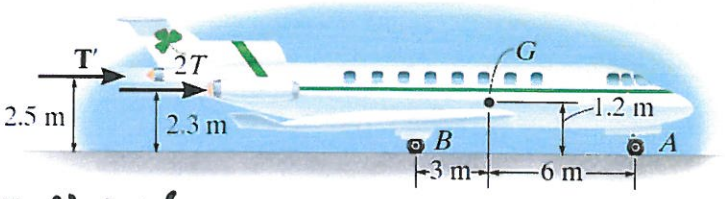
17-26

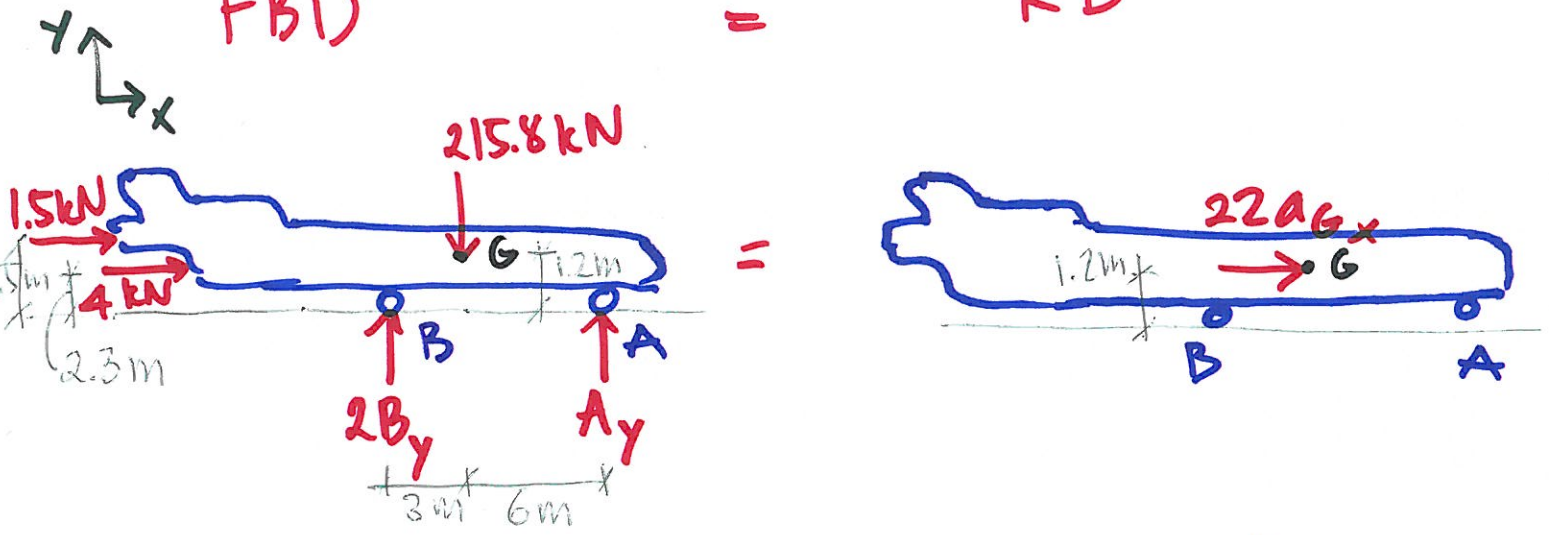
The jet aircraft has a total mass of 22 Mg and a center of mass at G. Initially at take-off the engines provide a thrust $2T = 4$ kN and $T' = 1.5$ kN. Determine the acceleration of the plane and the normal reactions on the nose wheel and each of the two wing wheels located at B. Neglect the mass of the wheels and, due to low velocity, neglect any lift caused by the wings.



$m = 22\ \text{Mg} = 22\times10^3\ \text{kg}$

$W = 22\times10^3 \times 9.81 = 215.8\ \text{kN}$

FBD = KD



$$\stackrel{+}{\rightarrow}\Sigma F_x = ma_{Gx}: \quad 1.5 + 4 = 22a_{Gx} \quad (1)$$

$$a_{Gx} = 0.250\ \text{m/s}^2 \quad \text{Ans.}$$

$$\circlearrowleft \Sigma M_G = I_G\alpha \ (\alpha \rightarrow \phi): \quad -1.5(1.3) - 4(1.1) - 2B_y(3) + A_y(6) = 0$$

$$6A_y - 6B_y = 6.35 \quad (2)$$

$$\uparrow \Sigma F_y = ma_{Gy} \ (a_{Gy} \rightarrow \phi): \quad 2B_y + A_y - 215.8 = 0 \quad (3)$$

Solve (1) & (2):

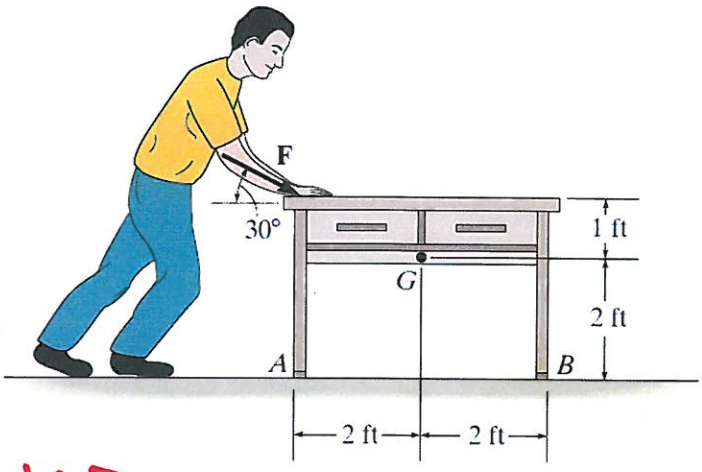
$$\begin{bmatrix} 6 & -6 \\ 1 & 2 \end{bmatrix}\begin{bmatrix} A_y \\ B_y \end{bmatrix} = \begin{bmatrix} 6.35 \\ 215.8 \end{bmatrix} \Rightarrow$$

$$A_y = 72.6\ \text{kN}\uparrow \quad \text{Ans.}$$

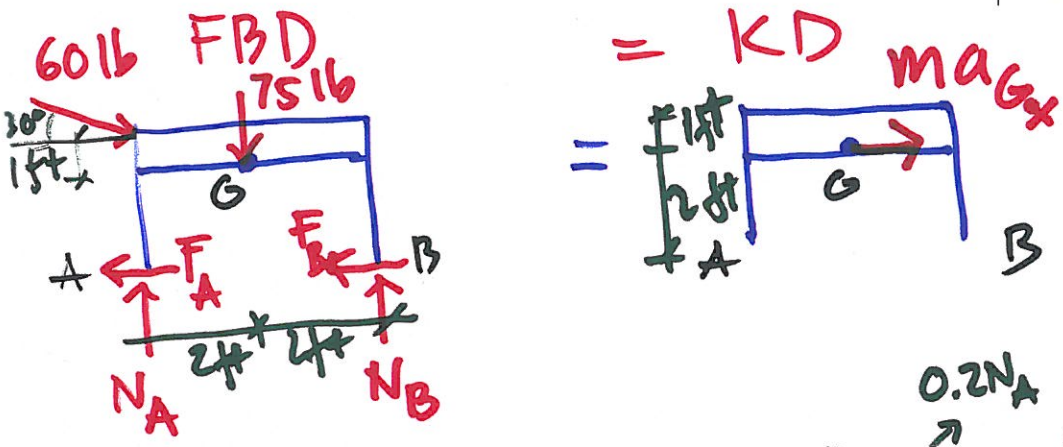
$$B_y = 71.6\ \text{kN}\uparrow \quad \text{Ans.}$$

17-35

The desk has a weight of 75 lb and a center of gravity at G. Determine its initial acceleration if a man pushes on it with a force $F = 60$ lb. The coefficient of kinetic friction at A and B is $\mu_k = 0.2$.



$$m = \frac{75\text{ lb}}{32.2} = 2.33 \text{ slugs}$$



$$\rightarrow \sum F_x = ma_{G_x}: \quad 60\cos 30^\circ - F_A - F_B = 2.33\, a_{G_x}$$

$$2.33\, a_{G_x} + 0.2N_A + 0.2N_B = 52.0 \quad (1)$$

$$+\uparrow \sum F_y = ma_{G_y}: \quad N_A + N_B - 75 - 60\sin 30^\circ = 0$$

$$N_A + N_B = 105 \quad (2)$$

$$\circlearrowleft \sum M_G = I_G\alpha: \quad 60\sin 30^\circ(2) - 60\cos 30^\circ(1) - N_A(2) + N_B(2) - 0.2N_A(2) - 0.2N_B(2) = 0$$

$$2.4N_A - 1.6N_B = 8.04 \quad (2)$$

Solve (1), (2) & (3)

$$\begin{bmatrix} 2.33 & 0.2 & 0.2 \\ 0 & 1 & 1 \\ 0 & 2.4 & -1.6 \end{bmatrix} \begin{bmatrix} a_{G_x} \\ N_A \\ N_B \end{bmatrix} = \begin{bmatrix} 52.0 \\ 105 \\ 8.04 \end{bmatrix}$$

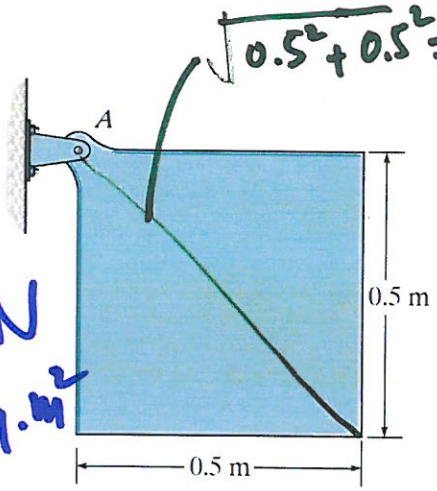
$a_{G_x} = 13.30 \text{ ft/s}^2$

$N_A = 44.0 \text{ lb}$

$N_B = 61.0 \text{ lb}$

17-58

The uniform 24-kg plate is released from rest at the position shown. Determine its initial angular acceleration and the horizontal and vertical reactions at the pin *A*.

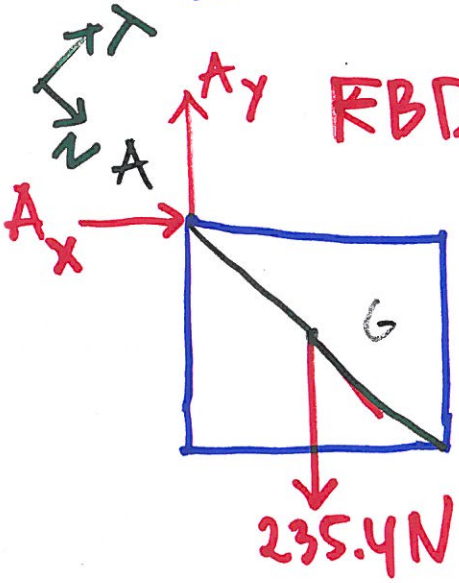


$\sqrt{0.5^2+0.5^2} = .707\ m$

RAFA

$mass = 24\ kg \quad W = 24 \times 9.81 = 235.4\ N$

$I_G = \frac{1}{12} m(a^2+b^2) = \frac{1}{12} 24(0.5^2+0.5^2) = 1\ kg \cdot m^2$



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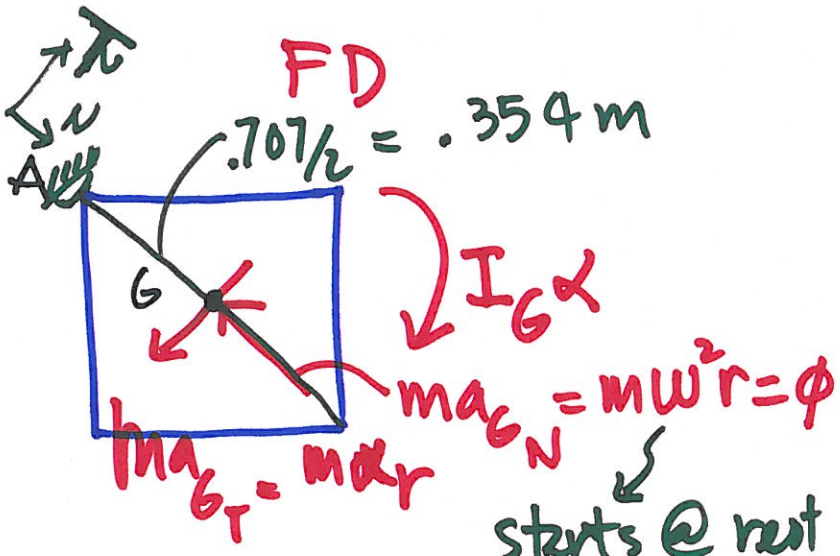

$\rightarrow \sum F_T = ma_{G_T}: \quad -A_x \cos 45^\circ - A_y \sin 45^\circ + 235.4 \sin 45^\circ = m a_{G_T}$

$24 \times \alpha \times .354 + .707 A_x + .707 A_y = 166.5 \quad (1)$

$\nearrow \sum F_N = ma_{G_N}: \quad A_x \sin 45^\circ - A_y \cos 45^\circ + 235.4 \cos 45^\circ = \phi$

$A_x - A_y = -235.4 \quad (2)$

$\circlearrowleft \sum M_G = I_G \alpha: \quad -A_x(0.25) - A_y(0.25) = -I_G \alpha$

$A_x + A_y = +4\alpha \quad (3)$

Solve (1) (2) & (3):

$$\begin{bmatrix} 8.496 & .707 & .707 \\ 0 & 1 & -1 \\ -4 & 1 & 1 \end{bmatrix} \begin{bmatrix} \alpha \\ A_x \\ A_y \end{bmatrix} = \begin{bmatrix} 166.5 \\ -235.4 \\ 0 \end{bmatrix} \Rightarrow$$

$\alpha = 14.72\ rad/s^2 \circlearrowright$

$A_x = -88.3 = 88.3\ N \leftarrow$

$A_y = 147.2\ N \uparrow$