Physics 111 Formulae

$v = v_0 + at, \quad x = \frac{1}{2}(v_0 + v)t, \quad x = v_0 t + \frac{1}{2}at^2, \quad v^2 = {v_0}^2 + 2ax, \quad \sum \vec{F} = m\vec{a}, \quad F = G\frac{m_1 m_2}{r^2},$

$f_s \le f_s^{MAX} = \mu_s F_N, \quad f_k = \mu_k F_N, \quad v = \frac{2\pi r}{T}, \quad a_c = \frac{v^2}{r} = r\omega^2, \quad W = (F\cos\theta)\, s, \quad \mathrm{KE} = \frac{1}{2}mv^2,$

$W_{net} = KE_f - KE_0, \quad PE = mgh, \quad E = KE + PE, \quad E_0 + W_{nc} = E_f, \quad \overline{P} = \frac{W}{t} = F\overline{v}, \quad \vec{p} = m\vec{v},$

$\vec{\overline{F}}\Delta t = \vec{p}_f - \vec{p}_0, \quad \theta = \frac{s}{r}, \quad v_T = r\omega, \quad a_T = r\alpha, \quad \tau = F\ell, \quad \Sigma\tau = I\alpha, \quad W_R = \tau\theta, \quad KE_R = \frac{1}{2}I\omega^2,$

$L = I\omega, \quad F = -kx, \quad \omega = \frac{2\pi}{T} = 2\pi f, \quad x = A\cos(\omega t), \quad v = -A\omega\sin(\omega t),$

$a = -A\omega^2\cos(\omega t), \quad \omega = \sqrt{\frac{k}{m}}, \quad PE_{elastic} = \frac{1}{2}kx^2, \quad \omega = \sqrt{\frac{g}{L}}, \quad \rho = \frac{m}{V}, \quad P = \frac{F}{A}, \quad P_2 = P_1 + \rho gh,$

$F_B = W_{fluid}, \quad \rho_1 A_1 v_1 = \rho_2 A_2 v_2, \quad Q = Av, \quad P_1 + \frac{1}{2}\rho {v_1}^2 + \rho g y_1 = P_2 + \frac{1}{2}\rho {v_2}^2 + \rho g y_2,$

$Q = \frac{\pi R^4 (P_2 - P_1)}{8\eta L}, \quad v = f\lambda, \quad v = \sqrt{\frac{F}{m/L}}, \quad y = A\sin\left(2\pi f t \mp \frac{2\pi x}{\lambda}\right), \quad I = \frac{P}{A},$

$\beta = (10\ \mathrm{dB})\log\left(\frac{I}{I_0}\right), \quad f_o = f_s\left(\frac{1 \pm \frac{v_o}{v}}{1 \mp \frac{v_s}{v}}\right), \quad f_b = |f_2 - f_1|, \quad F = k\frac{|q_1 q_2|}{r^2}, \quad \vec{F} = q_0\vec{E}, \quad E = \frac{k|q|}{r^2},$

$\Delta EPE = q_0 \Delta V, \quad V = \frac{kq}{r}, \quad E = -\frac{\Delta V}{\Delta s}, \quad I = \frac{q}{t}, \quad V = IR, \quad R = \rho\frac{L}{A}, \quad \rho = \rho_0[1 + \alpha(T - T_0)],$

$P = IV = I^2R = \frac{V^2}{R}, \quad \overline{P} = I_{rms}V_{rms}, \quad I_{rms} = \frac{I_0}{\sqrt{2}}, \quad V_{rms} = \frac{V_0}{\sqrt{2}}, \quad R_S = R_1 + R_2 + R_3 + \cdots,$

$\frac{1}{R_P} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \cdots, \quad F = |q_0|vB\sin\theta, \quad \theta_r = \theta_i, \quad n = \frac{c}{v}, \quad n_1\sin\theta_1 = n_2\sin\theta_2, \quad m = -\frac{d_i}{d_o},$

$\frac{1}{d_o} + \frac{1}{d_i} = \frac{1}{f}, \quad m_{tot} = m_1 m_2, \quad \mathrm{power} = \frac{1}{f}, \quad M = \frac{\theta'}{\theta}, \quad M = \left(\frac{1}{f} - \frac{1}{d_i}\right)N, \quad M = m_0 M_e,$

$M = -\frac{f_o}{f_e}, \quad \sin\theta = \frac{m\lambda}{d}, \quad E = hf = \frac{hc}{\lambda}, \quad hf = KE_{max} + W_0, \quad p = \frac{h}{\lambda}, \quad \lambda' - \lambda = \frac{h}{mc}(1 - \cos\theta),$

$r_n = r_1\frac{n^2}{Z}, \quad E_n = -E_1\frac{Z^2}{n^2} \quad \frac{1}{\lambda} = RZ^2\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right) \quad [n_2 > n_1], \quad \lambda_0 = \frac{hc}{eV}, \quad r \approx R_0 A^{1/3},$

$BE = (\Delta m)c^2, \quad N = N_0 e^{-\lambda t}, \quad A = \lambda N, \quad T_{1/2} = \frac{\ln 2}{\lambda} = \frac{0.693}{\lambda}, \quad Q = [(\text{initial masses}) - (\text{final masses})]\ c^2$

Physics 111 Constants

$M_E = 5.98 \times 10^{24}$ kg, $R_E = 6.38 \times 10^6$ m, $\rho_{water} = 1.000 \times 10^3$ kg/m^3, $P_{atm} = 1.013 \times 10^5$ Pa,
$g = 9.80$ m/s^2, $G = 6.67 \times 10^{-11}$ N·m^2/kg^2, $I_0 = 1.00 \times 10^{-12}$ W/m^2, $v_{sound\ in\ air} = 343$ m/s,
$e = 1.60 \times 10^{-19}$ C, $k = 8.99 \times 10^9$ N·m^2/C^2, $c = 3.00 \times 10^8$ m/s, $h = 6.63 \times 10^{-34}$ J·s $= 4.14 \times 10^{-15}$ eV·s,
$r_1 = 5.29 \times 10^{-11}$ m, $E_1 = 13.6$ eV, $R = 1.10 \times 10^7$ m^{-1}, $R_0 \approx 1.2 \times 10^{-15}$ m, $m_e = 9.11 \times 10^{-31}$ kg
$m_p = 1.67 \times 10^{-27}$ kg $= 1.007276$ u, $m_H = 1.007825$ u, $m_n = 1.67 \times 10^{-27}$ kg $= 1.008665$ u,
$c^2 = 931.5$ MeV/u

revised 30 August 2005

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 = $\frac{4}{3}\pi r^3$

Pythagorean theorem: $h^2 = h_{opp}^2 + h_{adj}^2$

Sine of an angle: $\sin\theta = h_{opp} / h$

Cosine of an angle: $\cos\theta = h_{adj} / h$

Tangent of an angle: $\tan\theta = h_{opp} / h_{adj}$

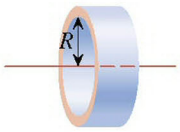
Quadratic formula:

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

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

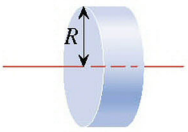
TABLE 9.1 Moments of Inertia for Various Rigid Objects of Mass *M*

Thin-walled hollow cylinder or hoop



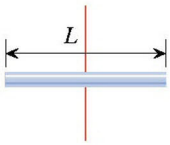
$I = MR^2$

Solid cylinder or disk



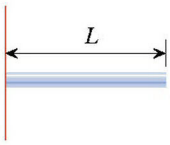
$I = \frac{1}{2}MR^2$

Thin rod, axis perpendicular to rod and passing through centre



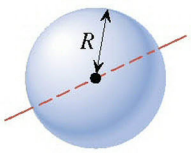
$I = \frac{1}{12}ML^2$

Thin rod, axis perpendicular to rod and passing through one end



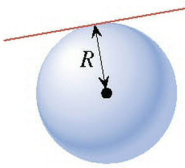
$I = \frac{1}{3}ML^2$

Solid sphere, axis through centre



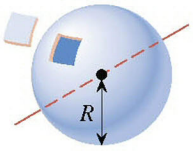
$I = \frac{2}{5}MR^2$

Solid sphere, axis tangent to surface



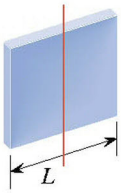
$I = \frac{7}{5}MR^2$

Thin-walled spherical shell, axis through centre



$I = \frac{2}{3}MR^2$

Thin rectangular sheet, axis parallel to one edge and passing through centre of other edge



$I = \frac{1}{12}ML^2$

Thin rectangular sheet, axis along one edge

$I = \frac{1}{3}ML^2$