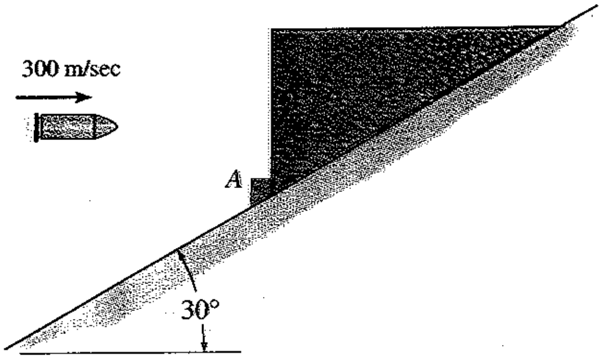
## Problem 15.47 (Page 231)

A 10-kg block is held at rest on a smooth inclined surface by a stop block at A. If a 10-gram bullet is traveling at 300 m/sec when it becomes embedded in the block, determine the distance the block will slide up the incline before it momentarily stops.

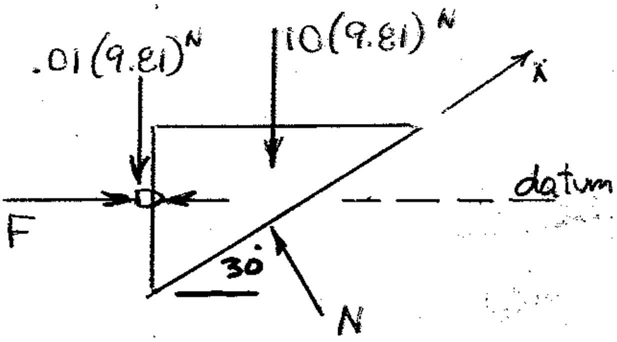


Conservation of Linear Momentum

$$m_b V_{b_x} = (m_b + m_B) V_x$$

$$.01(300 \cos 30^\circ) = (.01 + 10) V_x$$

$$V_x = 0.2595 \text{ m/s}$$



Conservation of Energy

$$T_1 + V_1 = T_2 + V_2$$

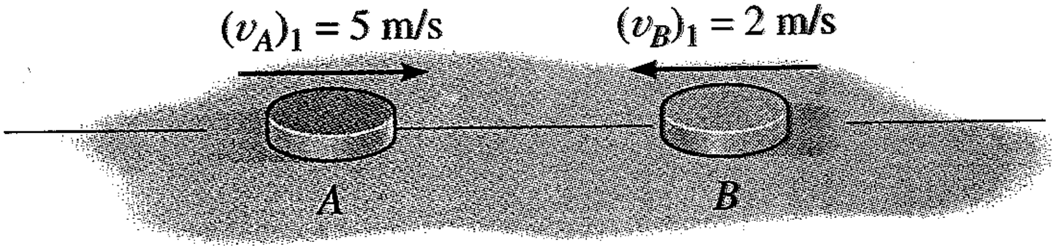
$$0 + \frac{1}{2}(10 + .01)(.2595)^2 = 0 + 98.198\, h$$

$$h = .003433 \text{ m} = 3.43 \text{ mm} \uparrow$$

$$d = 3.43 / \sin 30^\circ = 6.87 \text{ mm}$$

## Problem 15.57 (Page 240)

Disk A has a mass of 2 kg and is sliding forward on the smooth surface with a velocity of $v_{A1} = 5$ m/s when it strikes the 4-kg disk B, which is sliding towards A at $v_{B1} = 2$ m/s with a direct central impact. If the coefficient of restitution is $e = 0.4$, compute the velcities of A and B just after the collision.



$$m_A V_{A_1} + m_B V_{B_1} = m_A V_{A_2} + m_B V_{B_2}$$

$$2(5) + 4(-2) = 2V_{A_2} + 4V_{B_2}$$

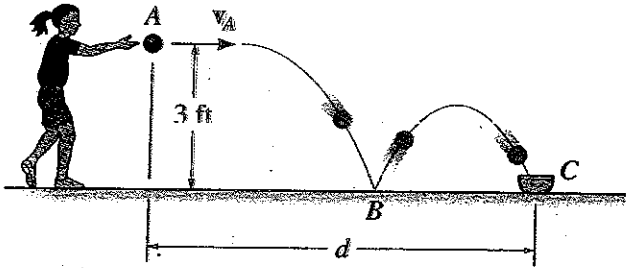
$$e = \frac{V_{B_2} - V_{A_2}}{V_{A_1} - V_{B_1}} = 0.4 = \frac{V_{B_2} - V_{A_2}}{5 - (-2)}$$

$$V_{A_2} = -1.53 \text{ m/s} \quad \text{or} \quad 1.53 \overleftarrow{\text{m/s}}$$

$$V_{B_2} = 1.\overrightarrow{27 \text{ m/s}}$$

Problem 15.64 (Page 241)

A girl throws a ball with a horizontal velocity of 8 ft/sec. Determine the distance d so that the ball will bounce on a smooth surface and then land in the cup C. The coefficient of restitution e = 0.8 as a consequence of the bounce at B.



$V_x = 8\,f/s = \frac{dx}{dt} =$ constant

$\int_0^t 8\,dt = \int_A^B dx$ $\quad X_{AB} = 8t_{AB}$

$g = -32.174\,f/s^2 = \frac{dV_y}{dt}$

$\int_0^t -32.174\,dt = \int_0^{V_y} dV_y$ $\quad V_y = \frac{dy}{dt} = -32.174t$

$\int_3^0 dy = \int_0^t -32.174t\,dt$ $\quad t_{AB} = 0.432$ sec $\quad X_{AB} = 3.455$ ft

Before impact at B $\quad V_x = 8\,\overrightarrow{f/s}$ $\quad V_y = 13.9\,f/s \downarrow$

$e = 0.8 = -\frac{V_f}{13.9}$ $\quad V_f = 11.12\,f/s \uparrow = \frac{dy}{dt}$ (After impact)

$X_{BC} = 8t_{BC}$

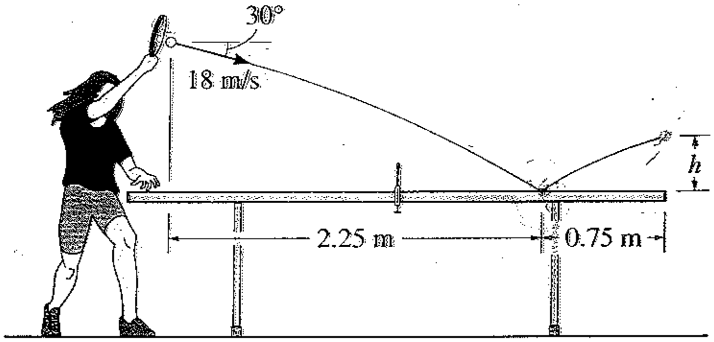
$V_y = \frac{dy}{dt} = 11.12 - 32.174t$

$0 = 11.12t_{BC} - \frac{32.174t_{BC}^2}{2}$ $\quad t_{BC} = .691$ sec $\quad X_{BC} = 5.53$

$d = X_{AB} + X_{BC} = 8.985$ ft $\quad t_{AC} = t_{AB} + t_{BC} = 1.01$ sec

Problem 15.75 (Page 242)

A ping pong balls has a mass of 2 grams and is struck with a velocity shown. Determine how high the ball rises, h, above the end of the smooth table after its has rebound. **e** = 0.8.



$\overset{+}{\rightarrow}$ $s = s_0 + V_0 t$

$2.25 = 0 + 18 \cos 30^\circ \, t$

$t = 0.144$ sec.

$V_{x_1} = V_{x_2} = 18 \cos 30^\circ$

$= 15.59$ m/s

$+\downarrow$ $V = V_0 + gt$

$V_{y_1} = 18 \sin 30^\circ + 9.81(.144) = 10.416$ m/s

$e = 0.8 = \dfrac{V_{y_2}}{10.416}$ $\qquad V_{y_2} = 8.33$ m/s

$\overset{+}{\rightarrow}$ $s = s_0 + V_0 t$

$0.75 = 0 + 15.59t$ $\qquad t = .048$ sec

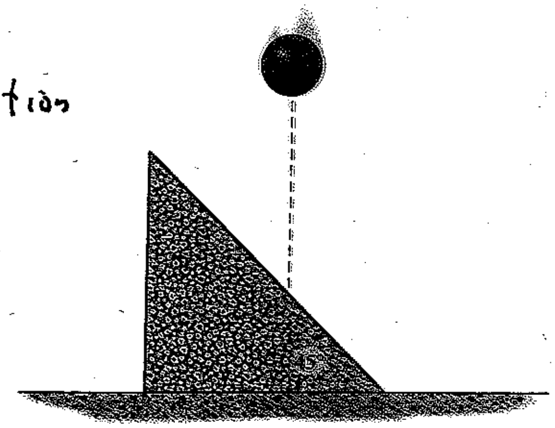
$+\uparrow$ $s = s_0 + V_0 t + \frac{1}{2} g t^2$

$h = 0 + 8.33(.048) + \frac{1}{2}(9.81)(.048)^2$

$h = 0.39$ m

Problem 15.79 (Page 243)

A sphere of mass m falls and strikes a triangular block with a vertical velocity v. The coefficient of restitution as a consequence of the collision is e. If the block rests on a smooth surface and has a mass 3m, determine a relationship for the velocity of the block just after the collision.



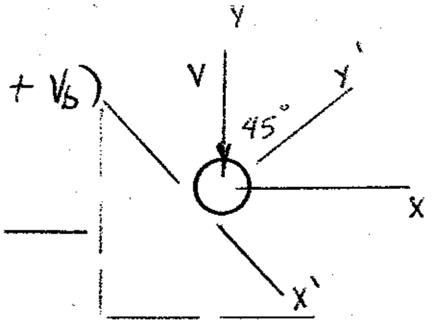
Conservation of momentum - x' direction

$mV_{1_{x'}} = mV_{2_{x'}}$ (sphere)

$mv\sin 45^\circ = mV_{2_{x'}}$ or $V_{2_{x'}} = \frac{v}{\sqrt{2}}$

y' direction

$e = \frac{V_{2_{y'}} - V_b\cos 45^\circ}{V\cos 45^\circ - 0}$ or $V_{2_{y'}} = \frac{1}{\sqrt{2}}(ev + V_b)$



x direction

$0 = m_s V_{s_x} + m_b V_b = m_s(V_{s_x} + 3V_b)$

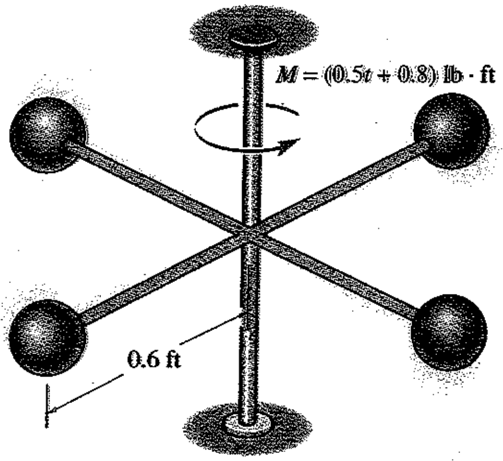
$= 3V_b + [-V_{2_{x'}}\cos 45^\circ - V_{2_{y'}}\sin 45^\circ]$

$= 3V_b - \frac{1}{2}v - \frac{1}{2}(ev - V_b)$

$= \frac{7}{2}V_b - \frac{v}{2}(1+e)$ or $V_b = \left(\frac{1+e}{7}\right)v$

Problem 15.102 (Page 258)

Four 5-lb spheres are rigidly attached to a crossbar frame. The frame has negligible mass and is initially at rest. If a couple moment M = 0.5 t + 0.8 (lb·ft) is applied as shown (t in seconds), determine the speed of the spheres 4 seconds after the moment is applied. Neglect the size of the spheres.



$$H_{z_1} + \sum \int_{t_1}^{t_2} M_z \, dt = H_{z_2}$$

$$0 + \int_0^4 (.5t + .8)\, dt$$

$$= 4\left[\frac{5}{32.174}(.6)v_2\right]$$

$$V_2 = 19.3 \text{ ft/sec}$$