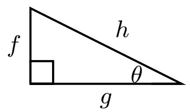
Basic Math

Length Circle: $C = 2\pi r$ Arc: $s = \theta r$

Areas Triangle: $\frac{1}{2}bh$ Cylinder: $2\pi rh + 2\pi r^2$
Circle: πr^2 Sphere: $4\pi r^2$

Volume Cylinder: $\pi r^2 h$ Sphere: $\frac{4}{3}\pi r^3$

Trig and Algebra



$f^2 + g^2 = h^2$
$\sin\theta = \frac{f}{h}$ $\cos\theta = \frac{g}{h}$

quadratic formula $x = \frac{-b\pm\sqrt{b^2-4ac}}{2a}$

Kinematics

Constant Velocity ($a = 0$): $v = \frac{\Delta d}{\Delta t}$
Constant Acceleration: $a_{avg} = \frac{\Delta v}{\Delta t}$, $v_{avg} = \frac{1}{2}(v_f + v_i)$

kinematic equations $\begin{cases} v_f = v_i + a\Delta t \\ v_f^2 = v_i^2 + 2a\Delta d \\ d_f = d_i + v_i\Delta t + \frac{1}{2}a\Delta t^2 \\ \Delta d = \frac{1}{2}(v_f + v_i)\Delta t \end{cases}$

Note: $d = x$ or y

Forces

Newton's 2nd Law: $\Sigma\vec{F} = m\vec{a} \Rightarrow \begin{cases} \Sigma\vec{F_x} = m\vec{a_x} \\ \Sigma\vec{F_y} = m\vec{a_y} \end{cases}$

Newton's 3rd Law $\vec{F}_{12} = -\vec{F}_{21}$
Gravity: $F_G = \frac{Gm_1m_2}{r^2} = mg$
Spring: $F_s = -ks$, s = extension or compression
Friction: $F_f = \mu_s F_N$ or $F_f = \mu_k F_N$

Circular Motion

Arc length: $s = r\Delta\theta$
Angular vel. & acc.: $\omega = \frac{\Delta\theta}{\Delta t}$, $\alpha = \frac{\Delta\omega}{\Delta t}$
Linear vel. & acc.: $v = r\omega$, $a_{\tan} = r\alpha$, $a_c = \frac{v^2}{r} = \omega^2 r$
Period: $T = \frac{2\pi}{\omega}$ Centripedal Force: $F_c = ma_c$

Work and Energy

Work: $W = Fd\cos\theta$ $W_{\text{net}} = \begin{cases} F_{\text{net}} \cdot d \\ \Sigma W_i \\ \Delta K \end{cases}$

$W_{NC} = \Delta K + \Delta U$

Energy $\begin{cases} K = \frac{1}{2}mv^2 \text{ (kinetic)} \\ U_G = mgh \text{ (grav)} \\ \quad = -\frac{Gm_1m_2}{r} \\ U_s = \frac{1}{2}ks^2 \text{ (spring)} \end{cases}$ Power $\begin{cases} P = \frac{W}{\Delta t} \\ P = F_{avg}v \end{cases}$

Conservation of Energy: $\begin{cases} W_{NC} = 0 \\ E_1 = E_2 \\ K_i + \Sigma U_i = K_f + \Sigma U_f \end{cases}$

Power: $P = \frac{\Delta E}{\Delta t}$

Momentum

Momentum: $\vec{p} = m\vec{v}$ Impulse: $\Delta p = F_{\text{avg}}\Delta t$
Conservation of momentum (all collisions):

$$\vec{p}_i = \vec{p}_f$$
$$m_1v_{1i} + m_2v_{2i} = m_1v_{1f} + m_2v_{2f}$$

Conservation of KE (**elastic coll**):

$$\Sigma K_i = \Sigma K_f$$
$$m_1v_{1i}^2 + m_2v_{2i}^2 = m_1v_{1f}^2 + m_2v_{2f}^2$$

Elastic collisions with $\mathbf{v_{2i} = 0}$:

$$v_{1f} = \frac{(m_1 - m_2)}{(m_1 + m_2)}v_{1i} \qquad v_{2f} = \frac{2m_1}{(m_1 + m_2)}v_{1i}$$

Centre of Mass: $x_{CM} = \frac{1}{m}\sum m_i x_i$ $v_{CM} = \frac{1}{m}\sum m_i v_i$

Torque and Angular Momentum

Rotational KE: $K_{rot} = \frac{1}{2}I\omega^2$ Rot. Inertia: $I = \sum m_i r_i^2$
Torque: $\tau = rF\sin\theta = I\alpha$
Work: $W = \tau\Delta\theta$, $W = \frac{1}{2}I\left(\omega_f^2 - \omega_i^2\right)$ Power $P = \tau\omega$
Angular Momentum: $L = I\omega$
Conservation of angular momentum: $\vec{L}_i = \vec{L}_f$

Fluids

Density: $\rho = m/V$
Pressure: $P = F_\perp/A$, $P_d = P_{atm} + \rho gd$
Buoyant Force: $F_B = \rho_F V_F g$
Specific Gravity: S.G. $= \frac{\rho}{\rho_{water}} = \frac{\rho}{1000 \text{ kg/m}^3}$
Continuity Eqn: $A_1v_1 = A_2v_2$
Bernoulli's Eqn: $P_1 + \rho gh_1 + \frac{1}{2}\rho v_1^2 = P_2 + \rho gh_2 + \frac{1}{2}\rho v_2^2$
Viscous Force: $F = \eta A\frac{v}{l}$ η = viscosity
Poiseuilles Law: $\frac{\Delta V}{\Delta t} = \frac{\pi}{8}\frac{\Delta P/L}{\eta}r^4$

Oscillations

Frequency: $f = 1/T$
Angular Frequency: $\omega = 2\pi f$

$$\omega = \begin{cases} \sqrt{\frac{k}{m}} \text{ (spring-block)} \\ \sqrt{\frac{g}{L}} \text{ (simple pendulum)} \\ \sqrt{\frac{3g}{2L}} \text{ (rigid pendulum)} \end{cases}$$

E is conserved $E = \frac{1}{2}kx_{\max}^2 = \frac{1}{2}mv_{\max}^2$, $v_{\max} = A\omega$
$E = \frac{1}{2}kx^2 + \frac{1}{2}mv^2$

Waves

Speed $v = \lambda f$ Intensity: $I = \frac{P}{Area}$
Standard Eqn: $y(x,t) = A\cos(\omega t + kx)$
Wave number: $k = \frac{\omega}{v} = \frac{2\pi}{\lambda}$

Temperature and the Ideal Gas

Linear Expansion: $L = (1 + \alpha\Delta T)L_0$
Volume Expansion: $V = (1 + \beta\Delta T)V_0$
Ideal Gas Law: $PV = kNT$ or $PV = nRT$

Heat

Molecular KE: $\langle K_{tr}\rangle = \frac{3}{2}kT$
Heat flow: $Q = C\Delta T$, $Q = mc\Delta T$

Thermodynamics

First Law: $\Delta U = Q + W$, $W = -P\Delta V$
Isothermal Expansion: $W = nRT\ln\frac{V_i}{V_f}$

Standard Symbols

Name	Symbol	SI Unit
Acceleration	a	m/s^2
Angular Frequency	ω	rad/s
Coeff. of Friction	μ_k, μ_s	
Density	ρ	kg/m^3
Distance/Displacement	x, s, r, d	m
Speed/Velocity	v	m/s
Energy	E	J
Potential	U	
Kinetic	K	
Force	F	N
Normal	F_N	
Friction	F_f	
Gravity	F_g	
Spring	F_s	
Tension	F_T	
Frequency	f	Hz
Heat	Q	J
Intensity	I	W/m^2
Mass	M, m	kg
Momentum	p	kg m/s
Period	T	s
Power	P	W
Pressure	P	Pa
Spring constant	k	N/m
Stretch/Compression	s, x	m
Time	t	s
Temperature	T	K
Viscosity	η	Pa s
Wavelength	λ	m or nm
Work	W	J

SI prefixes

Prefix	Symbol	Value	Prefix	Symbol	Value
exa	E	10^{18}	femto	f	10^{-15}
peta	P	10^{15}	pico	p	10^{-12}
tera	T	10^{12}	nano	n	10^{-9}
giga	G	10^{9}	micro	μ	10^{-6}
mega	M	10^{6}	milli	m	10^{-3}
kilo	k	10^{3}	centi	c	10^{-2}

Fundamental constants

Constant	Symbol	Value
gravitational accel.	g	$9.81\ m/s^2$
speed of light in vacuum	c	$3.00\times10^{8}\ \frac{m}{s}$
gravitational constant	G	$6.67\times10^{-11}\ Nm^2/kg^2$
mass of electron	m_e	9.11×10^{-31} kg
mass of proton	m_p	1.672×10^{-27} kg
mass of neutron	m_n	1.675×10^{-27} kg
absolute zero	0 K	-273°C
molar gas constant	R	$8.31\ \frac{J}{mol\,K}$
Boltzmann constant	k	1.38×10^{-23} J/K

Conversions

Parameter	SI Unit	Conversion to SI
angle	rad	$1\ rad = 180^\circ/\pi$
speed	m/s	1 m/s = 3.6 km/hr
temperature	K	ΔT of 1 K = 1°C
area	m^2	$1\ m^2 = 1\times10^4\ cm^2$
	cm^2	$1\ cm^2 = 1\times10^{-4}\ m^2$
volume	m^3	$1\ m^3 = 1\times10^6\ cm^3$
	cm^3	$1\ cm^3 = 1\times10^{-6}\ m^3$