Physics 115 Formulae

$v = v_0 + at$, $\Delta x = \bar{v}t = \frac{1}{2}(v_0 + v)t$, $\Delta x = v_0 t + \frac{1}{2}at^2$, $v^2 = v_0^2 + 2a\Delta x$, $\sum \vec{\mathbf{F}} = m\vec{\mathbf{a}}$, $F_g = G\frac{m_1 m_2}{r^2}$, $w = mg$,

$f_s \le f_{s,\max} = \mu_s n$, $f_k = \mu_k n$, $W = (F\cos\theta)\, d$, $KE_t = \frac{1}{2}mv^2$, $W_{\text{net}} = \Delta KE$, $W_{nc} = (KE_f + PE_f) - (KE_i + PE_i)$,

$PE_g = mgy$, $F_s = -kx$, $PE_s = \frac{1}{2}kx^2$, $\overline{P} = \frac{W}{\Delta t}$, $P = Fv$, $\vec{\mathbf{p}} = m\vec{\mathbf{v}}$, $\vec{\mathbf{I}} = \vec{\mathbf{F}}_{\text{av}}\Delta t = \Delta\vec{\mathbf{p}} = m\mathbf{v}_f - m\mathbf{v}_i$, $\theta = \frac{s}{r}$,

$\omega_{\text{av}} = \frac{\Delta\theta}{\Delta t}$, $\alpha_{\text{av}} = \frac{\Delta\omega}{\Delta t}$, $v_t = r\omega$, $a_t = r\alpha$, $a_c = \frac{v^2}{r} = r\omega^2$, $PE_g = -G\frac{m_1 m_2}{r}$, $\tau = rF\sin\theta$, $I_{\text{point mass}} = mr^2$,

$\sum\tau = I\alpha$, $KE_r = \frac{1}{2}I\omega^2$, $L = I\omega$, $F_e = k_e\frac{|q_1||q_2|}{r^2}$, $\vec{\mathbf{F}} = q\vec{\mathbf{E}}$, $E = \frac{k_e|q|}{r^2}$, $\Delta PE_{\text{el}} = -qE_x\Delta x$, $\Delta V = \frac{\Delta PE_{\text{el}}}{q}$,

$\Delta V = -E_x\Delta x$, $V = k_e\frac{q}{r}$, $PE_{\text{el}} = k_e\frac{q_1 q_2}{r}$, $I_{\text{av}} = \frac{\Delta Q}{\Delta t}$, $I = nqv_d A$, $R = \frac{\Delta V}{I}$, $R = \rho\frac{\ell}{A}$, $\rho = \rho_0[1 + \alpha(T - T_0)]$,

$P = I\Delta V = I^2 R = \frac{\Delta V^2}{R}$, $R_{\text{eq}} = R_1 + R_2 + R_3 + \cdots$, $\frac{1}{R_{\text{eq}}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \cdots$, $F_{\text{mag}} = qvB\sin\theta$, $F_{\text{mag}} = BI\ell\sin\theta$

Physics 115 Constants

$G = 6.674 \times 10^{-11}$ N·m²/kg², $R_E = 6.38 \times 10^6$ m, $M_E = 5.98 \times 10^{24}$ kg, $g = 9.80$ N/kg, $e = 1.602 \times 10^{-19}$ C,
$k_e = 8.99 \times 10^9$ N·m²/C², $\varepsilon_o = 8.85 \times 10^{-12}$ C²/ N·m², $\mu_o = 4\pi \times 10^{-7}$ T·m/A

Physics 117 Constants

$\rho_{\text{water}} = 1.00 \times 10^3$ kg/m³, $P_{\text{atm}} = 101.3$ kPa, $I_0 = 1.00 \times 10^{-12}$ W/m², $N_A = 6.022 \times 10^{23}$ mol⁻¹,
$\sigma = 5.670 \times 10^{-8}$ W/(m²·K⁴), $k_B = 1.381 \times 10^{-23}$ J/K = 86.1 μeV/K, $R = 8.314$ J/K·mol, 1 kcal = 4186 J,
$h = 6.626 \times 10^{-34}$ J·s = 4.136×10^{-15} eV·s, $\hbar = h/2\pi$, $c = 2.998 \times 10^8$ m/s, $R_H = 1.097 \times 10^7$ m⁻¹,
$a_o = 5.29 \times 10^{-11}$ m, $r_0 = 1.2 \times 10^{-15}$ m, $hc = 1240$ eV·nm, $k_e e^2 = 1.44$ MeV·fm, eV·nm = keV·pm = MeV·fm,
$m_e = 9.109 \times 10^{-31}$ kg = 0.00054858 u = 0.511 MeV/c², $m_p = 1.673 \times 10^{-27}$ kg = 1.007276 u = 938.28 MeV/c²,
$m_n = 1.675 \times 10^{-27}$ kg = 1.008665 u = 939.57 MeV/c², $m_H = m_p + m_e = 1.007825$ u, $c^2 = 931.494$ MeV/u

Standard Prefixes Used to Denote Multiples of Ten

Prefix	Symbol	Factor
Tera	T	10^{12}
Giga	G	10^{9}
Mega	M	10^{6}
Kilo	k	10^{3}
Hecto	h	10^{2}
Deka	da	10^{1}
Deci	d	10^{-1}
Centi	c	10^{-2}
Milli	m	10^{-3}
Micro	μ	10^{-6}
Nano	n	10^{-9}
Pico	p	10^{-12}
Femto	f	10^{-15}

Basic Mathematical Formulae

Area of a circle = πr^2

Circumference of a circle = $2\pi r$

Surface area of a sphere = $4\pi r^2$

Volume of a sphere = $\frac{4}{3}\pi r^3$

Volume of a cylinder = $\pi r^2 h$

Pythagorean theorem:
$c^2 = a^2 + b^2$

Trigonometric relations:

$\sin\theta$ = opp/hyp = a/c

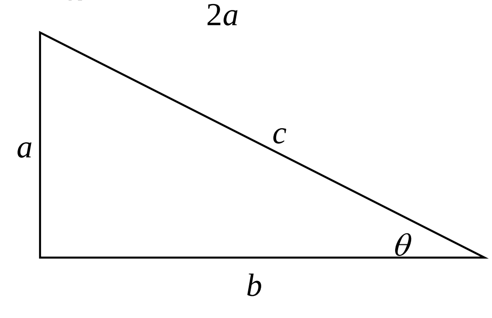
$\cos\theta$ = adj/hyp = b/c

$\tan\theta$ = opp/adj = $\frac{a}{b} = \frac{\sin\theta}{\cos\theta}$

Quadratic formula:

If $ax^2 + bx + c = 0$, then

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



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Physics 117 Formulae

$\rho = \frac{M}{V}$, $P_{av} = \frac{F}{A}$, $\frac{F}{A} = Y\frac{\Delta L}{L_0}$, $\frac{F}{A} = S\frac{\Delta x}{h}$, $\Delta P = -B\frac{\Delta V}{V}$, $P_2 = P_1 + \rho g(y_1 - y_2)$, $P_{gauge} = P_{absolute} - P_0$,

$B = \rho_{fluid} V_{fluid} g$, $\rho_1 A_1 \upsilon_1 = \rho_2 A_2 \upsilon_2$, $A_1\upsilon_1 = A_2\upsilon_2$, $P_1 + \frac{1}{2}\rho\upsilon_1^2 + \rho g y_1 = P_2 + \frac{1}{2}\rho\upsilon_2^2 + \rho g y_2$, $\frac{\Delta V}{\Delta t} = \frac{\pi R^4 (P_1 - P_2)}{8\eta L}$,

$F_r = 6\pi\eta r\upsilon$, $F_s = -kx$, $PE_s = \frac{1}{2}kx^2$, $\omega = 2\pi f = \frac{2\pi}{T} = \sqrt{\frac{k}{m}}$, $T = 2\pi\sqrt{\frac{L}{g}}$, $T = 2\pi\sqrt{\frac{I}{mgL}}$, $x = A\cos(2\pi f t)$,

$\upsilon_x = -A\omega\sin(2\pi f t)$, $a_x = -A\omega^2\cos(2\pi f t)$, $\upsilon = \frac{\lambda}{T} = f\lambda$, $\upsilon = \sqrt{\frac{F}{\mu}}$, $\upsilon = (331\,\text{m/s})\sqrt{\frac{T}{273\,\text{K}}}$, $I = \frac{P}{A}$, $\beta = 10\log\left(\frac{I}{I_0}\right)$,

$f_O = \left(\frac{\upsilon + \upsilon_O}{\upsilon - \upsilon_S}\right) f_S$, $r_2 - r_1 = n\lambda$, $r_2 - r_1 = (n + \frac{1}{2})\lambda$, $d_{NN} = \frac{1}{2}\lambda$, $f_b = |f_2 - f_1|$, $\frac{\sin\theta_2}{\sin\theta_1} = \frac{\upsilon_2}{\upsilon_1}$, $n_1\sin\theta_1 = n_2\sin\theta_2$,

$n = \frac{c}{\upsilon}$, $M = \frac{h'}{h} = -\frac{q}{p}$, $\frac{1}{p} + \frac{1}{q} = \frac{1}{f}$, $\frac{1}{f} = (n-1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$, $\delta = r_2 - r_1 = d\sin\theta$, $d\sin\theta_{bright} = m\lambda$,

$d\sin\theta_{dark} = (m + \frac{1}{2})\lambda$, $\sin\theta_{dark} = m\frac{\lambda}{a}$, $P = \frac{1}{f}$, $m = \frac{\theta}{\theta_0}$, $m = \frac{N}{p} = \frac{25\,\text{cm}}{p}$, $m = M_1 m_e = -\frac{L}{f_o}\left(\frac{25\,\text{cm}}{f_e}\right)$,

$\sin\theta \geq \frac{1.22\lambda}{a}$, $T_C = T - 273.15$, $\Delta L = \alpha L_0 \Delta T$, $\Delta A = 2\alpha A_o \Delta T$, $\Delta V = \beta V_o \Delta T$, $PV = Nk_BT = nRT$,

$\frac{1}{2}m\upsilon_{rms}^2 = \frac{3}{2}k_BT$, $Q = mc\Delta T$, $P_{net} = \sigma A e(T^4 - T_0^4)$, $P = kA\frac{(T_h - T_c)}{L}$, $\lambda_{max}T = 2.898\times10^{-3}\,\text{m}\cdot\text{K}$, $E = hf = \frac{hc}{\lambda}$,

$KE_{max} = e\Delta V_s = hf - \phi$, $\lambda - \lambda_0 = \frac{h}{m_e c}(1 - \cos\theta)$, $p = \frac{E}{c} = \frac{h}{\lambda}$, $\lambda = \frac{h}{p} = \frac{h}{m\upsilon}$, $\frac{1}{\lambda} = R_H\left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right)$, $r_n = \frac{n^2}{Z}a_o$

$E_n = -\frac{13.6(Z^2)}{n^2}\,\text{eV}$, $\Delta E = (\Delta m)c^2$, $r = r_0A^{1/3}$, $R = \lambda N$, $N = N_0e^{-\lambda t} = N_0\left(\frac{1}{2}\right)^m$ $T_{1/2} = \frac{\ln 2}{\lambda} = \frac{0.693}{\lambda}$

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Table 8.1 Moments of Inertia for Various Rigid Objects of Uniform Composition