Some Formulas

Selected Formulas

Circumference of a circle: $C = 2\pi R$
Area of a circle: $A = \pi R^2$; $[A]$=m^2
Volume of a sphere: $V = \frac{4}{3}\pi R^3$
Surface area of sphere: $A = 4\pi R^2$
Volume of a cube: $V = length \times width \times height$, $[V]$ =m^3

International System of Units

Unit of	is the	Unit of	is the
length	meter (1 m)	temperature	kelvin (1 K)
time	second (1 s)	charge	coulomb (1 C)
mass	kilogram (1 kg)		

If prefix	multiply by	if prefix	divide by
giga- (G)	1 billion	centi- (c)	100
mega- (M)	1 million	milli- (m)	1000
kilo- (k)	1000	micro- (μ)	1million
		nano- (n)	1 billion

Motion

Speed: $v = \frac{d}{t}$; $[v]$=m/s
Velocity: $\vec{v}$ = speed and direction
Acceleration: $\vec{a} = \frac{\Delta\vec{v}}{t}$; $[a]$=m/s^2
Uniform acceleration: a = constant:
$v = v_0 + at$
$d = v_0 t + \frac{1}{2}at^2$
Free fall:
vertical acceleration $a = g = 9.8$ m/s^2
horizontal acceleration $a = 0$

Forces

Newton's second law: $\vec{F} = m\vec{a}$; $[F]$=kg m/s^2=N (newton)
Newton's third law: action = reaction
Weight: force of gravity $w = mg$
Centripetal acceleration: $a_c = v^2/r$
Centripetal force: $F_c = ma_c$

Newton's law of universal gravitation: $F_g = G\frac{m_1 m_2}{r^2}$

Gravitational constant: $G = 6.67 \times 10^{-11}$ Nm^2/kg^2

Work and Energy

Work: $W = Fd$; $[W]$=Nm=J (joule)
Power: $P = W/t$; $[P]$=J/s=W (watt)
Kinetic energy: $KE = \frac{1}{2}mv^2$; $[KE]$=J
Gravitational potential energy: $PE = mgh$; $[PE]$=J
Conservation of energy: $E = KE + PE$ =constant.

Linear Momentum

Impuls and Momentum: $F\Delta t = \Delta p$, $p = mv$
Conservation of momentum: If $F_{external} = 0$ then p_{total} =constant; $m_1\vec{v}_{1i} + m_2\vec{v}_{2i} = m_1\vec{v}_{1f} + m_2\vec{v}_{2f}$

Rotational Motion

Period: T = time for one full rotation (cycle)
Frequency: $f = 1/T$,$[f]$ = 1/s= Hz (hertz)
Angle: Θ =(length of arc segment)/(radius)=s/r; $[\Theta] = radian$
Circumference: $s_{\text{circle}} = 2\pi r$
Angular speed: $\omega = \Theta/t$
Torque: $\tau = F_{\text{tang}} r$

Properties of Matter:

Density: $\rho = m/V$, $[\rho]$ = kg/m^3

Material	Density (kg/m^3)
Aluminum	2700
Iron	7860
Brass	8500
Copper	8930
Silver	10500
Water	1000
Seawater	1030
Ice	920
Mercury (liquid)	13600

Pressure: $P = F/A$, $[P] = \text{N/m}^2 = \text{Pa}$ (pascal)
Pressure-depth relationship: $P = \rho gh$
Buoyant force: *weight of the displaced liquid*
$F_b = \rho_{\text{liquid}} V_{\text{object}} g$
Ideal Gas Law: $PV = NkT$, P is pressure, V is volume, T is temperature in K, N is number of molecules, k is Bolzman constant.
Hooke's Law: $F = k\Delta L$, k is spring constant.

Heat and Temperature:

$T(\text{in K}) = T(\text{in } ^o\text{C}) + 273$
$T(\text{in } ^o\text{F}) = [1.8 \times T(\text{in } ^o\text{C})] + 32$
Thermal expansion: $L' = L(1 + \alpha\Delta T)$
$\alpha_{\text{steel}} = 1.2 \times 10^{-5}/\text{C}^o$
Specific heat of water: 1 calorie to raise the temperature of 1 gram of water by 1 degree celsius.
Latent heat of fusion: 80 calories to melt one gram of ice.
Latend heat of evaporation: 540 calories to vaporize (turn into gas) 1 g of water.
1 calorie = 4.186 joules
Food Calories: 1 Calorie = 1000 calories = 1 kilocalorie.

Waves and Sound:

Period: T = time for one full cycle
Frequency: $f = 1/T$; $[f] = 1/s = Hz$ (hertz)
Wavelength: λ = distance between adjacent crests (or troughs)
Wave speed: $v = f \times \lambda$
Speed of sound in air: 344 m/s
Speed of light: 3×10^8 m/s
Wave speed on a string with tension F, length L, mass M:
$v = \sqrt{F/\mu}$; $\mu = M/L$
Standing waves on a string:
1st harmonic: $\lambda = 2L$
2nd harmonic: $\lambda = L$
3rd harmonic: $\lambda = \frac{2}{3}L$

Electric and Magnetic Forces:

Electrostatic force (Coulomb's law): $F_e = \frac{kq_1 q_2}{r^2}$

Coulomb's constant: $k = 9 \times 10^9$ N·m^2/C^2
Elementary charge: $e = 1.6 \times 10^{-19}$ C
Electric field: $\vec{E} = \vec{F}_e/q$
Magnetic field: B; $[B]$ =T (tesla)
Magnetic force on moving charge: $F_m = qvB$ ($\vec{v}$ perp. to $\vec{B}$)

Electric Circuits

Electric potential: $V = PE/q$; $[V]$ =V (volt)
Electric potential energy: $PE = qV$
Electric current: $I = q/t$; $[I]$ =A (ampere)

Ohm's law and resistance: $\Delta V = IR$; $[R] = \Omega$ (ohm)
series circuits: $R_{\text{series}} = R_1 + R_2 + R_3 + ...$

$$\text{parallel circuits: } \frac{1}{R_{\text{parallel}}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + ...$$

Electric power: $P = VI$
Transformer: $V_2/V_1 = N_2/N_1$
Electromagnetic Waves: (see Waves and Sound)