1. (25) The coefficient of static friction between the flat bed of the truck and the crate it carries is 0.3. Determine the minimum stopping distance \( s \) which the truck can have from a speed of 70 km/h with constant deceleration if the crate is not to slip forward.

2. (25) The ball is released from position \( A \) with a velocity of 3 m/s and swings in a vertical plane. At the bottom position, the cord strikes the fixed bar at \( B \), and the ball continues to swing in the dashed arc. Calculate the velocity \( v_C \) of the ball as it passes position \( C \).

3. (25) A rope is wrapped around a cylinder of radius \( r \) and mass \( m \). Knowing that the cylinder is released from rest, determine the velocity of the center of the cylinder after it has moved downward a distance \( s \).

4. (25) A 5-kg projectile is fired from ground level with an initial velocity \( v_A = 20 \) m/s in the direction shown. When it reaches its highest point \( B \), it explodes into two 2.5-kg fragments. If one fragment travels vertically upward at 3 m/s, determine the distance between the fragments after they strike the ground.
Equation Sheet

\[ v = \frac{dx}{dt} \quad a = \frac{dv}{dt} = \frac{d^2x}{dt^2} = v \frac{dv}{dx} \]

Uniform rectilinear motion
\[ x = x_0 + vt \]

Uniformly accelerated rectilinear motion
\[ v = v_0 + at \]
\[ x = x_0 + v_0 t + \frac{1}{2} at^2 \]
\[ v^2 = v_0^2 + 2a \left( x - x_0 \right) \]

Acceleration components

Tangential & normal:
\[ a_t = \frac{dv}{dt} \quad a_n = \frac{v^2}{\rho} \]

Radial and transverse:
\[ a_r = \vec{r} - r\dot{\theta}^2 \quad a_\theta = r\ddot{\theta} + 2\dot{r}\dot{\theta} \]

Work and energy: \[ T_1 + U_{1\rightarrow 2} = T_2 \]
Conservation of energy: \[ T_1 + V_1 = T_2 + V_2 \]

Impulse and momentum: \[ m\vec{v}_1 + \int_{t_1}^{t_2} \vec{F} dt = m\vec{v}_2 \]

Coefficient of restitution: \[ e = \frac{v'_B - v'_A}{v_A - v_B} \]
\[ \vec{v}_B = \vec{v}_A + \vec{v}_{B/A} = \vec{v}_A + \vec{\omega} \times \vec{r}_{B/A} \]
\[ \vec{a}_B = \vec{a}_A + \vec{a}_{B/A} = \vec{a}_A + \left( \vec{\omega}_{B/A} \right)_n + \left( \vec{\omega}_{B/A} \right)_t \]
\[ (a)_n = r\alpha \]
\[ (\alpha)_n = r\omega^2 \]
\[ \sum \vec{F} = m\vec{a}_g \quad \sum \vec{M}_G = I_G \vec{\alpha} \]

Impulse and momentum for rigid bodies: \[ m\vec{v}_{G1} + \int_{t_1}^{t_2} \vec{F} dt = m\vec{v}_{G2} \quad I_G \vec{\omega}_1 + \int_{t_1}^{t_2} \vec{M}_G dt = I_G \vec{\omega}_2 \]

For a uniform cylinder, \[ I_G = \frac{1}{6} mr^2 \]
For a uniform rod, \[ I_G = \frac{1}{12} ml^2 \]
For a uniform sphere, \[ I_G = \frac{2}{5} mr^2 \]
\[ I = mk^2 \]