SPH4U Equations

Percent Error

$$\% \text{error} = \left| \frac{\text{accepted value} - \text{experimental value}}{\text{accepted value}} \right| \times 100\%$$

$$\text{adj} = \text{hyp} \cos\theta$$
$$\text{opp} = \text{hyp} \sin\theta$$

Conversions

	mega	kilo	centi	milli	micro	nano
to base	10^6	10^3	10^{-2}	10^{-3}	10^{-6}	10^{-9}
from base	10^{-6}	10^{-3}	10^2	10^3	10^6	10^9

$$\text{km/h} \div 3.6 = \text{m/s}$$
$$\text{m/s} \times 3.6 = \text{km/h}$$

Cosine and Sine Law

$$a^2 = b^2 + c^2 - 2bc\cos A$$
$$b^2 = a^2 + c^2 - 2ac\cos B$$
$$c^2 = a^2 + b^2 - 2ab\cos C$$

$$\frac{\sin A}{a} = \frac{\sin B}{b} = \frac{\sin C}{c} \qquad \frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$$

Motion Equations

$$\vec{v}_{av} = \frac{\vec{d}}{t} \qquad \vec{a} = \frac{\vec{v}_2 - \vec{v}_1}{t}$$

$$\vec{d} = \vec{v}_1 t + 1/2\,\vec{a}t^2$$
$$1/2\,\vec{a}t^2 + \vec{v}_{y1}t - \vec{d} = 0$$

$$\vec{x} = \vec{v}_x t \qquad \boxed{\vec{a}_g = -9.8\,\tfrac{m}{s^2}}$$

$$\vec{v}_{av} = \frac{\vec{v}_1 + \vec{v}_2}{2} \qquad \vec{d} = \frac{\vec{v}_2^2 - \vec{v}_1^2}{2\vec{a}} \qquad \vec{v}_2 = \sqrt{2\vec{a}\,\vec{d} + \vec{v}_1^2}$$

Forces

$$\vec{F}_{net} = m\vec{a} \qquad \vec{F}_g = m\vec{g} \qquad F_N = mg \qquad \mu = \frac{F_F}{F_N} \qquad \boxed{\vec{g} = -9.8\,\tfrac{N}{kg}}$$

Circular Motion

$$F_c = \frac{mv^2}{r} = m(4\pi^2 r)f^2 \qquad v = 2\pi r f \qquad a_c = \frac{v^2}{r} = 4\pi^2 r f^2$$

$$r_E = 6.38 \times 10^6\text{ m} \qquad m_E = 5.98 \times 10^{24}\text{ kg}$$

$$F_G = \frac{Gm_1m_2}{r^2} \qquad G = 6.67\times10^{-11}\,\tfrac{Nm^2}{kg^2}$$

Energy and Momentum

$$W = Fd\cos\theta \qquad W = \Delta E_k \qquad E_g = mgh \qquad E_{th} = F_k d \qquad E_k = \frac{1}{2}mv^2$$

$$\vec{F}_{av}\,t = \Delta\vec{p} \qquad \vec{p} = m\vec{v} \qquad T = 2\pi\sqrt{\frac{m}{k}} \qquad F_E = kx \qquad E_E = \frac{1}{2}kx^2$$

Light

$c = f\lambda$ | $c = 3.00 \times 10^8$ m/s

$n_1 \sin i = n_2 \sin R$

$n = \frac{c}{v}$

$\frac{\sin i}{\sin R} = \frac{n_2}{n_1} = \frac{\lambda_1}{\lambda_2} = \frac{v_1}{v_2}$

$v = f\lambda$

Single slit equations:

$\sin\theta_n = \frac{n\lambda}{w} = \frac{y_n}{L}$

$\lambda = \frac{w\Delta y}{L}$ $\quad \sin\theta_m = \frac{(m+\frac{1}{2})\lambda}{w}$

Double slit (2 point sources) equations:

$\sin\theta_n = \frac{(n-\frac{1}{2})\lambda}{d} = \frac{x_n}{L}$

$\lambda = \frac{d\Delta x}{L}$ $\quad \sin\theta_m = \frac{m\lambda}{d}$

Diffraction gratings:

$\sin\theta_m = \frac{m\lambda}{d}$

Two point sources equations:

$|P_n s_1 - P_n s_2| = (n - \frac{1}{2})\lambda$

$|P_m S_1 - P_m S_2| = m\lambda$

Thin Films:

Phase change both top and bottom:

Constructive: $t = \frac{\lambda}{2} \times \frac{n_1}{n_2}$

Destructive: $t = \frac{\lambda}{4} \times \frac{n_1}{n_2}$

Phase change top but NOT bottom:

Constructive: $t = \frac{\lambda}{4} \times \frac{n_1}{n_2}$

Destructive: $t = \frac{\lambda}{2} \times \frac{n_1}{n_2}$

Fields

$F_e = \frac{kq_1q_2}{r^2} = q\,\varepsilon$ $\quad k = 8.99 \times 10^9 \ \frac{Nm^2}{C^2}$ $\quad F_M = qvB\sin\theta$ $\quad F_M = IlB\sin\theta$

$\varepsilon = -\frac{\Delta V}{d}$ $\quad \varepsilon = \frac{\Delta V}{r}$ $\quad \varepsilon = \frac{kq}{r^2}$ $\quad q = Ne$ $\quad V = \frac{kq}{r} = \frac{E_e}{q}$ $\quad q = \frac{mgr}{\Delta V}$

$E_e = \frac{kq_1q_2}{r}$ $\quad \Delta Ee = -qed$ $\quad \Delta E_e + \Delta E_k = 0$ $\quad \Delta V = \frac{-W}{q} = \frac{\Delta E_e}{q}$ $\quad r = \frac{mv}{qB}$

$e = -/+\ 1.60 \times 10^{-19}$ C $\quad m_e = 9.11 \times 10^{-31}$ kg $\quad m_p = 1.67 \times 10^{-27}$ kg $\quad m_n = 1.67 \times 10^{-27}$ kg

Relativity

$h = 6.63 \times 10^{-34}$ J·s $\quad c = f\lambda$ $\quad p = \frac{h}{\lambda}$ $\quad c = \ 1.60 \times 10^{-19}$ J/eV

$E_{ph} = hf = \frac{hc}{\lambda}$ $\quad E_{ph} = E_{k(rel)} + W$ $\quad MeV = 10^6$ eV

$E_{rest} = mc^2$ $\quad E_T = E_{k(rel)} + E_{rest}$ $\quad E_T = \gamma mc^2 = \gamma E_{rest}$ $\quad \gamma = \frac{1}{\sqrt{1-\frac{v^2}{c^2}}}$

$t_s = \frac{t_m}{\gamma}$ $\quad L_S = \gamma L_M$ $\quad p = mv$ $\quad p_{rel} = \gamma mv$ $\quad m_{rel} = \gamma m_{rest}$

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