SPH4U: Physics, Grade 12, University Preparation — CONSTANTS AND EQUATIONS

CONSTANTS

$g = 9.8\ m/s^2$ $r_{earth} = 6.38\times10^6\ m$ $m_e = 9.11\times10^{-31}\ kg$ $e = 1.6\times10^{-19}\ C$ $k = 9.0\times10^9\ \mathrm{N\cdot m^2/C^2}$

$G = 6.67\times10^{-11}\ \frac{N\cdot m^2}{kg^2}$ $m_{earth} = 5.98\times10^{24}\ kg$ $m_p = 1.67\times10^{-27}\ kg$ $c = 3.0\times10^8\ \mathrm{m/s}$ $\mu_0 = 4\pi\times10^{-7}\ T\cdot m/A$

CONVERSIONS

$f = 10^{-15}$ $p = 10^{-12}$ $n = 10^{-9}$ $\mu = 10^{-6}$ $m = 10^{-3}$ $k = 10^3$ $M = 10^6$ $G = 10^9$ $T = 10^{12}$ $P = 10^{15}$

MATHEMATICAL EQUATIONS

$c^2 = a^2 + b^2 - 2ab\cos C$ $\cos A = \frac{b^2+c^2-a^2}{2bc}$ $\frac{\sin A}{a} = \frac{\sin B}{b} = \frac{\sin C}{c}$ $\sin\theta = \frac{o}{h}$ $\cos\theta = \frac{a}{h}$ $\tan\theta = \frac{o}{a}$ $A = \pi r^2$ $C = 2\pi r$

FORMULAS

Kinematics

$v_{av} = \frac{d}{\Delta t}$ $\vec{v}_{av} = \frac{\Delta\vec{d}}{\Delta t}$ $\vec{a}_{av} = \frac{\Delta\vec{v}}{\Delta t}$ $\vec{d} = \frac{(\vec{v}_1+\vec{v}_2)}{2}t$ $\vec{v}_2 = \vec{v}_1 + \vec{a}t$ $\vec{d} = \vec{v}_2 t - \frac{1}{2}\vec{a}t^2$ $\vec{d} = \vec{v}_1 t + \frac{1}{2}\vec{a}t^2$ $\vec{v}_2{}^2 - \vec{v}_1{}^2 = 2\vec{a}\vec{d}$

Dynamics

$\vec{F}_{Net} = m\vec{a}$ $\vec{F}_g = m\vec{g}$ $\vec{F}_k = \mu_k\vec{F}_N$ $\vec{F}_{s,max} = \mu_S\vec{F}_N$

Circular Motion and Universal Gravitation

$\vec{a}_c = \frac{v^2}{r}$ $\vec{a}_c = \frac{4\pi^2 r}{T^2}$ $\vec{F}_c = m\vec{a}_c$ $\vec{F}_g = \frac{Gm_1m_2}{r^2}$ $v_s = \sqrt{\frac{Gm_E}{r}}$ $g = G\frac{m}{r^2}$ $G = 6.67\times10^{-11}\ \mathrm{N\cdot m^2/kg^2}$

$\vec{a}_c = 4\pi^2 r f^2$ $T = 1/f$

Work and Energy

$W = \vec{F}\cdot\Delta\vec{d}$ $W_{total} = \Delta E_K$ $E_K = \frac{1}{2}mv^2$ $E_G = mgh$ $E_{TH} = \vec{F}_f\cdot\Delta\vec{d}$ $E_S = \frac{1}{2}kx^2$ $F_S = -kx$

Momentum

$\vec{p} = m\vec{v}$ $\vec{J} = \vec{F}_{net}\Delta t = \Delta\vec{p}$ $m_1\vec{v}_1 + m_2\vec{v}_2 = m_1\vec{v}'_1 + m_2\vec{v}'_2$ $\vec{v}'_1 = \left(\frac{m_1-m_2}{m_1+m_2}\right)\vec{v}_1$ $\vec{v}'_2 = \left(\frac{2m_1}{m_1+m_2}\right)\vec{v}_1$

Electrostatics

$q = Ne$ $\vec{\varepsilon} = \frac{kq_1}{r^2}$ $E_E = qV$ $V = \frac{kq_1}{r}$ $k = 9.0\times10^9\ \mathrm{N\cdot m^2/C^2}$

$\vec{F}_E = q\vec{\varepsilon}$ $\vec{F}_E = \frac{kq_1q_2}{r^2}$ $\vec{a} = \frac{\vec{F}_E}{m}$ $E_E = \frac{kq_1q_2}{r}$ $V = \varepsilon\cdot d$ $e = 1.6\times10^{-19}\ C$

$m_e = 9.11\times10^{-31}\ kg$

$m_p = 1.67\times10^{-27}\ kg$

Magnetism

$\Phi_B = BA\cos\theta$ $\mu_0 = 4\pi\times10^{-7}\ T\cdot m/A$ $\frac{\vec{F}_M}{L} = \frac{\mu_0 I_1 I_2}{2\pi d}$ $V = -\frac{\Delta\Phi}{\Delta t}$ $B = \frac{\mu_0 I}{2\pi r}$ $B = \frac{\mu_0 NI}{L}$

$\vec{F}_M = q\vec{v}\vec{B}\sin\theta$ $\vec{F}_M = ILB\sin\theta$

Waves and Light

$n = \frac{c}{v}$ $c = \lambda f$ $v = \lambda f$ $c = 3.0\times10^8\ \mathrm{m/s}$

Two Point Sources and Double Slit Diffraction

$|P_nS_1 - P_nS_2| = \left(n-\frac{1}{2}\right)\lambda,\quad n = 1,2,3,\ldots$ $|P_mS_1 - P_mS_2| = m\lambda,\quad m = 0,1,2,\ldots$

$\frac{x_n}{L} = \sin\theta_n = \left(n-\frac{1}{2}\right)\frac{\lambda}{d},\quad n = 1,2,3,\ldots$ $\frac{x_m}{L} \approx \sin\theta_m = \frac{m\lambda}{d},\quad m = 0,1,2,\ldots$

Single Slit Diffraction

$\frac{x_n}{L} \approx \sin\theta_n = \frac{n\lambda}{w},\quad n = 1,2,3,\ldots$

$\frac{x_m}{L} \approx \sin\theta_m = \frac{\left(m+\frac{1}{2}\right)\lambda}{w},\quad m = 1,2,3,\ldots$

Diffraction Gratings

$\sin\theta_n = \left(n-\frac{1}{2}\right)\frac{\lambda}{d},\quad n = 1,2,3,\ldots$

$\sin\theta_m = \frac{m\lambda}{d},\quad m = 0,1,2,\ldots$

Note: In these equations, the subscript 'n' represents minima or nodes; whereas, 'm' represents maxima or anti-nodes.

Reflection from Thin Films

$t = \frac{n\lambda}{4}$ $n = 0, 2, 4$ (dark) $n = 1, 3, 5$ (bright)

Transmission through Thin Films

$t = \frac{n\lambda}{4}$ $n = 0, 2, 4$ (bright) $n = 1, 3, 5$ (dark)

Special Relativity

$L_m = L_s\sqrt{1-\frac{v^2}{c^2}}$ $\Delta t_m = \frac{\Delta t_s}{\sqrt{1-\frac{v^2}{c^2}}}$ $p = \frac{mv}{\sqrt{1-\frac{v^2}{c^2}}}$ $E_{Total} = \frac{mc^2}{\sqrt{1-\frac{v^2}{c^2}}}$ $E_K = \frac{mc^2}{\sqrt{1-\frac{v^2}{c^2}}} - mc^2$ $E_{Rest} = mc^2$