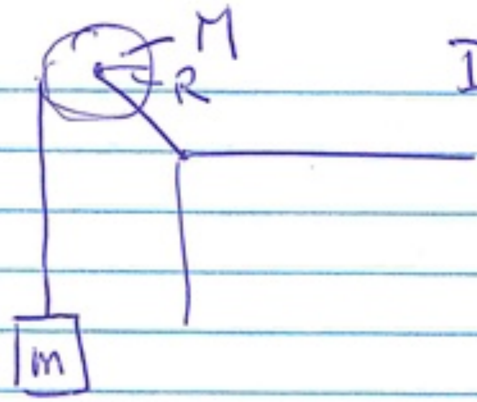
Example 7



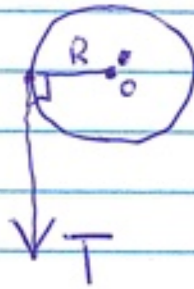
$I = \frac{1}{2} M R^2$

$M = 2.5\,kg$
$R = 0.20\,m$

$m = 1.2\,kg$.

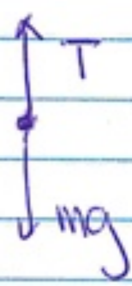
free-body diagram

disc



$$\sum \tau_o = RT = I\alpha$$
$$= \frac{1}{2} M R^2 \alpha$$
$$\therefore T = \frac{1}{2} M R \alpha \qquad (1)$$

block



$$\sum F_y = T - mg = ma \qquad (2)$$

Relationship is $\boxed{a = -\alpha R}$

$$T = \frac{1}{2} M R \alpha$$
$$= -\frac{1}{2} M a \qquad \text{using } \alpha = -\frac{a}{R}$$
$$= ma + mg$$
$$\therefore \left(m + \frac{1}{2} M\right) a = -mg$$
$$\therefore a = -\frac{mg}{m + \frac{1}{2} M}$$

$$T = -\frac{1}{2} M a$$

$$a = -4.8 \frac{m}{s^2}$$

$$T = 6.0\,N$$

$$v^2 = v_i^2 + 2a\Delta y \qquad v_i = 0$$

$$= 2a\Delta y \qquad \Delta y = -h.$$

$$\Rightarrow v^2 = 2.2 \frac{m}{s} \qquad (\text{Put } h = 0.5m)$$

Example 8

$$\Delta E = 0 = \Delta K + \Delta U$$

$$\Delta K = K_f - K_i \qquad K_i = 0$$

$$K_f = \frac{1}{2} m v^2 + \frac{1}{2} I \omega^2$$

$$\boxed{v = -\omega R}$$

$$\therefore K_f = \frac{1}{2} m v^2 + \frac{1}{2}\left(\frac{1}{2} M R^2\right)\left(\frac{v}{R}\right)^2$$

$$= \frac{1}{2} v^2 \left(m + \frac{1}{2} M\right)$$

$$\Delta U = mg\Delta y = -mgh \qquad (\Delta y = -h)$$

$$\therefore \Delta K = -\Delta U$$

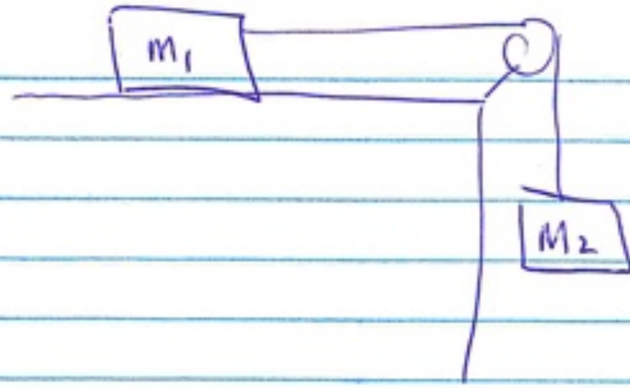
$$\therefore \frac{1}{2} v^2 \left(m + \tfrac{1}{2} M\right) = mgh$$

$$\Rightarrow v^2 = 2gh\left(\frac{m}{m + \frac{1}{2}M}\right)$$

$$= 2a\Delta y = -2ah$$

$$\Rightarrow \boxed{a = -g \frac{m}{m + \frac{1}{2}M}} \text{ as before.}$$

Example 9

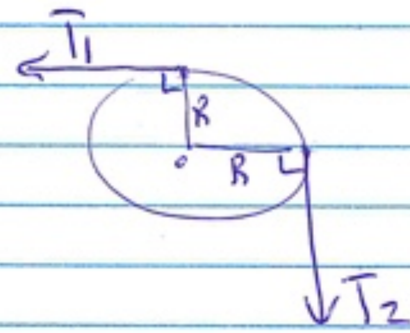


Using F = ma

m_1)

$$T_1 = m_1 a_1 \qquad (1)$$

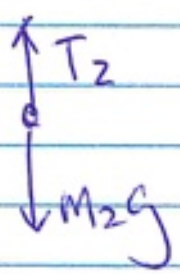
pulley)



$$\tau_o = T_1 R - T_2 R$$

$$= I\alpha \qquad (2)$$

m_2)



$$T_2 - m_2 g = m_2 a_2 \qquad (3)$$

$$\boxed{a_2 = -a_1}$$ (opposite sign)

$$\boxed{a_2 = \alpha R}$$ (same sign)

$$\therefore \; T_2 = m_2 a_2 + m_2 g$$

$$T_2 = -m_2 a_1 + m_2 g$$

$$T_1 = m_1 a_1$$

$$T_1 - T_2 = \frac{I\alpha}{R} = -\frac{1}{2} m_3 \frac{a_1}{\cancel{R}}$$

using $I = \frac{1}{2} m_3 R^2$ and $\alpha = -\frac{a_1}{R}$

Solve to get

$$\therefore \; a_1 = + \frac{m_2}{(m_1 + m_2 + \frac{1}{2} m_3)} g$$