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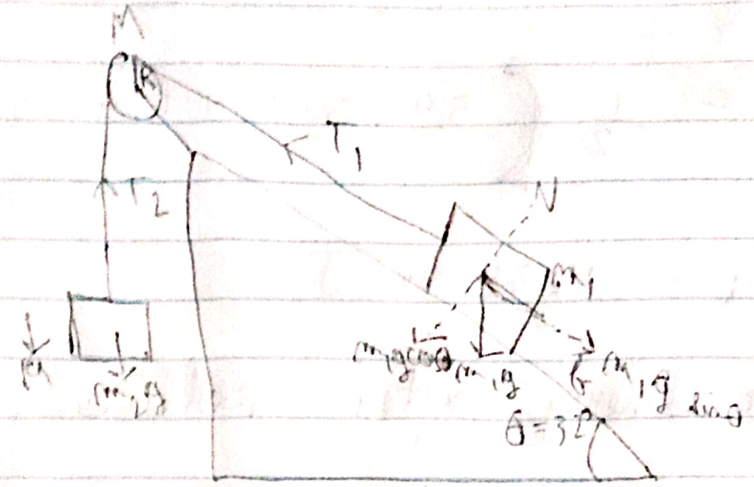
PHYS-230
LAB QUIZ #8

Ans.-



Here,

$M = 3.67$ kg
$R = 0.67$ m
$m_1 = 4.32$ kg
$m_2 = 8.54$ kg
$\theta = 32°$
$\mu_k = 0.23$

Let the linear acceleration of the system be a m/s.

For block of mass m_1 :-

normal reaction, $N = m_1 g \cos\theta$

~~frictional~~ frictional force, $f = \mu_k N$

$= \mu_k m_1 g \cos\theta$

[μ_k = co-efficient of friction]

(P.T.O)

(1)

$\therefore \; T_1 = m_1 g \sin\theta + f + m_1 a$

$\Rightarrow T_1 = m_1 g \sin\theta + \mu_{1k} m_1 g \cos\theta + m_1 a \rightarrow (1)$

From block of mass m_2 :-

$$m_2 g = T_2 + m_2 a$$

$$\Rightarrow T_2 = m_2 (g - a) \rightarrow (2)$$

From the pulley of mass M & radius R :-

Moment of inertia, $I = \frac{1}{2} M R^2$

$\therefore \; (T_2 - T_1) R = I \alpha \quad \left[\alpha = \frac{a}{R} \text{ (angular acceleration)} \right]$

$\Rightarrow (T_2 - T_1) R = \frac{1}{2} M R^2 \alpha$

$\therefore \; (T_2 - T_1) R = \frac{1}{2} M R^2 \frac{a}{R}$

$\Rightarrow [m_2 (g - a) - (m_1 g \sin\theta + \mu_{1k} m_1 g \cos\theta + m_1 a)] R = \frac{1}{2} M R a$

(Combining the values from (1) & (2))

$\Rightarrow m_2 g - m_2 a - m_1 g \sin\theta - \mu_{1k} m_1 g \cos\theta - m_1 a = \frac{1}{2} M a$

$\Rightarrow m_2 g - m_1 g \sin\theta - \mu_{1k} m_1 g \cos\theta = (\frac{1}{2} M + m_2 + m_1) a$

(2)

P.T.O

$$\Rightarrow a = \frac{(m_2 g - m_1 g \sin\theta - \mu_k m_1 g \cos\theta)}{(\frac{1}{2}M + m_2 + m_1)}$$

$$\Rightarrow a = \frac{8.54 \times 9.81 - 4.32 \times 9.81 \times \sin 32^\circ - 0.23 \times 4.32 \times \cos 32^\circ}{\frac{3.67}{2} + 8.54 + 4.32}$$

$$\Rightarrow a = 4.12\ m/s^2$$

$\therefore$ The acceleration of the system is $4.12\ m/s^2$

The direction of the acceleration is from the bottom to the top of the inclined plane from m_1 to m_2, since $m_2 g > m_1 g \sin\theta$.