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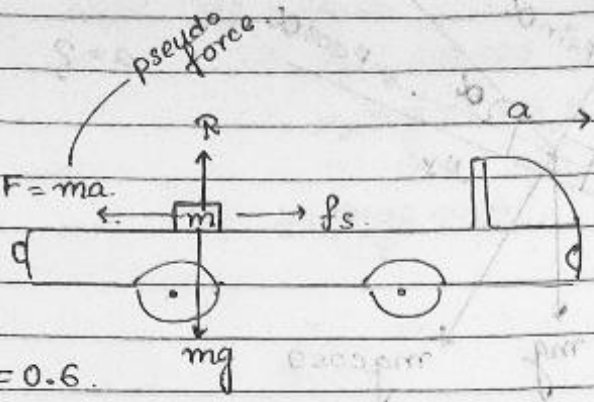
DOSE – I

1)



$f_s = \mu_s R$
$= \mu_s mg$
$= 0.6 \times 1 \times 10$
$= 6\ N$

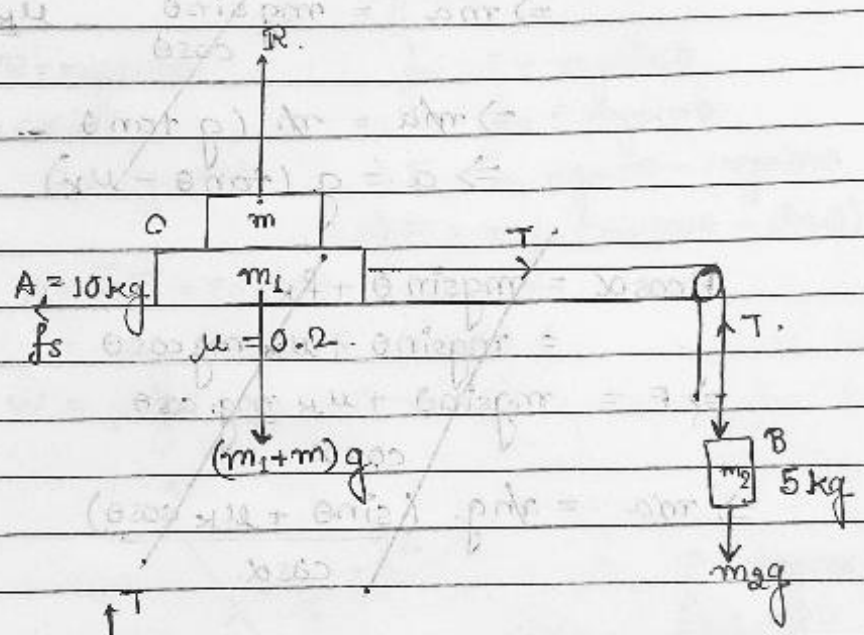
$\mu_s = 0.6$
$a = 5\ m/s^2$

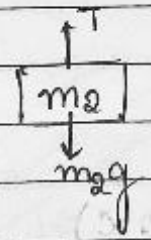
Ans) 6 N → limiting friction.

$F = m \times a$
$= 1\ kg \times 5\ ms^{-2}$
$= 5\ N$

Ans) 5 N

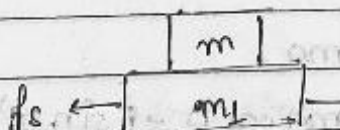
2)





$T = m_2g = 5 \times 10 = 50\ N$

$R = (m_1+m)g$



$f_s = \mu mg$
$= \mu (m_1+m)g$
$= 0.2(10+m) \times 10$

$f_s = T$

$T = 0.2(10+m) \times 10$

$\Rightarrow 50 = 2(10+m)$

$\Rightarrow 10+m = 25$

$\Rightarrow m = 15\ kg$ (Ans).

29-7-21

Numericals.

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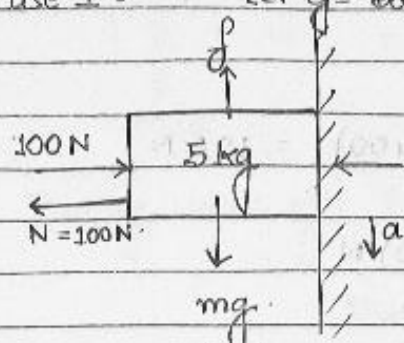
3) Case I: Let $g = 10\ m/s^2$ / $9.8\ m/s^2$



$N = 100\ N$.

$f_s = \mu_s N$

$= 0.4(100)$

$= 40\ N$

$f_K = \mu_K N$

$= 0.3(100) = 30\ N$

$mg > f_s$

∴ Body accelerates downwards.

$F_{net} = mg - f_K = 50 - 30 = 20\ N$.

$F = ma$ $\quad \therefore a = \frac{F_{net}}{m} = \frac{20}{5} = 4\ m/s$. (Ans)

Case II

$f_s = \mu_s N$

$= 0.4 \times 500 = 200\ N$

$f_k = \mu_K N$

$= 0.3 \times 500 = 150\ N$.

$mg < f_s$. $\quad F_{net} = 50 - 50 = 0\ N$

Block does not slide down

$a = 0\ m/s^2$.

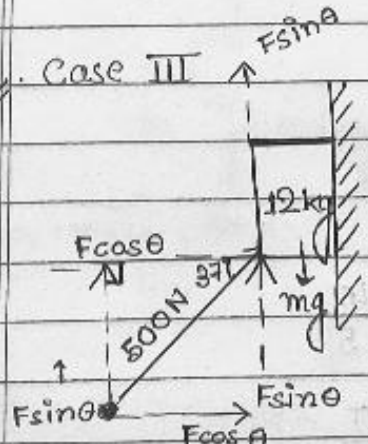
$f_s = mg = 50\ N$

(self-adjusting force)

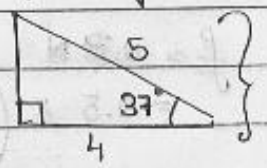
$\mu_K = 0.3$.

$\mu_S = 0.4$

Imp. Case III



{Pythagorean Angle



}

$F\sin 37^\circ = 500 \times \frac{3}{5} = 300\ N$.

$F\cos 37^\circ = 500 \times \frac{4}{5} = 400\ N$.

$\mu_K = 0.3$.

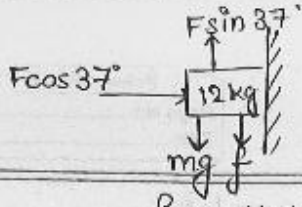
$\mu_S = 0.4$

$mg = 120\ N$

Body has tendency to move up.

$mg < F\sin 37^\circ$

friction acts downwards.



$f_s = \mu_s N$ $\quad N = F\cos 37° = 400\ N$

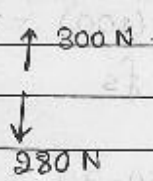
$= (0.4)\,400$

$= 160\ N$

$f_K = \mu_K N = (0.3)(400) = 120\ N$

Downward → $(160 + 120)\ N$

$= 280\ N$



Body move upward

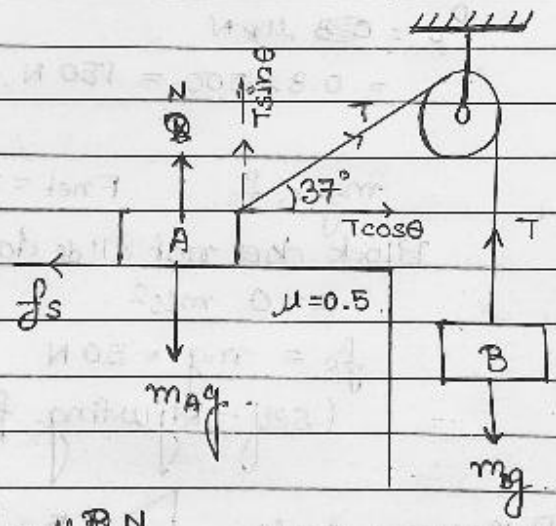
$F_{net} = 300 - (120+120)$

$= 60\ N.$

$\frac{F_{net}}{m} = a \quad \Rightarrow a = \frac{60}{12} = 5\ m/s^2$

Ans) $5\ m/s^2$

4)



$\cos 37 = 4/5.$

$\sin 37 = 3/5.$

$N + T\sin 37 = m_A g$

$\Rightarrow N = m_A g - T \times \frac{3}{5}.$

$f_s = \mu_B N$

$= 0.5 \times \left(m_A g - \frac{3T}{5}\right).$

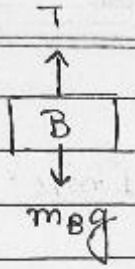
In equilibrium, $f_s = T\cos 37 = \frac{4T}{5}.$

$\frac{1}{2}\left(m_A g - \frac{3T}{5}\right) = \frac{4T}{5}.$

$\Rightarrow m_A g - \frac{3T}{5} = \frac{8T}{5}.$

$\Rightarrow 5 m_A g - 3T = 8T.$

$\Rightarrow m_A g = \frac{11T}{5} \quad \text{—(i)}.$



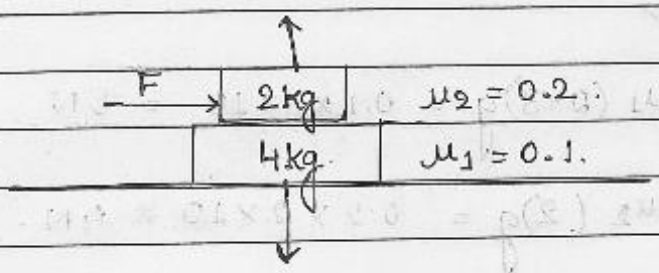
$T = m_B g$ — (ii)

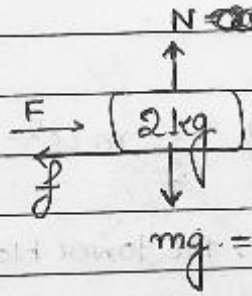
Putting value of T in previous eq. (i).

$$m_A g = \frac{11}{5}(m_B g)$$

$$\Rightarrow \frac{m_A g}{m_B g} = \frac{11}{5} \qquad \Rightarrow \frac{m_A}{m_B} = \frac{11}{5} \quad \text{(Ans)}$$

5)

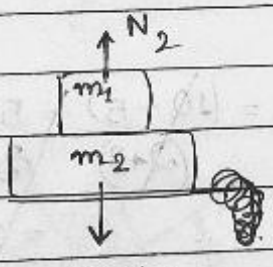




$N = mg = 20\ N.$

$f_s = \mu_s N = 0.2 \times 20 = 4\ N$

$F_{min} = 4\ N.$



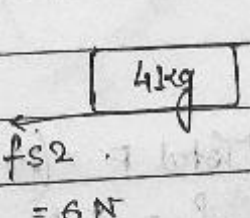
$N_2 = 60\ N$

$f_s = \mu_s \times 60$

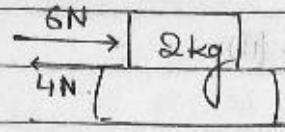
$= 0.1 \times 60$

$= 6\ N.$

$F'_{min} = 6\ N.$

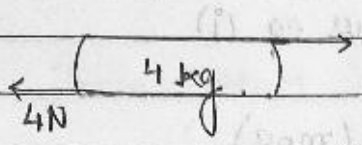


Total $F_{min} = 4N$.



$F_{net} = 2N$

$a = \frac{2}{2} = 1\ m/s^2$

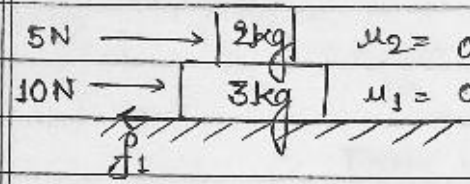


$F'_{net} = 0$

$a = 0$.

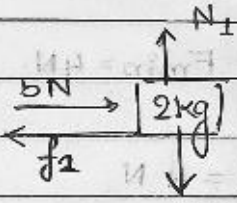
(6N is max.)

6)



$f_1 = \mu_1 (2+3) g = 0.1 \times 5 \times 10 = 5N$

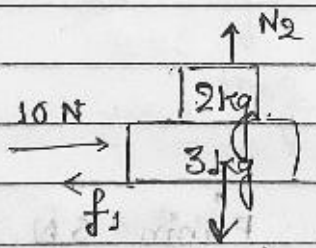
$f_2 = \mu_2 (2) g = 0.2 \times 2 \times 10 = 4N$.



$N_2 = 20\ N$.

$a_1 = \frac{(5-4)}{2} = \frac{1}{2}\ m/s^2$.

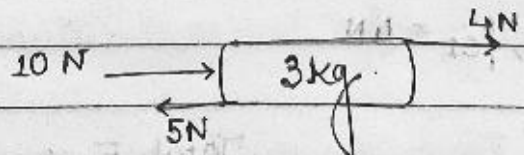
(wrt. the lower block)



$N_2 = 50\ N$.

$a = \frac{(10-5)}{(2+3)} = \frac{5}{5}\ m/s^2$

$= 1\ m/s^2$



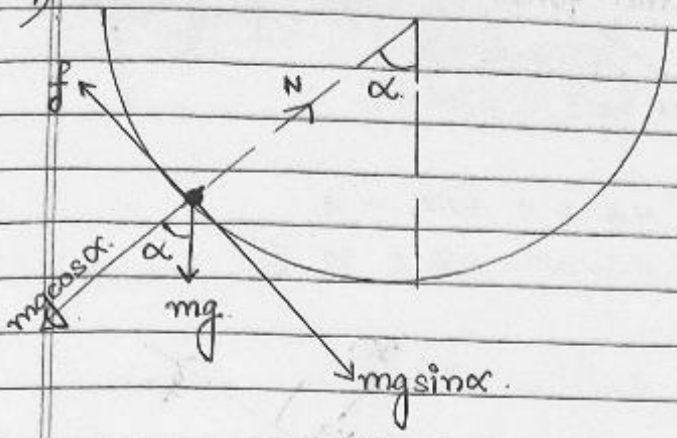
Total F = (10 + 5) = 15N.

$f_1 = 5\ N$.

$F_{net} = (15-5) = 10\ N$

$a = \frac{F_{net}}{M} = \frac{10}{5} = 2\ m/s^2$

7)



$\mu = \frac{1}{3}$

$N = mg\cos\alpha$

$f_s = mg\sin\alpha$

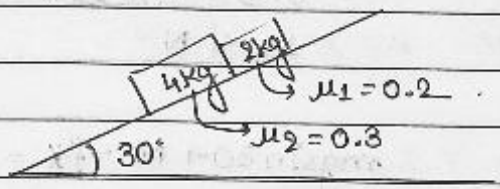
$\frac{mg\sin\alpha}{mg\cos\alpha} = \frac{f_s}{N}$

$\Rightarrow \tan\alpha = \frac{f_s}{N} = \mu = \frac{1}{3}$

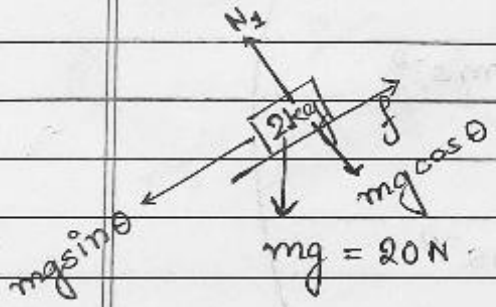
Ans) $\alpha = \tan^{-1}(1/3)$

$\Rightarrow \alpha = \tan^{-1}(1/3)$

8)



Calculate a of 2kg block



$N_1 = mg\cos\theta$

$= (2)(10)\cos 30^\circ$ N

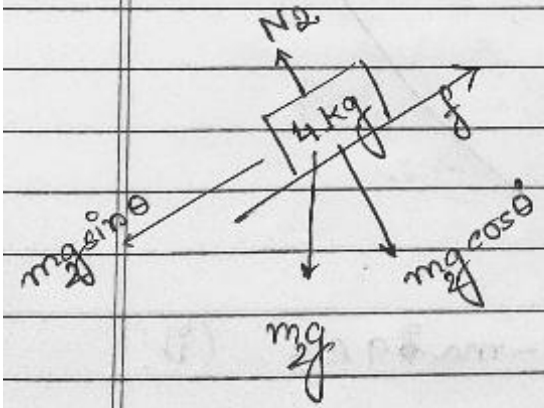
$= 20 \times 0.866 = 17.32$ N.

$mg\sin 30^\circ = 20 \times 0.5 = 10$ N

$f_1 = \mu_1 N = (0.2 \times 17.32)$

$= 3.464$ N

$F_{net} = 10 - 3.46 = 6.54$ N



$m_2g = 4(10) = 40$ N.

$N_2 = m_2 g\cos 30^\circ$

$= 4 \times 10 \times 0.866$

$= 34.64$ N

$m_2 g\sin 30^\circ = 4(10) \times 0.5 = 20$ N.

$f_s = \mu_K \times (mg\cos\theta)$

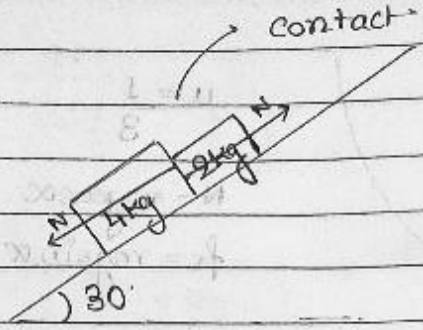
$= 0.3 \times 4 \times 10 \times \cos 30^\circ$

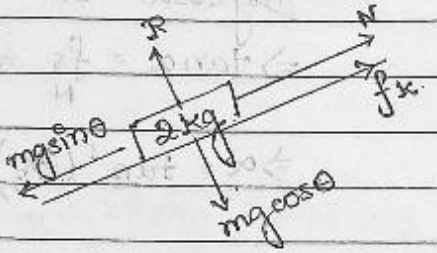
$= 10.4$ N

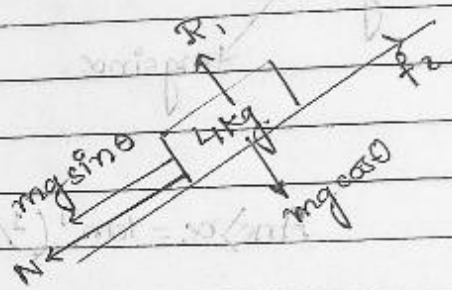
$f_2 = \mu_2 N_2 = 0.3 \times 34.64$

$= 10.392$ N.

$F_{net} = 20 - f_s = 20 - 10.4 = 9.6$ N.







$f_k = 0.2 \times 2 \times 10 \times \cos 30°$

$= 3.46$ N

$f_k = \mu_k * mg\cos\theta$

$= 0.3 \times 4 \times 10 \times \cos 30°$

$= 10.4$ N

$mg\sin 30 + N - f_k = ma$

Acceleration for 2kg body →

$$a = \frac{6.54}{2} = 3.27\ ms^{-2}$$

Acceleration for 4kg body →

$$a = \frac{9.6}{4} = 2.4\ ms^{-2}$$

Both body comes down together.

$\therefore 4 \times 10 \times \frac{1}{2} + N - 10.4 = ma$

$\Rightarrow 20 + N - 10.4 = ma$

$\Rightarrow N - ma = 9.6$ $\Rightarrow N - ma = 9.6$ ... (i)

For 2kg body,

$mg\sin 30 + N - f_k = ma$

$\Rightarrow 2(10)\left(\frac{1}{2}\right) - N - 3.46 = ma$

$\Rightarrow 10 - N - 3.46 = ma$

$\Rightarrow N + ma = 6.54$ — (ii)

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Adding eq. (i) and (ii)

$2N = -3.06$

$\Rightarrow N = -1.02$ N

$N + ma = 6.54$

$\Rightarrow N + 2a = 6.54$ — (i) | $\times 2$.

$N - 4a = -9.6$ — (ii)

$\therefore \quad 2N + 4a = 13.08$

$N - 4a = -9.6$

$3N = 3.48$.

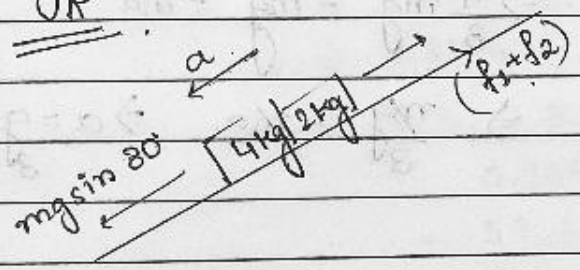
$N = 1.16$ N.

$N + 2a = 6.54 \Rightarrow a = \frac{6.54 - 1.16}{2} = 2.69$

$a \approx 2.7\ ms^{-2}$ (Ans).

OR

8)



$f_1 = \mu_1 m_1 g \cos 30°$

$= 0.2 \times 2 \times 10 \times \cos 30°$

$= 3.46$ N.

$f_2 = \mu_2 m_2 g \cos 30°$

$= 0.3 \times 4 \times 10 \times \cos 30°$

$= 10.4$ N.

$f = f_1 + f_2 = (3.46 + 10.4)$ N $= 13.86$ N

$\therefore (m_1 + m_2) g \sin 30°$

$= 6 \times 10 \times 0.5 = 30$ N.

$F_{net} = (30 - 13.86) = 16.14$ N.

$a = \frac{16.14}{6} = 2.69 \approx 2.7$ N. (Ans).