Exam 3 Review

Momentum:

1. Initial: \( V_1 \rightarrow V_2 \)
2. Final A: Perfectly Inelastic
   \[ m_1 V_1 + m_2 V_2 = (m_1 + m_2) V_f \]
   \[ P_i = P_f \]
   *\( V_2 \) will be negative

Specific example: Perfectly Inelastic, given \( V_2 \) and \( V_{1f} \), solve for \( V_{2f} \)

Use a system of equations:

\[ m_1 V_1 + m_2 V_2 = m_1 V_{1f} + m_2 V_{2f} \]
\[ V_1 - V_2 + V_{1f} = V_{2f} \]

Solve for \( V_2 \):

\[ V_2 = \frac{V_{1f} (m_1 + m_2) - V_1 (m_1 - m_2)}{2m_2} \]

Final B: Perfectly Elastic

\[ m_1 V_1 + m_2 V_2 = m_1 V_{1f} + m_2 V_{2f} \]
\[ P_i = P_f \]

Velocity Reversal Equation

\[ (V_1 - V_2) = V_{2f} - V_{1f} \]

Energy:

\[ KE_i = KE_f \]
A Bullet hits a Block—how high does it go?

3 stages:

\[ \begin{array}{c}
\text{Frame 1} \\
\text{Frame 2} \\
\text{Frame 3}
\end{array} \]

Between Frames 1 and 2, we have conservation of momentum over an inelastic collision, but not conservation of kinetic energy.

\[ M_0 = \text{mass of bullet} \quad m_g = \text{mass of system} \]

\[ p_i = p_f \]

\[ m_0 v_{bi} = m_g v_f \]

Between Frames 2 and 3, Energy is conserved:

\[ \sum E_i = \sum E_f \]

\[ \frac{1}{2} m_g v_f^2 = m_g h \]

Rotational Motion: don't forget \( v = \omega r \), \( a = \alpha r \), \( \alpha = \omega^2 r \)

For context, consult physics.info/rotational-kinematics/practest.html

\( \alpha = \frac{v^2}{2x} \)

\( \theta = \frac{1}{2} \alpha t^2 \quad \text{solve for } \alpha : \frac{2\theta}{t^2} = \alpha \)

\[ \bar{V} = \frac{x}{t} \]

\[ \omega = \omega_0 + \alpha t \]

\[ \omega = \alpha t \]
Centripetal Acceleration: (also from Hypertextbook)

1. Roller Coaster/circular track:
   - Given mass, radius, velocity:
   - Consider several points on a track:
   - Find Normal and Friction
   - For each point, we look for \( \Sigma F \):

   \[ \Sigma F_y : N - mg = ma = \frac{mv^2}{r} \]
   \[ N = m\left(g + \frac{v^2}{r}\right) \]
   \[ \Sigma F_x : f_r = 0 \]
   \[ \Sigma F_y : f_r - mg = 0 \]
   \[ f_r = mg \]

2. Planets: (From physics classroom)
   - Imagine a geosynchronous satellite; what is its height?
   - Given... nothing!

   \[ \Sigma F = ma \]

   \[ f_g = m \cdot \frac{v^2}{r} \]

   \[ \frac{v^2}{r} = \frac{GM_\text{p}}{r^2} \]  \( (s = \text{satellite}, \ p = \text{planet}) \)

   \[ \frac{v^2}{r} = \frac{GM_\text{p}}{r^2} \rightarrow \frac{v^2}{r} = 6.67 \times 10^{-11} \times \frac{\text{kg} \cdot \text{m}^2}{\text{kg}^2} \times \frac{\text{m}^3}{\text{kg}^2} \]

   \[ \therefore \]

   \[ r = \left( \frac{GM_\text{p}}{4\pi^2} \right)^{\frac{1}{3}} \]

3. Torque: Salad Tossor
   - Planet in orbit:

   \[ L = Iw = mr^2w \]

   because it's just like a point mass

   \[ = mr^2 \left( \frac{v}{r} \right) = mr \cdot v \]
Torque: \( \sum \tau = I \alpha \)
\( T_1 R - T_2 r = \alpha \)

Wheel:

Spinng Top: (Hyperbook) physics.info/rotational-dynamics/practice.shtml
For context:

\( a \) \( T \)? \( \frac{3}{10} m r^2 \)

b) Tension
Sum forces use kinematics to solve for a
\( \sum F_x = ma \)
\( T = ma \)
\( T = m \frac{V_i^2}{2\Delta x} \)

\( c \) \( \omega_f \)
Sum Toreques solve for \( \alpha \)
\( \sum \tau = I \alpha \)
\( T_r = I \alpha \)
\( \frac{mV_i^2}{2\Delta x} = \frac{I \omega_i}{t} \)
(from b)

\( d \) \( \theta = \frac{\omega \Delta t}{2} \)
use kinematics
\( \ell = r \theta \)