

PHYS 1312 Fall 2022 Final
Equation Sheet

Test 1 equations

$$v = f\lambda \quad \omega = 2\pi f \quad f = 1/T \quad v_{\text{sound}} = \left(\frac{\gamma k_B T}{m}\right)^{1/2} \quad (1)$$

$$y(x, t) = A \sin(kx \mp \omega t + \phi_0) = A \sin \varphi \quad k = 2\pi/\lambda \quad (2)$$

$$\Delta\varphi = \frac{2\pi}{\lambda}\Delta x + \Delta\phi_0 = n2\pi \quad f_o = f_s \left(\frac{1 \pm v_o/v}{1 \mp v_s/v}\right) \quad (3)$$

$$f_n^{oo} = n \frac{v}{2L} \quad f_n^{oc} = n \frac{v}{4L} \quad (4)$$

$$n = \frac{c}{v} \quad n_1 \sin \theta_1 = n_2 \sin \theta_2 \quad (5)$$

$$\frac{1}{p} + \frac{1}{q} = \frac{1}{f} \quad \frac{n_1}{p} + \frac{n_2}{q} = \frac{n_2 - n_1}{R} \quad \frac{1}{f} = (n - 1) \left(\frac{1}{R_1} - \frac{1}{R_2} \right) \quad (6)$$

$$f = \frac{R}{2} \quad M = \frac{h'}{h} = \frac{-q}{p} \quad f\text{-number} = f/D \quad P = \frac{1}{f} \quad (7)$$

$$I \propto \frac{D^2}{f^2} \quad I = \text{Energy}/(A\Delta t) \quad m = \frac{\theta}{\theta_0} \quad (8)$$

$$m_{\text{max}} = 1 + \frac{25 \text{ cm}}{f} \quad M_0 = \frac{-L}{f_0} \quad M = M_0 m_e = -\frac{L}{f_0} \frac{25 \text{ cm}}{f_e} \quad (9)$$

$$m = -\frac{f_0}{f_e} \quad x(t) = A \cos(\omega t + \phi_0) \quad (10)$$

Test 2 equations

$$\delta = r_2 - r_1 = d \sin \theta_{\text{bright}} = m\lambda \quad d \sin \theta_{\text{dark}} = \left(m + \frac{1}{2}\right)\lambda \quad (11)$$

$$y_{\text{bright}} \approx \frac{\lambda L m}{d} \quad y_{\text{dark}} \approx \frac{\lambda L}{d} \left(m + \frac{1}{2}\right) \quad I = I_{\text{max}} \cos^2(\phi/2) \quad (12)$$

$$E(t) = E_0 \sin(\omega t + \phi) \quad \phi = \frac{2\pi}{\lambda} \delta \quad (13)$$

$$\beta = \frac{2\pi}{\lambda} a \sin \theta \quad a \sin \theta_{\text{dark}} = m\lambda \quad I = I_{\text{max}} \left[\frac{\sin(\beta/2)}{\beta/2} \right]^2 \quad (14)$$

$$\theta_{\min} = \frac{\lambda}{a} \quad \theta_{\min} = 1.22 \frac{\lambda}{D} \quad R = \frac{\lambda_{\text{avg}}}{\Delta\lambda} = Nm \quad (15)$$

$$\delta = 2d \sin \theta = m\lambda \quad (16)$$

$$\vec{F}_e = \frac{k_e q_1 q_1}{r^2} \hat{r} \quad k_e = \frac{1}{4\pi\epsilon_0} \quad \vec{E} = \vec{F}_e/q \quad (17)$$

$$|\vec{E}_{\text{axis}}| \approx \frac{k_e 2qs}{r^3} \quad |\vec{E}_{\text{perp}}| \approx \frac{k_e qs}{r^3} \quad \vec{p} = q\vec{s} = \alpha\vec{E} \quad (18)$$

$$|\vec{E}_{\text{induced}}| \approx \frac{k_e^2 2\alpha q_1}{r^5} \quad \bar{v} = uE_{\text{net}} \quad (19)$$

Test 3 equations

$$\lambda = Q/L \quad \sigma = Q/A \quad \rho = Q/V \quad (20)$$

$$\vec{E} = k_e \sum_i \frac{q_i}{r_i^2} \hat{r}_i = k_e \int \frac{dq}{r^2} \hat{r} \quad E_{x,\text{rod}} = \frac{k_e Q}{a(L+a)} \quad (21)$$

$$\vec{E}_{\text{rod}} = \frac{k_e Q}{r\sqrt{r^2 + (L/2)^2}} \hat{r} \quad E_{z,\text{ring}} = \frac{k_e Qz}{(R^2 + z^2)^{3/2}} \quad (22)$$

$$E_{z,\text{disk}} = \frac{Q/A}{2\epsilon_0} \left[1 - \frac{z}{\sqrt{R^2 + z^2}} \right] \quad E_{z,\text{capacitor}} = \frac{Q/A}{\epsilon_0} \quad (23)$$

$$\Delta V = \frac{\Delta U_e}{q} = - \int \vec{E} \cdot d\vec{\ell} \quad \vec{E} = -\vec{\nabla}V \quad V = \frac{k_e q}{r} \quad (24)$$

$$V = k_e \int \frac{dq}{r} \quad \vec{E}_{\text{insulator}} = \vec{E}_{\text{applied}}/K \quad \Delta V_{\text{insulator}} = \Delta V_{\text{vacuum}}/K \quad (25)$$

$$\text{Energy/volume} = \frac{1}{2} \epsilon_0 E^2 \quad (26)$$

Post-Test 3 equations

$$I = |q|nA\bar{v} = |q|i \quad \vec{B} = \frac{\mu_0}{4\pi} \frac{q\vec{v} \times \hat{r}}{r^2} \quad (27)$$

$$\Delta \vec{B} = \frac{\mu_0}{4\pi} \frac{I \Delta \vec{\ell} \times \hat{r}}{r^2} \quad B_{z,\text{ring}} = \frac{\mu_0}{4\pi} \frac{2\pi R^2 I}{(R^2 + z^2)^{3/2}} \quad \vec{B}_{\text{axis}} = \frac{\mu_0}{4\pi} \frac{2\vec{\mu}}{z^3} \quad (28)$$

$$B_{wire} = \frac{\mu_0}{4\pi r} \frac{LI}{\sqrt{(L/2)^2 + r^2}} \quad \mu = IA \quad \vec{\mu}_L^e = \mu_B \vec{L}/\hbar \quad (29)$$

$$\vec{\mu}_S^e = 2.0023\mu_B \vec{S}/\hbar \quad L = \sqrt{\ell(\ell+1)}\hbar \quad S = \sqrt{s(s+1)}\hbar \quad (30)$$

$$\sum \Delta V_i = 0 \quad I = \int \vec{J} \cdot d\vec{A} \quad J = I/A \quad \vec{J} = \sigma \vec{E} \quad (31)$$

$$R = \rho\ell/A \quad \Delta V = IR \quad (32)$$

Math relations and constants

$$\sin(A \pm B) = \sin A \cos B \pm \cos A \sin B \quad (33)$$

$$\cos(A \pm B) = \cos A \cos B \mp \sin A \sin B \quad (34)$$

$$\sin A + \sin B = 2 \cos\left(\frac{A-B}{2}\right) \sin\left(\frac{A+B}{2}\right) \quad (35)$$

$$\sin x = x - \frac{x^3}{3!} + \frac{x^5}{5!} - \dots \quad \cos x = 1 - \frac{x^2}{2!} + \frac{x^4}{4!} \dots \quad (36)$$

$$\frac{d}{dx} \left[\frac{u}{v} \right] = \frac{1}{v} \frac{du}{dx} - \frac{u}{v^2} \frac{dv}{dx} \quad (37)$$

$$(1 + \epsilon)^n \approx 1 + n\epsilon, \epsilon \ll 1 \quad (38)$$

$$\int \frac{x dx}{\sqrt{x^2 \pm y^2}} = \sqrt{x^2 \pm y^2} \quad \int \frac{dx}{\sqrt{x^2 \pm y^2}} = \ln(x + \sqrt{x^2 \pm y^2}) \quad (39)$$

$$\int \frac{x dx}{(x^2 \pm y^2)^{3/2}} = \frac{-1}{\sqrt{x^2 \pm y^2}} \quad \int \frac{dx}{(x^2 \pm y^2)^{3/2}} = \frac{\pm x}{y^2 \sqrt{x^2 \pm y^2}} \quad (40)$$

$$c = 3 \times 10^8 \text{ m/s} \quad k_e = 8.99 \times 10^9 \text{ Nm}^2/\text{C}^2 \quad \epsilon_0 = 8.854 \times 10^{-12} \text{ C}^2/(\text{Nm}^2) \quad (41)$$

$$e = 1.602 \times 10^{-19} \text{ C} \quad m_e = 9.11 \times 10^{-31} \text{ kg} \quad k_B = 1.38 \times 10^{-23} \text{ J/K} \quad (42)$$

$$m_p = 1.6726 \times 10^{-27} \text{ kg} \quad 1\text{eV} = 1.6 \times 10^{-19} \text{ J} \quad (43)$$

$$\frac{\mu_0}{4\pi} = 1 \times 10^{-7} \text{ Tm/A} \quad \mu_B = \frac{e\hbar}{2m_e} = 9.274 \times 10^{-24} \text{ Am}^2 \quad (44)$$