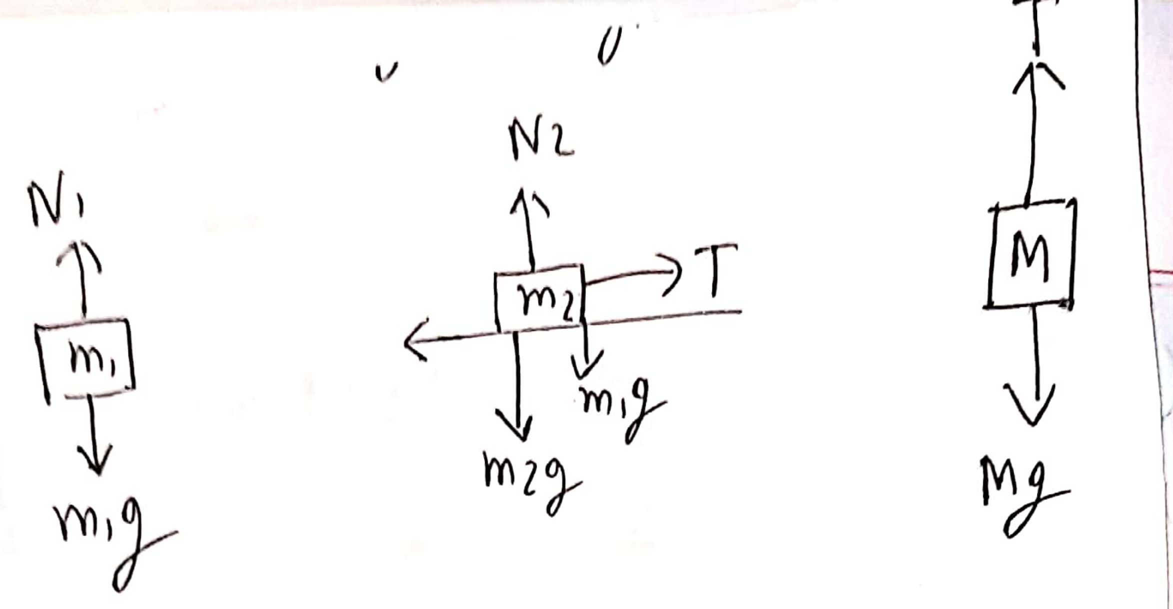
1) A



Free body diagram

For block M, we can write,

$$T - Mg = 0$$

$$\therefore T = Mg \quad \text{— (i)}$$

For block m2, we can write,

$$T - \mu_s(m_1 + m_2)g = 0 \quad \text{— (ii)}$$

$$\therefore T = \mu_s(m_1 + m_2)g$$

From (i) and (ii) we get,

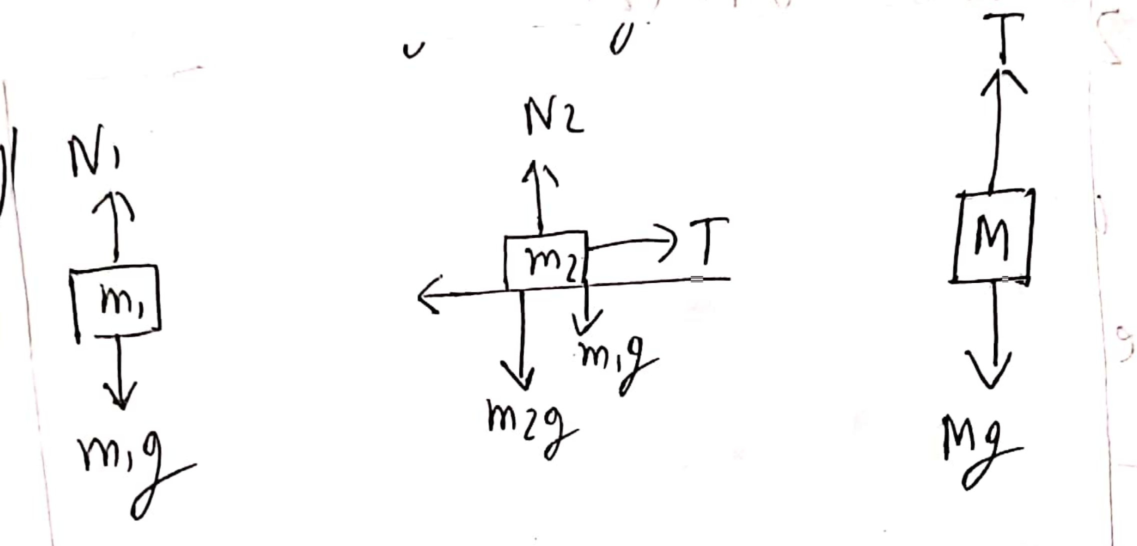
$$\mu_s(m_1 + m_2)g = Mg$$

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

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

The blocks can remain at rest if the value of M is 1.5 kg.

b)



Free body diagram

① Ans: If the blocks move together,

For block M,

$Mg - T = Ma$ — ① [As it is going to accelerate downwards]

For block m_2,

$T - \mu_{2k}(m_1 + m_2)g = (m_1 + m_2)a$ — ⑪ [As it is going forwards tension]

(i) + (ii),

$Mg - \mu_{2k}(m_1+m_2) = Ma + (m_1+m_2)a$

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

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

The force block m_1 feels for the accelaration ~~is an~~ and the tension,

$F = m_1 a$

$= 2 \times 2.2867$

$= 4.5733 \ N$

The friction force of m_1 is,

$F_s = \mu_{1s} m_1 g$

$= 0.2 \times 2 \times 9.8$

$= 3.92 \ N$

As $F_i > F_s$

∴ ~~B~~ Block 1 will get slipped from block-2

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

~~B1~~ Block 1 will remain at rest.

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

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

(11) Ans:

As block-1 is no ~~lo~~ longer in the syste

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,

$T - \mu_{2k} m_2 g = m_2 a_2$ — (ii)

(i) + (ii)

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

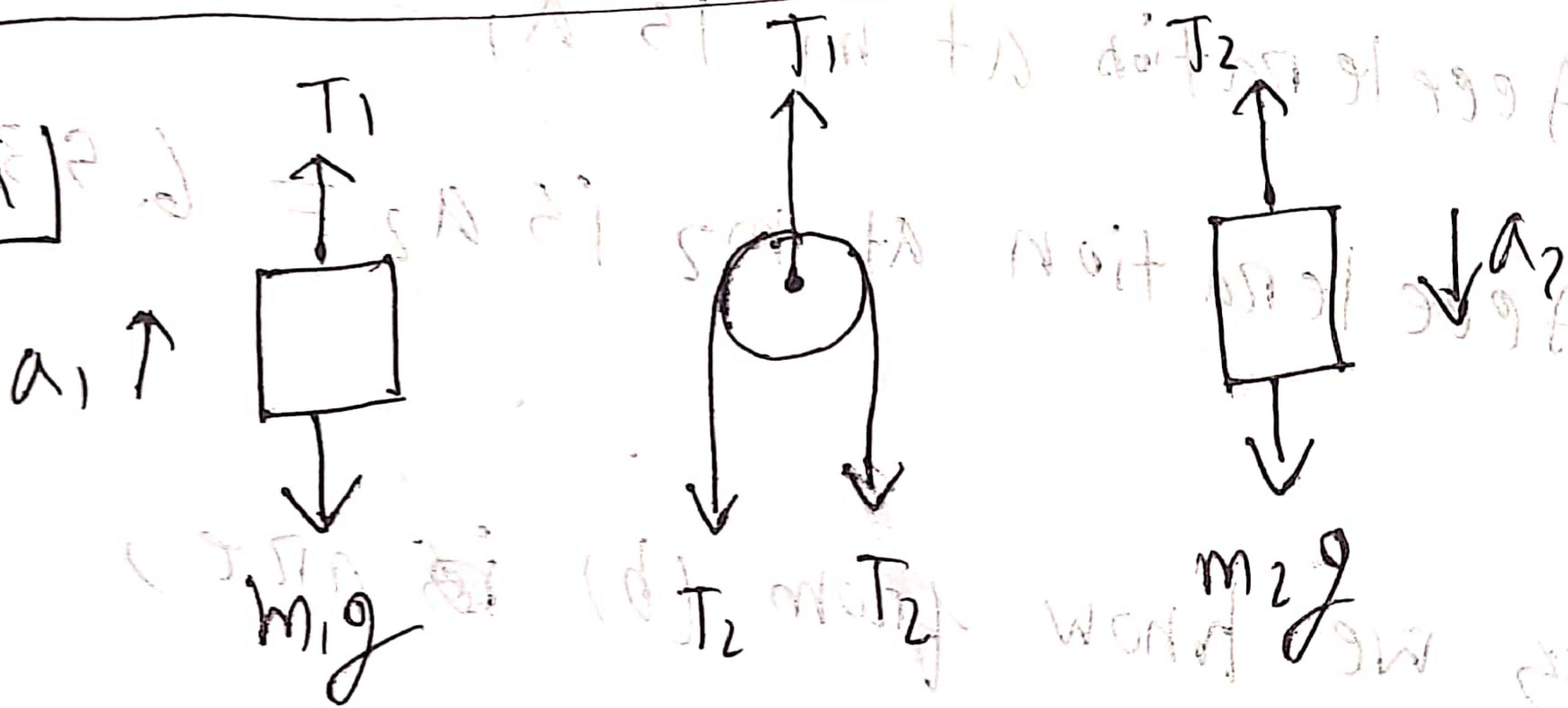
$\Rightarrow 2.5 \times 9.8 - 0.15 \times 3 \times 9.8 = a_2 (5.5)$

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

The acceleration of block 2 $a_2 = 3.6527 ms^{-2}$

(Ans)

2] a]



Free body Diagram of the system

b) Newtons 2nd law on block-2,

$F_{net} = m_2 a_2$

$m_2 g - T_2 = m_2 a_2$ —— (1)

From the concept of force balance of pulley

$T_1 = T_2 + T_2$

$\Rightarrow T_1 = 2T_2$

Newtons 2nd law on block-1,

$F_{net} = m_1 a_1$

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$T_1 - m_1 g = m_a a_1$ — (ii)

we know, if one end of the string is fixed

then the acceleration of the moveable pulley,

$a_2 = -2a_1$

For bloc-1,

$2T_2 - m_1 g = -m_1 \frac{a_2}{2}$ — (i)

For block-2

$m_2 g - T_2 = m_2 a_2$

$\equiv 2m_2 g - \cancel{2}2T_2 = 2m_2 a_2$ — (ii)

(i) + (ii)

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

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

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

We know,

$T_1 - m_1 g = m_1 a_1$

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

$m_2 g - T_2 = m_2 a_2$

$T_2 = m_2 (g - a_2)$

$= m_2 (g + 2a_1)$

As,

$T_1 = 2T_2$

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

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

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

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

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$a_2 = -2 \times a_1$

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

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

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

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

e) As we know from (b) a.r.e.,

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

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

$T_1 = m_1(a_1 + g)$

$= 5(-3.27 + 9.8)$

$= \cancel{32.65 N}\ 65.35\ N$

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

$$= 2(9.8 + 6.53)$$

$$= 32.68\ N$$

3] a) Speed of the drum $v = 4.7 ms^{-1}$

Radius of the drum given in the question,

$r = 0.3 m$

$\therefore$ Angular velocity $\omega = \frac{v}{r} = \frac{4.7}{0.3} = 15.667 rad s^{-1}$

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 (gravitional force), radius angular velocity. ~~As from t~~ So we can say that, the sock will not slide down.

c) We know from (a)

$w = 15.667 \ rad s^{-1}$

$w_f = w - \alpha t$

$\Rightarrow t = \dfrac{w - w_f}{\alpha}$

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

$= 4.82063$ sec

After 4.82063 s the drums stops.

we know,

$$w_f^2 = w^2 - 2\alpha\theta$$

$$\Rightarrow \theta = \frac{w^2 - w_f^2}{2\alpha}$$

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

$$= 37.762 \text{ rad}$$

$\therefore \cancel{\theta = 37.6}$

$\therefore \theta = 37.762$ rad

$= 6$ rev

It makes 6 rev before coming to rest