Problem 15.64 (Page 250)

A girl throws a ball with a horizontal velocity of $v_A = 8 \text{ ft/sec}$. The coefficient of restitution between the ball and the surface $e = 0.8$. Determine the distance $d$ that would occur if the ball bounces once on a smooth surface and then lands in a cup at C.

\[
\begin{align*}
A \to B & \quad \Rightarrow \quad v_A = \int -g \, dt \\
\int_0^{t_{AB}} dy = \int_0^{t_{AB}} -g \, dt & \quad \Rightarrow \quad t_{AB} = \frac{b}{g} \\
V_A & = 8 \text{ ft/sec} = \text{constant} = \frac{dx}{dt} \\
X_{AB} & = 8 \times t_{AB} = 8 \left( \frac{b}{g} \right)^2 = 3.455 \text{ ft} \\
\hline
B \to C & \quad \Rightarrow \quad v_B = \sqrt{\frac{b}{q}} \\
V_B & = 13.89 \text{ ft/sec} \\
V_y & = 11.1145 - gt = \frac{dy}{dt} \\
\int_0^0 dy = 11.1145t - \frac{1}{2} g t^2 & = 0 \\
X_{BC} & = 8 \times 0.691 = 5.528 \text{ ft} \\
d & = 3.455 + 5.528 = 8.983 \text{ ft}
\end{align*}
\]
Problem 15.74 (Page 252)

A tennis ball is struck by a racket with a horizontal velocity \( v_A \) and strikes the smooth ground at B as shown, then bounces upward at \( 30^\circ \). Determine a) the initial velocity \( v_A \), b) the final velocity \( v_B \), and c) the coefficient of restitution between the ball and the ground.

\[
\begin{align*}
Q &= -q = \frac{dv}{dt} = v \frac{dv}{dy} \\
\int v dv &= -q \int dy \\
V_B^2 &= 2(32.17)(7.5) \\
V_B &= 21.98 \text{ m/sec} \\
\int -q dt &= \int dv \\
V_B &= -32.17 t = 21.98 \\
t &= 0.682 \text{ sec} \\
V_A &= \text{constant} = \frac{dx}{dt} = V_{Bx} \\
x &= V_{A_x} t \quad \text{or} \quad 20 + t = V_{A_x} (0.682) \\
V_{A_x} &= 29.3 \text{ ft/sec} = V_b \cos 30^\circ \\
V_b &= 33.8 \text{ ft/sec} \\
V_{by} &= 33.8 \sin 30^\circ = 16.92 \text{ ft/sec} \\
e &= \frac{V_{by2} - 0}{V_{by1} - 0} = \frac{16.92}{21.98} = 0.77
\end{align*}
\]
Problem 15.87 (Page 255)

Two smooth disks A and B have initial velocities shown just before they collide at O. If they have masses \( m_A = 8 \text{ kg} \) and \( M_b = 6 \text{ kg} \), determine their speed just after impact.  the coefficient of restitution \( e = 0.5 \).

\[
V_A = \sqrt{2.14^2 + 2.77^2} = 3.5 \text{ m/sec} \[60.3^\circ]\]

\[
\gamma_A = \tan^{-1} \frac{2.14}{2.77} = 37.69^\circ
\]

\[
67.38 + 1.95 + \phi_A = 90^\circ
\]

\[
\phi_A = 21^\circ
\]

\[
V_B = \sqrt{2.14^2 + 2.77^2} = 3.5 \text{ m/sec} \[60.3^\circ]\]

\[
\gamma_B = \tan^{-1} \frac{2.14}{2.77} = 37.69^\circ
\]

\[
67.38 + \phi_B - 37.69 = 90^\circ
\]

\[
\phi_B = 60.3^\circ
\]
Problem 15.87 (Page 255)

Two smooth disks A and B have initial velocities shown just before they collide at O. If they have masses $m_A = 8 \text{ kg}$ and $m_B = 6 \text{ kg}$, determine their speed just after impact. The coefficient of restitution $e = 0.5$.

\[ \sum mV_i = \sum mV_f \]

\[-b(3 \cos 67.38^\circ) + 8(7 \cos 67.38^\circ) = 6V_{Bn} + 8V_{An} \]

\[ e = 0.5 = \frac{V_{Bn} - V_{An}}{7 \cos 67.38^\circ - (-3 \cos 67.38^\circ)} \]

\[ V_{Bn} = 2.14 \text{ m/s} \quad \quad V_{An} = 0.22 \text{ m/s} \]

\[ V_{Bx} = 3 \sin 67.38^\circ = 2.77 \text{ m/s} \]

\[ V_{Ay} = 7 \sin 67.38^\circ = -6.46 \text{ m/s} \]

\[ V_B = \sqrt{2.14^2 + 2.77^2} = 3.5 \text{ m/sec} \]

\[ V_A = \sqrt{0.22^2 + (-6.46)^2} = 6.47 \text{ m/sec} \]
Problem 15.101 (Page 267)

A small cylinder C has a mass of 10 kg and is attached to the end of a rod whose mass may be neglected. The frame is subjected to a couple $M = 8t^2 + 5$ (N m), where $t$ is in seconds. If the cylinder is subjected to a force of 60 N, which is always directed as shown, determine the speed of the cylinder when $t = 2$ sec. The cylinder has an initial speed of $v_o = 2$ m/sec when $t = 0$.

\[ \sum H_{z1} + \sum \int M_z dt = H_{z2} \]

\[ 10 \text{ kg} \times \left( 2 \text{ m} \right) \times \left( 0.75 \text{ m} \right) \]

\[ + 60 \left( 2 \right) \left( \frac{3}{5} \right) \times (0.75) + \int_0^2 (8t^2 + 5) dt \]

\[ = 10 \times 2 \times 0.75 \]

\[ 15 + 54 + \left[ \frac{8t^3}{3} + 5t \right]_0^2 = 7.5 \times 31.33 \]

\[ v = 13.38 \text{ m/sec} \]
Problem 15.103 (Page 258)
A satellite of mass $700$ kg is launched into orbit about the earth with an initial velocity of $v_A = 10$ km/sec when the distance from the center of the earth is $r_A = 15$ Mm. If the launch angle at this position $\phi_A = 70^\circ$, determine the speed $v_B$ of the satellite at its closest distance $r_B$ and that distance measured from the center of the earth. The earth has a mass $M_e = 5.976 \times 10^{24}$ kg and the gravitation force is given by $F = GM_e m_s / r^2$.

\[
H_0 = H_{0z}
\]

\[
m_s (v_A \sin \phi_A) r_A = m_s v_b r_b
\]

\[
700[10 \times 10^3 \sin 70^\circ]15 \times 10^6 = 700 v_b r_b \quad (1)
\]

\[
T_A + v_A = T_B + v_b
\]

\[
\frac{1}{2} m_s v_A^2 - \frac{GM_e m_s}{r_A} = \frac{1}{2} m_s v_b^2 - \frac{GM_e m_s}{r_b}
\]

\[
\frac{1}{2} (700)[10 \times 10^3]^2 - \frac{66.73(10^{-12})(5.976)10 (700)^{2Y}}{15 \times 10^6}
\]

\[
= \frac{1}{2} (700) v_b^2 - \frac{66.73(10^{-12})(5.976)10 (700)^{2Y}}{r_b} \quad (2)
\]

Solving equations (1) and (2)

\[
v_b = 10.2 \text{ Kms/sec} \quad r_b = 13.8 \text{ Mm}
\]
Problem 15.108 (Page 269)

For the figure shown, a 50 kg child in a swing stops when $\theta_1 = 30^\circ$. Determine the speed of the child at $\theta = 0^\circ$ and the angle $\theta_2$ when she will stop at the upswing.

\[
T_1 + V_1 + U_{l-z} = T_2 - V_z
\]

\[
0 + 2.80(1 - \cos 30^\circ)(50)(9.81)
= \frac{1}{2}(50)V_z^2 + 0
\]

\[
V_z = 2.713 \text{ m/sec} \quad \text{For } r = 2.8 \text{ m}
\]

\[
\text{For a change in } r \text{ from } 2.8 \text{ to } 3 \text{ m}
\]

\[
H_{\text{before}} = H_{\text{after}}
\]

\[
50(2.713)2.8 = 50(V)3
\]

\[
V_{\text{after}} = 2.63 \text{ m/sec} \quad \text{just after } \theta = 0^\circ
\]

\[
T_2 + V_z + U_{l-z} = T_3 + V_z
\]

\[
\frac{1}{2}(50)(2.53)^2 + 0 + 0 = 0 + 50(9.81)3(1 - \cos \theta_3)
\]

\[
\theta_3 = 27^\circ
\]