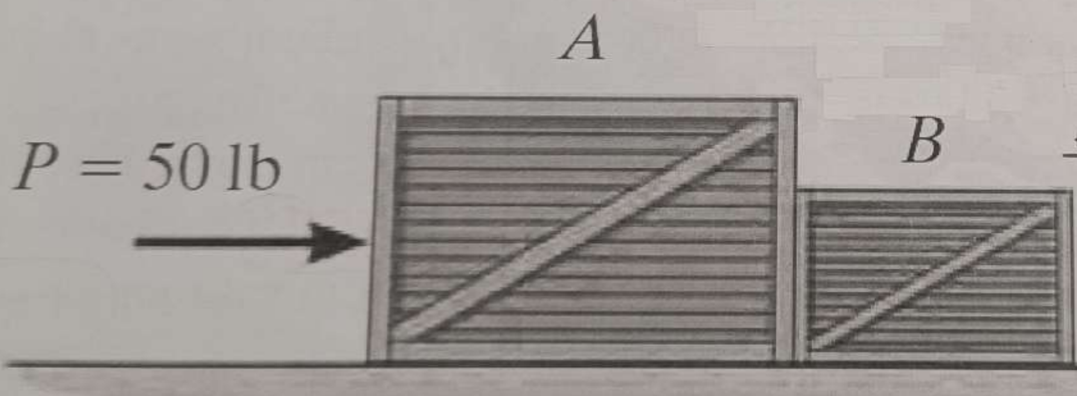
# Homework

**Problem 1**

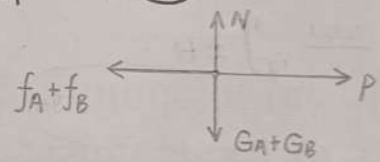
Crates $A$ and $B$ weigh $\underbrace{100 \text{ lb}}_{}$ and 50 lb, respectively. If they start from rest, determine their speed when $t = 5$ s. Also, find the force exerted by crate $A$ on crate $B$ during the motion. The coefficient of kinetic friction between the crates and the ground is $\mu_k = 0.25$.

$G_A$ $G_B$

$g = 32.18 \ ft/s^2$




解: For AB




$$f_A + f_B = \mu_K \cdot N = 0.25 \times (100 + 50) = 37.5 \ lb$$

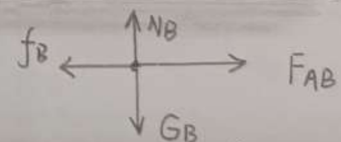
$\xrightarrow{+}$ x direction:

$$+Pt - (f_A + f_B)t = (m_A + m_B) \cdot V$$

$$\Rightarrow V = \frac{(P - f_A - f_B)t}{m_A + m_B} = \frac{(50 - 37.5) \times 5}{\frac{100+50}{32.18}} = 13.41 \ ft/s$$

$\boxed{ANS}$

For B:




$\xrightarrow{+}$ x direction: $F_{AB} \cdot t - f_B \cdot t = m_B \cdot V$

$$\Rightarrow F_{AB} = \frac{m_B V + f_B \cdot t}{t} = \frac{(\frac{50}{32.18}) \times 13.41 + (0.25 \times 50) \times 5}{5} = 16.67 \ lb$$

$\boxed{ANS}$

# Angular Impulse and Momentum

**Problem 2**

The 18000-kg jet uses thrust vectoring to allow it to take off vertically. In one maneuver, the pilot reaches the top of her static hover at 200 m. The combined thrust and lift force on the airplane applied at the end of the static hover can be expressed as $\mathbf{F} = (44t + 2500t^2)\mathbf{i} + (250t^2 + t + 176580)\mathbf{j}$, where $F$ and $t$ are expressed in newtons and seconds, respectively. Determine (a) how long it will take the airplane to reach a cruising speed of 1000 km/hr (cruising speed is defined to be in the x-direction only), (b) the altitude of the plane at this time.

解: static hover: $V_{x_1} = V_{y_1} = 0$

a) x direction

$$\int_0^t F_x(t)\,dt = mV_x - 0$$

$$\int_0^{t_1} (44t + 2500t^2)\,dt = 18000 \times \frac{1000\times10^3}{3600}$$

$$22t_1^2 + \frac{2500}{3}t_1^3 = 5\times10^6$$

$$\Rightarrow t_1 = 18.16 \text{ s} \quad \boxed{\text{ANS}}$$

b) y direction

$$+\uparrow \Sigma F_y = F_y - G = 250t^2 + t + 176580 - 18000\times9.81 = 250t^2 + t$$

$$\int_0^{t_1} (F_y - G)\,dt = mV_y$$

$$\int_0^{t_1}\int_0^{t_1} \left(\frac{F_y - G}{m}\right) dt\,dt = H$$

$$\therefore H = \int_0^{t_1} \frac{1}{18000}\cdot\left(\frac{250}{3}t^3 + \frac{1}{2}t^2\right)dt$$

$$= \frac{1}{18000}\left(\frac{125}{6}t_1^4 + \frac{1}{6}t_1^3\right)$$

$$= 125.93 \text{ m}$$

Altitude = 125.93 + 200 = 325.93 m $\boxed{\text{ANS}}$

# Homework

## Problem 3

The cue ball $A$ is given an initial velocity $(v_A)_1 = 5\ \mathrm{m/s}$. If it makes a direct collision with ball $B$ $(e = 0.8)$, determine the velocity of $B$ and the angle $\theta$ just after it rebounds from the cushion at $C$ $(e' = 0.6)$. Each ball has a mass of 0.4 kg. Neglect their size.

解:

A、B collision

$$mV_{A_1} + 0 = mV_{B_2} + mV_{A_2} \quad ①$$

$$e = 0.8 = \frac{V_{B_2} - V_{A_2}}{-V_{B_1} + V_{A_1}} \quad ②$$

$\Rightarrow V_{A_2} = 0.5\ \mathrm{m/s}$

$V_{B_2} = 4.5\ \mathrm{m/s}$, $V_{B_2x} = 4.5\cos 30^\circ$, $V_{B_2y} = 4.5\sin 30^\circ$

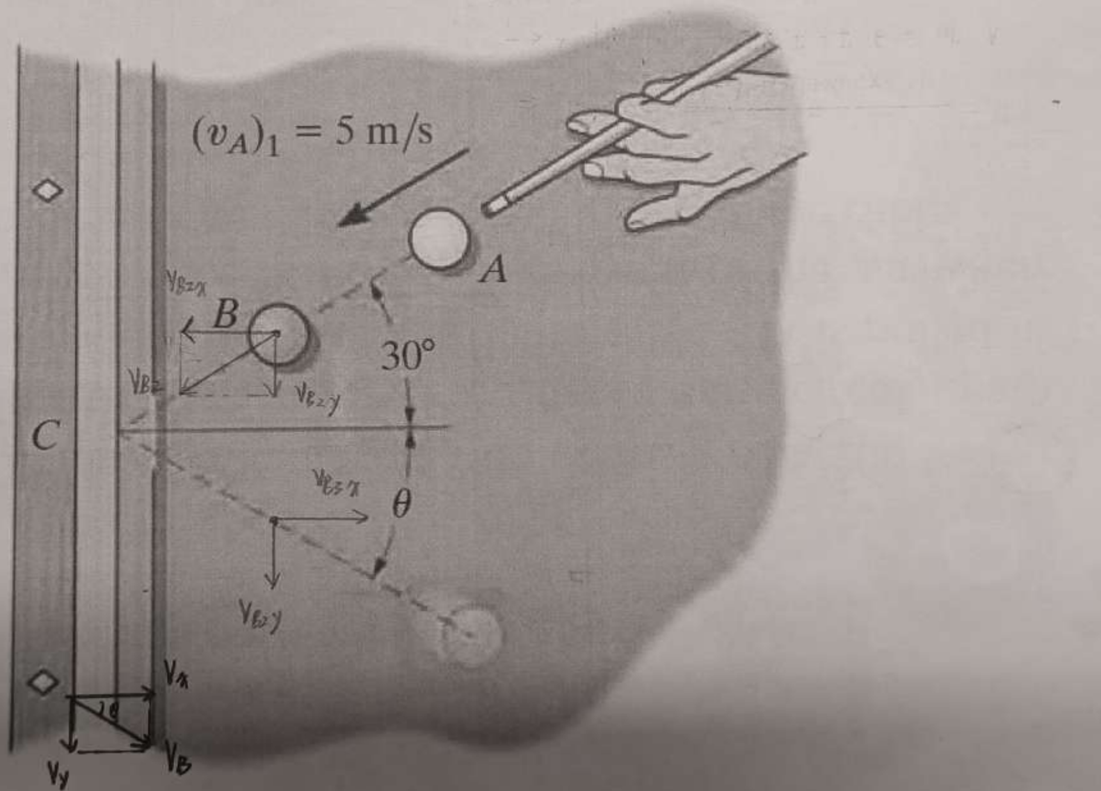
B、C collision

in y direction: $V_{B_2y} = V_{B_3y} = V_{B_3x}\cdot\tan\theta$

$$e' = \frac{V_{B_3x} - 0}{0 - V_{B_2x}} = 0.6$$

$\Rightarrow V_{B_3x} = -2.338\ \mathrm{m/s}$, $V_{B_3y} = V_{B_2y} = 2.25\ \mathrm{m/s}$ $\Rightarrow V_B = 3.244\ \mathrm{m/s}$ $\boxed{\text{ANS}}$

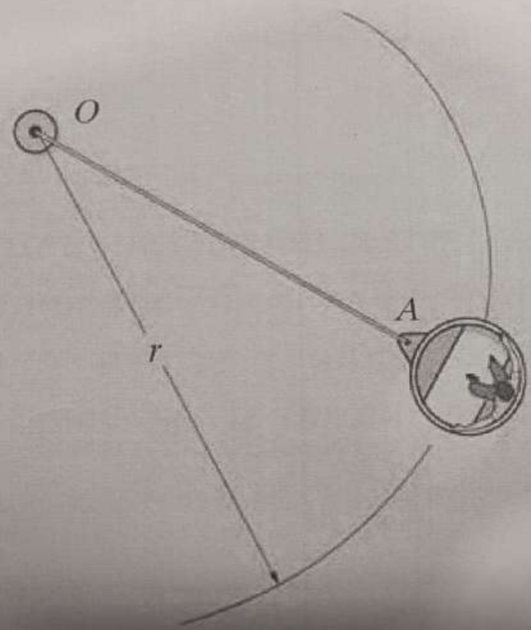
$\theta = 43.90^\circ$ $\boxed{\text{ANS}}$



# Homework

**Problem 4**

The amusement park ride consists of a 200-kg car and passenger that are traveling at 3 m/s along a circular path having a radius of 8 m. If at $t = 0$ the cable $OA$ is pulled in toward $O$ at 0.5 m/s, determine the speed of the car when $t = 4$ s. Also, determine the work done to pull in the cable.




解:

At $t=0$,

$V_{\theta_1} = 3 m/s$, $(V_{r_1} = -0.5 m/s)$.

$H_{O.1} = H_{O.2}$

$m\, r\, V_{\theta_1} = m\,(r + t \cdot V_{r_1})\, V_{\theta_2}$

$\Rightarrow V_{\theta_2} = \dfrac{r V_{\theta_1}}{r + t V_{r_1}} = \dfrac{8 \times 3}{8 - 0.5 \times 4} = 4 m/s$

$V_{r_2} = V_{r_1} = -0.5 m/s$

$V_2 = \sqrt{V_{\theta_2}^2 + V_{r_2}^2} = 4.031\ m/s$ $\boxed{ANS}$

$W = \frac{1}{2} m V_2^2 - \frac{1}{2} m V_1^2 = \frac{1}{2} \times 200 \times (4.031^2 - 3^2)$

$= 724.9\ J$ $\boxed{ANS}$