PHYS 125 **Formula Sheet** Spring 2015

Formula Sheet

In showing work, these formulas may be used without derivation.

CONSTANTS

$v = 343\,\mathrm{m/s} \qquad c = 2.998 \times 10^8\,\mathrm{m/s}$

$\rho_{\text{air}} = 1.21\,\mathrm{kg/m^3}$

Prefixes: f- $= 10^{-15}$

$e = 1.602 \times 10^{-19}\,\mathrm{C}$

$m_e = 9.11 \times 10^{-31}\,\mathrm{kg}$

$m_p = 1.67 \times 10^{-27}\,\mathrm{kg}$

$k = 8.99 \times 10^9\,\mathrm{Nm^2/C^2}$

$\varepsilon_0 = 8.85 \times 10^{-12}\,\mathrm{C^2/Nm^2}$

MATH

sphere: $4\pi R^2 \quad \frac{4}{3}\pi R^3$

cylinder : $2\pi RL \quad \pi R^2 L$

$$\frac{d}{dx}\sin(kx) = k\cos(kx)$$

$$\int \sin(kx)\,dx = \frac{-1}{k}\cos(kx)$$

$$\int \frac{dx}{x} = \ln x$$

$$\int \frac{dx}{\sqrt{x^2+a^2}} = \ln\left(x + \sqrt{x^2+a^2}\right)$$

$$\int \frac{x dx}{\sqrt{x^2+a^2}} = \sqrt{x^2+a^2}$$

$$\int \frac{dx}{(x^2+a^2)^{3/2}} = \frac{x}{a^2\,(x^2+a^2)^{1/2}}$$

$$\int \frac{x\;dx}{(x^2+a^2)^{3/2}} = \frac{-1}{(x^2+a^2)^{1/2}}$$

$$\vec{A}\times\vec{B} = (A_yB_z - A_zB_y)\hat{\imath} + (A_zB_x - A_xB_z)\hat{\jmath} + (A_xB_y - A_yB_x)\hat{k}$$

MECHANICS

$$x(t) = x_0 + v_0 t + \tfrac{1}{2}at^2$$

$$v(t) = v_0 + at$$

$$v^2 = v_0^2 + 2a(x - x_0)$$

WAVES

$$y(x,t) = y_m \sin(kx - \omega t + \phi_0)$$

$$k = \frac{2\pi}{\lambda} \qquad f = \frac{\omega}{2\pi} = \frac{1}{T}$$

$$v = \frac{\omega}{k} = \lambda f \qquad v = \sqrt{\frac{\tau}{\mu}}$$

$$P_{\text{avg}} = \tfrac{1}{2}\mu v \omega^2 y_m^2$$

$$\frac{\Delta\phi}{2\pi} = \frac{\Delta L}{\lambda} \qquad \frac{\Delta\phi}{2\pi} = \frac{\Delta t}{T}$$

$$\Delta\phi = 2m\pi \qquad \Delta\phi = (2m+1)\pi$$

$$y' = \left[2y_m\cos\left(\frac{\phi_0}{2}\right)\right]\sin\left(kx - \omega t + \frac{\phi_0}{2}\right)$$

$$y' = [2y_m \sin kx]\cos\omega t$$

$$f = \frac{v}{2L}n \qquad f = \frac{v}{4L}n$$

SOUND

$$v = \sqrt{\frac{B}{\rho}} \qquad \Delta p_m = (v\rho\omega)s_m$$

$$s = s_m\cos(kx - \omega t)$$

$$\Delta p = \Delta p_m \sin(kx - \omega t)$$

$$I = \frac{P}{A} \qquad I = \frac{P}{4\pi r^2} \qquad I = \tfrac{1}{2}\rho v \omega^2 s_m^2$$

$$\beta = (10\text{ dB})\log\frac{I}{I_0} \qquad I_0 = 10^{-12}\,\mathrm{W/m^2}$$

$$f' = f\left(\frac{v \pm v_D}{v \pm v_S}\right)$$

LIGHT

$$v = \frac{c}{n} \qquad \lambda_n = \frac{\lambda}{n}$$

$$N_2 - N_1 = \frac{L}{\lambda}(n_2 - n_1) \qquad y_m = \frac{m\lambda D}{d}$$

$$d\sin\theta = m\lambda \qquad d\sin\theta = \left(m + \tfrac{1}{2}\right)\lambda$$

$$\frac{2L}{\lambda_n} = m \qquad \frac{2L}{\lambda_n} = m + \tfrac{1}{2}$$

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ELECTROSTATICS

$$\vec{F} = k\frac{q_1 q_2}{r^2}\hat{r} = \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{r^2}\hat{r}$$

$$\vec{F} = q_0\vec{E} \qquad \vec{E} = k\frac{q}{r^2}\hat{r}$$

$$\vec{p} = q\vec{d} \qquad \vec{E} = -k\frac{\vec{p}}{x^3} \qquad \vec{E} = 2k\frac{\vec{p}}{z^3}$$

$$\vec{\tau} = \vec{p}\times\vec{E} \qquad U = -\vec{p}\cdot\vec{E}$$

$$\lambda = \frac{Q}{L} \qquad \sigma = \frac{Q}{A} \qquad \rho = \frac{Q}{V}$$

$$\Phi = \vec{v}\cdot\vec{A} = vA\cos\theta$$

$$\Phi_E = \int \vec{E}\cdot d\vec{A}$$

$$\varepsilon_0\Phi_E = \varepsilon_0\oint \vec{E}\cdot d\vec{A} = q_{\text{enc}}$$

$$E = \frac{\sigma}{\varepsilon_0} \qquad E = \frac{\sigma}{2\varepsilon_0}$$

POTENTIAL

$$V_f - V_i = -\int_i^f \vec{E}\cdot d\vec{s}$$

$$V = \frac{1}{4\pi\varepsilon_0}\frac{q}{r} \qquad V = k\,\frac{p\cos\theta}{r^2}$$

$$W_{\text{app}} = -W = U_f - U_i$$

$$\Delta V = V_f - V_i = \frac{U_f}{q_0} - \frac{U_i}{q_0} = \frac{\Delta U}{q_0}$$

$$V = \frac{U}{q_0} \qquad U = \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{r_{12}}$$

$$E_s = -\frac{\partial V}{\partial s} \qquad E_{x,y,z} = -\frac{\partial V}{\partial x, y, z}$$

CIRCUIT ELEMENTS

$$q = C\,\Delta V \qquad \Delta V = Ed$$

$$E = \frac{q}{\kappa\varepsilon_0 A} \qquad C = \kappa\varepsilon_0\frac{A}{d}$$

$$C_{\text{eq}} = C_1 + C_2 + C_3 + ...$$

$$\frac{1}{C_{\text{eq}}} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} + ...$$

$$U = \frac{q^2}{2C} \qquad U = \tfrac{1}{2}C\,\Delta V^2 \qquad u = \tfrac{1}{2}\varepsilon_0 E^2$$

$$i = \frac{dq}{dt} \qquad q = \int i\,dt$$

$$J = \frac{i}{A} \qquad i = \int \vec{J}\cdot d\vec{A} \qquad \vec{J} = qn\vec{v}_d$$

$$\Delta V = iR \qquad P = i\,\Delta V = i^2 R = \frac{\Delta V^2}{R}$$

$$\vec{E} = \rho\vec{J} \qquad R = \rho\frac{L}{A}$$

NOT on the Formula Sheet

TO BE MEMORIZED unless otherwise indicated

CONSTANTS

metric prefixes G, M, k, c, m, μ, n , p

$$\lambda_{\text{visible}} \approx 500 \text{ nm}$$

$$n_{air} \approx 1.000$$

$$1 \ e\text{V} = 1.602 \times 10^{-19} \text{ J}$$

MATH

circle: $2\pi R \quad \pi R^2$

right triangle: $C^2 = A^2 + B^2$

$$\vec{A} \cdot \vec{B} = A_x B_x + A_z B_z + A_z B_z = AB\cos(\theta)$$

$$|\vec{A} \times \vec{B}| = AB\sin(\theta)$$

Right Hand Rule

$$ds = r d\theta$$

$$\frac{d}{dx}\left(x^n\right) = nx^{n-1} \qquad \int x^n dx = \frac{x^{n+1}}{n+1}$$

$$\frac{d}{dx}\cos\left(kx\right) = -k\sin\left(kx\right)$$

$$\int \cos\left(kx\right) dx = \frac{1}{k}\sin\left(kx\right)$$

MECHANICS

$$\sum \vec{F} = m\vec{a}$$

WAVES

transverse velocity from $u = \dfrac{dy}{dt}$

$$\mu = \frac{m}{L} \qquad \rho = \frac{m}{V}$$

$$f_{\text{beat}} = |f_1 - f_2|$$

CIRCUIT ELEMENTS

$$\sigma = \frac{1}{\rho}$$

Supplied if Necessary, Need NOT Memorize

Any electric field or electric potential that can be obtained by integration, unless the question is intended to test your ability to perform that integration.