PHYS 125 **Formula Sheet** Spring 2015

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

CONSTANTS

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

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

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

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

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

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

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

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

$\mu_0 = 4\pi \times 10^{-7}\,\mathrm{Tm/A}$

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

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

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

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

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

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

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

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

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

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

SOUND

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

CIRCUIT ELEMENTS

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

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

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

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

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

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

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

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

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

POTENTIAL

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

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

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

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

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

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

MAGNETIC FIELD

$$\vec{F} = q\left(\vec{v}\times\vec{B}\right) \qquad \vec{F} = i\vec{L}\times\vec{B}$$

$$r = \frac{mv}{|q|B} \qquad f = \frac{|q|B}{2\pi m} \qquad n = \frac{Bi}{Vle}$$

$$|\vec{\mu}| = NiA \qquad \vec{\tau} = \vec{\mu}\times\vec{B} \qquad U = -\vec{\mu}\cdot\vec{B}$$

$$d\vec{B} = \frac{\mu_0}{4\pi}\frac{i\,d\vec{s}\times\hat{r}}{r^2} \qquad B = \frac{\mu_0 i}{2\pi R}$$

$$B = \frac{\mu_0 i}{4\pi R}\frac{L}{\sqrt{L^2+R^2}} \qquad B = \frac{\mu_0 i}{4\pi R}\phi$$

$$F_{ba} = \frac{\mu_0 L i_a i_b}{2\pi d} \qquad \oint \vec{B}\cdot d\vec{s} = \mu_0 i_{\text{enc}}$$

$$B = \mu_0 i n \qquad \vec{B} = \frac{\mu_0}{2\pi}\frac{\vec{\mu}}{z^3}$$

MAGNETIC INDUCTION

$$\mathcal{E} = -N\frac{d\Phi_B}{dt} \qquad \Phi_B = \oint \vec{B}\cdot d\vec{A}$$

$$\mathcal{E} = NBhv \;\; Fv = P = \frac{N^2B^2h^2v^2}{R}$$

NOT on the Formula Sheet

TO BE MEMORIZED

CONSTANTS

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

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

$$n_{air} \approx 1.000$$

$$k = \frac{1}{4\pi\varepsilon_0}$$

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

MATH

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

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

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

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

Right Hand Rule

$$ds = r d\theta$$

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

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

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

MECHANICS

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

WAVES

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

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

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

CIRCUIT ELEMENTS

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

MAGNETIC FIELD

$$B = \frac{\mu_0 i}{2R}$$

Supplied if Necessary, Need NOT Memorize

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