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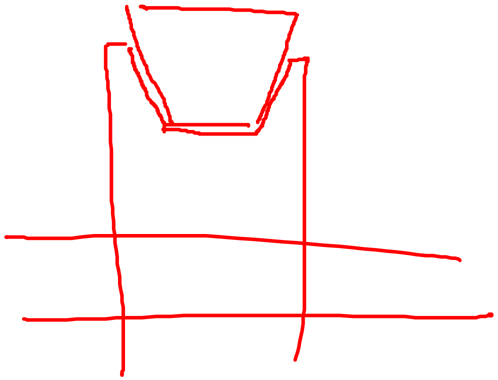
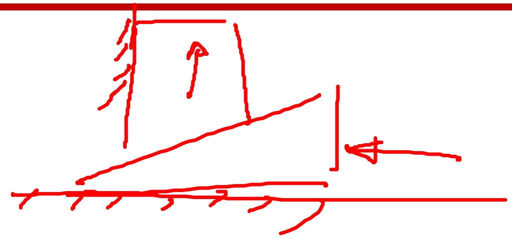
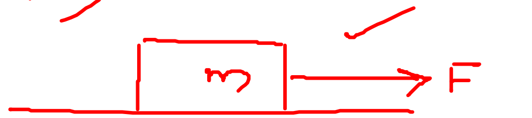
FRICTION

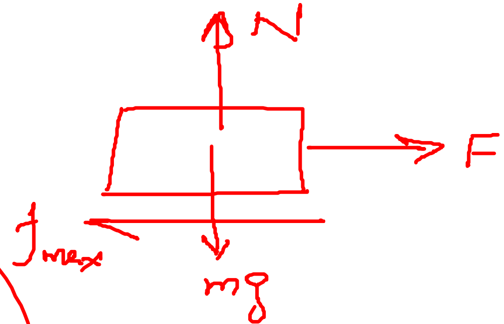


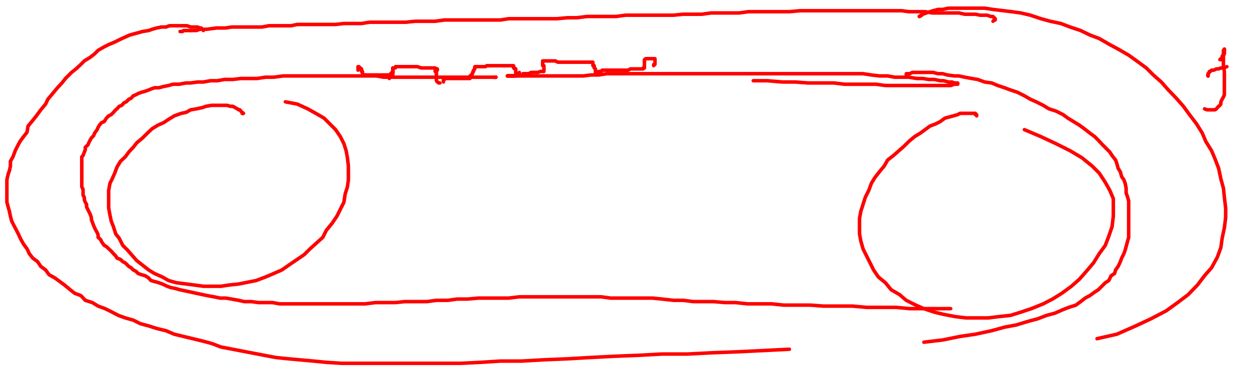
Dry friction

- sliding friction
- wedge friction
- Belt friction
- Screw friction ×









$$f_{max} \propto N$$

$$f_{max} = \mu_s N$$

μ_s — $0 - 0.9$

$mg\sin\theta \le f_{max} = \mu N$

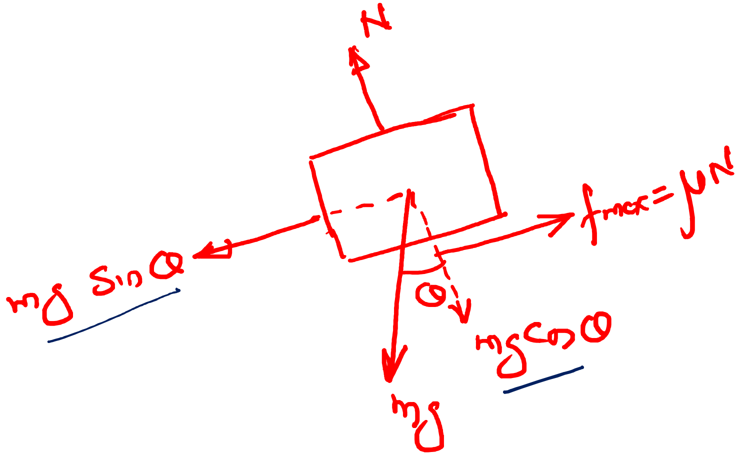
$mg\cos\theta \le N$

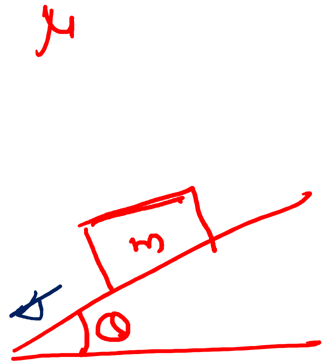
$mg\cos\theta = N$ ✓

$mg\sin\theta = \mu N$

$mg\sin\theta = \mu \cdot mg\cos\theta$

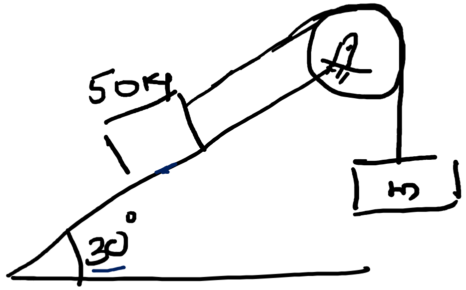
$\mu_s = \tan\theta$ — Angle of friction.





Range for m — for the block will be in equilibrium

$\mu_s = 0.3$

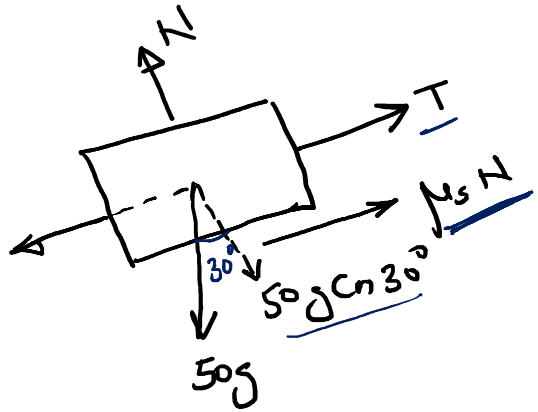


Solution : Two possibilities

(i) — The block can slide down, it mean 'm' should be sufficient to hold it.'

(ii) — Keep increasing 'm', such that the block start to slide upwards,

1st case :- Equilibrium $\parallel$ to the plane



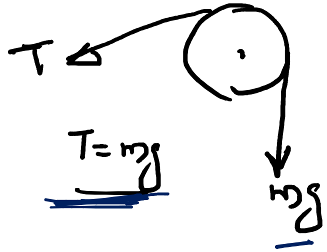
$T + \mu_s N = 50g\sin 30°$ — I

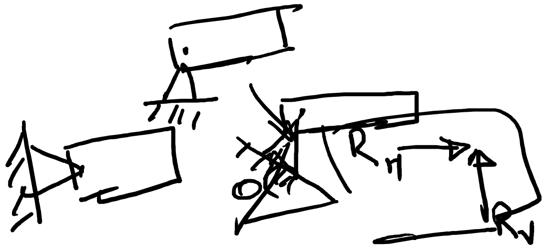
Equilibrium normal to the plane

$N = 50g\cos\theta$

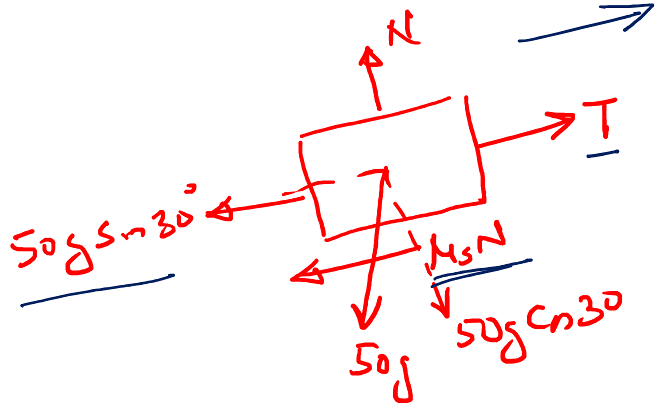
$mg + \mu_s(50g\cos 30°) = 50g\sin 30°$

$\boxed{m = 12\text{ kg}}$





Case II : Tendency to move u/p



$$T = \mu_s N + 50g \sin 30^\circ$$

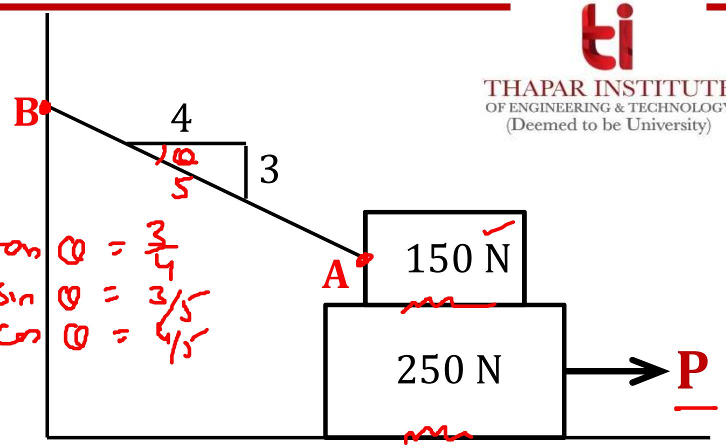
$$N = 50g \cos 30^\circ$$

$$mg = 0.3 \times 50g \cos 30 + 50g \sin 30^\circ$$

$$m = 13 + 25 = 38 \text{ kg.}$$

$$\boxed{\text{Range of } m = 12\text{–}38 \text{ kg}}$$

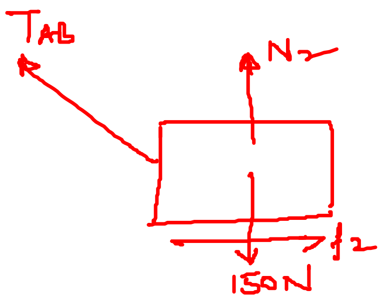
Example: A block of weight 250 N rests on a horizontal surface and also supports another block of weight 150 N on top of it. The upper block is attached to a vertical wall by a string *AB* as shown in the figure. Find the amount of horizontal force ***P***, applied at the lower block necessary for impending slipping. The coefficient of friction for all mating surfaces is 0.3. $\mu_s = 0.3$

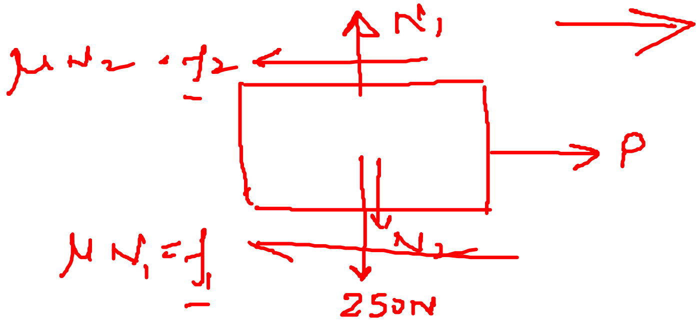


$\tan\theta = \frac{3}{4}$

$\sin\theta = 3/5$

$\cos\theta = 4/5$





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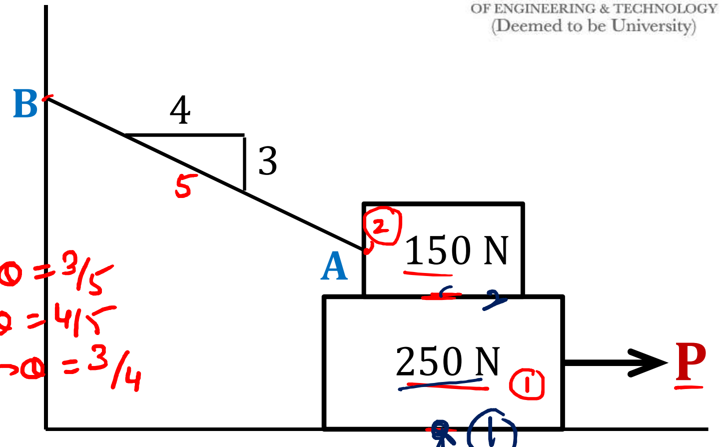


$\sin\theta = 3/5$

$\cos\theta = 4/5$

$\tan\theta = 3/4$

Consider FBD - 2

$\Sigma F_x = 0$, $T\cos\theta = \mu N_2$, $T = \dfrac{\mu N_2}{\cos\theta}$

$\Sigma F_y = 0$, $T\sin\theta + N_2 = 150$

$$N_2 = 150 - \frac{\mu N_2}{\cos\theta}\cdot\sin\theta$$

$$= 150 - 0.3 \times \frac{3}{4}\cdot N_2$$

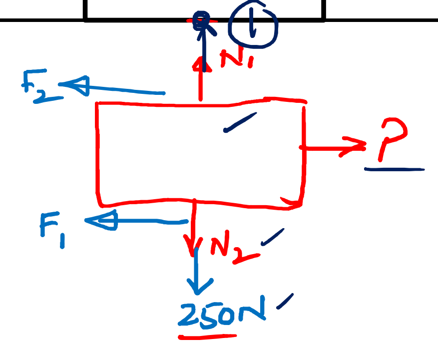
$$\boxed{N_2 = 122.45\,N}$$

Consider FBD-1.

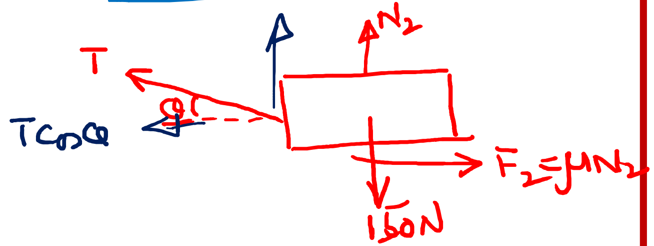
$\Sigma F_y = 0$, $N_1 = N_2 + 250 = 122.45 + 250 = 372.45\,N$

$\Sigma F_x = 0$, $P = \mu N_1 + \mu N_2 = 0.3(372.45 + 122.45)$

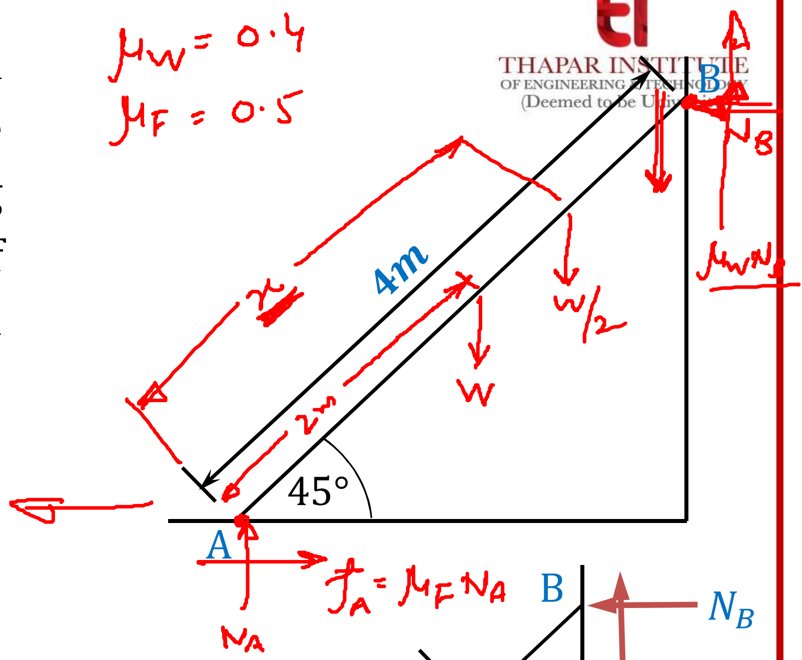
$$\boxed{P = 148.47\,N}$$

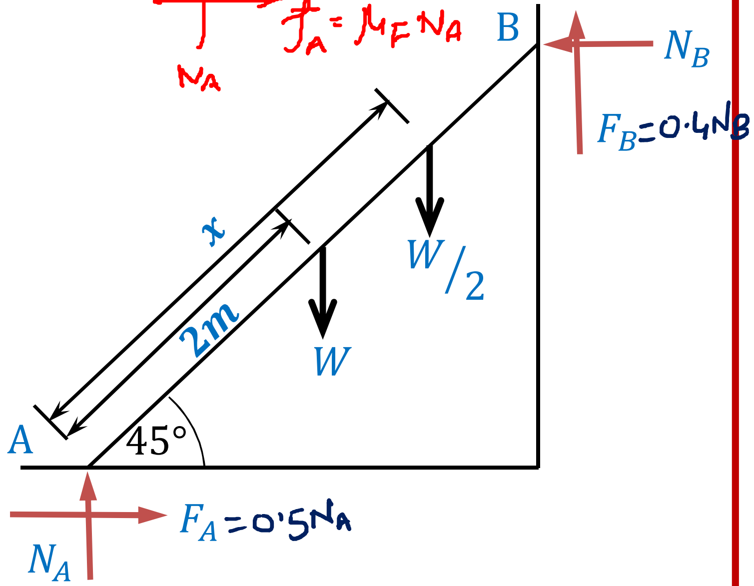


FBD of block 2



Example: A ladder of length 4 m, weight ***W***, resting against a rough wall at 45°. The co-efficient of friction between the ladder and the wall is 0.4. The ladder is lying on a rough horizontal surface having co-efficient of friction as 0.5. A man having a weight equal to the half the weight of the ladder, what will the height up to which the man will be able to climb up the ladder before it begin to slip on the floor?





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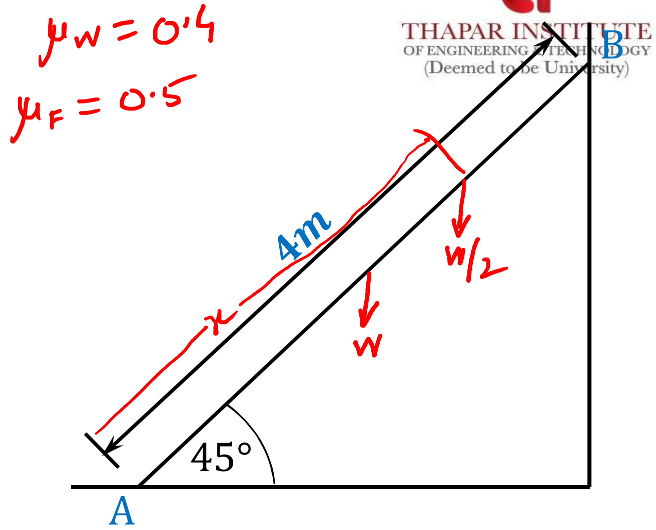
$\mu_w = 0.4$

$\mu_F = 0.5$



$\Sigma F_y = 0$

$0.4 N_B + N_A - W - W/2 = 0$, $\quad 0.4 N_B + N_A = \frac{3}{2} W \quad$ — I

$\Sigma F_x = 0$, $\quad N_B = 0.5 N_A$

$0.4 \times 0.5 N_A + N_A = \frac{3}{2} W$

$1.2 N_A = 1.5 W$

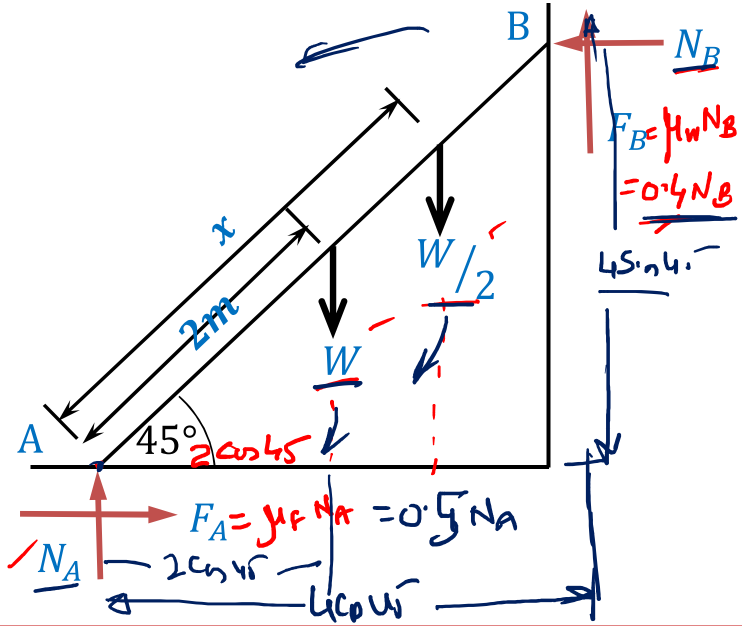
$\boxed{N_A = 1.25 W}$

$\boxed{N_B = 0.625 W}$

$\Sigma M_A = 0$

$W \times 2 \cos 45 + \frac{W}{2} \times x \cos 45 - 0.4 N_B \times 4 \cos 45 - N_B \times 4 \sin 45 = 0$

$0.353 x = 1.06$, $\quad \boxed{x = 3.00 \text{ m}}$



Example: A block A weighing 100 N rests on a rough inclined plane 45° to the horizontal. The block is connected to another block B lying on rough horizontal plane of weight 300 N, by a weightless bar inclined at 30° to the horizontal. Find the horizontal force P required to be applied to just move the block A in upward direction. Assume angle of limiting friction as 15° for all surfaces of contact.