EXAM 2 Review - CH 9-15

CH 9 - Momentum and Impulse
\[ \vec{p} = m \vec{v} \quad \Delta \vec{p} = \int \vec{F} \, dt = \vec{J} \text{ impulse} \]

Conservation of Momentum \[ \vec{p} = \text{constant} \] - ALWAYS TRUE - (no external forces)

Elastic collisions \[ \Rightarrow \Delta K = \text{constant also} \]
Inelastic collisions \[ \Rightarrow \text{energy dissipated into heat} \]
- handy to shift reference frame to solve

CH 10 - Energy
\[ K = \frac{1}{2} mv^2 = \frac{p^2}{2m} \text{ kinetic energy} \]

\[ U_g = mgy \] grav. pot. energy near Earth

Spring \[ F = -kx \quad U_x = \frac{1}{2} kx^2 \quad x = \text{displ. from eq.} \]

CH 11 - Work
\[ W = \int \vec{F} \cdot d\vec{r} \] Work done on object by force \( F \) acting on object

Conservative Force \( \vec{F}(\vec{r}) \) \[ \Rightarrow \text{can keep track of work with potential energy function} \]
\[ \vec{F} = -\nabla U(\vec{r}) \quad \text{typ. } \vec{F} = -\frac{dU}{dx} \]

Power = rate of doing work \[ \vec{P} = \vec{F} \cdot \vec{v} \]

Cons. of Energy, general: \[ \Delta K + \Delta U + \Delta E_m = W_{\text{ext, diss}} \] (e.g. friction)
EXAM 2 Review

CH 12 - Rotation

moment of inertia \( I = \int r^2 \, dm \) depends on axis

kinetic energy \( K = \frac{1}{2}I\omega^2 \)

center of mass \( \mathbf{r}_{cm} = \frac{1}{m} \int \mathbf{r} \, dm \)

parallel axis theorem \( I = I_{cm} + mr_{cm}^2 \)

torque \( \mathbf{T} = \mathbf{r} \times \mathbf{F} \)

Right hand rule \( \Rightarrow \mathbf{T}, \mathbf{r}, \omega \)

rotational dynamics \( \mathbf{T} = I \mathbf{\ddot{\omega}} \)

work \( W = \int \mathbf{F} \cdot d\mathbf{r} \) (Gradians!)

power \( P = \mathbf{T} \cdot \omega \)

Static Equilibrium

\( \sum \mathbf{F} = 0 \) (constant translation)

\( \sum \mathbf{T} = 0 \) (constant rotation)

Angular momentum \( \mathbf{L} = I \mathbf{\omega} \)

\( = m \mathbf{r} \times \mathbf{\dot{r}} \) single particle

if \( \sum \mathbf{T} = 0 \Rightarrow \mathbf{L} = \text{constant} \)

CH 13 Gravitation

\( \mathbf{F}_G = -G \frac{mM}{r^2} \)

\( \mathbf{U}_G = -G \frac{mM}{r} \to 0 \)

\( \Rightarrow \) Kepler's laws

\( \omega^2 = \frac{GM}{r^3} \) (3rd law)

elliptic/hyperbolic orbits (1st law)

equal areas in equal times (2nd law)
Exam 2 Review

CH 14 Simple Harmonic Motion

harmonic equation $\ddot{x} + \omega^2 x = 0$

spring: $\omega^2 = \frac{k}{m}$ pendulum $\omega^2 = \frac{g}{l}$

Solution $x = A \sin(\omega t + \phi_0)$ or $\cos(\omega t + \phi_0)$

generally, energy $\propto \omega^2$

any system near equilibrium oscillates $\omega = \frac{\sqrt{\ddot{v}^2(x)}}{m}$

CH 15 Fluids

hydrostatic pressure $p = \rho g d = \text{weight of fluid}$

buoyancy $F_B = \text{weight of displaced fluid}$

mass flow rate $\rho A \dot{v} = \text{constant in steady state}$

"continuity" eqn

conservation of energy $\rho + \frac{1}{2} \rho v^2 + \rho g y = \text{constant}$ (incompressible)