Physics 121 -- Review for Midterm #3

Equations (in addition to Review 1 and 2 equations)

Potential energy:

\[ U = -W, \quad U = mgh, \quad U = \frac{1}{2} kx^2 \]

Potential energy and force;

\[ F = -\frac{dU}{dx}, \quad U = -\int F \, dx \quad \text{or} \quad F = -\frac{dU}{dr} \quad \text{or} \quad U = -\int F \, dr \]

Work:

\[ W = \vec{F} \cdot \vec{d} = Fd\theta \quad \text{or} \quad W = \int \vec{F} \cdot d\vec{r} \]

Centripetal acceleration/force

\[ \alpha_{\text{cent}} = \frac{v^2}{r} \quad F_{\text{cent}} = \frac{mv^2}{r} \]

Constant tangential acceleration (including \( \alpha_{\text{tan}} = 0 \)) – compare equations for linear motion:

\[ \theta = \theta_0 + \omega_0 t + \frac{1}{2} \alpha_{\text{tan}} t^2 \]
\[ \omega = \omega_0 + \alpha_{\text{tan}} t \]
\[ \omega^2 - \omega_0^2 = 2 \alpha_{\text{tan}} (\theta - \theta_0) \]

Torque and angular momentum equations – compare force equations:

\[ \tau = I\alpha \quad L = I\omega \quad \vec{\tau} = \frac{d\vec{L}}{dt} \]
\[ \vec{L} = \vec{r} \times \vec{p} \quad \vec{\tau} = \vec{r} \times \vec{F} \]

Kinetic energy

\[ K = \frac{1}{2} mv^2 \quad K = \frac{1}{2} I\omega^2 \]

Center of mass equations:

\[ x_{cm} = \frac{m_1 x_1 + m_2 x_2 + \cdots + m_N x_N}{m_1 + m_2 + \cdots + m_N} \quad x_{cm} = \frac{1}{M} \int x \rho \, dV \]

Moment of inertia equations:

For point masses: \( I = \sum m d^2 \) \quad For a mass distribution: \( I = \int d^2 \rho \, dV \)

Parallel axis theorem:

\[ I' = I + md^2 \]
Review Topics

Look over the first two basic tests and the first two midterm exams.

Energy conservation: translational kinetic energy, rotational kinetic energy, potential energy, rotational energy, work

Find potential energy given the force as a function of position or the force given the potential energy as a function of position.

Conservative and non-conservative forces

Drag forces: linear and quadratic (Don’t memorize the equations.)

Dot (scalar) products

Energy bar diagrams

Potential energy graphs (potential wells)

Centripetal acceleration, angular acceleration, tangential acceleration

Apparent forces in an accelerating car

I (no integrals on the test I’ll give you the page from the text.)

Cross (vector) products: magnitude and direction, right-hand rule

Find torques and use the torques to get angular acceleration and rotational motion.

Various problems involving force, torque, rotation, kinetic energy, and angular momentum:

Merry-go-round, Ferris wheel, Atwood machine, ball on inclined plane, yo-yo, see-saw, conical pendulum, pushing a box

Find the center of mass of a collection of objects (no integration).