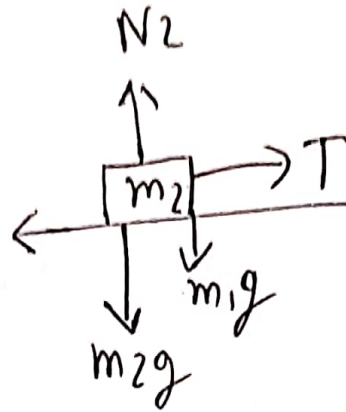
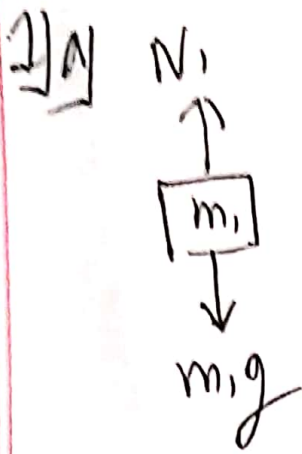


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Sec: 08



Free body diagram

For block M, we can write,

$$T - Mg = 0$$

$$\therefore T = Mg \quad \text{--- ①}$$

For block m2, we can write,

$$T - \mu_2(m_1 + m_2)g = 0$$

$$\therefore T = \mu_2(m_1 + m_2)g \quad \text{--- ②}$$

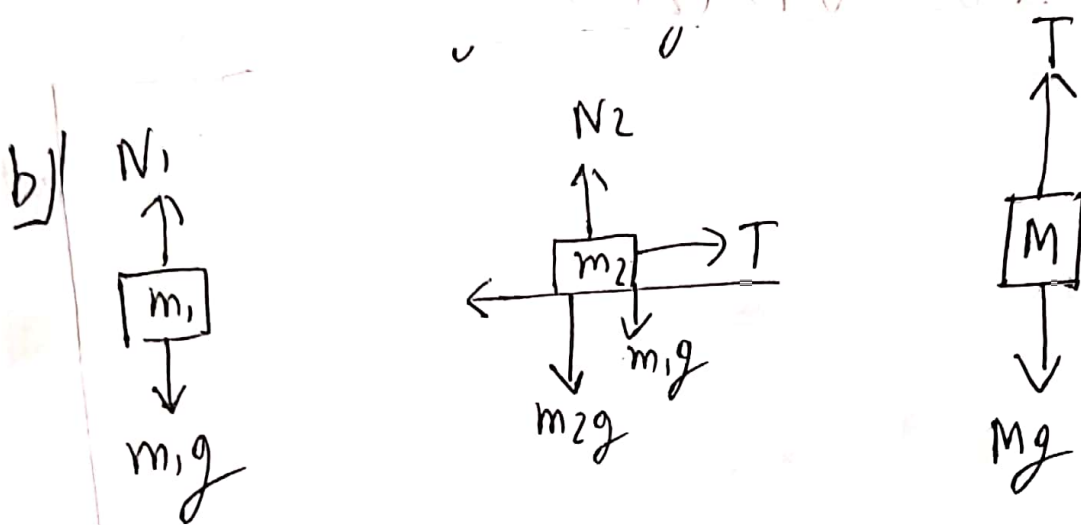
From ① and ② we get,

$$\mu_2(m_1 + m_2)g = Mg$$

$$\Rightarrow 0.3(2 + 3) = M$$

$$\Rightarrow M = 1.5 \text{ kg}$$

✓ The blocks can remain at rest if the value of  $M$  is  $1.5 \text{ kg}$ .



Free body diagram

① Ans: If the blocks move together,

For block  $M$ ,

$$Mg - T = Ma \quad \text{--- (1) [As it is going to accelerate downwards]}$$

For block  $m_2$ ,

$$T - \mu_2 k (m_1 + m_2) g = (m_1 + m_2) a \quad \text{--- (2) [As it is going forwards tension]}$$

① + ② ,

$$m_1 g - \mu_2 k (m_1 + m_2) = m_1 a + (m_1 + m_2) a$$

$$\Rightarrow 2.5 \times 9.8 - 0.15 (2+3) = (2.5 + 2+3) a$$

$$\Rightarrow a = 2.2867 \text{ ms}^{-2}$$

The force block  $m_1$  feels for the acceleration is  $\vec{a}$  and the tension,

$$F = m_1 a$$

$$= 2 \times 2.2867$$

$$= 4.5733 \text{ N}$$

The friction force of  $m_1$  is,

$$F_f = \mu_1 m_1 g$$

$$= 0.2 \times 2 \times 9.8$$

$$= 3.92 \text{ N}$$

As  $F_1 > F_s$

∴ Block 1 will get slipped from block-2

As it got slipped from block-2 they are not going to move together

Block 1 will remain at rest.

So the acceleration  $a_1 = 0 \text{ ms}^{-2}$

∴ Acceleration of block-1  $a_1 = 0 \text{ ms}^{-2}$

⑪ Ans:

As block-1 is no longer in the system

We can write,

For M block,

$$Mg - T = Ma_2$$

— (1)

[ $a_2$  is unknown because block 1 is no longer in the system]



For  $m_2$  block,

$$T - \mu_{2k} m_2 g = m_2 a_2 \quad \text{--- (11)}$$

① + ⑪

$$mg - \mu_{2k} m_2 g = a_2 (m + m_2)$$

$$\Rightarrow 2.5 \times 9.8 - 0.15 \times 3 \times 9.8 = a_2 (5.5)$$

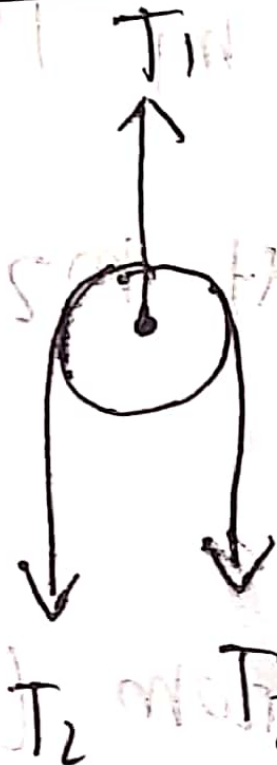
$$\Rightarrow a_2 = \cancel{3.0} 3.6527 \text{ ms}^{-2}$$

The acceleration of block 2,  $a_2 = 3.6527 \text{ ms}^{-2}$  (Ans)

2]

a]

$a_1 \uparrow$



$a_2 \downarrow$

Free body Diagram of the system

b) Newton's 2nd law on block-2

$$F_{\text{net}} = m_2 a_2$$

$$m_2 g - T_2 = m_2 a_2 \quad \text{--- (1)}$$

From the concept of force balance of pulley

$$T_1 = T_2 + T_2$$

$$\Rightarrow T_1 = 2T_2$$

Newton's 2nd law on block-1

$$F_{\text{net}} = m_1 a_1$$



$$T_1 - m_1 g = m_1 a_1 \quad \text{--- (I)}$$

We know, if one end of the string is fixed then the acceleration of the moveable pulley,

$$a_2 = -2a_1$$

For block - 1,

$$2T_2 - m_1 g = -m_1 \frac{a_2}{2} \quad \text{--- (II)}$$

For block - 2

$$m_2 g - T_2 = m_2 a_2$$

$$\Rightarrow 2m_2 g - 2T_2 = 2m_2 a_2 \quad \text{--- (III)}$$

$$\text{(I) + (III)}$$

$$2T_2 - m_1 g = -m_1 \frac{a_2}{2}$$

$$2m_2 g - 2T_2 = 2m_2 a_2$$

---


$$2m_2 g - m_1 g = a_2 \left( 2m_2 - \frac{m_1}{2} \right)$$

We know,

$$T_1 - m_1 g = m_1 a_1$$

$$\Rightarrow T_1 = m_1 (a_1 + g)$$

$$T_2 - m_2 g = m_2 a_2$$

$$T_2 = m_2 (g - a_2)$$

$$= m_2 (g + 2a_1)$$

As,

$$T_1 = 2T_2$$

$$\Rightarrow m_1 (a_1 + g) = 2m_2 (g + 2a_1)$$

$$\Rightarrow m_1 a_1 + m_1 g = 2m_2 g + 4m_2 a_1$$

$$= a_1 (4m_2 - m_1) = m_1 g - 2m_2 g$$

$$\Rightarrow a_1 = \frac{m_1 g - 2m_2 g}{4m_2 - m_1} = 3.267 \text{ ms}^{-2}$$

$$a_2 = -2 \times a_1$$

$$= -6.533 \text{ ms}^{-2}$$

In the question we are told to take downward as positive and upward as negative.

$$\therefore \text{Acceleration at } m_1 \text{ is } a_1 = -3.27 \text{ ms}^{-2}$$

$$\therefore \text{Acceleration at } m_2 \text{ is } a_2 = 6.533 \text{ ms}^{-2}$$

e) As we know from (b) is a part,

$$a_1 = +3.27 \text{ ms}^{-2}$$

$$a_2 = -6.533 \text{ ms}^{-2}$$

$$T_1 = m_1 (a_1 + g)$$

$$= 5 (-3.27 + 9.8)$$

$$= 32.65 \text{ N} \quad 65.35 \text{ N}$$

$$T_2 = m_2(g - a_2)$$

$$= 2(9.8 + 6.53)$$

$$= 32.68 \text{ N}$$

3) Speed of the drum  $v = 4.7 \text{ m/s}$   
Radius of the drum given in the question,

$$R = 0.3 \text{ m}$$

$$\therefore \text{Angular velocity } \omega = \frac{v}{R} = \frac{4.7}{0.3} = 15.667 \text{ rad/s}$$

From Newton's second law we get,  $F = mg$

$$\therefore \cancel{F} = mg$$

$$\therefore \mu_s F = mg$$

$$\Rightarrow \mu_s m \omega^2 R = mg$$

$$\therefore \mu_s = \frac{mg}{m \omega^2 R} = \frac{g}{\omega^2 R} = \frac{9.8}{(15.667)^2 \times 0.3} = 0.133$$

$\therefore$  Minimum static friction is  $\mu_s = 0.133$  (Ans)

b) We know that,  $\mu_s m \omega^2 R = mg$

$$\Rightarrow \mu_s = \frac{g}{\omega^2 R}$$

So, we can say that sock will not slide down, because coefficient does



not depends on mass. It only depends on acceleration (gravitational force), radius angular velocity. ~~As from~~ so we can say that, the sock will not slide down.

c) we know from (a)

$$\omega = 15.667 \text{ rad s}^{-1}$$

$$\omega_f = \omega - \alpha t$$

$$\Rightarrow t = \frac{\omega - \omega_f}{\alpha}$$

$$= \frac{0 - 15.667}{-3.25}$$

$$t = 4.82063 \text{ sec}$$

After 4.82063 s the drums stops.

We know,

$$\omega_f^2 = \omega^2 - 2\alpha\theta$$

$$\Rightarrow \theta = \frac{\omega^2 - \omega_f^2}{2\alpha}$$

$$= \frac{0 - (15.667)^2}{-2(3.25)}$$

$$= 37.762 \text{ rad}$$

$$\therefore \theta = 37.6$$

$$\therefore \theta = 37.762 \text{ rad}$$

$$= 6 \text{ rev}$$

It makes 6 rev before coming to rest