Phys1110 Exam 3 Review:

Chapters 1 through 7 , 12 (see previous reviews)

Chapter 8: Momentum

- $\vec{F}_{net} = \dfrac{d\vec{p}}{dt} \quad \Rightarrow \quad \text{Impulse} = \Delta\vec{p} = \vec{F}_{net} \cdot \Delta t$
- Conservation of Momentum: $\vec{F}_{net} = 0 \quad \Rightarrow \quad \vec{p} = \text{constant}$

  for system isolated from outside forces, $\vec{p}_{tot} = m_1\vec{v}_1 + m_2\vec{v}_2 = \text{constant}$
- Collisions:

  $\vec{p}_{tot}$ *always* conserved.

  KE is conserved *only* in perfectly elastic collisions
- 2D collisions: $p_{x,tot}$ and $p_{y,tot}$ are separately conserved.

Chapter 9, 10: Rotations

Analogy between rotation about a fixed axis and 1D translation along the x-axis:

- $\theta(\text{rads}) = \dfrac{s}{r}, \quad \omega = \dfrac{d\theta}{dt}, \quad \alpha = \dfrac{d\omega}{dt} \quad (\text{like } x, \quad v = \dfrac{dx}{dt}, \quad a = \dfrac{dv}{dt})$
- $v_{tan} = r\,\omega \quad , \quad a_{tan} = r\,\alpha$
- torque $|\tau| = r \cdot F_{\perp}$
- moment of inertia $I = \sum_i m_i r_i^2$
- $\tau_{net} = I \cdot \alpha \quad (\text{like } F_{net} = m\,a)$
- $KE_{rotation} = (1/2)\, I\, \omega^2 \quad [\text{like } KE_{trans} = (1/2)\, m\, v^2]$
- Rolling motion: $KE_{tot} = KE_{trans} + KE_{rot} = \dfrac{1}{2} m v^2 + \dfrac{1}{2} I \omega^2$

Angular Momentum

- $\vec{\tau} \equiv \vec{r} \times \vec{F}, \quad \vec{L} \equiv \vec{r} \times \vec{p}$ (for particle) $\Rightarrow \vec{L} = I\vec{\omega}$ (for rotating object)
- $\vec{\tau}_{net} = \dfrac{d\vec{L}}{dt} \quad (\text{like } \vec{F}_{net} = \dfrac{d\vec{p}}{dt})$
- Conservation of Angular momentum: If $\vec{\tau}_{net} = 0 \Rightarrow \dfrac{d\vec{L}}{dt} = 0 \Rightarrow \vec{L} = \text{constant}$

$L = \text{constant} \quad \Rightarrow \quad I_i\,\omega_i = I_f\,\omega_f$

Chapter 11: Static Equilibrium

$\sum F_x = 0$, $\sum F_y = 0$ and $\sum \tau = 0$ The net torque about *any* axis must be zero.

Chapter 13: Simple Harmonic Motion

- $F_{restore} \propto -x$, $PE \propto x^2$,
- period T independent of amplitude A,
- sinusoidal motion

Differential Equation: $F_{net} = m a = -k x \quad \Rightarrow \quad m a = -k x, \quad \frac{d^2x}{dt^2} = -\frac{k}{m} x$

Mass m on spring k, $\omega = \frac{2\pi}{T} = \sqrt{\frac{k}{m}}$

$$x(t) = A\cos(\omega t + \varphi)$$
$$v(t) = -A\,\omega\,\sin(\omega t + \varphi) \; .$$
$$a(t) = -A\,\omega^2\cos(\omega t + \varphi)$$

Conservation of Energy: $\frac{1}{2} m v^2 + \frac{1}{2} k x^2 = E_{tot} \;\Rightarrow\; E_{tot} = \frac{1}{2} k A^2 = \frac{1}{2} m v_{max}^2$

Simple Pendulum: SHM in limit of small amplitude: $\omega = \sqrt{\frac{g}{L}}$

Remember: to solve any before/after problem in an isolated system, try

Conservation of energy or

Conservation of momentum or

Conservation of angular momentum.

To prepare for Exams:

- Review Concept Tests and CAPA problems. Read question and recall reasoning that gets to the answer. Be able to solve CAPA algebraically.
- Prepare your formula sheet.
- Take the practice exam.
- It is no good to memorize answers. You have to understand and remember how you construct the answers.