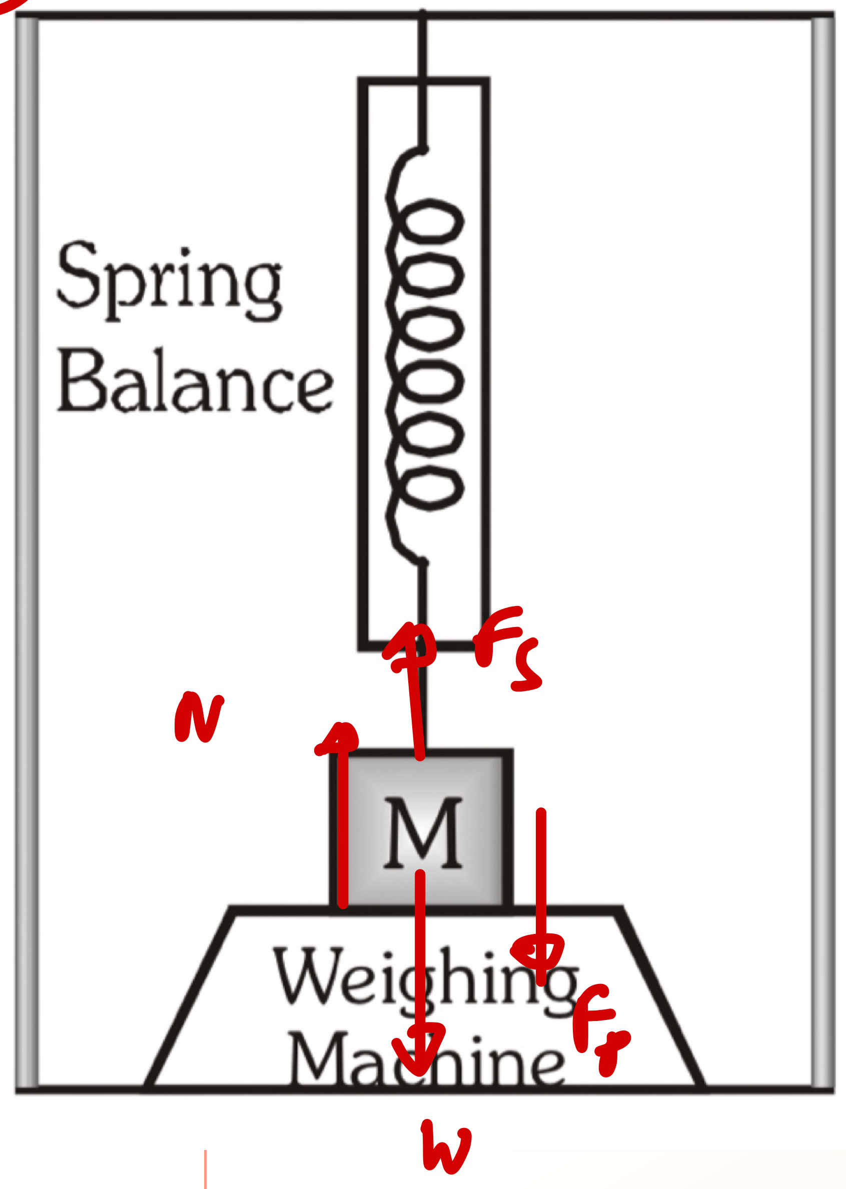


$a = 0$

$F_s = W$

$F_s = 400$ N

19



let $a \uparrow$

$\cancel{N} + F_s - \cancel{W} - F_p = 0$

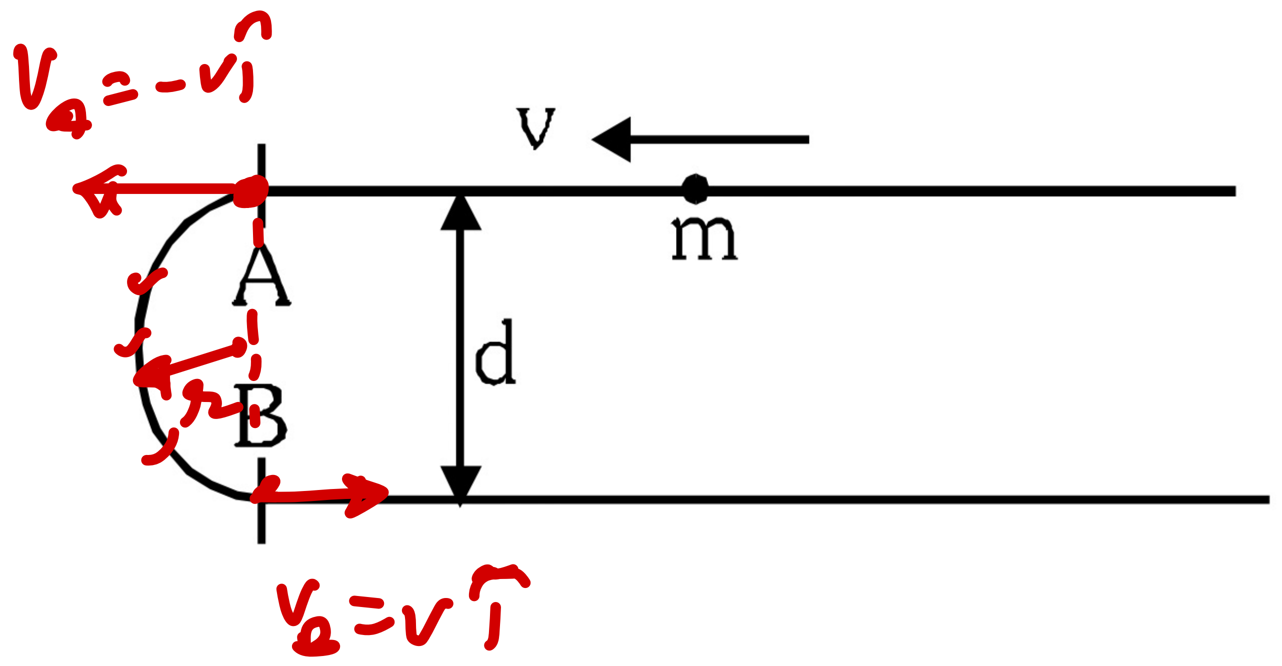
$\therefore$ $N = W$ (True weight)

$F_s = F_p$

$450 = 40 \times a$

$\boxed{\frac{45}{4} \text{ m/s}^2 = a}$ Ans

2. Fig. shows a bead of mass m moving with uniform speed v through a U–shaped smooth wire the wire has a semicircular bending between A and B. Calculate The average force exerted by the bead on the part AB of the wire.



$$F_{avg} = \left|\frac{\Delta p}{\Delta t}\right|$$

$$\Delta p = m|\vec{v}_B - \vec{v}_A|$$

$$= m|v\hat{i} - (-v\hat{i})|$$

$$\Delta p = 2mv$$

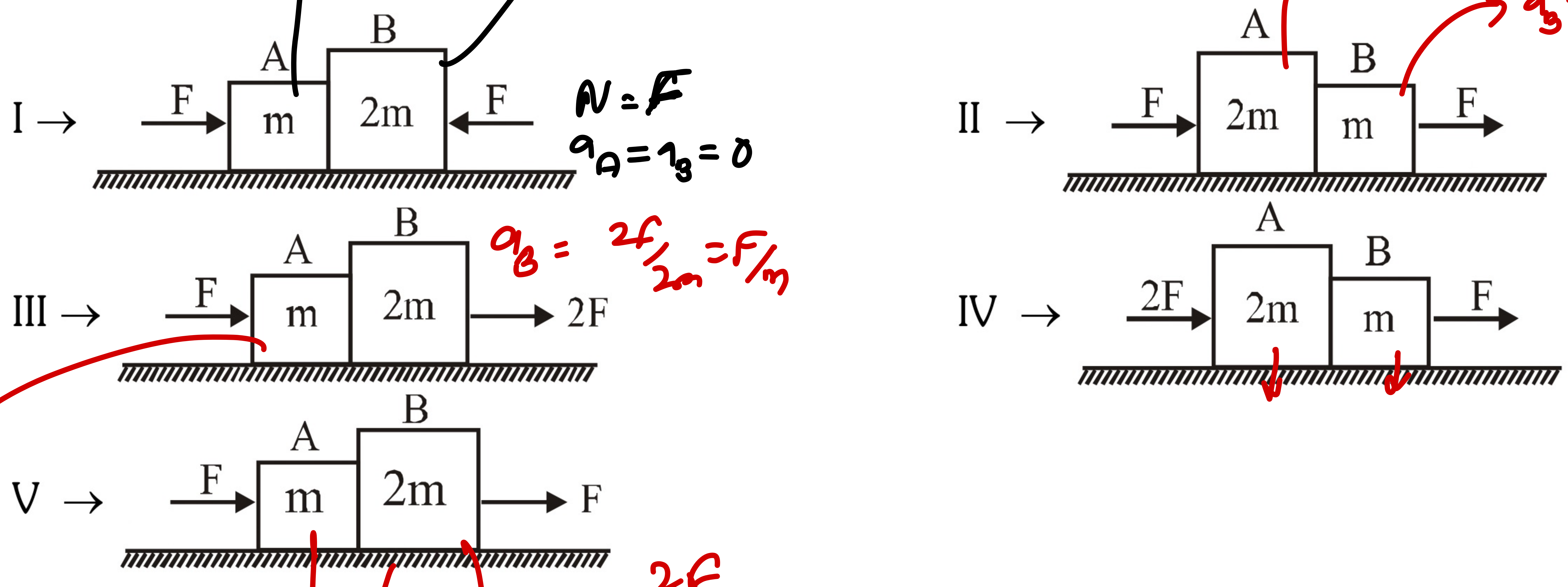
$$t_{AB} = \frac{\pi r}{v} \qquad r = \frac{d}{2}$$

$$t_{AB} = \frac{\pi d}{2v}$$

$$\boxed{F_{avg} = \frac{2mv}{\pi d/2v} = \frac{4mv^2}{\pi d}}$$ Ans

Illustration 12.

Five situations are given in the figure (All surfaces are smooth)



$a_A = F/m$ $a_B = F/2m$

$N = F$

$a_A = a_B = 0$

$F/2m = a_A$

$a_B = F/m$

$a_B > a_A$

$N = 0$

$a_B = 2F/2m = F/m$

$a = F/m$

$\boxed{N = 0}$

$a_A = F/m$

$a = \frac{2F}{3m}$

$a_A = F/m$

$a_B = F/2m$

$\boxed{N \neq 0}$

Find ; mg