Problem #1. The slotted arm revolves in the vertical plane about the fixed axis through point O. The 2-lb slider is being drawn inward toward O at the constant rate of 6 in./sec by pulling the cord S. At the instant depicted in the diagram at left, the slider is 12 in. from point O, and the arm has a counterclockwise angular velocity of 4 rad/sec, but is slowing down at the rate of 1 rad/sec². Given a kinetic friction coefficient of \( \mu = 0.25 \), determine the instantaneous values of the cord tension (T), and the force of normal contact (N) between the slot and the slider.

\[
\begin{align*}
\overline{r} &= 1 \\
\dot{r} &= -\frac{1}{2} \\
\ddot{r} &= 0
\end{align*}
\]

\[
\theta = 30° \\
\dot{\theta} = 4 \\
\ddot{\theta} = -1
\]

\[
\overline{a} = \left( \overline{\dot{\theta}} - \frac{1}{4} \right) \hat{e}_r + \left[ 1(\dot{r}) + 2 \left( \frac{1}{2} \right) 4 \right] \hat{e}_\theta
\]

\[
\overline{a} = (-16 \hat{e}_r - 5 \hat{e}_\theta) \text{ ft/sec}^2
\]

\[
\sum F = \left[ \frac{1}{2} mg + \frac{1}{4} N - T \right] \hat{e}_r + \left[ N - \frac{1}{2} mg \right] \hat{e}_\theta
\]

\[
N = \frac{1}{2} mg = \frac{1}{2} (2 \text{ lb}) = 1 \text{ lb}
\]

\[
T = \frac{1}{2} mg + \frac{1}{4} N - \frac{1}{2} mg = 2.898 \text{ lbs}
\]

\[
\sum F = ma
\]

\[
\hat{e}_r: \quad V^2 + \frac{1}{4} N - T = \frac{1}{2} (\frac{1}{2}) (16)
\]

\[
\hat{e}_\theta: \quad N - 1 = \frac{1}{2} \left( \frac{1}{2} \right) (5)
\]

\[
N = 1 - \frac{10}{32} = 0.6874 \text{ lbs}
\]

\[
T = \sqrt{3} + \frac{32}{32} \approx 2.898 \text{ lbs}
\]
Problem 2. A small block is set to sliding along the inner surface of a smooth parabolic bowl at point A.

(a) Determine the largest initial horizontal (transverse) release velocity \( v_0 = u = ? \) for which the block will NOT fall out of the (4-ft. high) bowl.

(b) For this release velocity, determine the block's velocity vector (in cylindrical component form) as it passes upward through the point B.

\[
\begin{align*}
\text{Cons of E: } V_z^2 + 2gz &= \text{const.} \quad (A) \quad U^2 + 2g \\
V_r^2 + V_\theta^2 + 2g z &= U^2 + 2g \\
V_z^2 &= V_\theta^2 + \frac{1}{4} V_r^2 \\
V_r^2 &= \frac{\frac{1}{4} V_r^2}{2g} \\
(1 + \frac{1}{2}) V_\theta^2 + V_z^2 + 2g z &= U^2 + 2g \\
\text{Cons of H_2: } r V_\theta = r A U = 1 u = u \\
V_\theta = \frac{10}{2} \Rightarrow (V_\theta = \frac{U^2}{2}) \\
(1 + \frac{1}{2}) V_\theta^2 + \frac{U^2}{2} + 2g z &= U^2 + 2g \\
\text{!! Select } u \text{ so that } z_{\text{max}} = 4 \Rightarrow V_\theta = z = 0 \text{ @ } z = 4 \\
\Theta + \frac{21}{4} + 2g (4) &= U^2 + 2g \\
\frac{3}{4} U^2 &= 6g \Rightarrow U^2 = 8g \Rightarrow U = 16.05 \text{ ft/sec} \\
(1 + \frac{1}{2}) V_\theta^2 + 2g \left[ z + \frac{1}{2} \right] &= 10g \\
\Theta \text{ pt. B } z = 2 \& t = V_\theta \text{ so that } \hat{\theta} \\
(1 + \frac{1}{2}) V_\theta^2 + 2g (4) &= 10g \\
\frac{9}{8} V_\theta^2 &= 2g \Rightarrow V_\theta = \sqrt{\frac{16g}{9}} = 7.566 \\
\text{surface constraint: } V_z = 2 r V_r \Rightarrow V_r = 2.675 \text{ ft/sec} \\
\Theta \text{ & Motion constraint: } V_\theta = \frac{U}{r} \approx 11.350 \\
\hat{\theta} \nabla = (2.675 \hat{r} + 11.350 \hat{\theta} + 7.566 \hat{z}) \text{ ft/sec}
\end{align*}
\]