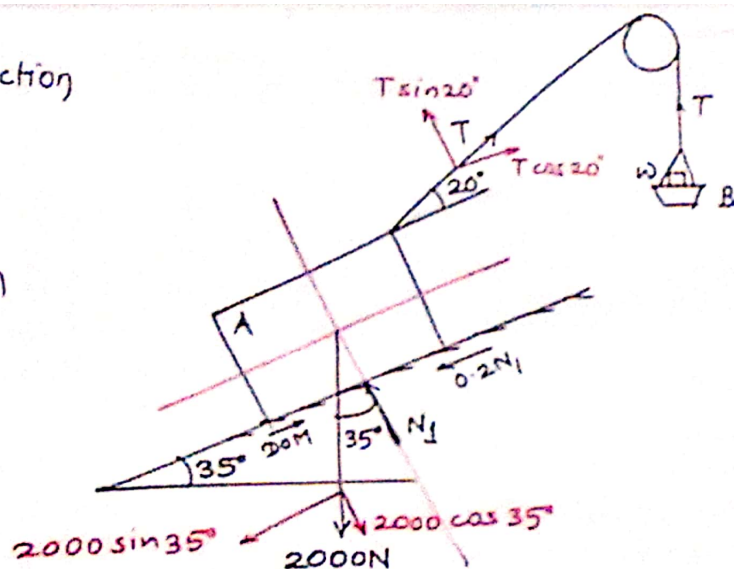
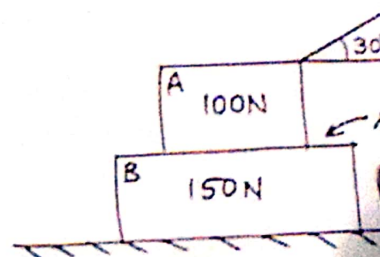


ent of friction
Reaction

friction



Pg-89, Q 1 c)



$$\sum F_x = T \cos 20^\circ - 0.2 N_1 - 2000 \sin 35^\circ = 0$$

$$T \cos 20^\circ - 0.2 N_1 = 2000 \sin 35^\circ$$

$$\sum F_y = T \sin 20^\circ + N_1 - 2000 \cos 35^\circ = 0$$

$$T \sin 20^\circ + N_1 = 2000 \cos 35^\circ$$

$$T = 1462.96 \text{ N}$$

$$N_1 = 1137.93 \text{ N}$$

Friction

Frictional force

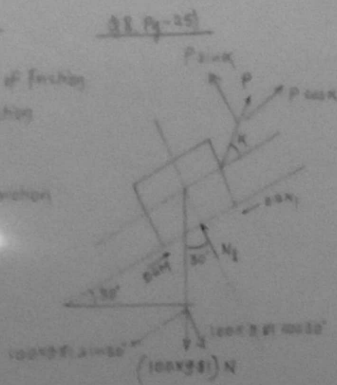
$$F = \mu N$$

$\mu \rightarrow$ Co-efficient of friction

$N \rightarrow$ Normal Reaction

Given $\phi = 25^\circ$

Angle of friction



$$\sum F_x = P \cos \alpha - 0.2 N_1 - 981 \sin 30^\circ = 0$$

$$\sum F_y = P \sin \alpha + N_1 - 981 \cos 30^\circ = 0$$

$$N_1 = 981 \cos 30^\circ - P \sin \alpha$$

$$P \cos \alpha - 0.2 (981 \cos 30^\circ - P \sin \alpha) - 981 \sin 30^\circ = 0$$

$$P \cos \alpha - 169.91 + 0.2 P \sin \alpha - 981 \sin 30^\circ = 0$$

$$P \cos \alpha + 0.2 P \sin \alpha = 660.41$$

$$P (\cos \alpha + 0.2 \sin \alpha) = 660.41$$

$$P = \frac{660.41}{\cos \alpha + 0.2 \sin \alpha} \quad \text{--- (1)}$$

$$\frac{d}{d\alpha} (\cos \alpha + 0.2 \sin \alpha) = 0$$

$$-\sin \alpha + 0.2 \cos \alpha = 0$$

$$0.2 \cos \alpha = \sin \alpha$$

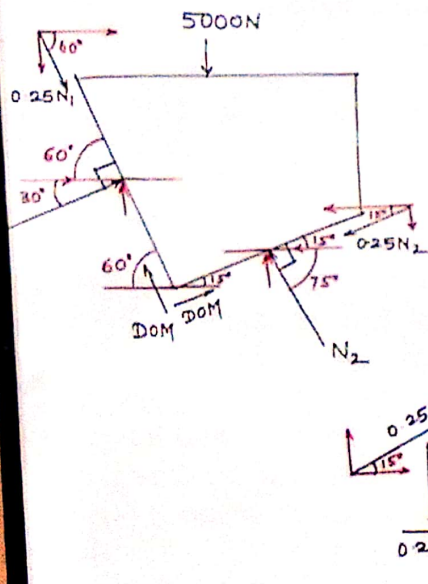
$$0.2 = \tan \alpha$$

$$\alpha = 11.3^\circ$$

from eqn (1)

$$P = \frac{660.41}{\cos (11.3^\circ) + 0.2 \sin (11.3^\circ)}$$

$$P = 647.59 \text{ N}$$



$$\sum F_x = 0.25 N_1 \cos 60^\circ + N_1 \cos 30^\circ - N_2 \cos 75^\circ - 0.25 N_2 \cos 15^\circ = 0$$

$$(0.25 \cos 60^\circ + \cos 30^\circ) N_1 + (-\cos 75^\circ - 0.25 \cos 15^\circ) N_2 = 0 \quad \text{--- (I)}$$

$$\sum F_y = -0.25 N_1 \sin 60^\circ + N_1 \sin 30^\circ + N_2 \sin 75^\circ - 0.25 N_2 \sin 15^\circ - 5000 = 0$$

$$(-0.25 \sin 60^\circ + \sin 30^\circ) N_1 + (\sin 75^\circ - 0.25 \sin 15^\circ) N_2 = 5000 \quad \text{--- (II)}$$

$$N_1 = 2416.99 \text{ N}$$

$$N_2 = 4787.72 \text{ N}$$

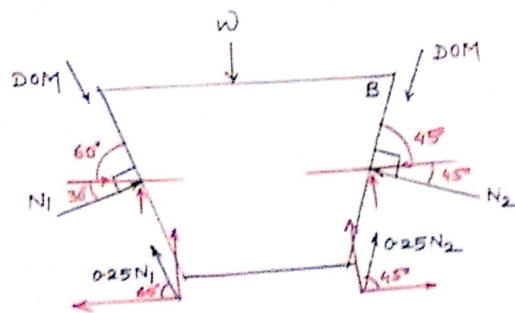
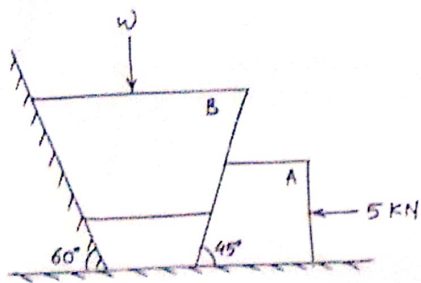
$$\sum F_y = -N_2 \sin 75^\circ + 0.25 N_2 \sin 15^\circ + N_3 = 0$$

$$N_3 = 4314.79 \text{ N}$$

$$\sum F_x = N_2 \cos 75^\circ + 0.25 N_2 \cos 15^\circ + 0.25 N_3 - P = 0$$

$$P = 3474 \text{ N}$$

$$\mu = 0.25$$



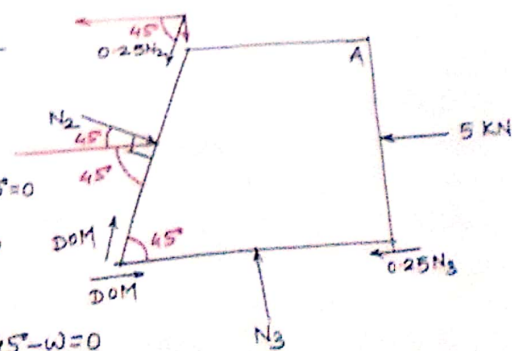
$$\sum F_x = N_1 \cos 30^\circ - 0.25 N_1 \cos 60^\circ + N_2 \sin 45^\circ + 0.25 N_2 \sin 45^\circ = 0$$

$$(\cos 30^\circ - 0.25 \cos 60^\circ) N_1 + (\sin 45^\circ + 0.25 \sin 45^\circ) N_2 = 0$$

$$N_1 = 11.56 \text{ kN}$$

$$\sum F_y = N_1 \sin 30^\circ + 0.25 N_1 \sin 60^\circ + N_2 \sin 45^\circ + 0.25 N_2 \sin 45^\circ - W = 0$$

$$W = 22.56 \text{ kN}$$



$$\sum F_x = -0.25 N_2 \cos 45^\circ + N_2 \sin 45^\circ = 0$$

$$(-0.25 \cos 45^\circ + \sin 45^\circ) N_2 = 0$$

$$\sum F_y = -0.25 N_2 \sin 45^\circ - N_2 \cos 45^\circ + 5 = 0$$

$$(-0.25 \sin 45^\circ - \cos 45^\circ) N_2 + 5 = 0$$



33) A heavy metal bar AB of length 100m, inclined at 40° to the horizontal. A force of 200N is applied at point B, perpendicular to the bar. The bar is supported by a hinge at point A. Find the reaction forces at A.

Ans: -

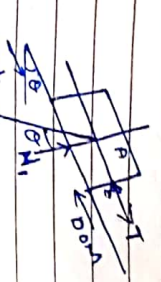
34) A block of mass 20kg is placed on a horizontal surface. A force of 100N is applied to the block at an angle of 30° to the horizontal. Find the reaction forces at the surface.

$$\sum F_x = -0.25N_1 \cos 45^\circ + N_2 \cos 45^\circ - 0.25N_2 = -5 = 0$$

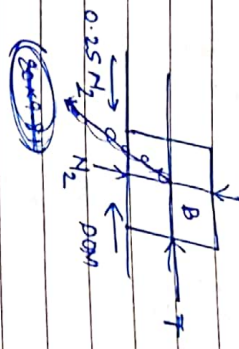
$$(-0.25 \cos 45^\circ + \cos 45^\circ) N_2 - 0.25N_2 = 5 \quad \text{--- (7)}$$

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$$(20 \times 9.81) \cos 45^\circ - (20 \times 9.81) \sin 45^\circ = 0$$



For block B

$$\sum F_y = 0$$

$$N_2 - 20 \times 9.81 = 0$$

$$N_2 = 196.2 \text{ N}$$

$$\sum F_x = 0$$

$$-T + 0.25N_2 = 0$$

$$T = 0.25 \times 196.2$$

$$T = 49.05$$

For block A

$$\sum F_y = 0$$

$$N_1 - (20 \times 9.81) \cos 45^\circ = 0$$

$$N_1 = (20 \times 9.81) \cos 45^\circ$$

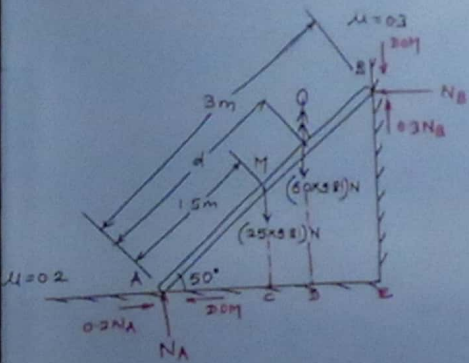
$$\sum F_x = 0$$

$$T + 0.25N_1 - (20 \times 9.81) \sin 45^\circ = 0$$

$$T + 0.25[(20 \times 9.81) \cos 45^\circ] - (20 \times 9.81) \sin 45^\circ = 0$$

$$49.05 +$$

$$\theta = 28.07^\circ$$

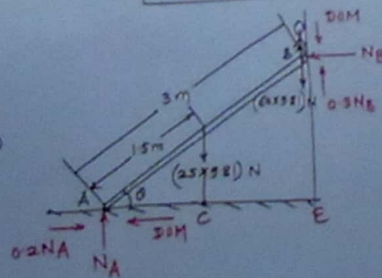


$$\begin{aligned}\sum F_x &= 0.2N_A - N_B = 0 \\ \sum F_y &= N_A + 0.3N_B - (25 \times 9.81) - (60 \times 9.81) = 0 \\ N_A + 0.3N_B &= 833.85 \\ N_A &= 786.65 \text{ N} \\ N_B &= 157.33 \text{ N}\end{aligned}$$

$$\begin{aligned}\cos 50^\circ &= \frac{AC}{1.5} & \cos 50^\circ &= \frac{AD}{d} & \cos 50^\circ &= \frac{AE}{3} \\ AC &= 0.964 \text{ m} & AD &= d \cos 50^\circ & AE &= 1.928 \text{ m} \\ \sin 50^\circ &= \frac{BE}{3} & & & BE &= 2.298 \text{ m}\end{aligned}$$

$$\sum M_A = -(25 \times 9.81 \times 0.964) - (60 \times 9.81 \times d \cos 50^\circ) + (0.3N_B \times 1.928) + (N_B \times 2.298) = 0$$

$$d = 0.571 \text{ m}$$



$$\begin{aligned}\cos \theta &= \frac{AC}{1.5} & \cos \theta &= \frac{AE}{3} & \sin \theta &= \frac{BE}{3} \\ AC &= 1.5 \cos \theta & AE &= 3 \cos \theta & BE &= 3 \sin \theta\end{aligned}$$

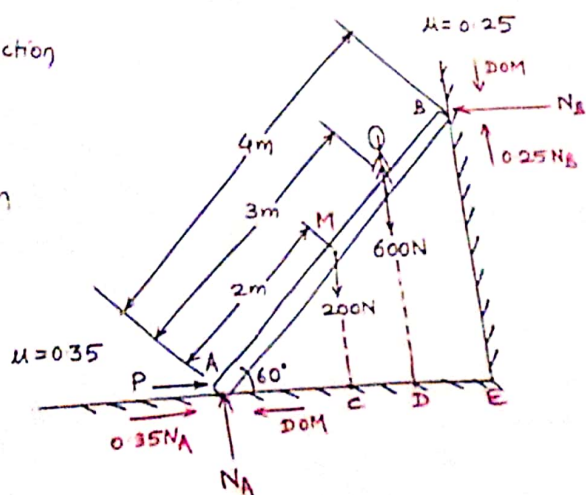
$$\sum M_A = -(25 \times 9.81 \times 1.5 \cos \theta) - (60 \times 9.81 \times 3 \cos \theta) + (0.3N_B \times 3 \cos \theta) + (N_B \times 3 \sin \theta) = 0$$

$$\theta = 76.67^\circ$$

Force

coefficient of friction
Reaction

μ
of friction



$$\sum M_A = -(200 \times 2 \cos 60^\circ) - (600 \times 3 \cos 60^\circ) + (0.25N_B \times 4 \cos 60^\circ) + (N_B \times 4 \sin 60^\circ) = 0$$

$$N_B = 277.49\text{N}$$

$$\sum F_y = N_A - 200 - 600 + 0.25N_B = 0$$

$$N_A = 730.63\text{N}$$

$$\sum F_x = P + 0.35N_A - N_B = 0$$

$$P = 2179\text{N}$$