

SPH4U Formula Sheet

Unit 1 – Forces and Motion: Dynamics

$\vec{F} = m\vec{a}$	$\vec{F}_g = m\vec{g}$	$ \vec{F}_f = \mu_k \vec{F}_N $	$\Delta\vec{d} = \vec{v}\Delta t$
$\vec{v}_2 = \vec{v}_1 + \vec{a}\Delta t$	$\Delta\vec{d} = \vec{v}_1\Delta t + \frac{1}{2}\vec{a}\Delta t^2$	$\Delta\vec{d} = \vec{v}_2\Delta t - \frac{1}{2}\vec{a}\Delta t^2$	
$\vec{v}_2^2 = \vec{v}_1^2 + 2\vec{a}\Delta\vec{d}$	$F_c = \frac{mv^2}{r} = \frac{4\pi^2 rm}{T^2}$	$\frac{T^2}{r^3} = k$	$\vec{F}_g = \frac{-Gm_1m_2}{r^2}\hat{r}$

Unit 2 – Energy and Momentum

$\vec{p} = m\vec{v}$	$\Delta\vec{p} = \vec{F}\Delta t$	$ W = F\Delta d \cos \theta$ $W = \vec{F} \cdot \vec{d}$	$W = \Delta E$
$E_k = \frac{1}{2}mv^2$	$E_g = mg\Delta h$	$F_k = kx$	$E_e = \frac{1}{2}kx^2$
$F_c = \frac{mv^2}{r} = \frac{Gm_1m_2}{r^2}$ $= F_g$	$v = \sqrt{\frac{GM}{r}}$	$v_{\text{escape}} = \sqrt{\frac{2GM}{r}}$	
$E_g = -\frac{GMm}{r}$	$E_k = \frac{GMm}{2r}$	$E_{\text{total}} = -\frac{GMm}{2r}$	$E_{\text{binding}} = \frac{GMm}{2r}$

Unit 3 – Electric, Gravitational, and Magnetic Fields

$\vec{F}_Q = \frac{kq_1q_2}{r^2}\hat{r}$	$\vec{F}_Q = q\vec{E}$	$E_Q = \frac{kq_1q_2}{r}$	$V = \frac{kq}{r}$
$\Delta V = \vec{E}_Q \Delta d$	$\Delta E_k = \Delta E_Q$ $\frac{1}{2}mv^2 = -kq_1q_2\left(\frac{1}{r_2} - \frac{1}{r_1}\right)$	$\Delta E_Q = -q\Delta V$	$\vec{F}_M = q\vec{v} \times \vec{B}$ $ \vec{F}_M = qvB \sin \theta$
$\vec{F}_M = I\vec{l} \times \vec{B}$ $ \vec{F}_M = IlB \sin \theta$	$\Sigma B_{ }\Delta l = \mu_0 I$	$B = \mu_0 \left(\frac{I}{2\pi r}\right)$	$B = \mu_0 \left(\frac{NI}{L}\right)$

Unit 4 – The Wave Nature of Light

$n\lambda = d \sin \theta_n$	$n\lambda = d \frac{\Delta x}{L}$	$\lambda = W \frac{\Delta x}{L}$	$\sin \theta_{\min} = \frac{1.22\lambda}{D}$
$\lambda_{\text{coating}} = \frac{\lambda_{\text{air}}}{n_{\text{coating}}}$			

Unit 5 – Matter-Energy Interface

$t' = \frac{t}{\sqrt{1 - \frac{v^2}{c^2}}}$	$t' = \gamma t$	$\gamma = \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}}$	$L' = L \sqrt{1 - \frac{v^2}{c^2}}$	$\lambda_{obs} = \frac{\sqrt{1 \pm \frac{v}{c}}}{\sqrt{1 \mp \frac{v}{c}}} \lambda_{source}$	$L' = L \sqrt{1 - \frac{v^2}{c^2}}$
$L' = \frac{L}{\gamma}$	$m = \frac{m_0}{\sqrt{1 - \frac{v^2}{c^2}}}$	$E = mc^2$	$E = m_0 c^2 + E_k$	$E_k = mc^2 - m_0 c^2$ $= \gamma m_0 c^2 - m_0 c^2$ $= (\gamma - 1) m_0 c^2$	
$E = hf = \frac{hc}{\lambda}$	$c = f\lambda$	$E_k = hf - W$	$p = \frac{h}{\lambda}$	$\lambda = \frac{h}{mv}$	$\Delta x \Delta p = \frac{h}{2\pi}$
$\frac{1}{\lambda} = R \left(\frac{1}{n_l^2} - \frac{1}{n_u^2} \right)$	$E_n = \frac{-13.6}{n^2}$	$A(t) = A_0 \left(\frac{1}{2} \right)^{\frac{t}{t_H}}$	$\Delta m = m_{products} - m_{reactants}$		

Constants

$c = 3.00 \times 10^8 \text{ m/s}$ $h = 6.626 \times 10^{-34} \text{ Js} = 4.13 \times 10^{-15} \text{ eVs}$ $R = 1.097 \times 10^7 \text{ m}^{-1}$ $G = 6.67 \times 10^{-11} \text{ Nm}^2/\text{kg}^2$ $\mu_0 = 4\pi \times 10^{-7} \text{ Tm/A}$ $k = 9.0 \times 10^9 \text{ Nm}^2/\text{C}^2$	$m_p = 1.67 \times 10^{-27} \text{ kg} = 938.28 \text{ MeV}/c^2 = 1.007276 \text{ u}$ $m_n = 1.68 \times 10^{-27} \text{ kg} = 939.573 \text{ MeV}/c^2 = 1.008665 \text{ u}$ $m_e = 9.1 \times 10^{-31} \text{ kg} = 0.511 \text{ MeV}/c^2 = 0.000549 \text{ u}$ $q_e = 1.602 \times 10^{-19} \text{ C}$ $m_{\text{Earth}} = 5.98 \times 10^{24} \text{ kg}$ $r_{\text{Earth}} = 6.38 \times 10^6 \text{ m}$
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Conversion Factors

$$1 \text{ eV} = 1.602 \times 10^{-19} \text{ J} \quad 1 \text{ u} = 931.5 \text{ MeV}/c^2 = 1.66 \times 10^{-27} \text{ kg}$$

Math

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} \text{ when } ax^2 + bx + c = 0$$

$$x^2 - y^2 = (x + y)(x - y)$$

$$x^2 + 2xy + y^2 = (x + y)^2$$