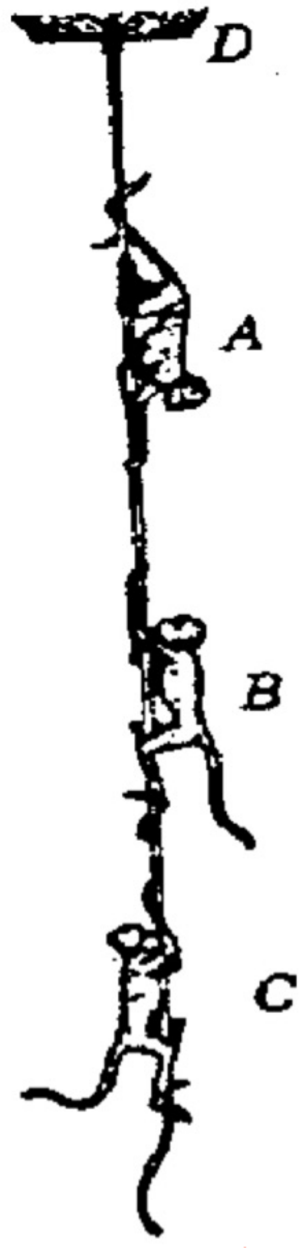
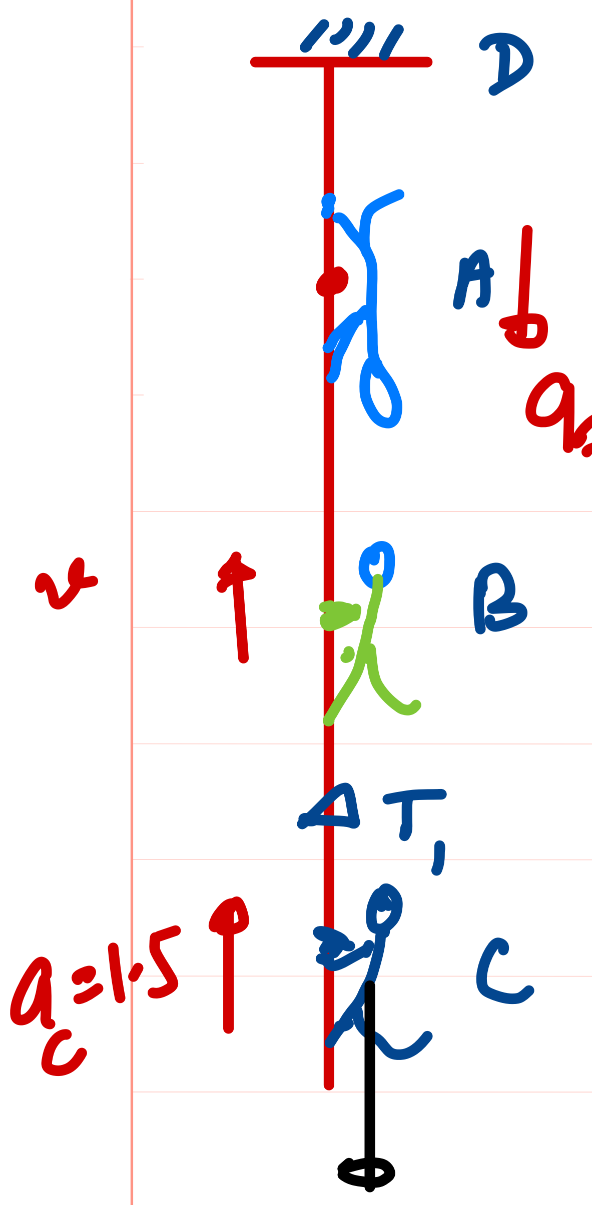
7. Three monkeys A, B and C with masses of 10 , 15 & 8 Kg respectively are climbing up & down the rope suspended from D . At the instant represented , A is descending the rope with an acceleration of 2 m/s^2 & C is pulling himself up with an acceleration of 1.5 m/s^2 . Monkeys B is climbing up with a constant speed of 0.8 m/s . Treat the rope and monkeys as a complete system & calculate the tension T in the rope at D. (g = 10 m/s^{-2})





$m_A = 10$ Kg

$m_B = 15$ kg

$m_C = 8$ kg

FOR C

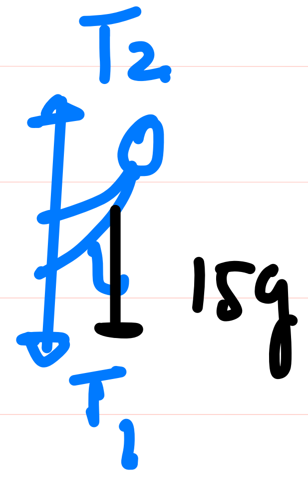
$T_1 - 8g = 8 \times 1.5$

$T_1 - 80 = 12$

$\boxed{T_1 = 92\,N}$

For B

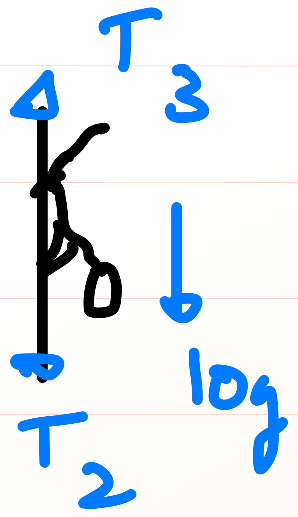
$a_B = 0$



$T_2 = T_1 + 15g$

$T_2 = 92 + 150$

For A



$T_2 + 10g - T_3 = 10 \times 2$

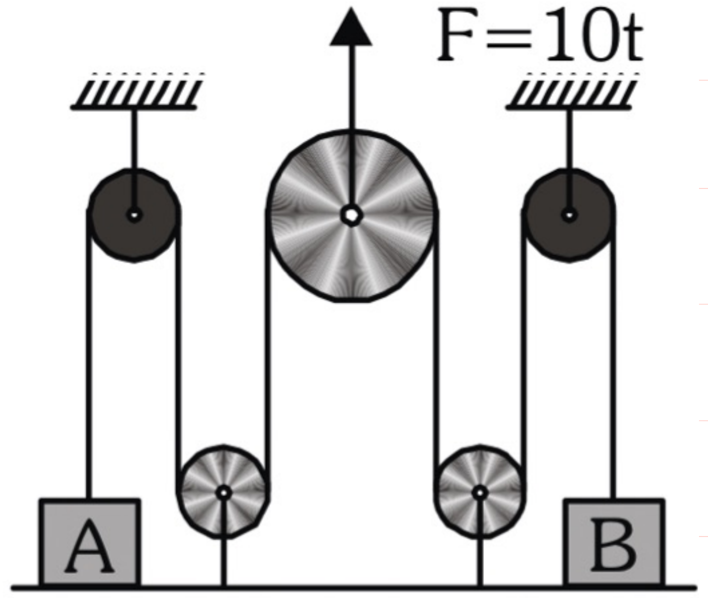
$92 + 150 + 100 - T_3 = 20$

$\boxed{T_3 = 322\,N}$

Ans

Ex

In the arrangement shown in figure $m_A = m$ and $m_B = 2m$, while all the pulleys and string are massless and frictionless. At $t = 0$, a force $F = 10t$ starts acting over central pulley in vertically upward direction. Find [Take all the units into S.I. system] [$m = 1kg$]

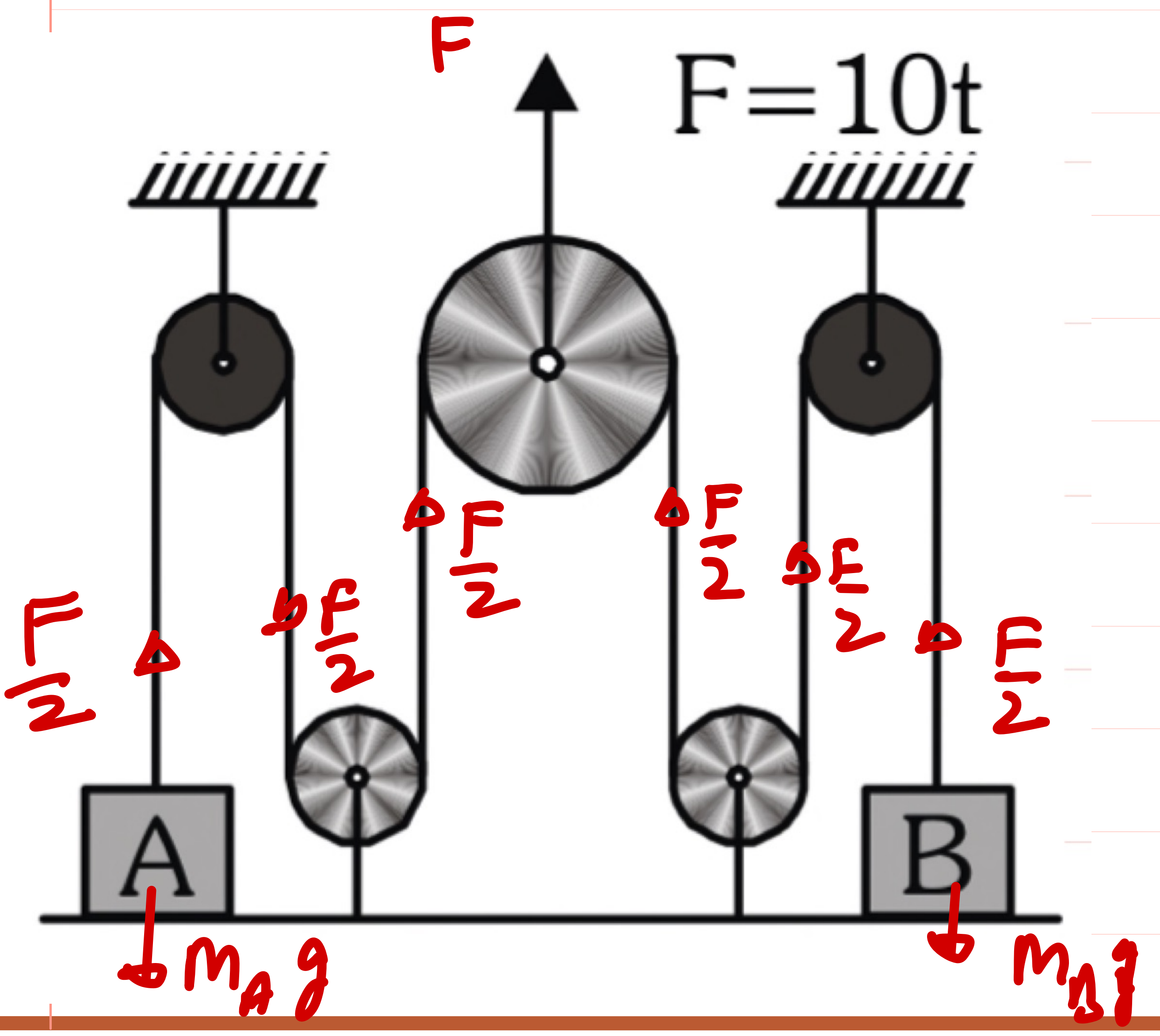


13. Time at which B loose contact with floor is

(A) 8 sec (B) 4 sec (C) 2 sec (D) 1 sec

14. Velocity of A when B loses contact with floor is

(A) 8 m/s (B) 6 m/s
(C) 10 m/s (D) 11 m/s



when B loose contact

$\frac{F}{2} = m_B g$

$\frac{10t}{2} = 2mg$

$5t = 2\times1\times10$

$\boxed{t = 4 sec}$

when A loose contact

$\frac{F}{2} = m_A g$

$5t = 1\times10$

$\boxed{t = 2 sec}$

b/w t = 2 sec to 4 sec

$\frac{F}{2} - m_A g = m_A a_A$

$5t - 10 = 1\, a_A$

$5t - 10 = \frac{dv}{dt}$

$\int_2^4 5t\,dt - \int_2^4 10\,dt = \int_0^v dv$

$\left[\frac{5t^2}{2}\right]_2^4 - [10t]_2^4 = v$

$v =$

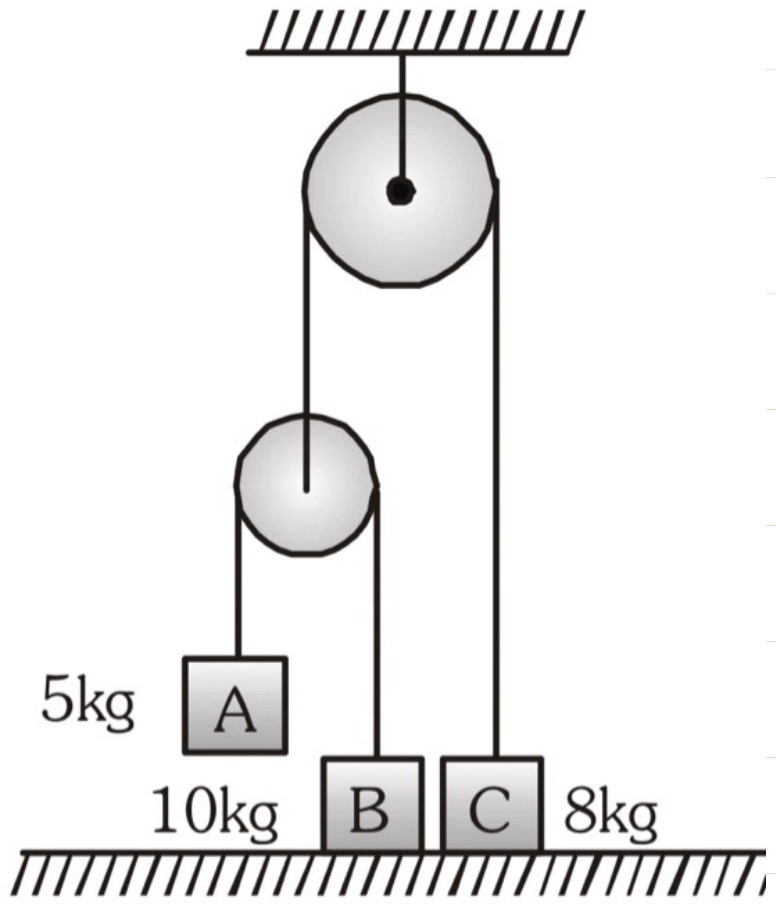
$\frac{5}{2}[4^2 - 2^2] - 10(4-2)$

$v = \frac{5}{2}[12] - 20$

$\boxed{v = 10 m/s}$

Ans

1*. In the following arrangement the system is initially at rest. The 5 kg block is now released. Assuming the pulleys and string to be massless and smooth, the acceleration of blocks is



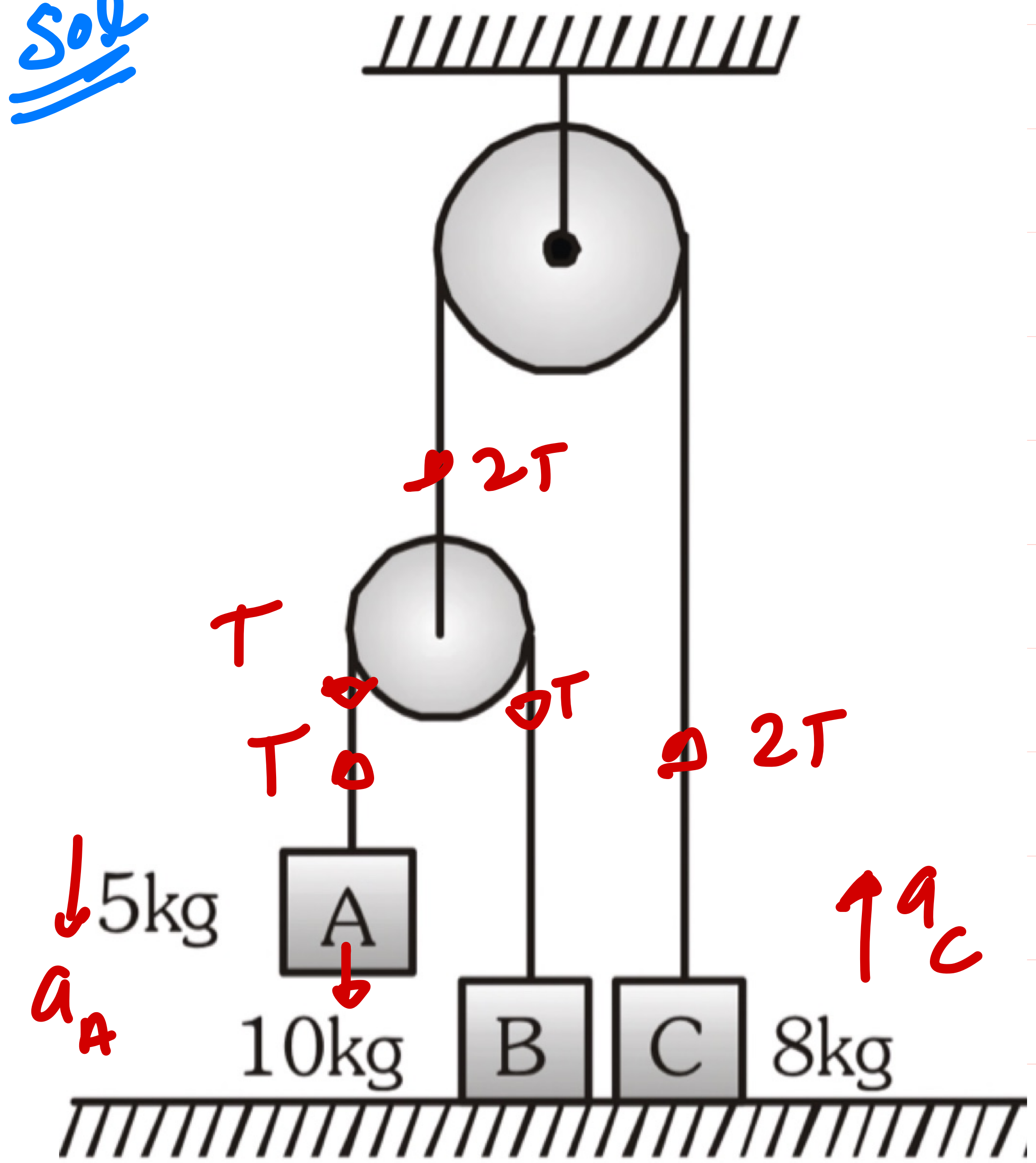
(A) $a_A = \frac{g}{7}$

(B) $a_B = 0\ m/s^2$

(C) $a_c = \frac{g}{14}$

(D) $2a_C = a_A$

Sol



$-Ta_A + 2Ta_c = 0$

$a_A = 2a_c$ — ①

FOR – A

$5g - T = 5a_A$ — ②

FOR – C

$2T - 8g = 8a_c$ — ③

② ×2 + ③

$10g - 2T = 10a_A$

$2T - 8g = 8a_c$

$2g = 10a_A + 8a_c$

$g = 5a_A + 4a_c$ — ④

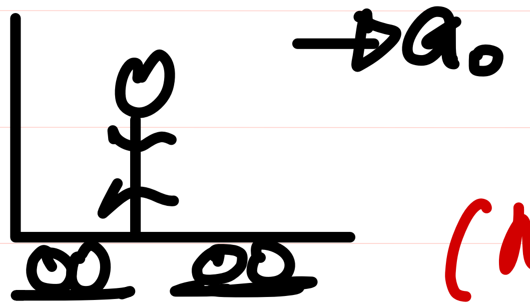
$g = 5(2a_c) + 4a_c$

$\boxed{a_c = \frac{g}{14}}$

$\boxed{a_A = \frac{2g}{14}}$

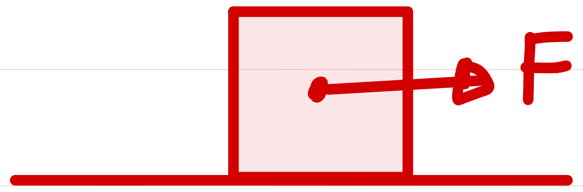
Pseudo Force :→ (motion in non-inertial frame)

O-A (Inertial)



O.B (Non-Inertial)

m



For Ob-A

$$\boxed{a = \frac{F}{m}}$$

For . O-B

$$a_{BB} = a - a_0 = a_r$$

multiply by m

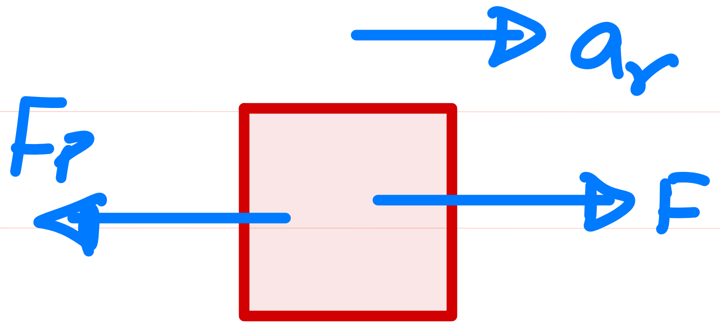
$$(m\,a_{BB}) = ma - ma_0$$

$$\boxed{m\vec{a}_r = \vec{F} + \vec{F}_p}$$

$$\boxed{\vec{F}_p = -m\vec{a}_0}$$

Pseudo force

w.r.t B motion of Block is



Ex

1kg [A] → 5N

$a_A = 5$

[B] → 20N

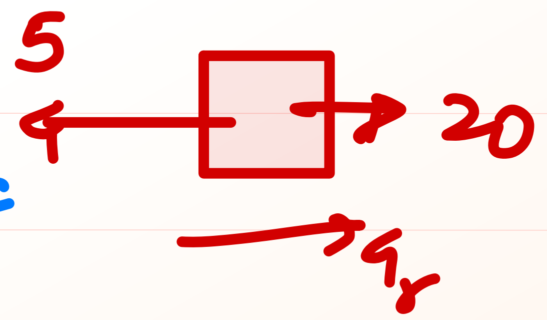
2kg

$a_B = 10$

Find Acc. of B w.r.t A

$$a_{BA} = a_B - a_A = 10-5$$

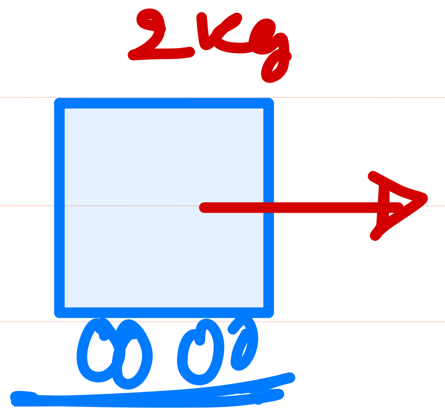
$$= 5\,m/s^2 \text{ Ans}$$

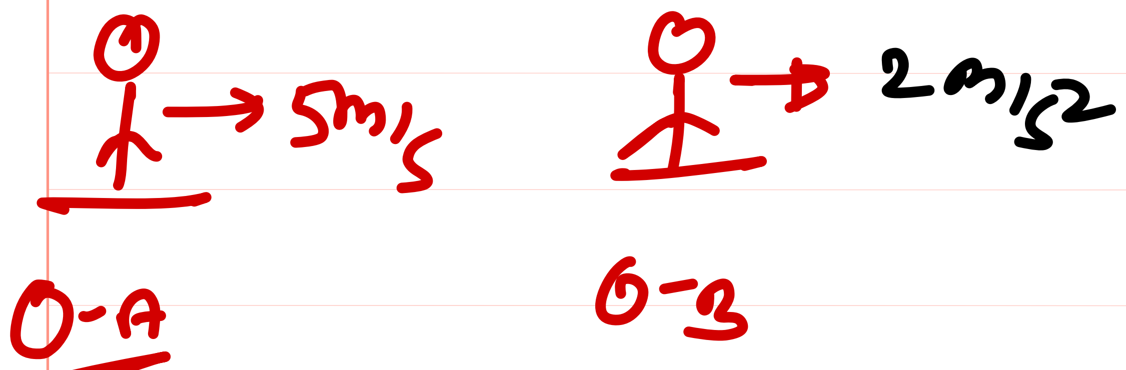


$F_p =$

$$20-10 = 2\times a_r \Rightarrow 2a_r = 10 \Rightarrow a_r = 5\,m/s^2$$

Ex





① Value of Pseudo on Box w.r.t O-A & O-B

O-A is INERTIAL frame

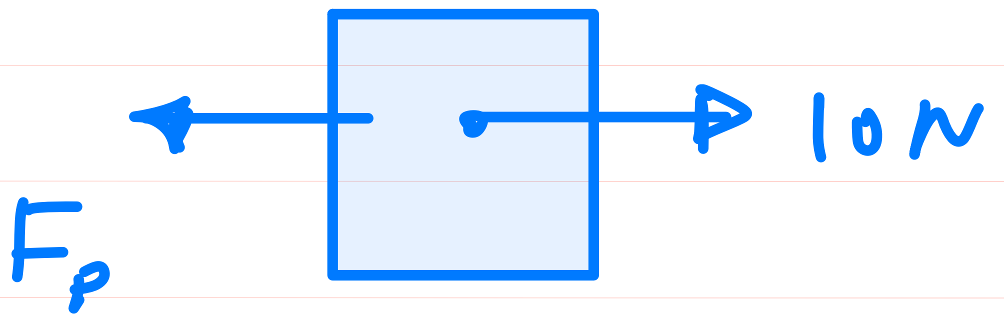
$$\boxed{F_p = 0\ N}$$

O-B is Non inertial frame

$F_p = m \times a$

$= 2 \times 2$

$= 4N$

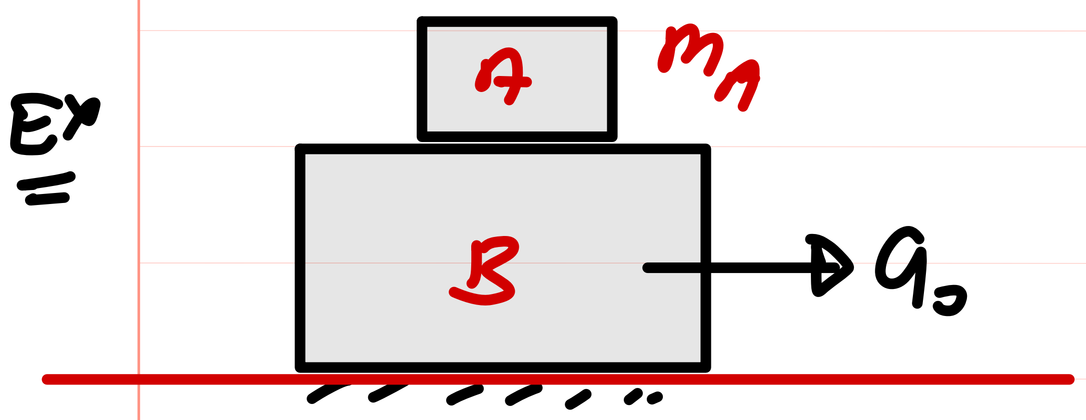


$10 - F_p = 2 \times a_r$

$10 - 4 = 2a_r$

$$\boxed{a_r = 3\ m/s^2}$$ Ans

Ex



Pseudo force on A w.r.t B

$F_p = m a_0$

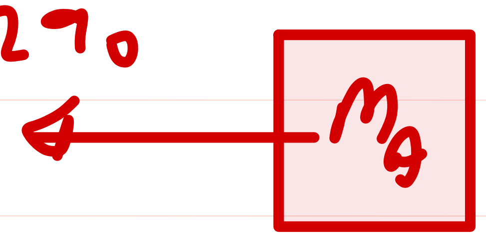
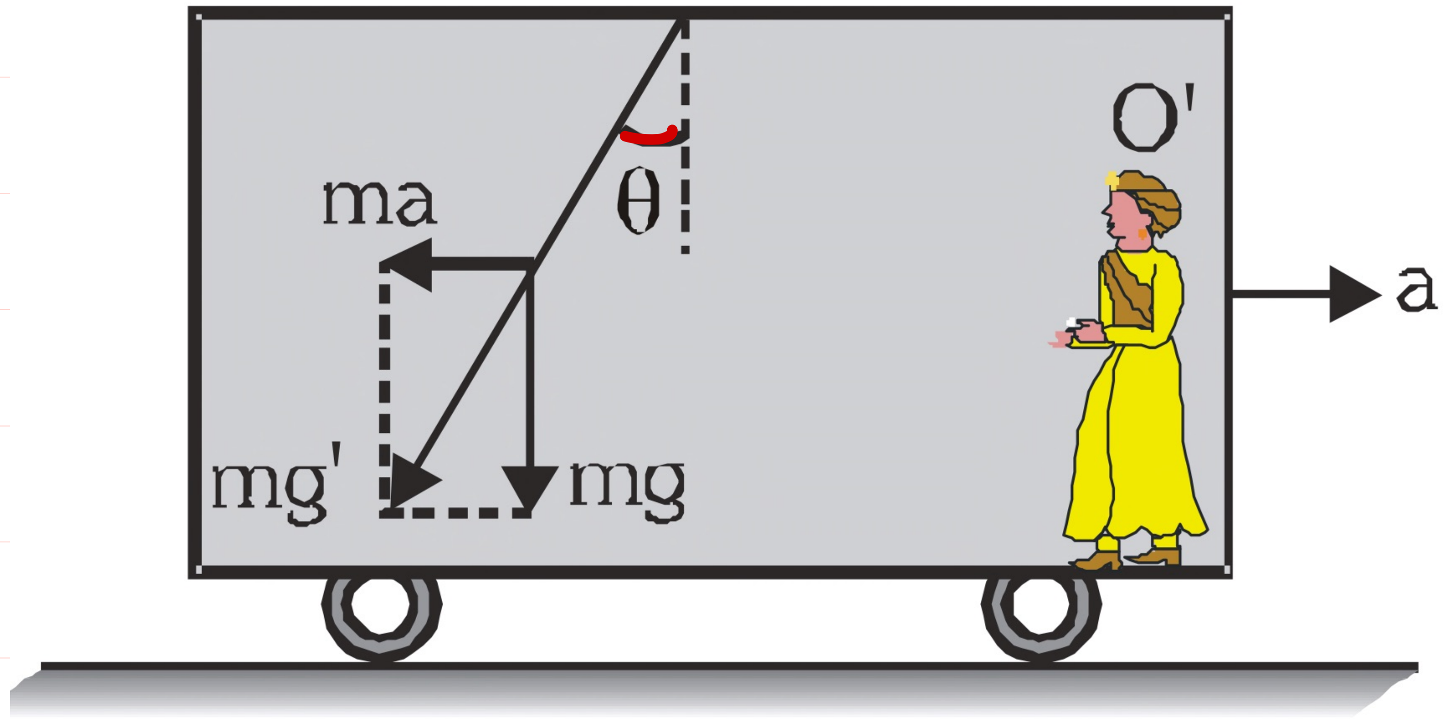
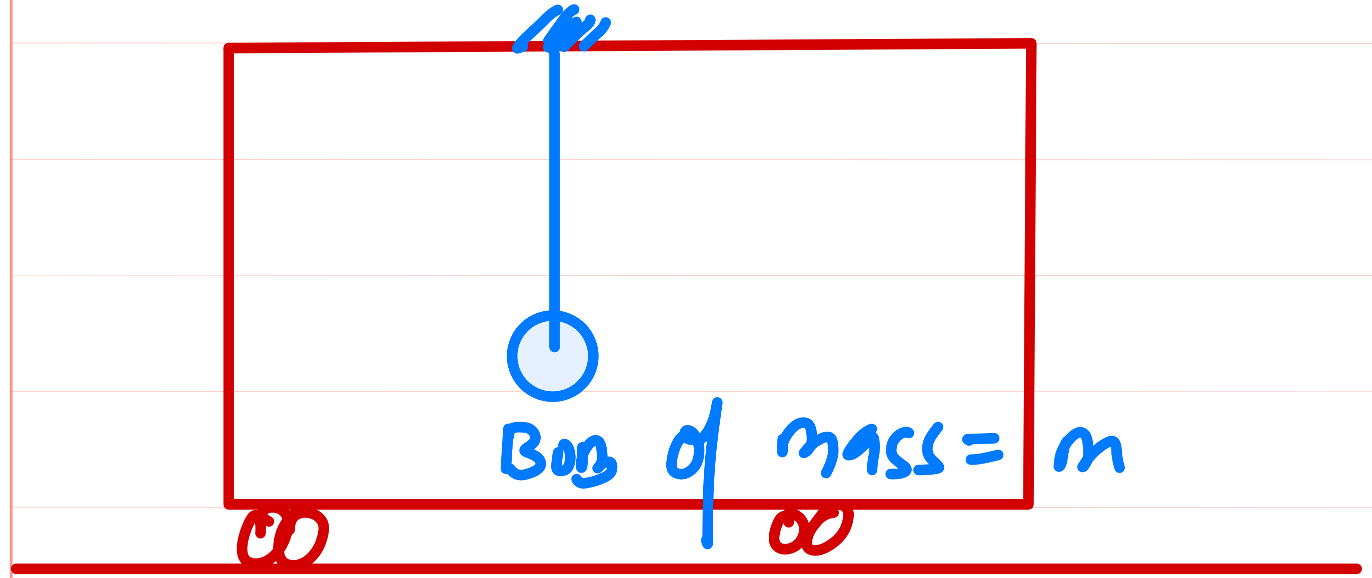
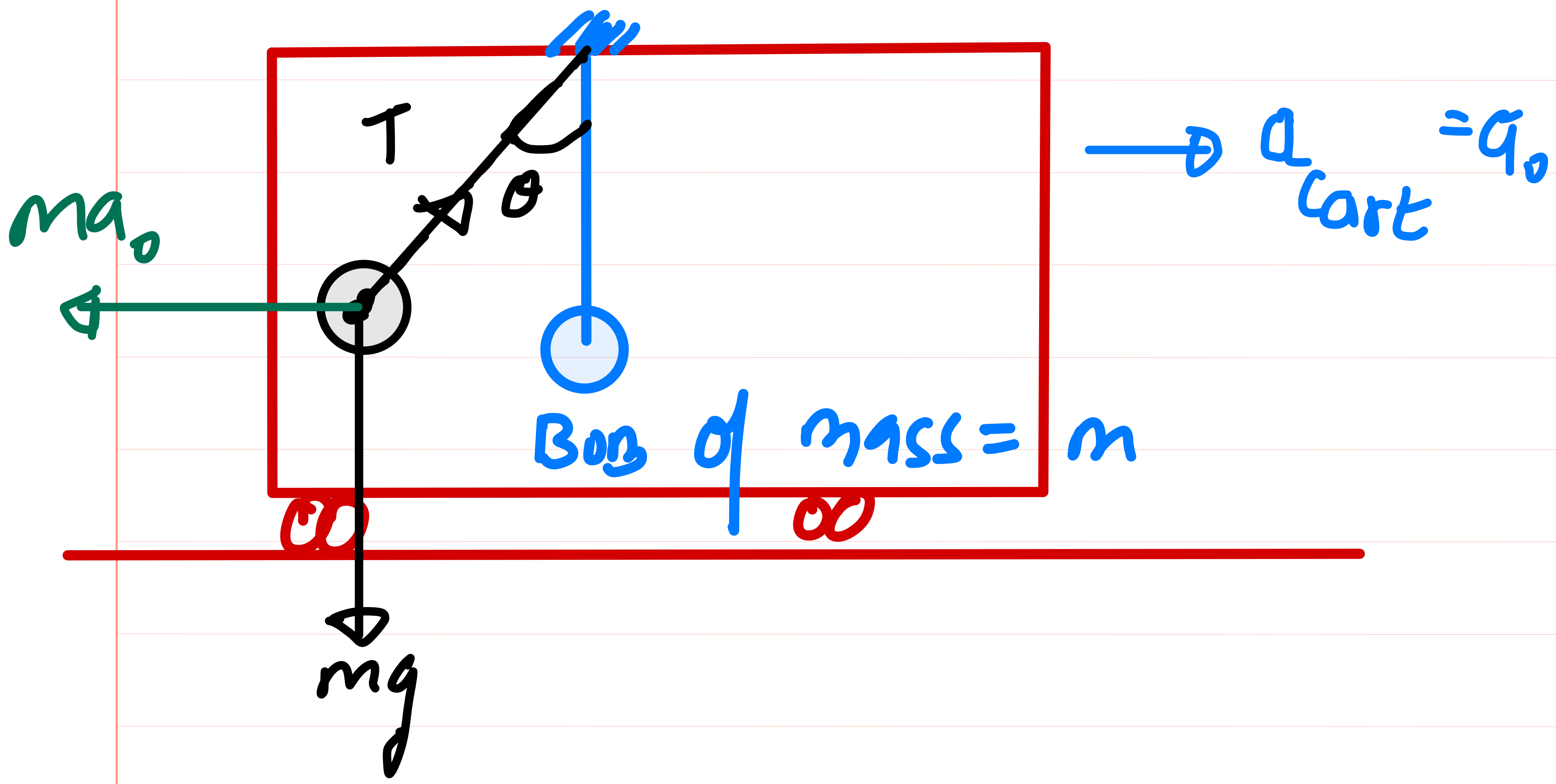


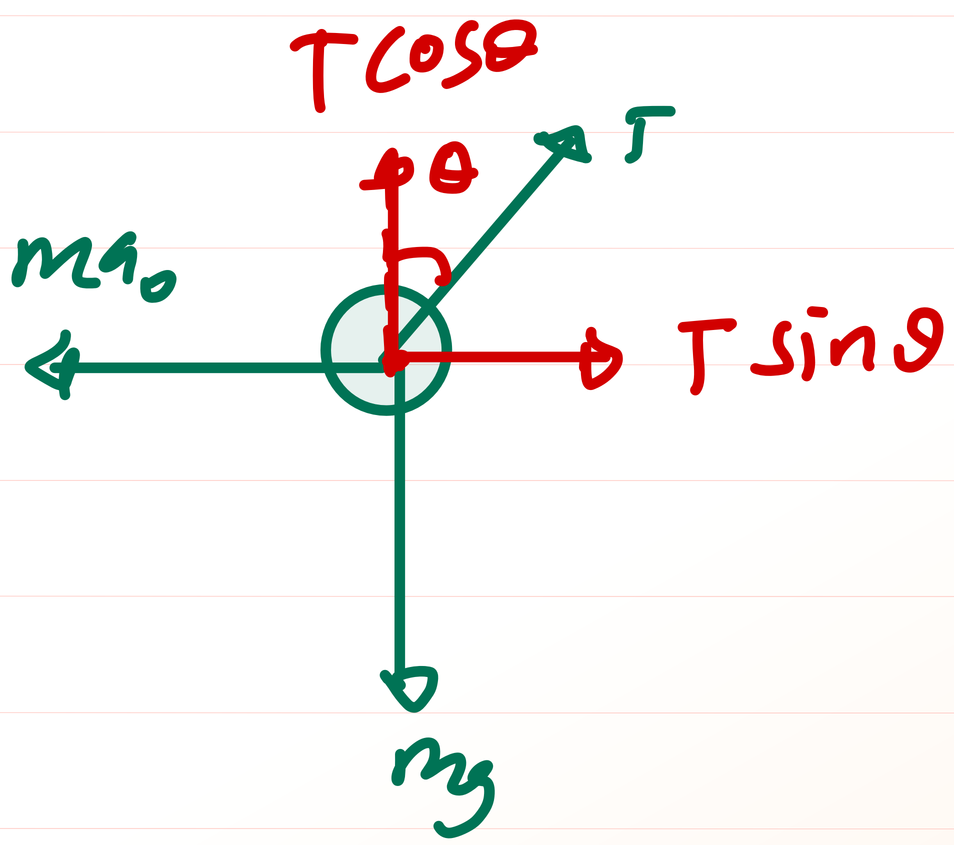
Illustration 29. A pendulum of mass m is suspended from the ceiling of a train moving with an acceleration 'a' as shown in figure. Find the angle θ in equilibrium position.







w.r.t Cart



$$\frac{T\sin\theta}{T\cos\theta} = \frac{ma_0}{mg}$$

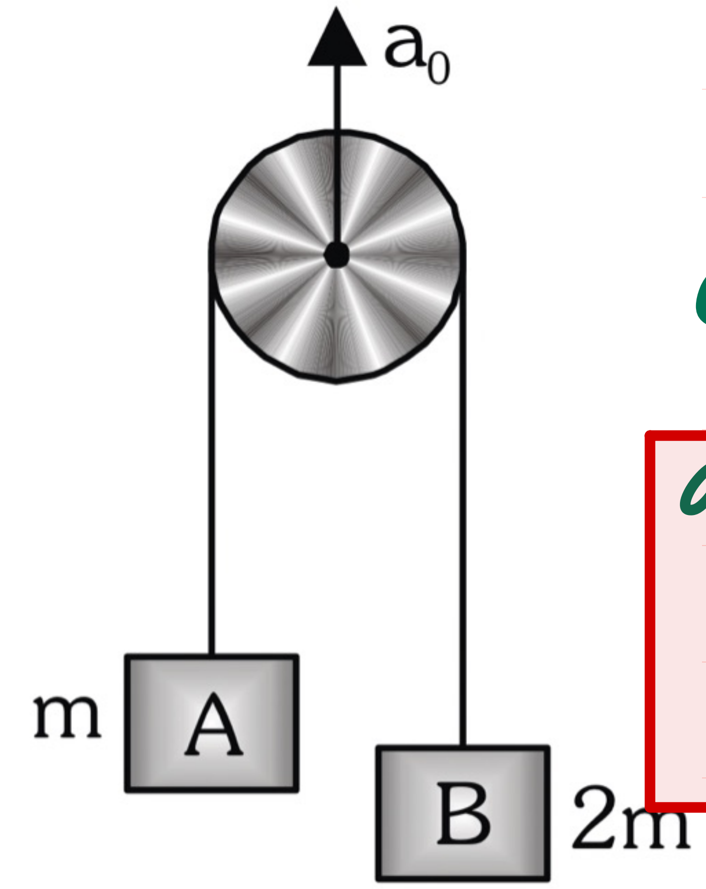
$$\tan\theta = \frac{a_0}{g} \Rightarrow \boxed{\theta = \tan^{-1}\left(\frac{a}{g}\right)}$$

$$\boxed{a_0 = g\tan\theta}$$

2. In the given figure pulley is moving with an accelation a_0 in upward direction, acceleration of block A with respect to pulley is

(A) $\frac{1}{3}(g + a_0)\uparrow$ ✓ (B) $\frac{1}{3}(g - a_0)\uparrow$

(C) $\frac{g + a_0}{2}\uparrow$ (D) $\left(\frac{g - a_0}{2}\right)\uparrow$

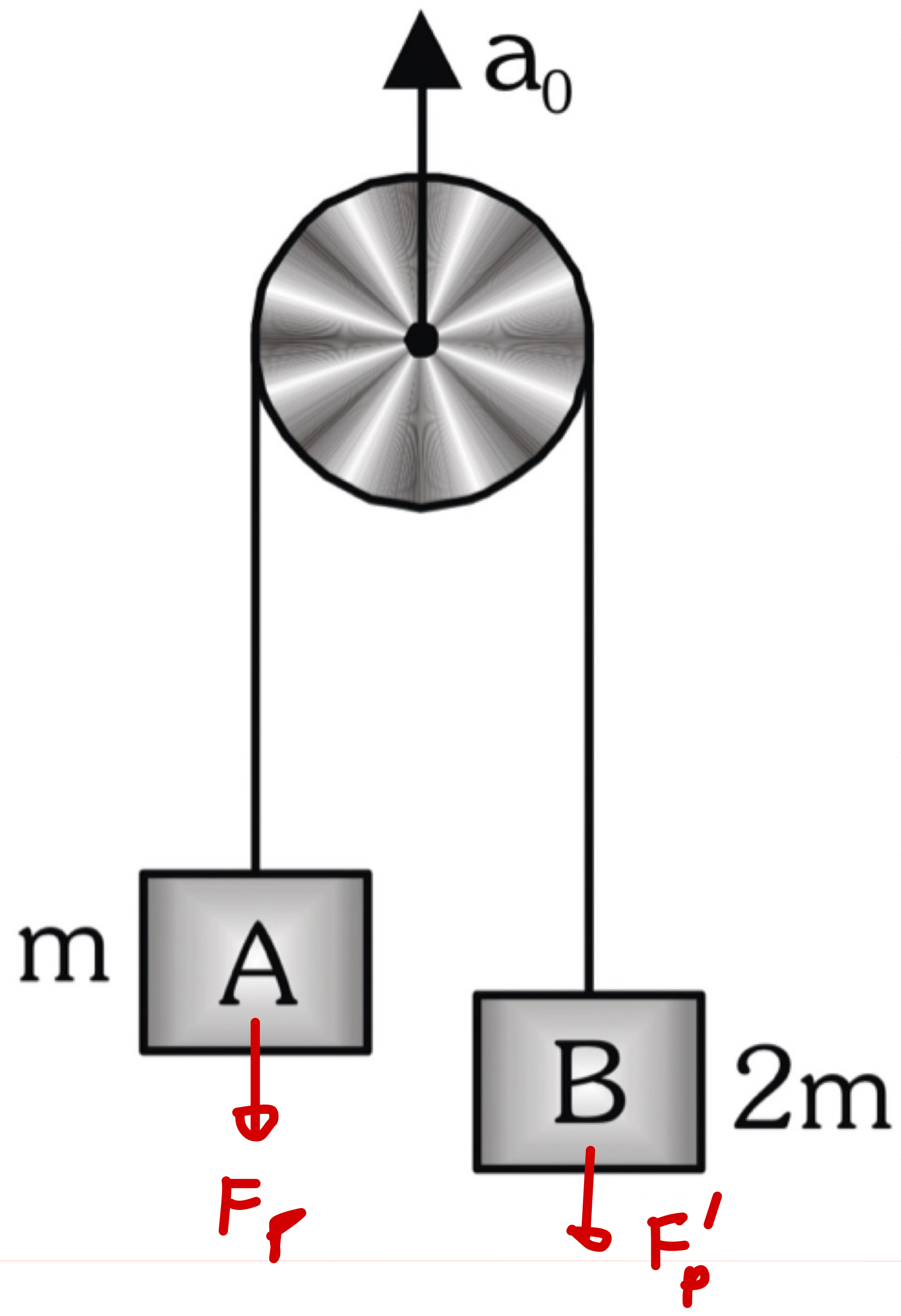


w.r.t to ground

$a_{Ap} = a_A - a_p$

$a_A = a_{Ap} + a_p$

$$\boxed{\begin{aligned} a_A &= a_r + a_0 \\ a_B &= -a_r + a_0 \end{aligned}}$$



FOR - A

$a_r \uparrow$ T

mg

ma_0

$T - mg - ma_0 = ma_r$ —(1)

FOR - B

T

$\downarrow a_r$

2mg

$2ma_0$

$2mg + 2ma_0 - T = 2ma_r$ —(2)

add (1) + (2)

$\cancel{m}g + \cancel{m}a_0 = 3\cancel{m}a_r$

$a_r = \left(\frac{g+a_0}{3}\right)$