Physics

Momentum, *p*, $\left(\frac{\text{Kg}\bullet\text{m}}{\text{sec}}\right)$

$p = mv$

$\Delta p = F(\Delta t) = m(\Delta v)$

$impulse = F \bullet (\Delta t) = \Delta p$

$KE = \frac{p^2}{2m}$

Power, *P*,

1 watt = 1J/sec

$P = \frac{work}{t} = Force \bullet velocity$

Work, *W*, (1 J= 1 N m)

$W = F \bullet d$

d is in direction of F

$W = F \bullet d \cos\theta$

$W = \Delta E$

Kinetic Energy, *KE*, (J)

$KE = \frac{1}{2}mv^2$

Potential Energy, *PE*, (J)

$PE = mgh$

Newton's Laws

First: object in motion stays in motion

Second: F=ma

Third: Every action has an equal and opposite reaction

Force, *F*, $(1\text{N} = \text{Kg} \bullet \text{m/sec}^2)$

$F = ma$

$weight = mg$

Frictional Force, F_f,

$F_f = \mu \bullet F_N$

CIRCULAR MOTION

Centripetal Acceleration, a_c

(pointed toward center)

$a_c = \frac{v^2}{r}$

Centripetal force, F_c

$F_c = ma_c = \frac{mv^2}{r}$

Centripetal velocity, v_c

$v_c = \frac{2\pi \bullet r}{T} = 2\pi \bullet r \bullet f$

$T = period$

LINEAR KINEMATICS

Linear distance, *d*, *(meter)*

$d = d_f - d_i$

Linear velocity, *v*, *(m/sec)*

$v = \frac{d}{t}$

Linear acceleration, *a*, *(m/sec²)*

$a = \frac{v_f - v_i}{t}$

at constant *a*

$v_f = v_i + at$

$v_{avg} = \frac{1}{2}(v_i + v_f)$

$v_f^2 = v_i^2 + 2a(\Delta d)$

$d_f = d_i + v_i t + \frac{1}{2}at^2$

$d_f = d_i + v_f t + \frac{1}{2}at^2$

$d_f = d_i + v_{avg}t$

Mechanical Advantage, MA

$MA = \frac{F\ out}{F\ in}$

MA = number of line supporting load

Efficiency, Eff

$Eff = \frac{\text{Work output}}{\text{total input}}$

ROTATIONAL KINEMATICS

Angular Displacement, θ

$\theta = \frac{s}{r}$

Angular velocity, ω

$\omega = \frac{v}{r} = \frac{\Delta\theta}{\Delta\tau}$

Angular Displacement, α

$\alpha = \frac{\Delta\omega}{\Delta\tau}$

at constant α

$\omega_f = \omega_i + \alpha t$

$\omega_{avg} = \frac{1}{2}(\omega_i + \omega_f)$

$\omega_f^2 = \omega_i^2 + 2\alpha(\theta_f - \theta_i)$

$\theta_f = \theta_i + \omega_i t + \frac{1}{2}\alpha t^2$

$\theta_f = \theta_i + \omega_f t + \frac{1}{2}\alpha t^2$

$\theta_f = \theta_i + \omega_{avg}t$

Rotational KE

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

$KE_{rot} = \frac{1}{2}m\omega^2 + \frac{1}{2}I\omega^2$

Work: $W = \tau\theta$

Power: $P = \tau\omega$

SIMPLE HARMONIC MOTION

Period, T: time to complete one cycle

Frequency, f or ν: cycle in one second, Hz = 1/sec

Angular frequency, ϖ: ϖ=2πf (rad/sec)

Overall: $T = \frac{1}{f} = \frac{2\pi}{\omega}$

Springs

Hooke's law : $F = -kx$

Period : $T = 2\pi\sqrt{\frac{m}{k}}$

Frequency : $f = \frac{1}{2\pi}\sqrt{\frac{k}{m}}$

Potential E : $PE = \frac{1}{2}kx^2$

Pendulum

Restoring F : $F = mg\sin\theta$

Period : $T = 2\pi\sqrt{\frac{\ell}{g}}$

Frequency : $f = \frac{1}{2\pi}\sqrt{\frac{g}{\ell}}$

Gravitational Force, F_g

$F_g = G\frac{m_1 m_2}{r^2}$

$G = 6.67 \times 10 - 11\ \text{N} \cdot \text{m}^2/\text{Kg}^2$

DOPPLER EFFECT

Observer with v_o	Source with v_s: stationary	Source with v_s: toward observer	Source with v_s: away from observer
stationary		$v_{eff} = v$ $\lambda_{eff} = \lambda \bullet \frac{v - vs}{v}$ $f_{eff} = f \bullet \frac{v}{v - vs}$	$v_{eff} = v$ $\lambda_{eff} = \lambda \bullet \frac{v + vs}{v}$ $f_{eff} = f \bullet \frac{v}{v + vs}$
toward source	$v_{eff} = v + vo$ $\lambda_{eff} = \lambda$ $f_{eff} = f \bullet \frac{v + vo}{v}$	$v_{eff} = v \pm vo$ $\lambda_{eff} = \lambda \bullet \frac{v \pm vs}{v}$ $f_{eff} = f \bullet \frac{v \pm vo}{v \pm vs}$	
away from source	$v_{eff} = v - vo$ $\lambda_{eff} = \lambda$ $f_{eff} = f \bullet \frac{v - vo}{v}$		

Physics

THERMODYNAMICS

Temperature: measure of average K.E. of system
Heat: transfer of thermal E.
Heat Capacity, C**:** energy to raise 1 gram by 1 degree
Heat Energy, Q**:** $Q = C\Delta T$
Conduction: through physical contact
Convection: hot fluid or gas rises through cooler fluid
Radiation: no medium needed for transfer, ex. electromagnetic wave

Calculating Heat or Energy

$Q = \Delta U + W$

$Q = m \cdot C \cdot \Delta T$

$Q = m \cdot \Delta H_{fus\,/\,vap}$

GASES

STP : 0° C and 1 atm

Ideal gas law : $PV = nRT$

Charles law : $\frac{V_1}{T_1} = \frac{V_2}{T_2}$

Boyle's Law : $P_1V_1 = P_2V_2$

Combined Law $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$

Molecular Speed $\mu = \sqrt{\frac{3RT}{MW}}$

Graham's effusion $\alpha \; \frac{1}{MW}$

WAVES

Wave speed, υ : $\upsilon = \frac{\lambda}{t}$

Intensity = loudness α A^2

Pitch determined by f

ELECTRICITY

Coulomb's law : $F = k\frac{q_1 q_2}{r^2}$

$k = 8.99 \times 109\ \mathrm{N \cdot m^2/C^2}$

Electric Field, (N/C) : $E = \frac{F}{q}$

E (for point charge) : $E = k\frac{q}{r^2}$

Direction of E: from + to -

Current, (1A = 1C/s): $I = q / t$

Ohm's law: $V = I R$
(1Ω = 1V/A)
$R = \text{resistivity} \cdot \frac{\text{Length}}{\text{Area}}$

Power, P, (W) :

$P = IV = I^2R = \frac{V^2}{R}$

Resistors (series):
$R_{eq} = R_1 + R_2 + R_3 + \cdot \cdot$

Resistors (parallel):
$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \cdots$

Capacitors (series):
$\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2} + \cdots$

Capacitors (parallel):
$C_{eq} = C_1 + C_2 + C_3 + \cdot \cdot$

Kirchhoff's Loop rule: Total change in potential in a closed circuit is zero
Kirchhoff's Junction rule: current into a junction = current out of junction

Atom

Thompson's: Electrons are distributed in a positive charged medium like "raisins in pudding"
Rutherford: mass is found in the positively charged nucleus and electrons move around it.
Bohr: Electrons move in orbits. Electrons can absorb or emit energy
Quantum Mechanics: Rather than orbits, electrons are more likely to be found in some regions

PHYSICAL CONSTANTS

Acceleration due to gravity	g	9.8 m / s^2
Avogadro's number	N_A	6.022 x 10^{23} particles
Coulomb's constant	k	8.988 x 10^9 $N \cdot m^2/C^2$
Gravitational constant	G	6.67 x 10^{-11} $N \cdot m^2/Kg^2$
Planck's constant	h	6.63 x 10^{-34} J·s
Ideal gas constant	R	0.0821 atm·L/(mol·K) 8.314 J/(mol·K) 1.987 cal/mol-K
Speed of sound at STP	c	331 m/s
Speed of light in vacuum	e	3.00 x 10^8 m/s
Electron charge	eV	1.6022 x 10^{-19} C
Electron volt	μ	1.6022 x 10^{-19} J
Atomic mass unit		1.6606 x 10^{-27} Kg
Mass of electron		9.11 x 10^{-31} Kg
Mass of proton		1.6726 x 10^{-27} Kg
mass of neutron		1.6750 x 10^{-27} Kg
Mass of earth		5.976 x 10^{24} Kg
Radius of earth		6.378 x 10^6 m

CONVERSION FACTORS

1 m = 39.37 in = 3.281 ft = 1.094 yd
1 m = 10^{15} f m = 10^{10} Å = 10^9 nm
1 mi = 5280 ft = 1.609 km
1 in = 2.540 cm
1 L = 10^3 cm^3 = 2.113 pints = 1.057 qt = 0.264 gal
1 qt = 4 pt = 0.25 gal
1 slug = 14.59 kg
1 atm = 1.013 x 10^5 N/m^2 = 1.013 bars = 760 mm Hg
1 atm = 14.70 lb/in^2
1 N = 10^5 dynes = 0.2248 lbs
1 lb = 4.448 N
1J = 107 ergs = 0.7373 ft-lb = 1 Kg·m/sec^2
1 cal = 4.184 J
1 eV = 1.602 x 10^{-19} J
1 BTU = 778 ft-lb = 252 cal = 1054 J
1 horsepower = 550 ft-lb/sec = 746 W
1 T = 10^4 G
1 Kg = 2.205 lb = 35.274 oz
1 lb = 16 oz = 453.59 g
1 ft = 12 in
1 yd = 3 ft
1 lb = 16 oz
1 Ton = 2,000 lbs

1 m = 10 dm
1 m = 100 cm
1 m = 1,000 mm
1 m = 10^6 μm
1 m = 10^{-9} nm
1 km = 1,000 m