**USEFUL EQUATIONS**

**Linear & Rotational Kinematics, Projectile Motion**

LINEAR ANGULAR

vf = vi + at ωf = ωi + αt

s = vit + at2 ɵ = ωit + αt2

s = vft - at2 ɵ = ωft - αt2

vf2= vi2+ 2as ωf2 = ωi2 + 2αɵ

s = (vi + vf) t ɵ = (ωi + ωf) t

y = (x tan θ) – (Trajectory Equation)

tmax height = (Time to Maximum Height)

R = xmax = 2 Sin θ Cos θ} ≡ Sin (2θ) (Maximum Symmetrical Range)

**Physical & Natural Laws**

= , **P** = m**v**, or more commonly, = m

W = **F**. dr **=** (Fdr) Cosθ (Work Done)

W = m m ≡ KEf  KEi = ∆KE (Work-Kinetic Energy Theorem)

Paverage = () Pinstantaneous = **F**.**v**

ΔPE =  mgΔy ΔETotal = ΔKE + ΔPE

 = (Conservation of Momentum) **J** = **F**ave ∆t (Impulse)

**r**cm = (Center of Mass)

Thrust = ve () ve ln () = vf vi (Rocket Equations)

**τ = r** x **F** = (Torque) **l** = **r** x **p** = Iω (Angular Momentum)

 =  → = (Conservation of Angular Momentum)

acm = (Center of Mass Acceleration of Rolling)

P= ρmgyb + Patm (Pressure at any Depth in a Liquid)

P(h) = P0 (Atmospheric Pressure vs Altitude)

 (Atmospheric Pressure vs Density)

Fb = mdisp liqg = ρliqVdisp liqg (Archimedes’ Principle for Buoyancy)

Fapp = Wair – Wdisp liq = mg – ρliqVdisp liqg (Apparent Weight in a Liquid)

A1v1 = A2v2 (Equation of Continuity)

P1 + ρgy1 + ρ= P2 + ρgy2 + ρ(Bernoulli’s Equation)

Ƞ = = (Viscosity)

**Waves, Oscillations & Gravity**

A (x, t) = Ao Sin (kx – ) (Amplitude of Traveling Wave)

x = A Cos (ωt + φ) (Oscillation of a Mechanical Wave)

P = µ2A2v (Power of Mechanical Wave on a String)

f’ = f ( (Doppler Equation)

(mc∆T) lost = (mc∆T) gained (Internal Heat Transfer)

**F**2,1 = 2,1 (Newton’s Law of Universal Gravitation)

PE = – (Gravitational Potential Energy)

Vesc = () (Escape Velocity)

T2 = a3 ≈ a3 (Kepler’s 3rd Law for Planetary Motion)

E = – = – KE (Total Satellite Mechanical Energy in Orbit)

**Electric Fields**

**F** = **F**2,1 = 2,1;

**(**Coulomb force law where = )

**E =**  =

(Electric Field due to a point charge)

**E =**

(Electric field due to a line of charge where r is the perpendicular distance from the line to the point)

Ez =

**(**Electric field due to a ring of charge at distance z along central axis)

Ez = [

(Electric field to a charged disk at distance z along central axis)

φ **=** ∫**E. dA**

(Flux through a Gaussian surface)

ε**o**φ = ε**o**∫**E.dA** = qenc

(Gauss’ Law; recall that the vector “dA” is perpendicular to the vector **E** and its positive direction points away from the inside of the Gaussian surface)

**Electricity**

 **J =** ne**v**d(current density of charge carriers)

 = dq/dt (current-differential)

 = ∫ **J. dA (**current)

R = (Ohm's law)

 ρ = = (conductivity)

 P = 2R = V2/R = V (power loss in circuit as thermal energy)

 ξ = (definition of ξ)

 = (current in a loop with ex/internal resistors)

 Req = (resistors in series)

Req = (resistances in parallel)

**Magnetism**

**F** = q**v** x **B** (force on charge q due to magnetic field B)

 **F** = **L** x **B** (force on current wire due to field B)

 qvB = (circular motion in a magnetic field)

 d**B** = ≡ (Biot-Savart Law)

B = (magnetic field for an infinitely long wire)

B = (magnetic field for a semi-infinitely long wire)

BC = (field at center of arc with θ in π radians)

 µo = 4π x 10-7 (permeability of free space)

 |e| = 1.6 x 10-19 C (magnitude of electronic charge)

 me = 9.109 x 10-31 kg (mass of electron)

1 eV = 1.602 x 10-19 J (electron-volt energy conversion)

**Electromagnetic Waves & Optics**

 v = f λ (velocity of traveling wave)

 f = (frequency vs. period of wave)

 **S** = (**E** x **B**) (Poynting vector)

|**S|** =E () = (Instantaneous value of Poynting Vector)

|**S|** = = (Average value of Poynting Vector - Intensity)

I = (Intensity of EM radiation, Erms = )

 c = = = 3 x 108 (speed of light in vacuum)

 n2Sin θ2 = n1Sin θ1 (Snell's Law of refraction)

 =  = (refractive index – velocity medium relationship)

 = + (plane mirror & lens equation)

() + () = () = () (spherical mirror equation)

  = () { - } (thin lens equation, = + )

 + = (spherical refracting surface)

 m = = = (magnification)

**Integrals & Differentials**



**Planetary Physical Constants**

