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: (1 watt = 1J/sec)

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

Work:

(1J = 1N m)

$W = F \cdot d = \Delta E$

$W = P \cdot A \cdot d$

$W = P \cdot V$

d is in direction of F

Kinetic Energy: $KE = \frac{1}{2}mv^2$

Potential Energy: $PE = mgh$

Newtons laws

First: object in motion stays in motion

Second: F=ma

Third: Every action has an equal and opposite reaction

Force: $F = ma = weight$

$(1N = Kg \bullet m/sec^2)$

Frictional Force: $F_f = \mu \bullet F_N$

CIRCULAR MOTION

Centripetal Acceleration: $a_c = \frac{v^2}{r}$

(pointed toward center)

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

Centripetal velocity

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

$T = period$

Fluids

$A_1v_1 = A_2v_2$

$\Delta P = \frac{\delta}{2}(V_2^2 - V_1^2)$ $\qquad P = \frac{F}{A}$

$P_1 + \frac{1}{2}\rho v_1^2 + \rho g h_1 = P_2 + \frac{1}{2}\rho v_2^2 + \rho g h_2$

$P = P_{atm} + \rho g h$

$(P_{atm} = 101 KPa, \rho = 10^3 Kg/m^3, h = meter)$

Bouyant F = F of displaced water

B = ρgV= ρgAh

Toricelli: Flow rate $= A\sqrt{2g\Delta h}$

LINEAR KINEMATIC

Distance *(m)*: $d = d_f - d_i$

Velocity *(m/sec)*: $v = \frac{d}{t}$

Acceleration *(m/sec²)*:

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

at constant *a*

$v_f = v_i + at$

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

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

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

$d_f = d_i + v_{avg} t$

Mechanical Advantage

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

MA = number of line supporting load

Efficiency, Eff

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

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

Electrical F= $k\frac{q_1 q_2}{r^2}$

ROTATIONAL KINEMATIC

Displacement (rad): $\theta = \frac{s}{r}$

Velocity (rad/s): $\omega = \frac{v}{r} = \frac{\Delta\theta}{\Delta\tau}$

Acceleration (rad/s²):

$\alpha = \frac{\Delta\omega}{\Delta\tau} = \frac{v}{rt} = \frac{a}{r}$

at constant *α*

$\omega_f = \omega_i + \alpha t$

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

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

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

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

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

Rotational KE: $KE = \frac{1}{2}I\omega^2$

Torque: $T = I\alpha = I\frac{a}{r}$

Work: $W = T\theta$

Power: $P = T\omega$

Angular momentum: $= I\omega$

Moments of Inertia

Hoop: $I = MR^2$ $\qquad$ Disk: $I = \frac{1}{2}MR^2$

Rod$_{(center\ rotation)}$: $I = \frac{1}{12}ML^2$

Rod$_{(end\ rotation)}$: $I = \frac{1}{3}ML^2$

Sphere: $I = \frac{2}{5}MR^2$

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

DOPPLER EFFECT

Observer with v_o	Source with v_s: stationary	toward observer	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^O 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

speed : $v = \frac{\lambda}{t}$

Pitch determined by f

Intensity = loudness α A^2

Atom

Thompson's: Electrons are distributed in a positive charged medium like "raising 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 Mechanic: Rather than orbits electrons are more likely to be found in some regions

ELECTRICITY

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

$E = \frac{F}{q} = k\frac{q}{r^2}$ (N/C)

Direction of E: from + to -

$\Delta V = E d$

$V = k\frac{q}{r}$ (1V=1J/C)

$W = \Delta PE = qEd = q\Delta V = k\frac{q_1q_2}{r}$

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

Ohm's law: $V = I R$

Resistance: $(1\Omega = 1\text{V/A})$

$R = \text{resistivity} \cdot \frac{\text{Length}}{\text{Area}}$

Power: (w) $P = IV = I^2R = \frac{V^2}{R}$

Capacitance: (F = 1C/V) $C = \frac{Q}{V} = k\varepsilon\frac{A}{d}$

$E = \frac{1}{2}QV = \frac{1}{2}CV^2 = \frac{Q^2}{2C}$

Series	parallel
$V_t = V_1 + V_2$	$V_t = V_1 = V_2$
$I_t = I_1 = I_2$	$I_t = I_1 + I_2$
$R_t = R_1 + R_2$	$\frac{1}{R_t} = \frac{1}{R_1} + \frac{1}{R_2}$
$\frac{1}{C_t} = \frac{1}{C_1} + \frac{1}{C_2}$	$C_t = C_1 + C_2$

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

PHYSICAL CONSTANTS

Acceleration (gravity)	g	9.8 m / s²
Avogadro's number	N_A	6.022 x 10^{23} particles
Coulomb's constant	k	8.988 x 10^9 N·m²/C²
Gravitational constant	G	6.67 x 10^{-11} N·m²/Kg²
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 (STP)	c	331 m/s
Speed of light (vacuum)	e	3.00 x 10^8 m/s
Permittivity free space	ε	8.85 x 10^{-12} C²/N·m²
Electron charge	eV	1.6022 x 10^{-19} C
Electron volt	μ	1.6022 x 10^{-19} J
Faraday	F	9.6485 x 10^4 C/mol
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
Specific heat (water)	C	1 cal/(g °C) 4.18 J/(g °C)
Heat of enthalpy (water)	ΔH_{vap}	2260 J/g
Heat of fusion (water)	ΔH_{fus}	334 J/g

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 cm³ = 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/m² or Pa = 1.013 bars = 760 mm Hg
1 atm = 14.70 lb/in²
1 Pa = 1 N/m²
1 N = 10^5 dynes = 0.2248 lbs
1 lb = 4.448 N
1J = 107 ergs = 0.7373 ft-lb = 1 Kg·m/sec² = 1 C·V
1 cal = 4.184 J
1 eV = 1.602 x 10^{-19} J = 1.602 x 10^{-19} C·V
1 V = 1J/C
1F = 1C/V
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