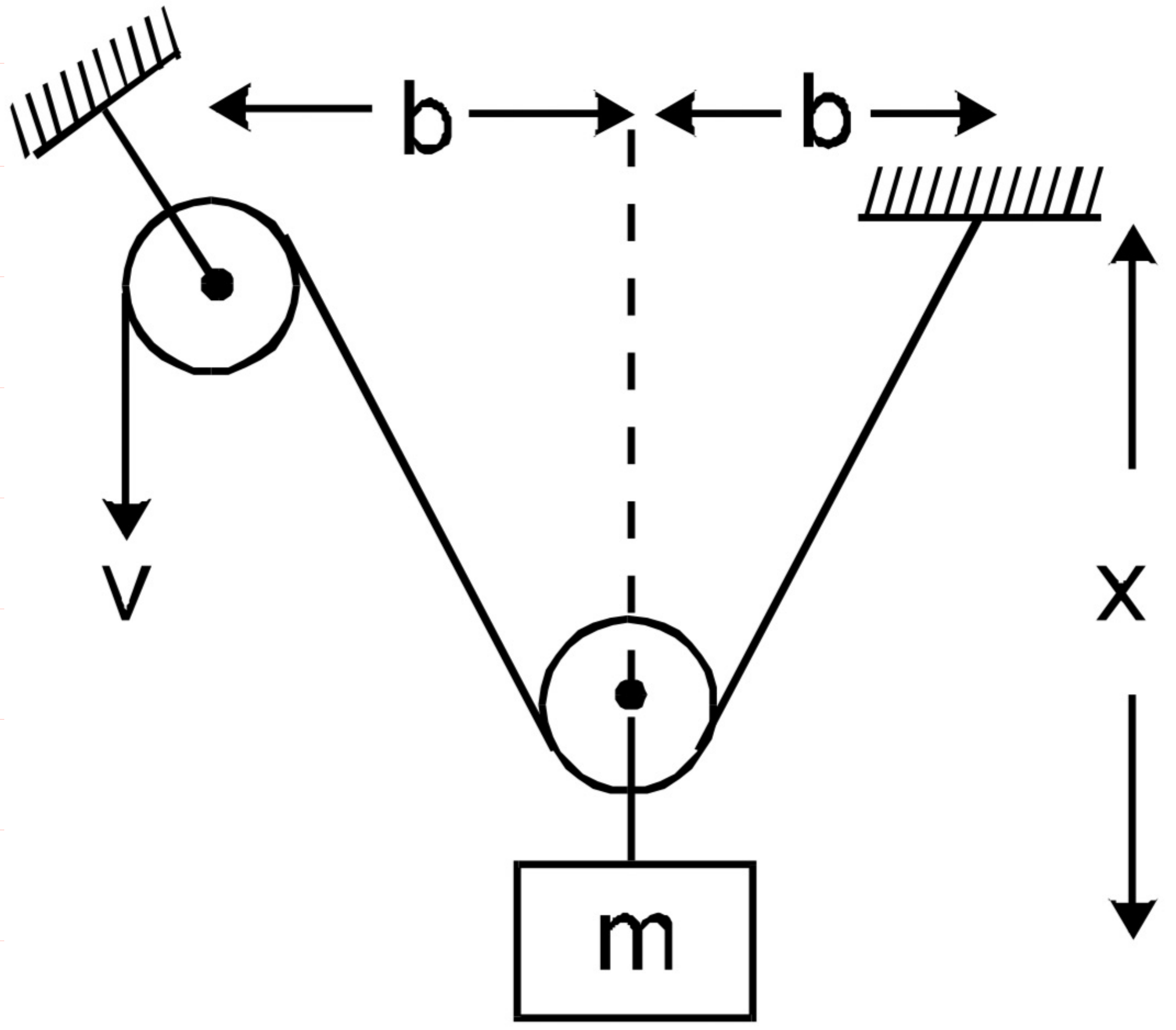
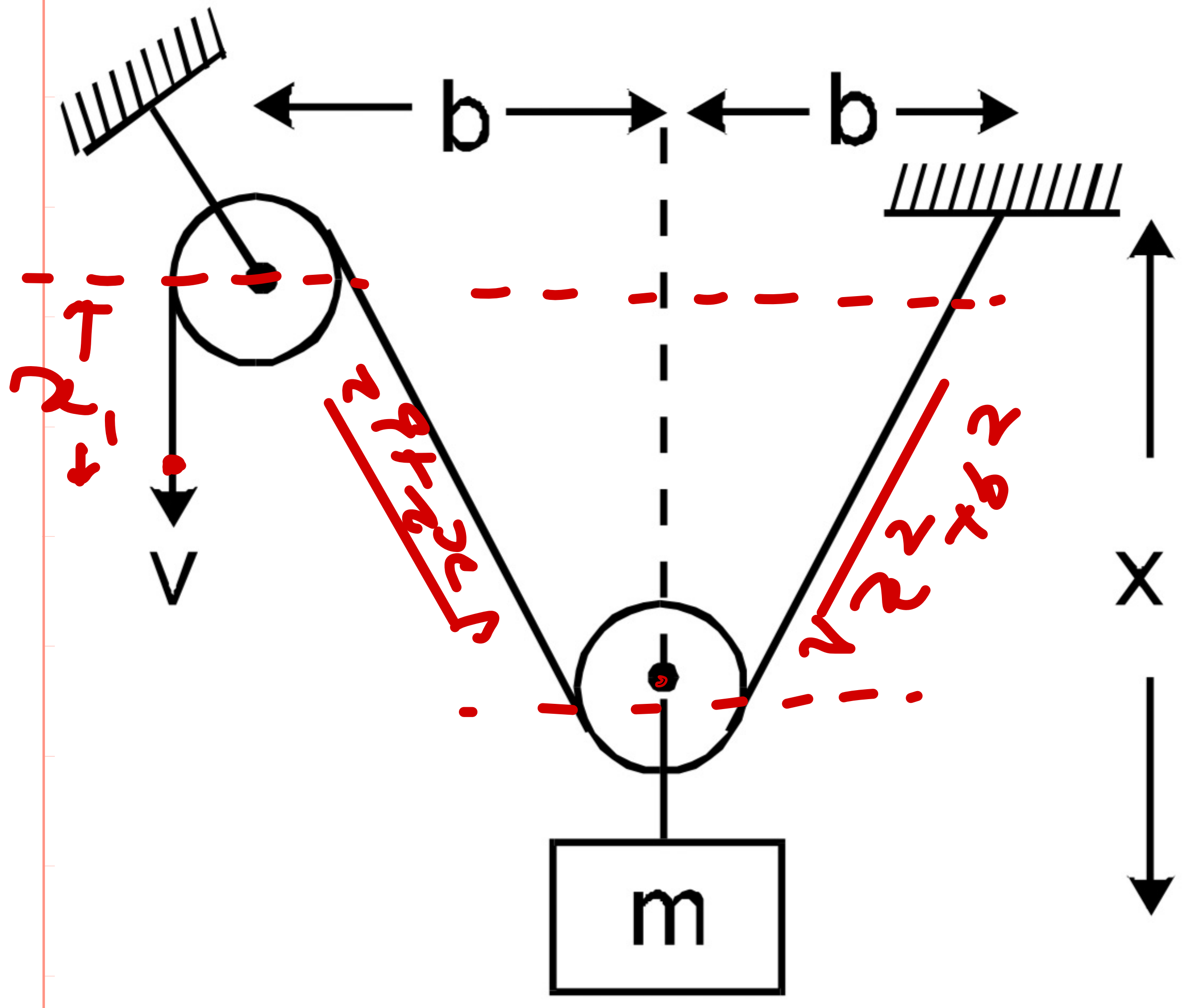
Illustration 21. The figure shows one end of a string being pulled down at constant velocity v. Find the velocity of mass 'm' as a function of 'x'.





$$\frac{dx}{dt} = v_p = v_B$$

$$\frac{dx_1}{dt} = v$$

Length method :→

$$2\sqrt{x^2+b^2} + x_1 = \text{constant}$$

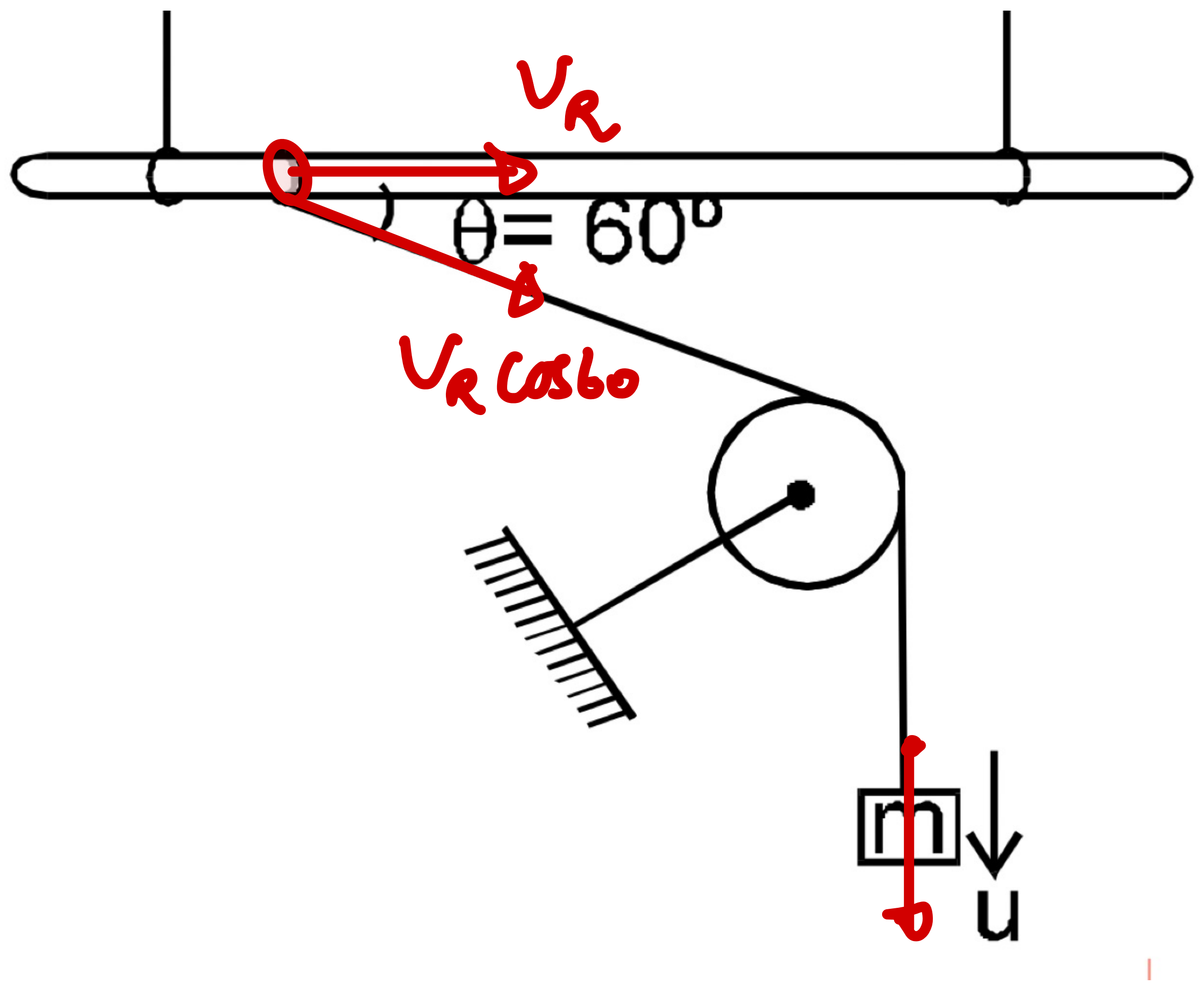
diff. w.r.t time

$$\cancel{2}\,\frac{1}{\cancel{2}\sqrt{x^2+b^2}}\cdot 2x\cdot\frac{dx}{dt} + \frac{dx_1}{dt} = 0$$

$$\left(\frac{2x}{\sqrt{x^2+b^2}}\right)v_p + (-v) = 0$$

$$\boxed{v_p = v_B = \frac{v\sqrt{x^2+b^2}}{2x}}$$ Ans

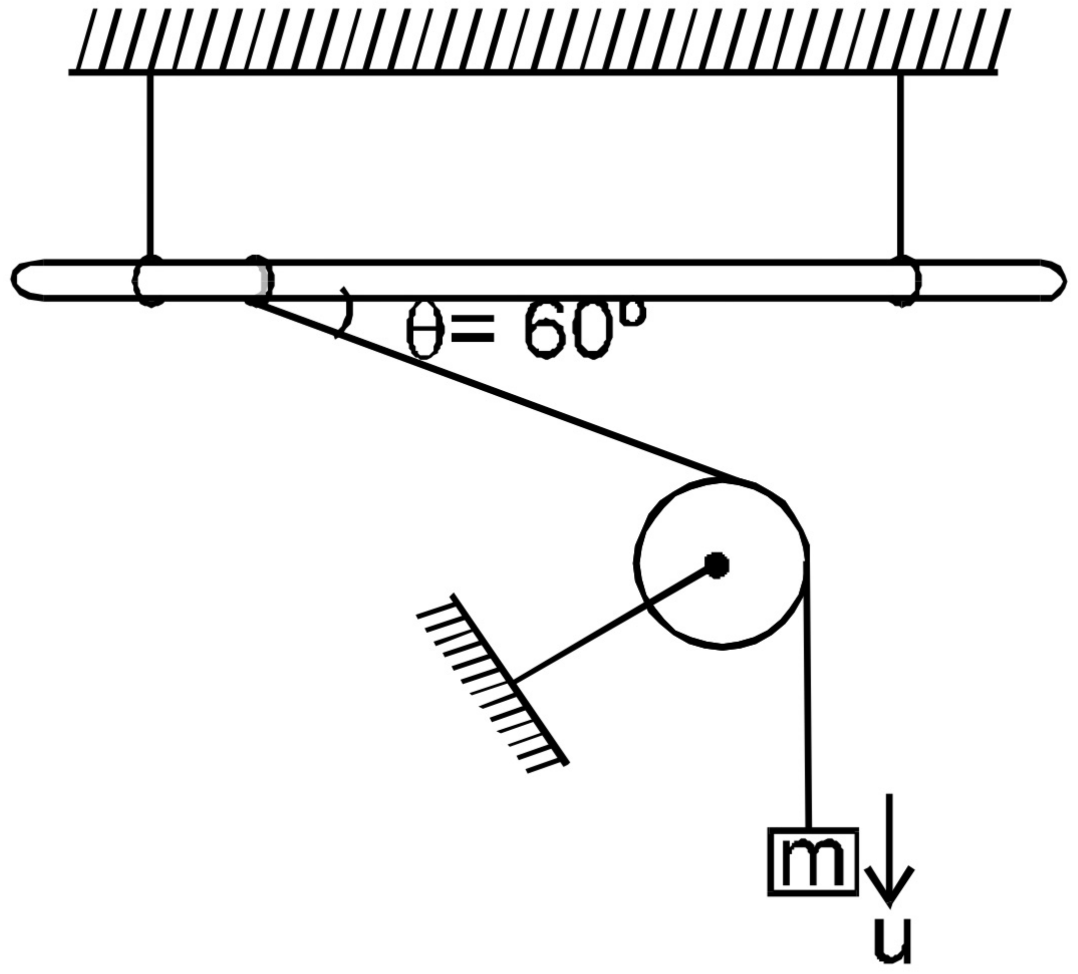
Illustration 22. The figure shows mass m moves with velocity u. Find the velocity of ring at that moment. Ring is restricted to move on smooth rod.



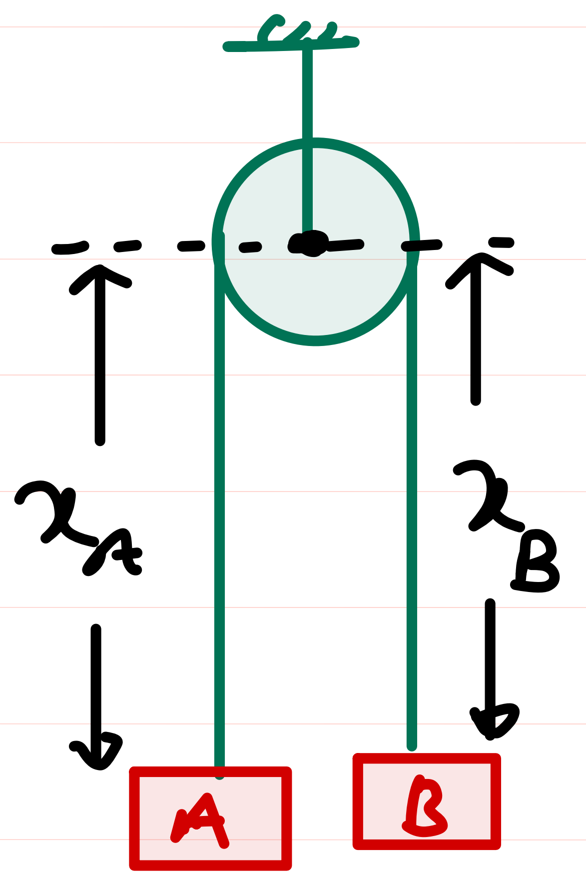
$$V_R \cos 60 = u$$

$$\frac{V_R}{2} = u$$

$$\boxed{V_R = 2u}$$



Pulley Constraint :→



$x_A + x_B =$ Constant

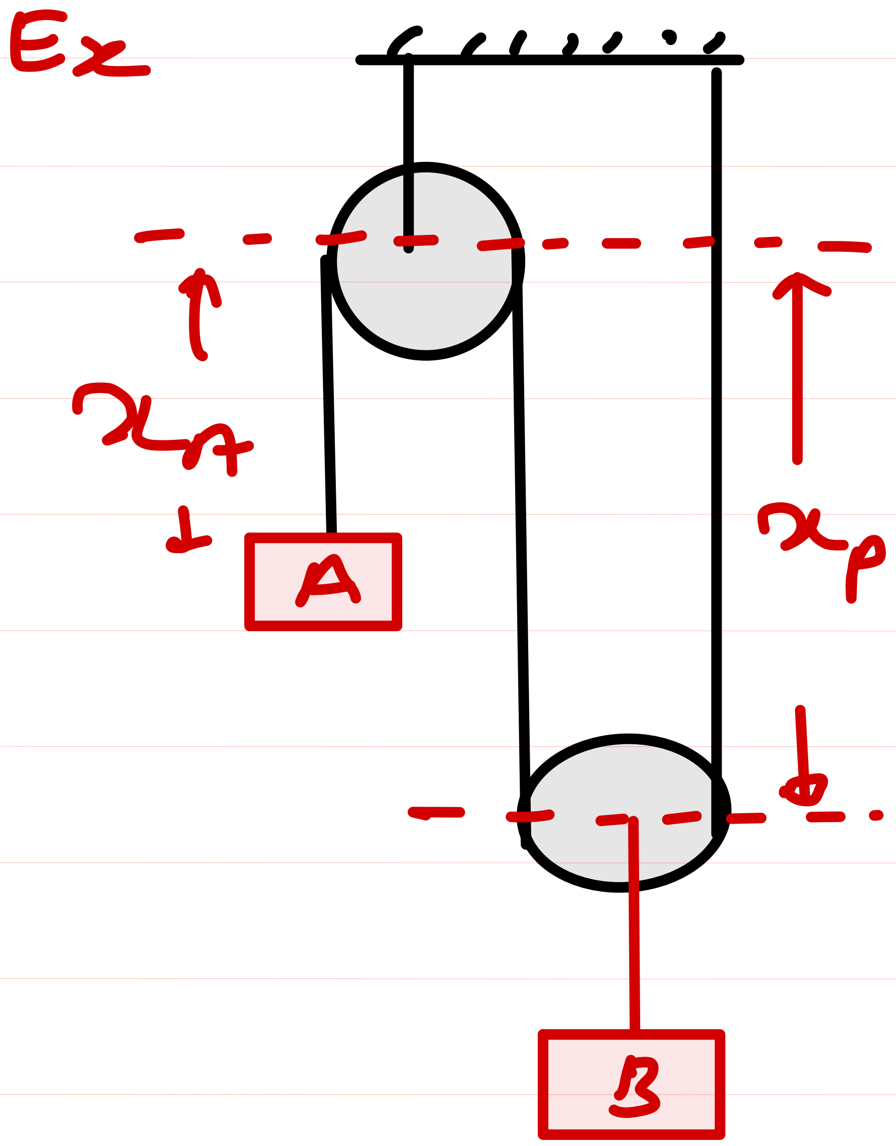
diff w.r.t time

$$\frac{dx_A}{dt} + \frac{dx_B}{dt} = 0$$

$$\boxed{\vec{v}_A + \vec{v}_B = 0}$$

$$\vec{v}_A = -\vec{v}_B$$

Ex



$$\frac{dx_p}{dt} = v_B = v_p$$

$$\frac{dx_A}{dt} = v_A$$

$x_A + 2x_p =$ constant

diff. w.r.t time

$$\frac{dx_A}{dt} + 2\frac{dx_p}{dt} = 0$$

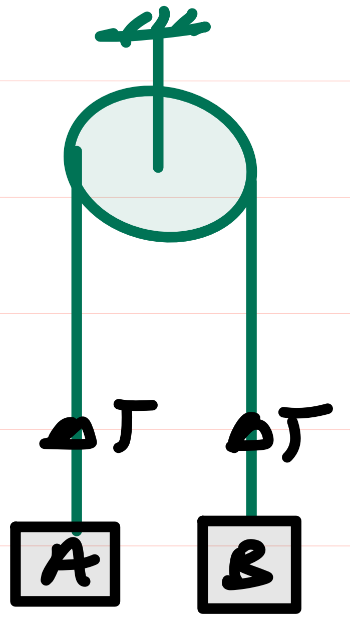
$$\boxed{\vec{v}_A + 2\vec{v}_B = 0}$$

$$\boxed{\vec{a}_A + 2\vec{a}_B = 0}$$

Tension method :→

$$\boxed{\sum \vec{T}\cdot\vec{v} = 0 = \sum \vec{T}\cdot\vec{a}}$$

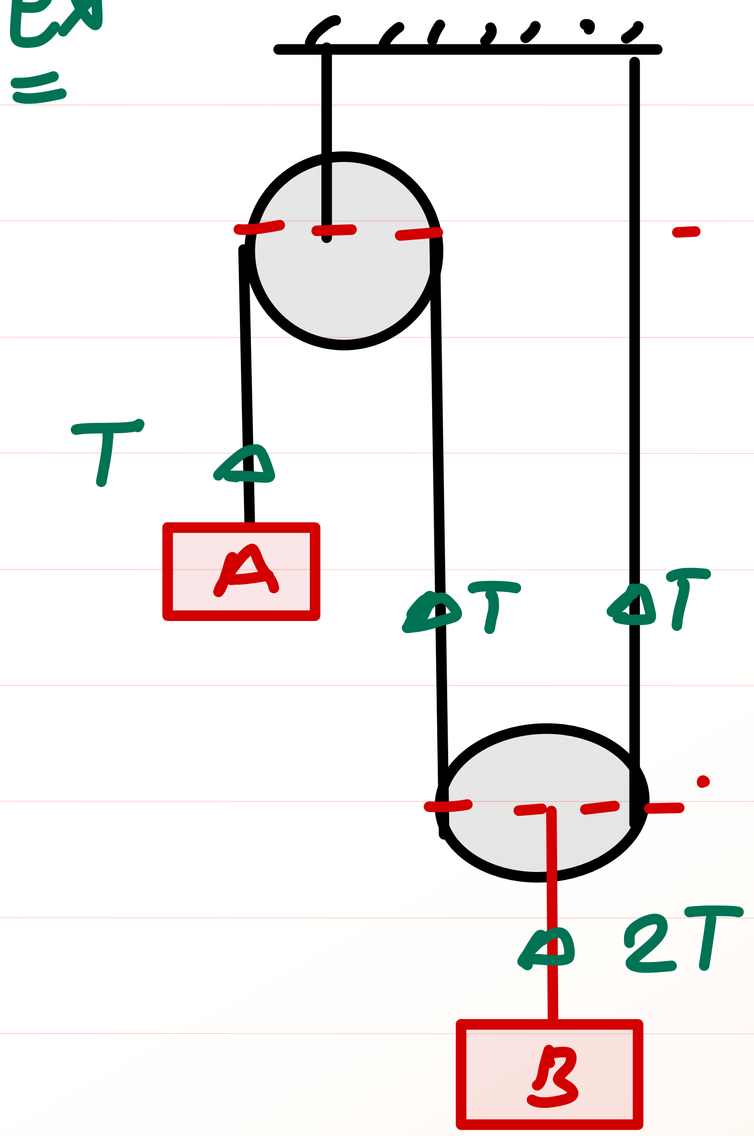
Ex



$$T\vec{v}_A + T\vec{v}_B = 0$$

$$\boxed{\vec{v}_A + \vec{v}_B = 0}$$

Ex



$$T\cdot\vec{v}_A + 2T\cdot\vec{v}_B = 0$$

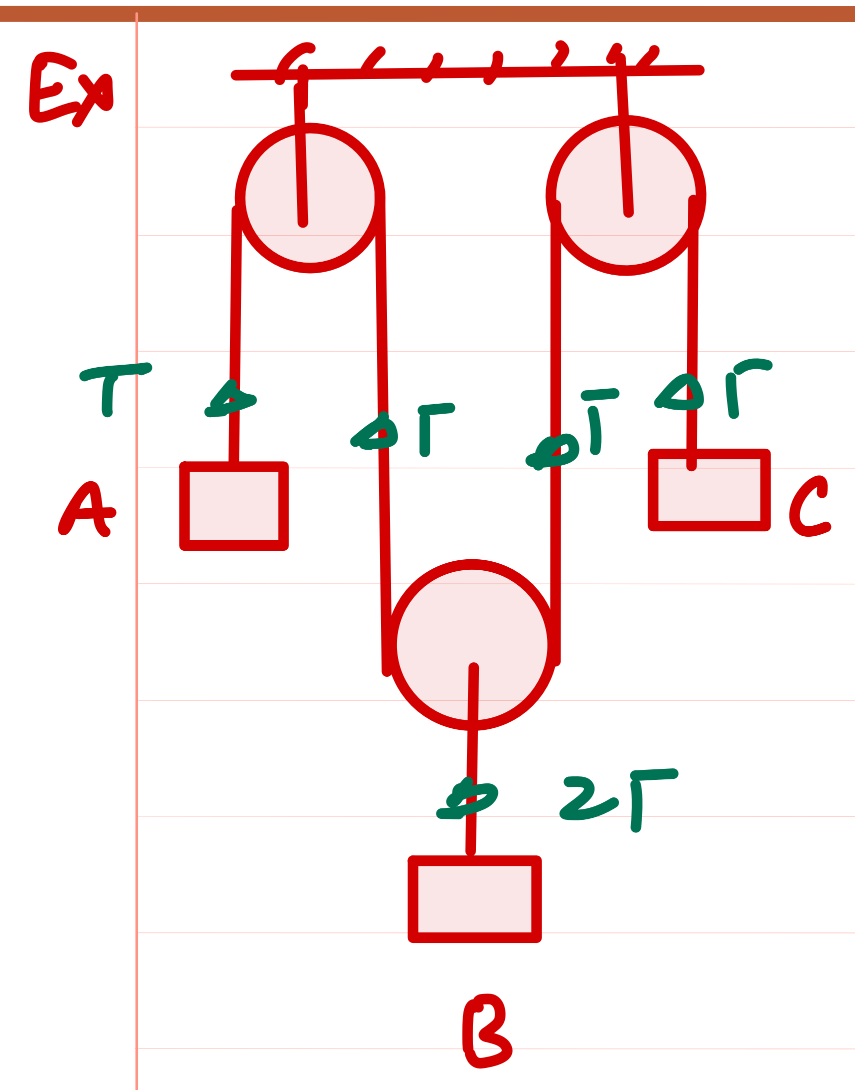
$$\boxed{\vec{v}_A + 2\vec{v}_B = 0}$$

$$T\vec{a}_A + 2T\vec{a}_B = 0$$

$$\boxed{\vec{a}_A + 2\vec{a}_B = 0}$$

$$\boxed{\vec{a}\cdot\vec{b} = ab\cos\theta}$$

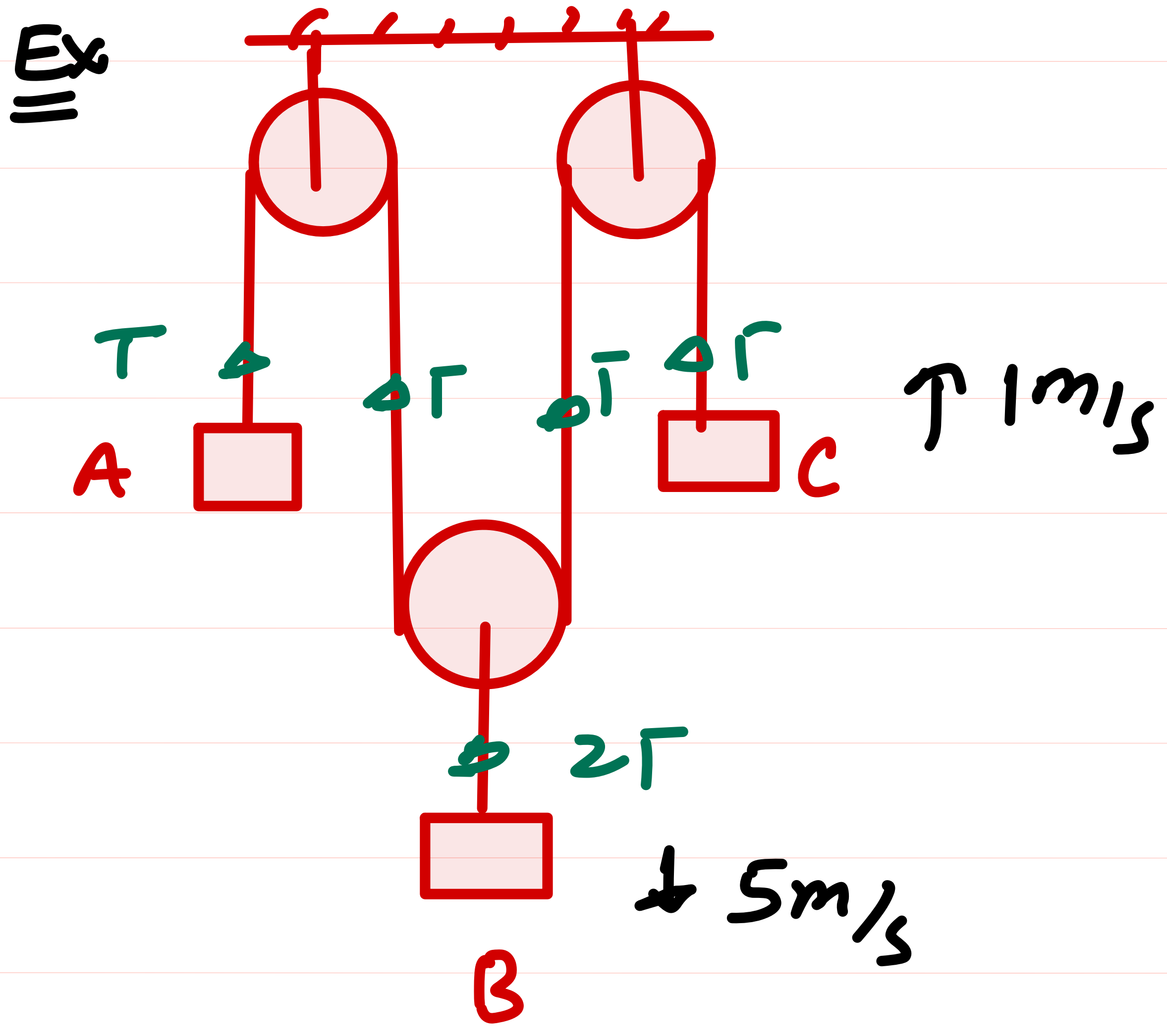
Ex



$$T\vec{V_A} + 2T\vec{V_B} + T\vec{V_C} = 0$$

$$\boxed{\begin{aligned}\vec{V_A} + 2\vec{V_B} + \vec{V_C} &= 0\\ \vec{a_A} + 2\vec{a_B} + \vec{a_C} &= 0\end{aligned}}$$

Ex



velocity of A is

$$\vec{V_A} + 2\vec{V_B} + \vec{V_C} = 0$$

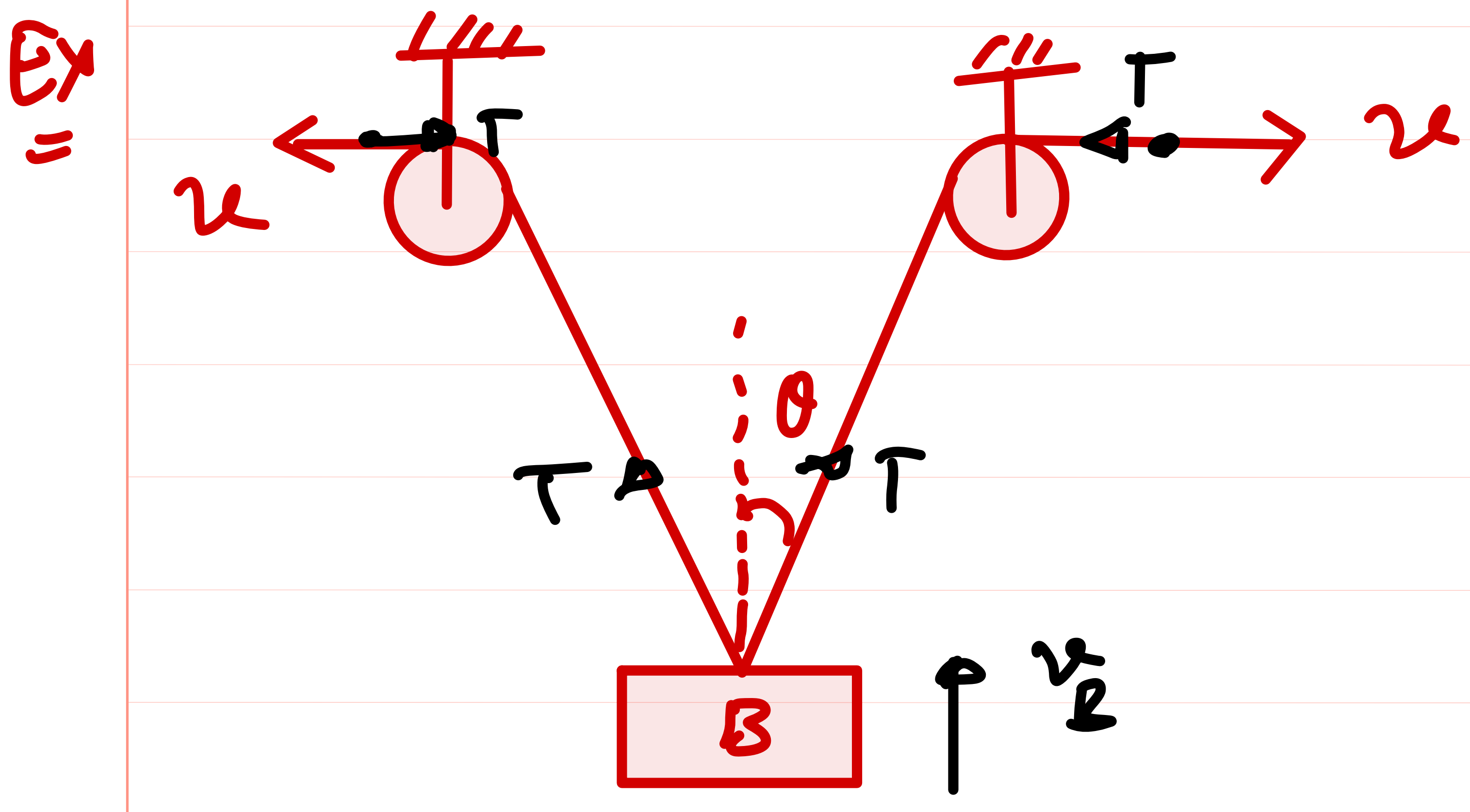
$$V_A + 2(-5) + 1 = 0$$

$$V_A - 10 + 1 = 0$$

$$\boxed{V_A = 9\ m/s \uparrow}$$

Ans

Ex

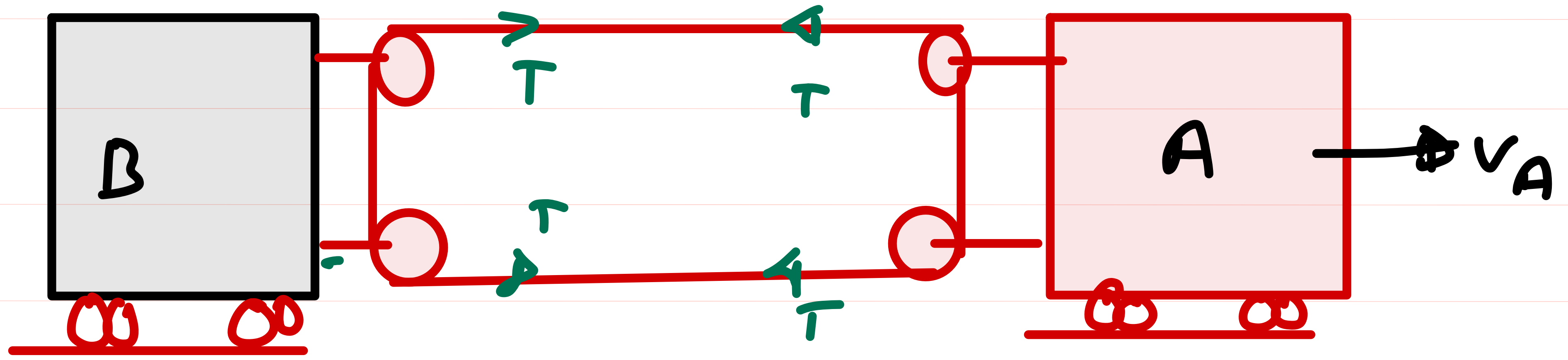


$$-TV - T\cdot V + TV_B\cos\theta + TV_B\cos\theta = 0$$

$$-2TV + 2TV_B\cos\theta = 0$$

$$\boxed{V_B = \frac{V}{\cos\theta}}$$

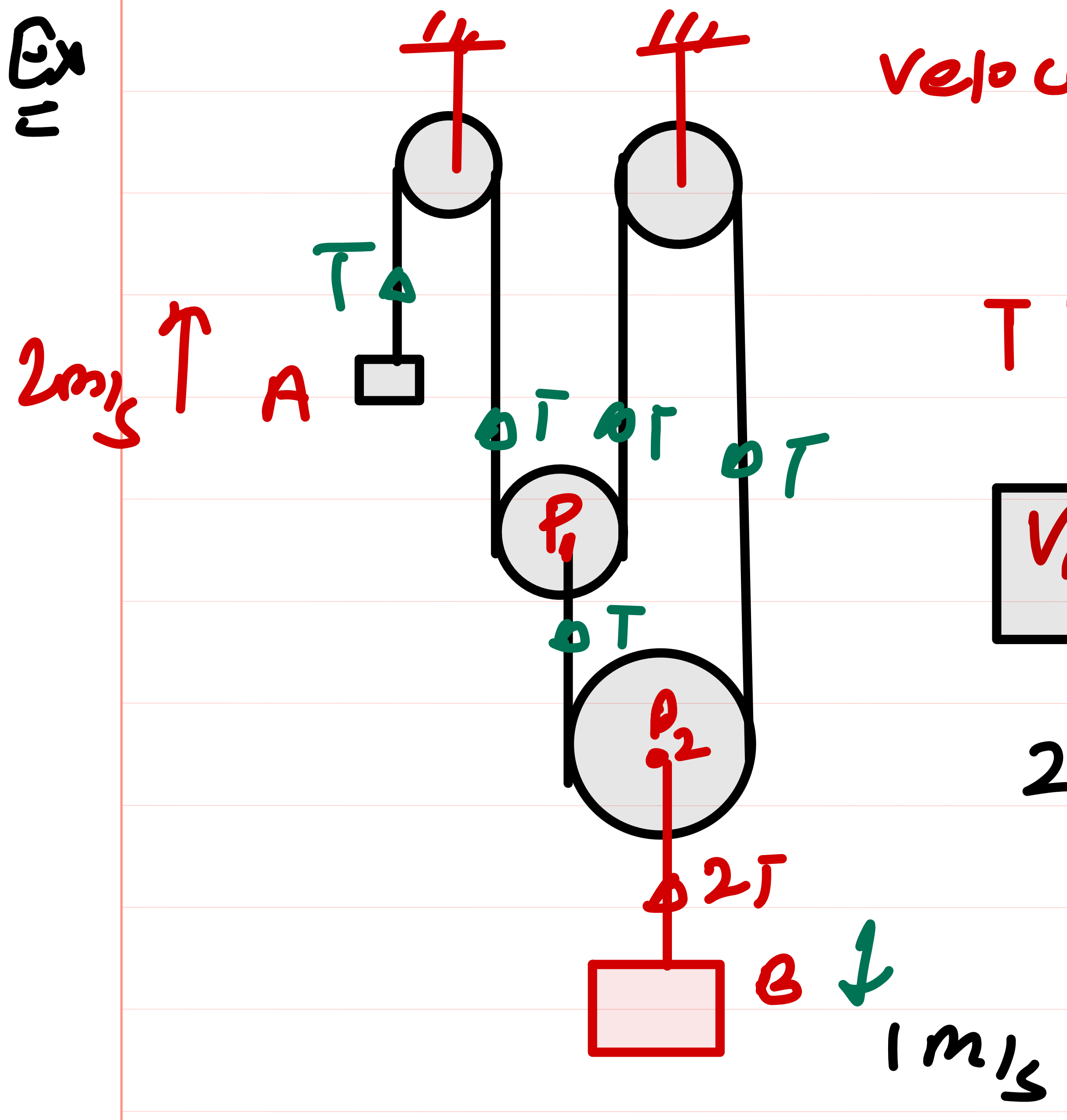
Ex



$V_B = ??$

$-V_A\,2T + 2T\cdot V_B = 0 \Rightarrow \boxed{V_B = V_A}$

Ex



velocity of P_1

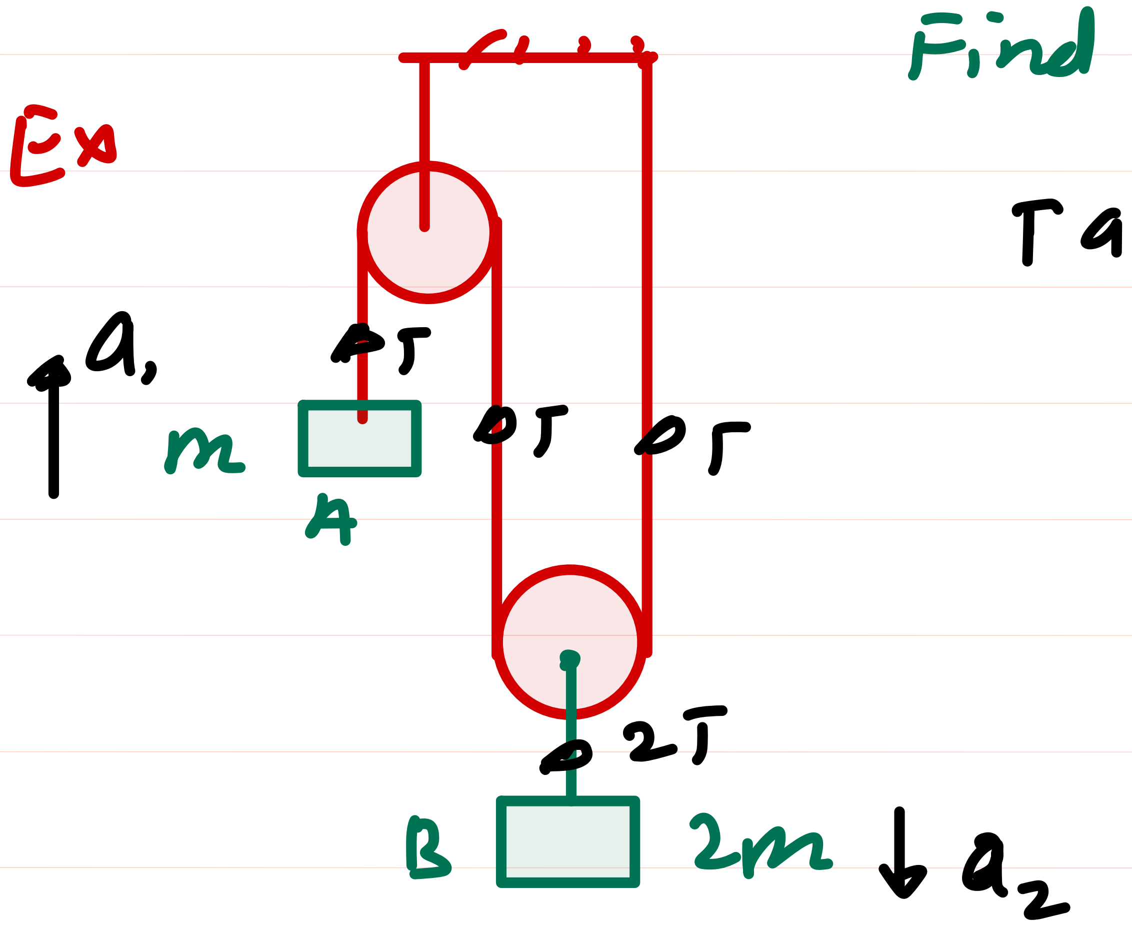
$T V_A + T V_{P_1} + 2T V_B = 0$

$\boxed{V_A + V_{P_1} + 2V_B = 0}$

$2 + V_{P_1} - 2 = 0$

$V_{P_1} = 0$

Ex

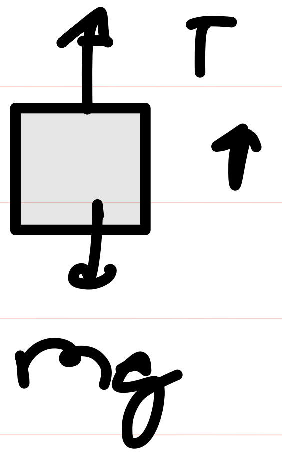


Find Acc. of blocks

$T a_1 + 2T(-a_2) = 0$

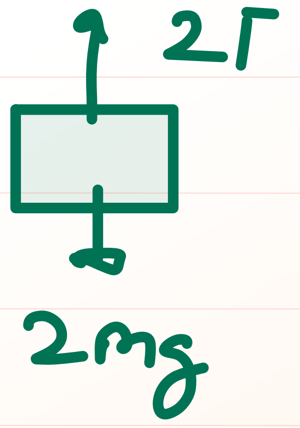
$a_1 = 2a_2 \quad \text{—} (1)$

F.B.D of A



$T - mg = ma_1 \quad (1)$

F.B.D of B



$2mg - 2T = 2ma_2$

$mg - T = ma_2 \quad \text{—} (2)$

add Eq (1) and (2)

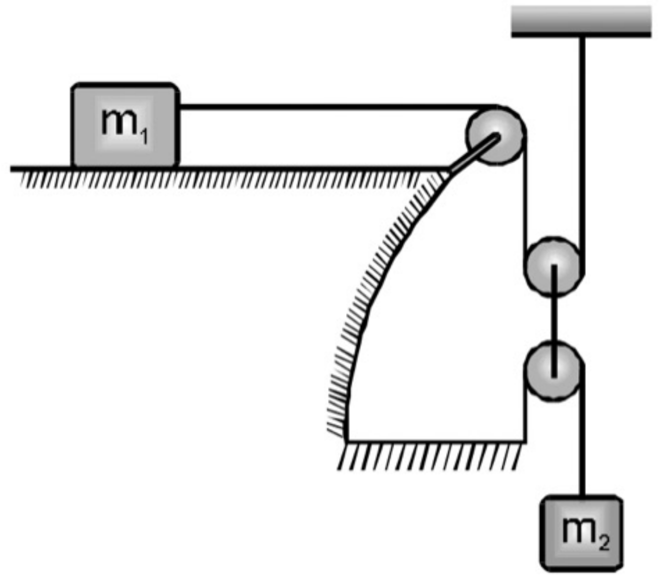
$0 = m(a_1 + a_2) \Rightarrow a_1 + a_2 = 0$

$2a_2 + a_2 = 0$

$\boxed{\begin{array}{l} a_2 = 0 \\ a_1 = 0 \end{array}}$

Ans

21. Two blocks of masses m_1 and m_2 are connected as shown in the figure. The acceleration of the block m_2 is:

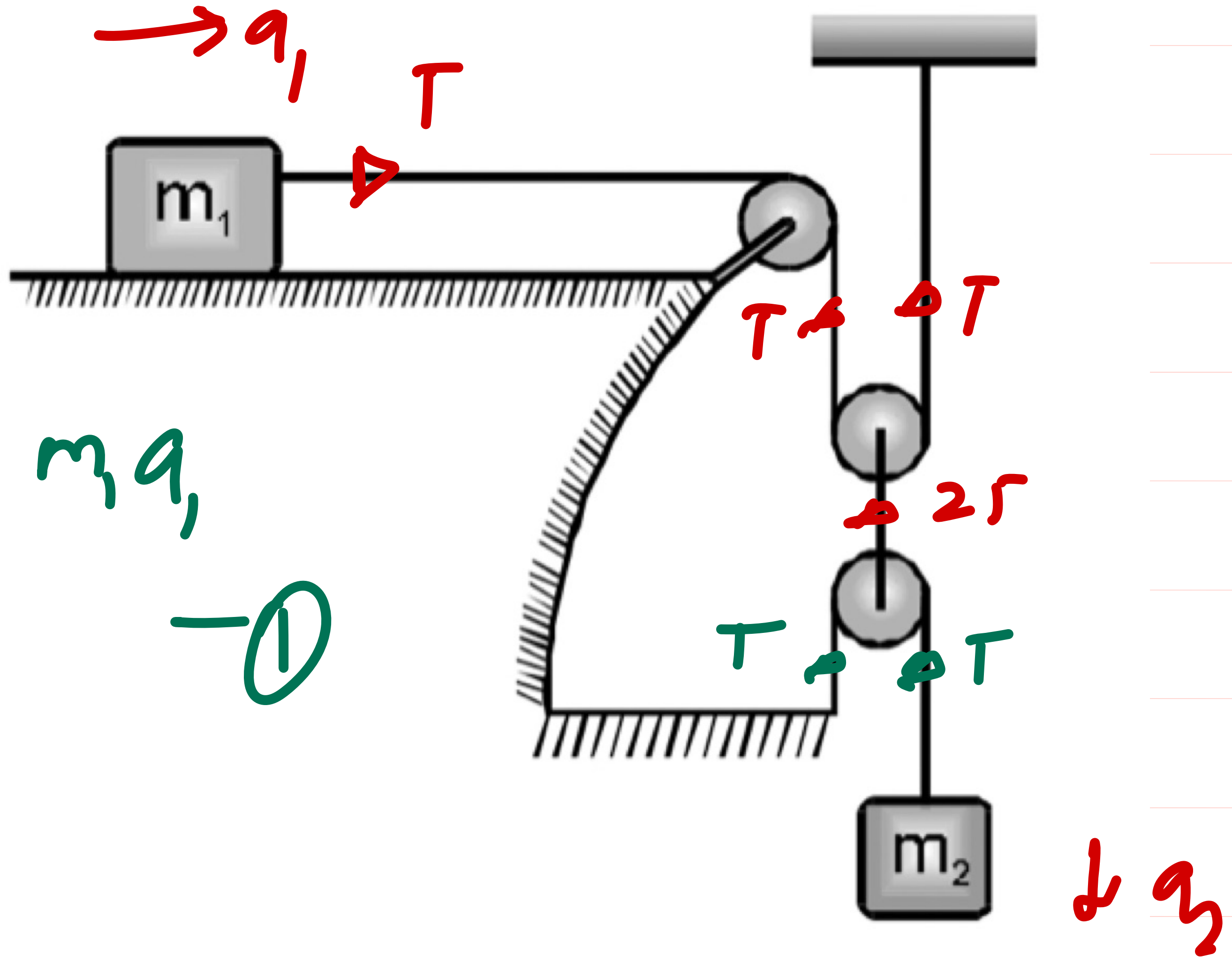


(A) $\dfrac{m_2 g}{m_1 + m_2}$

(B) $\dfrac{m_1 g}{m_1 + m_2}$

(C) $\dfrac{4 m_2 g - m_1 g}{m_1 + m_2}$

(D) $\dfrac{m_2 g}{m_1 + 4m_2}$



$T = m_1 a_1$ —(1)

$T a_1 - T a_2 = 0$

$\boxed{a_1 = a_2}$

$m_2 g - T = m_2 a_2$ —(2)

add Eq (1) & (2)

$m_2 g = m_1 a_1 + m_2 a_2$

$m_2 g = (m_1 + m_2) a_2$

$a_2 = \dfrac{m_2 g}{m_1 + m_2}$