

## Physics 250 Chapters 9-11 Equation Sheet

Velocity and acceleration:  $v_{av} = \frac{\Delta x}{\Delta t}$   $a_{av} = \frac{\Delta v}{\Delta t}$

Constant velocity:  $x_B = x_A + v_{AB}\Delta t_{AB}$

Constant acceleration:  $v_B = v_A + a_{AB}\Delta t_{AB}$

$$x_B = x_A + v_A\Delta t_{AB} + \frac{a_{AB}}{2}\Delta t_{AB}^2$$

$$v_B^2 = v_A^2 + 2a_{AB}\Delta x_{AB}$$

$$x_B = x_A + \left(\frac{v_A + v_B}{2}\right)\Delta t_{AB}$$

Circular motion:  $a_{rad} = v^2/r$   $F_{rad} = mv^2/r$

Forces:  $\vec{a} = \vec{F}_{net}/m$   $w = mg$   $f_s \leq \mu_s n$   $f_k = \mu_k n$   $f_r = \mu_r n$

$$f_{spring} = -kx$$

Energy:  $W_{net} = \int \vec{F}_{net} \cdot d\vec{s} = \int_{x_A}^{x_B} \vec{F}_{net} \cdot \left(\hat{i} + \frac{dy}{dx}\hat{j}\right) dx$

$$W_{net} = \Delta K \quad E_f = E_i + W_{other}$$

$$\Delta U = -W_{Cons} \quad K = \frac{1}{2}mv^2 \quad U_g = mgh \quad U_s = \frac{1}{2}kx^2$$

$$P = \frac{dW}{dt} = \vec{F} \cdot \vec{v}$$

Momentum:  $\vec{p} = m\vec{v}$   $\vec{J} = \vec{F}\Delta t$   $\vec{J} = \Delta\vec{p}$

Rigid body rotation in a plane:

Linear Quantity	Angular Quantity	Link/ definition
s	$\theta$	$s = r\Delta\theta$
v	$\omega$	$v_{tan} = r\omega$
a	$\alpha$	$a_{tan} = r\alpha$
M	I	$I_{point} = mr^2$
F	$\tau$	$\tau = rF\sin(\theta)$
P	L	$L = I\omega = rmvsin(\theta)$
F=ma	$\tau = I\alpha$	n/a

Moments of inertia of shapes about axes will be given in problems if needed.

Rotation in 3D:  $\vec{\tau} = \vec{r} \times \vec{F}$   $\vec{L} = \vec{r} \times \vec{p}$   $\vec{\tau} = \frac{d\vec{L}}{dt}$

**Simple Harmonic Motion:**

$$x = A \cos(\omega t + \varphi) \quad \omega = 2\pi f = 2\pi/T \quad \omega = \sqrt{k/m}$$

**Waves:**

$$y(x, t) = A \sin(kx \pm \omega t + \varphi) \quad k = 2\pi/\lambda \quad v = \sqrt{F/\mu}$$

$$f_n = \frac{n}{2L} \sqrt{F/\mu} \quad v = f\lambda \quad v = \omega/k$$

Constants:  $g = 9.80 \text{ m/s}^2$