GIVEN: \( M = 50 \text{ kg} \), \( M_n = 0.5 \text{ kg} \), \( v = 10 \text{ m/s} \), \( e = 0.8 \)
\( h = 10 \text{ m} \), \( \Delta t = \) ?

**FIND:** \( e \) after first impact, \( \Delta t \) at ground, \( E_{au} \)

1. \[ \begin{align*}
\text{KINEMATICS:} \\
\chi &= ? \\
\chi' &= ? \\
\chi' &= ?
\end{align*} \]

2. **KINEMATICS:**

   No forces in \( y \)-direction \( \Rightarrow V_y = \chi \frac{v}{\tan \theta} = 0 \)

   \[ m \frac{\chi_x'}{\chi_x} + M \chi_x'^2 = m \chi_x' + MV_x' \]  
   \( \theta = \frac{V_x' - \chi_x'}{\chi_x - \chi_x} \Rightarrow \chi_x' = -e \chi_x + V_x' \)

3. **SOLVE:**

   \[ V' = \frac{(1 + e)}{(1 + M \chi_x)} \chi_x \frac{v}{\tan \theta} = 0.178 \text{ m/s} \]

4. \[ V_x' = \sqrt{\chi_x'^2 - 2 \chi_x (-h)} \Rightarrow V_x' = 14.0 \text{ m/s} \]

5. \[ V' = 0.178 \text{ m/s} - 14.0 \text{ m/s} \]

6. \[ M \chi_x + \int (E - M g J) \, dt = 0 \]

7. \[ M \chi_x + E_{au} \Delta t - M g J \Delta t = 0 \]

8. \[ E_{au} = \frac{-1}{\Delta t} \left( M \chi_x + M g J \right) = -297 \text{ J} + 23800 \text{ J} \]

   \[ |E_{au}| = 23.802 \text{ J} \]
Given: \( N_a = 0.05 \text{m/s}^2 \), \( b = 0.06 \text{m} \), \( M = 0.5 \text{kg} \), \( h = 15 \text{cm} \)

Find \( m \) st \( N_c' = 0 \)

\begin{align*}
T_1 + V_1 + \frac{V_2^2}{2} - \frac{V_{n2}^2}{2} + V_2
\end{align*}

\begin{align*}
\frac{1}{2} I_p \omega^2 + \frac{1}{2} m V_{f,1}^2 + Mg h_0 &= m g h_{f,1} \\
m &= \frac{(I_p \omega^2 + 2Mgh_0)}{(-N_{f,1} + 2g \Delta h_{f,1})}
\end{align*}

\textbf{Kinematics}

\textit{INSC CENTRE AT} \( P \rightarrow \frac{V_p}{2}, \ L = -\frac{V_0}{h_0}, h = \frac{V_0^2}{2g} \)

\begin{align*}
V_H &= \frac{V_0}{h_0} h \uparrow \\
N_{f,1} &= \frac{\vec{r}_{p,1} \cdot \vec{a}_{p,1}}{\vec{r}_{p,1}}
\end{align*}

\begin{align*}
N_{f,1} &= \frac{V_0}{h_0} h \Rightarrow \frac{\vec{r}_{p,1} \cdot \vec{a}_{p,1}}{\vec{r}_{p,1}} = \frac{4}{3} \frac{V_0}{h_0} b = 1 \text{ m/s}
\end{align*}

\textbf{Inertial Props}

\[ I_p = I_0 + M (h_0)^2 = 0.0023 \text{ kg m}^2 \]

\textbf{Solve:}

\[ (1) \rightarrow m = 0.614 \text{ kg} \]
Given: $N_B = 15\psi$,
$\theta_B = \theta_C = Y_C = 0$, $l = 0.5m$

Find: $\omega_{AB}$, $\omega_{AC}$

Velocities

\[ V_A = \omega_{AC} \times r_{AC} = \omega_{AC} \times \frac{1}{2}l \left( \frac{3}{5} \hat{i} + \frac{4}{5} \hat{j} \right) \]
\[ = \omega_{AC} \left( \frac{3}{5} \hat{i} + \frac{4}{5} \hat{j} \right) \quad \ldots (1) \]

\[ V_A = \omega_{AB} \hat{r} + \omega_{AB} \times \vec{r}_{AB} = \omega_{AB} \hat{r} \times \left( \frac{3}{5} \omega_{AC} \hat{i} + \frac{4}{5} \omega_{AC} \hat{j} \right) + \omega_{AB} \hat{j} \]
\[ = \omega_{AB} \left( \frac{3}{5} \hat{i} + \frac{4}{5} \hat{j} \right) + \omega_{AB} \hat{j} \quad \ldots (2) \]

Equate (1) and (2):

\[ x: -4 \psi \omega_{AC} \hat{i} = 4 \psi \omega_{AB} \hat{i} \Rightarrow \omega_{AC} = -\omega_{AB} \]
\[ y: \quad \frac{3}{5} \omega_{AC} \hat{j} = \frac{3}{5} \omega_{AB} \hat{j} + \omega_{AB} \hat{j} \Rightarrow \omega_{AC} = -\frac{5}{3} \omega_{AB} \]
\[ \omega_{AB} = -\frac{6}{5} \frac{\omega_{AB}}{2l} \hat{k} = -\frac{6}{5} \frac{\omega_{AB}}{2l} \hat{k} = -\omega_{AC} \]

\[ \omega_{AC} = -2\frac{\omega_{AC}}{2l} \hat{k} \]

Accelerations

\[ a_A = \omega_{AC} \times \vec{r}_{AC} - \omega_{AC} \times \vec{r}_{AC} \]
\[ = \omega_{AC} \left( \frac{3}{5} \hat{i} + \frac{4}{5} \hat{j} \right) - \omega_{AC} \left( \frac{3}{5} \hat{i} + \frac{4}{5} \hat{j} \right) \quad \ldots (3) \]

\[ a_A = \omega_{AB} \times \vec{r}_{AB} - \omega_{AB} \times \vec{r}_{AB} \]
\[ = \omega_{AB} \left( \frac{3}{5} \hat{i} + \frac{4}{5} \hat{j} \right) - \omega_{AB} \left( \frac{3}{5} \hat{i} + \frac{4}{5} \hat{j} \right) \quad \ldots (4) \]

Equate (3) and (4):

\[ x: -4 \psi \omega_{AC} \hat{i} - \frac{3}{5} \omega_{AC} \hat{i} = 4 \psi \omega_{AB} \hat{i} - \frac{3}{5} \omega_{AB} \hat{i} \Rightarrow \omega_{AB} = -2 \psi \omega_{AC} \]
\[ y: \quad \frac{3}{5} \omega_{AC} \hat{j} - 4 \psi \omega_{AC} \hat{i} = \frac{3}{5} \omega_{AB} \hat{j} + \frac{3}{5} \omega_{AB} \hat{i} \]
\[ -8 \omega_{AC} = 6 \omega_{AB} \Rightarrow \omega_{AB} = -\frac{4}{3} \omega_{AC} \hat{k} \]
\[ \omega_{AB} = -\frac{4}{3} \left( \frac{2}{9} \right) \hat{k} \]
\[ = -\frac{2}{9} \hat{k} \]
\[ = \frac{2}{9} \hat{k} \]
\[ \omega_{AC} = \frac{2}{3} \hat{k} \]
\[ \omega_{AB} = -\frac{4}{3} \hat{k} \]
\[ \omega_{AC} = \frac{2}{3} \hat{k} \]
GIVEN: \( h-h_o = 0.09 \text{ m} \), \( I_o = 0.001 \text{ kg} \cdot \text{m}^2 \), \( M = 0.5 \text{ kg} \), \( \Sigma F = 10 \text{ N} \)

FIND: \( a_o, \alpha \)

**KINEMATICS:**

\[
\begin{align*}
\alpha &= a_x \hat{x} + a_y \hat{y} \\
\dot{x} &= a_x \hat{x}
\end{align*}
\]

**KINETICS:**

\[
\begin{align*}
\Sigma F &= \dot{a}_G = m(a_x \hat{x} + a_y \hat{y}) \\
\dot{a}_G &= \left( \frac{E}{m} - g \hat{y} \right) \\
&= 200 \text{ N} - 9.81 \text{ m/s}^2 \hat{y} \\
\Sigma M_o &= I_o \alpha \hat{z} \\
&= -F(h-h_o) = I_o \alpha \\
\alpha &= \frac{F(h-h_o)}{I_o} \hat{z} \\
&= -9000 \text{ rad/s}^2 \hat{z}
\end{align*}
\]