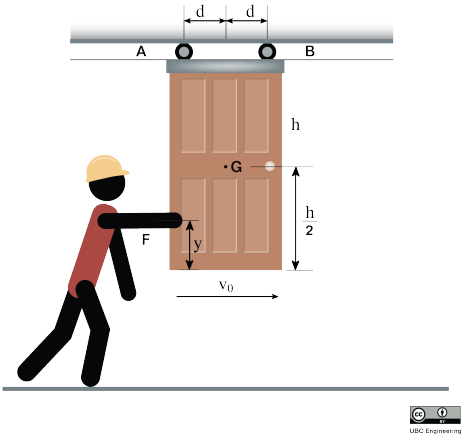
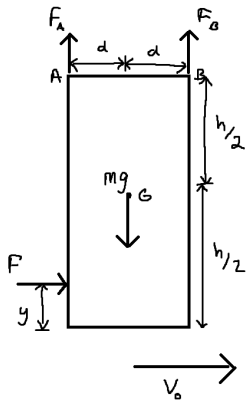
20-R-KIN-DK-14



An engineering student gets a co-op job at a door factory. They transport a door by pushing one on its side with a horizontal force of $F = 110\ N$. If the door has a mass of $m = 25\ kg$ and initial velocity of $v = 0.01\ m/s$, how far would it travel in $t = 5\ seconds$? What are the reaction forces at A and B? The center of gravity is an equal distance $d = 0.33\ m$ away from rollers A and B. The door has a height $h = 2.9\ m$ and the center of gravity is found at $h/2$. The student applies the force at a height $y = 0.4\ m$ from the bottom of the door.

Solution

Setting up the equations of motion:



$$\sum F_x : F = m(a_G)_x \implies (a_G)_x = \frac{110\ N}{25\ kg} = 4.4 \quad [\text{m/s}]^2$$
$$\sum F_y : F_A + F_B - mg = m(a_G)_y = 0 \implies F_A + F_B = 25 \cdot 9.81 = 245\ N$$

$$\sum M_G = 0 : \quad F(\tfrac{h}{2} - y) + F_B(d) - F_A(d) = 0$$
$$F(\tfrac{h}{2} - y) = -d(F_B - F_A) \implies F_A - F_B = F(\tfrac{h}{2} - y)/d = 350\ N$$

Now solving for F_A and F_B:

$$F_A + F_B = 245$$
$$F_A - F_B = 350$$

$$F_A = 297.5 \quad [\text{N}]$$
$$F_B = -52.5 \quad [\text{N}]$$

Finally applying the kinematic equation for motion $\Delta s = v_0 t + \frac{1}{2}at^2$:

$$\Delta s = 0.01(5) + \tfrac{1}{2}(4.4)(5^2) = 55.05 \quad [\text{m}]$$