

# PHYS 211X

## General Physics I

## Formulas

Dot Product:

$$\vec{A} \cdot \vec{B} = \|A\| \|B\| \cos(\theta) \quad (1)$$

Cross Product:

$$\vec{A} \cdot \vec{B} = AB \sin(\theta) \quad (2)$$

Position:

$$x, y, s, \text{ or } p = \vec{v} \Delta t = \int \vec{v} dt \quad (3)$$

$$x = \left( \frac{v_0 + v_f}{2} \right) \Delta t \quad (4)$$

$$x = v_0 t + \left( \frac{1}{2} \right) \vec{a} t^2 \quad (5)$$

Velocity:

$$\vec{v} = \vec{a} \Delta t = \frac{d}{dt}[p] = \int (\vec{a}) dt \quad (6)$$

$$\vec{v} = v_0 + \vec{a} t \quad (7)$$

$$\vec{v}_f^2 = v_0^2 + 2\vec{a} \Delta x \quad (8)$$

Acceleration

$$\vec{a} = \frac{d}{dt}[\vec{v}] \quad (9)$$

Projectile Motion:

$$y_f = y_0 + v_0(\Delta t) + \frac{1}{2}a(\Delta t^2) \quad (10)$$

Force:

$$\vec{F} = m\vec{a} \quad (11)$$

Friction:

$$f = \mu N \quad (12)$$

Drag:

$$\vec{F}_D \text{ or } D = \frac{1}{2} \rho C_D A v^2 \quad (13)$$

Circular Motion:

$$\vec{v} = r \quad (14)$$

$$a_{cent} = \frac{m\vec{v}^2}{r} \quad (15)$$

$$f = \mu n \quad (16)$$

$$v_{cent/crit} = \sqrt{gr} \quad (17)$$

$$N = mr\omega^2 \quad (18)$$

$$N = 3mg \quad (19)$$

$$\omega = \frac{\Delta\theta}{\Delta t} \quad (20)$$

Total Energy:

$$E = K + U \quad (21)$$

$$KE_i + U_i = KE_f + U_f \quad (22)$$

$$\frac{1}{2}mv_i^2 + mgy_i = \frac{1}{2}mv_f^2 + mgy_f \quad (23)$$

PE of a spring:

$$U = 1/2kx^2 \quad (24)$$

$$U_p = \frac{1}{2}k(x - L_0) \quad (25)$$

Potential Energy:

$$U_{tot} = mg + k\Delta y \quad (26)$$

Work:

$$W_{int} = -\frac{F_x}{\Delta} \quad (27)$$

$$F_x = -\frac{dU}{dx} \quad (28)$$

Momentum:

$$\rho = mv \quad (29)$$

$$\rho_\theta = \quad (30)$$

Torque:

$$\tau = r \times F \quad (31)$$

$$\tau = rF \sin(\theta) \quad (32)$$

$$N = I\alpha \quad (33)$$

Inertia:

$$I = \sum_i m_i r_i^2 = \int dm r^2 \quad (34)$$

Kinetic Energy of Rotation:

$$KE = \frac{1}{2}I\omega^2 \quad (35)$$

## Key

$v$  = velocity, meters/second

$y$  = height, meters

$x$  = distance, meters

$t$  = time, seconds

$m$  = mass, kilograms

$a$  = acceleration, meters/second<sup>2</sup>

$\theta$  = angle, degrees

$g$  = gravity: 9.8 meters/second<sup>2</sup>

$\omega$  = angular velocity, radians or degrees/second

$F$  = force, Newtons, kilogram · meters/second<sup>2</sup>

$\mu$  = coefficient of friction

$N$  = normal force, Newtons

$A$  = area, meters<sup>2</sup>

$\rho$  = volumetric mass density, kilograms/meters<sup>3</sup>

$C_D$  = drag coefficient (geometry dependant)

$K$  = kinetic energy

$U$  = potential energy

$\alpha$  = angular acceleration, degrees—radians/second<sup>2</sup>