# PHYS 211X

## General Physics I

Kaleb Burris

# Formulas

Dot Product:

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

Cross Product:

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

Position:

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

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

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

Velocity:

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

$$\vec{v} = v_0 + \vec{a}t \tag{7}$$

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

Acceleration

$$\vec{a} = \frac{d}{dt}[\vec{v}] \tag{9}$$

Projectile Motion:

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

Force:

$$\vec{F} = m\vec{a} \tag{11}$$

Friction:

$$f = \mu N \tag{12}$$

Drag:

$$\vec{F_D} \text{ or } D = \frac{1}{2}\rho C_D A v^2 \tag{13}$$

Circular Motion:

$$\vec{v} = r \tag{14}$$

$$F_c = \frac{m\vec{v}^2}{r} \tag{15}$$

$$f = \mu n \tag{16}$$

$$v_c = \sqrt{gr} \tag{17}$$

$$N = mr\omega^2 \tag{18}$$

$$N = 3mg \tag{19}$$

$$\omega = \frac{\Delta\theta}{\Delta t} \tag{20}$$

Total Energy:

$$E = K + U \tag{21}$$

$$KE_i + U_i = KE_f + U_f \tag{22}$$

$$\frac{1}{2}mv_i^2 + mgy_i = \frac{1}{2}mv_f^2 + mgy_f \tag{23}$$

PE of a spring:

$$U = 1/2kx^2 \tag{24}$$

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

Potential Energy:

$$U_{tot} = mg + k\Delta y \tag{26}$$

Work:

$$W_{int} = -\frac{F_x}{\Delta} \tag{27}$$

$$F_x = -\frac{dU}{dx} \tag{28}$$

Momentum:

$$\rho = mv \tag{29}$$

Torque:

$$\tau = r \times F \tag{30}$$

$$\tau = rF \sin(\theta) \tag{31}$$

$$N = I\alpha \tag{32}$$

Inertia:

$$I = \sum_i m_i r_i^2 = \int r^2 dm \tag{33}$$

$$I = r\omega^2 \tag{34}$$

Kinetic Energy of Rotation:

$$KE_{rot} = \frac{1}{2}I\omega^2 \tag{35}$$

Kinetic Energy of Rolling:

$$KE_{roll} = \frac{1}{2}I\omega^2 + \frac{1}{2}mv_c^2 \tag{36}$$

Angular Momentum:

$$L = I\omega \tag{37}$$

## Key

$v$ = velocity, meters/second
$y$ = height, meters
$x$ = distance, meters
$t$ = time, seconds
$m$ = mass, kilograms
$a$ = acceleration, meters/second$^2$
$\theta$ = angle, degrees
$g$ = gravity: 9.8 meters/second$^2$
$\omega$ = angular velocity, radians or degrees/second
$F$ = force, Newtons, kilogram $\cdot$ meters/second$^2$
$\mu$ = coefficient of friction
$N$ = normal force, Newtons
$A$ = area, meters$^2$
$\rho$ = volumetric mass density, kilograms/meters$^3$
$C_D$ = drag coefficient (geometry dependant)
$K$ = kinetic energy
$U$ = potential energy
$\alpha$ = angular acceleration, degrees—radians/second$^2$