A man of weight 667.5N stands on the middle position of a 222.5N ladder. The upper end B rests on the corner of a wall while lower end A is attached to stop to prevent slipping. The height of end B from ground is 3.66m while end A is 1.83m away from wall. Find the reaction forces at A & B.

Solution:

$\alpha -$ angle *which* ladder makes with the ground

$N_A - reaction\ force\ from\ the\ ground\ (end\ A)$

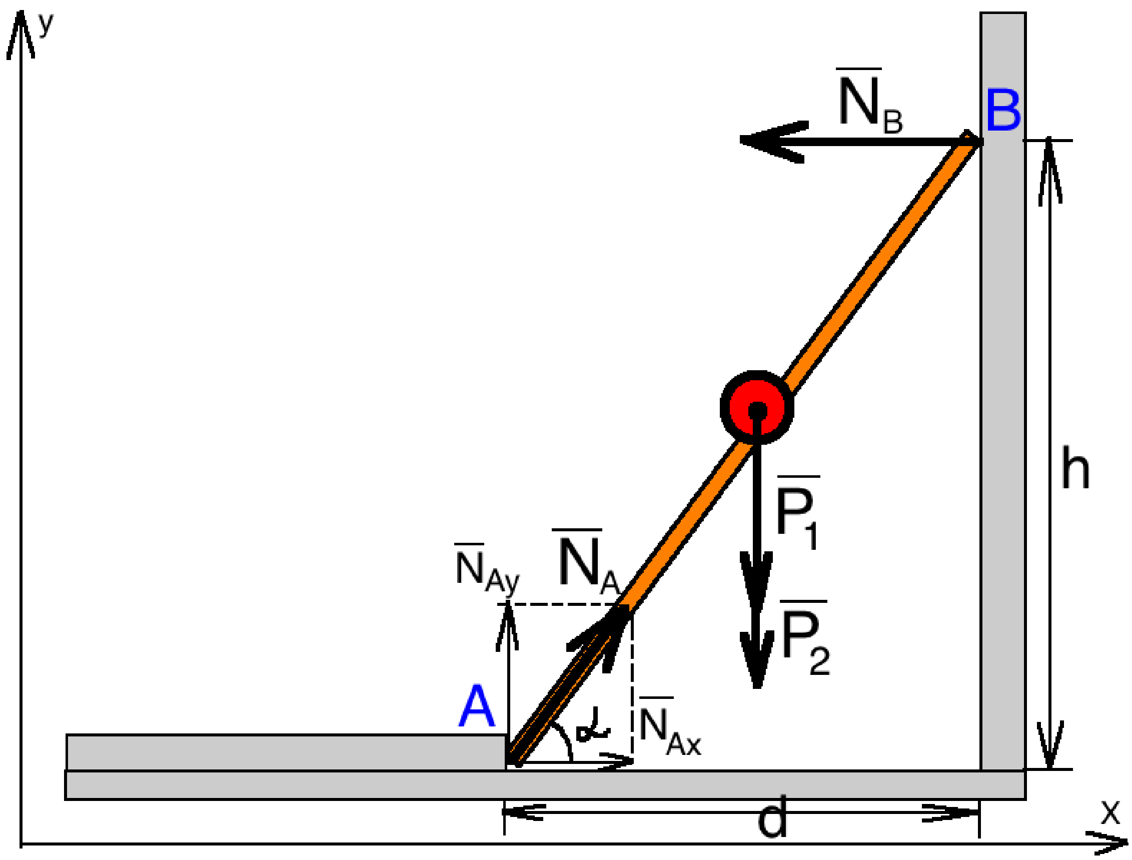
$N_B - reaction\ force\ from\ the$ wall (end B)

$P_1 = 222.5N - weight\ of\ the\ ladder$

$P_2 = 667.5N - weight\ of\ the\ man$

$h = 3.66m -$ height of end B from ground

$d = 1.83m -$ distance from end A to the wall



Angle which ladder makes with the ground:

$$\tan\alpha = \frac{h}{d} = \frac{3.66\ m}{1.83\ m} = 2$$

From the right triangle: $N_A = \sqrt{N_{Ax}^2 + N_{Ay}^2}$ (1)

Newton's second law for the ladder (the first law of equilibrium):

$\vec{P}_1 + \vec{P}_2 + \vec{N}_A + \vec{N}_B = \vec{0}$

Projection of the law on the X-axis:

$x: N_B - N_{Ax} = 0$ (2)

Projection of the law on the X-axis:

$y: N_{Ay} - P_1 - P_2 = 0$ (3)

$N_{Ay} = P_1 + P_2 = 222.5N + 667.5N = 890N$

Momentum equation for point A (the second law of equilibrium):

$A: M_{P_1} + M_{P_2} + M_{N_A} + M_{N_B} = 0$ (4)

$(M_{N_A} = M_{fr1} = 0, because\ moment\ arm\ of\ this\ forces\ is\ zero)$

$M_{P_1} = -P_1 \cdot \frac{d}{\tan\alpha}$ $(minus\ sign\ because\ of\ the\ direction\ of\ force)$

$M_{P_2} = -P_2 \cdot \frac{d}{\tan\alpha}$

$M_{N_B} = N_B \cdot h$

$\rightarrow$ (4):

$$N_B \cdot h - P_2 \cdot \frac{d}{\tan\alpha} - P_1 \cdot \frac{d}{\tan\alpha} = 0$$

$$N_B = \frac{d}{h \cdot \tan\alpha}(P_1 + P_2) = \frac{1.83\ m}{3.66m \cdot 2}(222.5N + 667.5N) = 222.5N$$

$$(1): N_A = \sqrt{N_{Ax}^2 + N_{Ay}^2} = \sqrt{(N_B)^2 + (N_{Ax})^2} = \sqrt{(222.5N)^2 + (890N)^2} = 917.4N$$

Answer: reaction forces at A and B: $N_A = 917.4N, N_B = 222.5N$.