

PHYS 211X

General Physics I

Formulae

Dot Product:

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

Cross Product:

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

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, v :

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

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

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

Acceleration, a :

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

Projectile Motion:

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

Force, F :

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

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:

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

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

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

$$v_c = \sqrt{gr} \quad (17)$$

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

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

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

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 :

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

Work, W :

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

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

Momentum, p :

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

Torque, τ :

$$\tau = r \times F \quad (30)$$

$$\tau = rF \sin(\theta) \quad (31)$$

$$N = I\alpha \quad (32)$$

Inertia, I :

$$I = \sum_i m_i r_i^2 = \int r^2 dm \quad (33)$$

$$I = r\omega^2 \quad (34)$$

Kinetic Energy of Rotation:

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

Kinetic Energy of Rolling:

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

Angular Momentum:

$$L = I\omega \quad (37)$$

Newton's Laws of Gravity:

$$F = \frac{Gm_1m_2}{r^2} \quad (38)$$

$$U = -\frac{Gm_1m_2}{r^2} \quad (39)$$

$$G = 6.67 \times 10^{-11} \text{ Nm}^2/\text{kg}^2 \quad (40)$$

$$a_{m_1} = \frac{Gm_2}{r^2} \quad (41)$$

$$v_e = \sqrt{\frac{GM}{r}} \quad (42)$$

Orbits:

$$\Delta T^2 = \frac{4\pi^2}{GM_\odot} r^3 \quad (43)$$

$$\frac{4\pi^2}{GM_\odot} = 1 \quad (44)$$

$$\Delta T^2 \propto r^3 \quad (45)$$

$$\vec{v} = \frac{2\pi r}{\Delta t} \text{ Valid for circular} \quad (46)$$

Density, ρ :

$$\rho = \frac{m}{V} \quad (47)$$

Pressure, ϕ :

$$\phi = \frac{F}{A} \quad (48)$$

$$\phi_h = \phi_0 e^{-\frac{mgh}{kT}} \quad (49)$$

$$\phi_h = \rho_l hg + \phi_a \quad (50)$$

Bernoulli's Law:

$$\phi_1 + \frac{1}{2}\rho v_1^2 + \rho gh_1 = \phi_2 + \frac{1}{2}\rho v_2^2 + \rho gh_2 \quad (51)$$

Continuity:

$$A_1 v_1 = A_2 v_2 \quad (52)$$

Key

v = velocity, meters/second

y = height, meters

x = distance, meters

t = time, seconds

m = mass, kilograms

a = acceleration, meters/second²

θ = angle, degrees

g = gravity: 9.8 meters/second²

ω = angular velocity, radians or degrees/second

F = force, Newtons, kilogram · meters/second²

μ = coefficient of friction

N = normal force, Newtons

A = area, meters²

ρ = volumetric mass density, kilograms/meters³

C_D = drag coefficient (geometry dependant)

K = kinetic energy

U = potential energy

α = angular acceleration, degrees—radians/second²