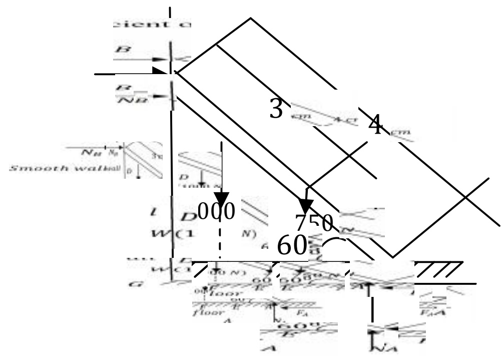
Problem 6:

A uniform laddu of weight 1000N and of length 4 m rests on a horizontal ground and leans against a smooth wall. The ladder makes an angle of 60^0 with horizontal. When a man of weight 750N stands on the ladder at a distance 3m from the top of the ladder, the ladder is at the point of sliding. Determine the coefficient of friction between the ladder and the floor.



Applying $\sum H = 0$

$$N_B - F_A = 0$$

$$N_B - \mu N_A = 0$$

$$N_B = \mu_A \times N_A$$

Applying $\sum V = 0$

$$N_A - 1000 - 750 = 0$$

$$\therefore N_A = 1750 \text{ N}$$

$$N_B = \mu_A \times 1750 \rightarrow (1)$$

Taking the moments of all forces about A and equating to zero.

Applying $\sum m_A = 0(\downarrow +)$

$$(N_B \times BG) - (1000 \times AF) - (750 \times AE) = 0$$

From the geometry of the Figure

$$BG = 4\sin 60 = 3.464m; AF = 2cos60 = 1m$$

$$AE = 1\cos 60 = 0.5\text{m}$$

$$\therefore (N_B \times 3.464) - (1000 \times 1) - (750 \times 0.5) = 0$$

$$N_B = 396.9\text{N}$$

Substitute N_B in (1)

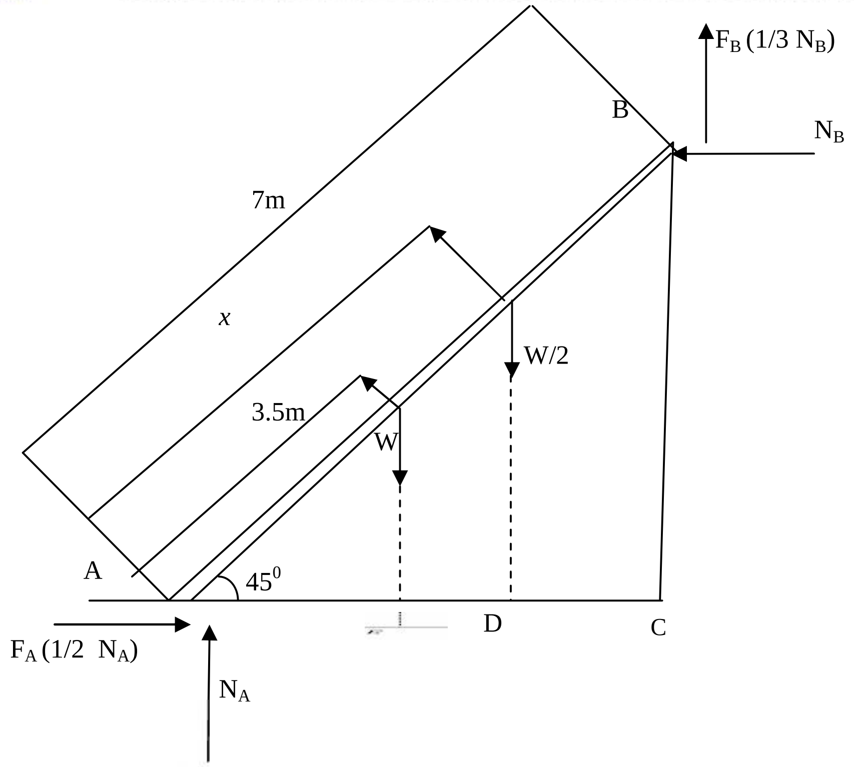
$$N_B = \mu_A \times 1750$$

$$396.9 = \mu_A \times 1750$$

$$\boxed{\mu_A = 0.226}$$

Problem 7:

A 7m long ladder rests against a vertical wall, with which it makes an angle of 45^0 and on a floor. If a man whose weight is one half that of the ladder climbs it at what distance along the ladder will he be, when the ladder is about to slip? Take coefficient of friction between the ladder and the wall is $\frac{1}{3}$ and that between the ladder and the floor is ½.



Applying $\sum H = 0\ (\rightarrow +)$

$$F_A - N_B = 0$$

$$\frac{1}{2} N_A - N_B = 0$$

$$N_A = 2N_B \rightarrow (1)$$

Applying $\sum V = 0\ (\uparrow +)$

$$N_A + F_B - W - \frac{W}{2} = 0$$

$$N_A + \frac{1}{3} N_B - \frac{3}{2} W = 0$$

Sub N_A

$$2N_B + \frac{1}{3}N_B - \frac{3}{2}W = 0$$

$$2N_B + \frac{1}{3}N_B = \frac{3}{2}W$$

$$\frac{6N_B + N_B}{3} = \frac{3}{2}W$$

$$\frac{7N_B}{3} = \frac{3}{2}W$$

$$N_B = \frac{9}{14}W$$

$$\therefore N_A = 2N_B = \frac{9}{7}W$$

Taking moment about A and equating to zero

$$\sum m_A = 0(\downarrow +)$$

$$(W \times AE) + \left(\frac{W}{2} \times AD\right) - (F_B \times A_C) - (N_B \times BC) = 0$$

From the geometry of the Figure,

$$AE = 3.5\cos 45^0 = 2.474\ m$$

$$AD = x\cos 45^0 = 0.707x\ m$$

$$AC = 7\cos 45^0 = 4.95\ m$$

$$BC = 7\sin 45^0 = 4.95\ m$$

$$(W \times 2.474) + \left(\frac{W}{2} \times 0.707x\right) - \left(\frac{N_B}{3} \times 4.95\right) - (N_B \times 4.95) = 0$$

Sub $N_B = \frac{9}{14}W$,

$$(W \times 2.474) + \left(\frac{W}{2} \times 0.707x\right) - \left(\frac{9}{14}W \times \frac{1}{3} \times 4.95\right) - \left(\frac{9}{4}W \times 4.95\right) = 0$$

Solving we get

$$\boxed{x = 5\ m}$$