Official Starting Equations
PHYS 2135, Engineering Physics II

From PHYS 1135:

$x = x_0 + v_{0x}\Delta t + \frac{1}{2}a_x(\Delta t)^2$ $\quad v_x = v_{0x} + a_x\Delta t$ $\quad v_x^2 = v_{0x}^2 + 2a_x(x - x_0)$ $\quad \sum \vec{F} = m\vec{a}$

$F_r = -\frac{mv_t^2}{r}$ $\quad P = \frac{F}{A}$ $\quad \vec{p} = m\vec{v}$ $\quad P = \frac{dW}{dt}$ $\quad W = \int \vec{F} \cdot d\vec{s}$

$K = \frac{1}{2}mv^2$ $\quad U_f - U_i = -W_{\text{conservative}}$ $\quad E = K + U$ $\quad E_f - E_i = (W_{\text{other}})_{i\to f}$ $\quad E = P_{\text{ave}}t$

Constants:

$g = 9.8\,\frac{\text{m}}{\text{s}^2}$ $\quad m_{\text{electron}} = 9.11 \times 10^{-31}\text{kg}$ $\quad m_{\text{proton}} = 1.67 \times 10^{-27}\text{kg}$ $\quad e = 1.6 \times 10^{-19}\text{C}$

$c = 3.0 \times 10^8\,\frac{\text{m}}{\text{s}}$ $\quad k = \frac{1}{4\pi\epsilon_0} = 9 \times 10^9\,\frac{\text{Nm}^2}{\text{C}^2}$ $\quad \epsilon_0 = 8.85 \times 10^{-12}\,\frac{\text{C}^2}{\text{Nm}^2}$ $\quad \mu_0 = 4\pi \times 10^{-7}\,\frac{\text{Tm}}{\text{A}}$

Electric Force, Field, Potential and Potential Energy:

$\vec{F} = k\frac{q_1q_2}{r_{12}^2}\hat{r}_{12}$ $\quad \vec{E} = k\frac{q}{r^2}\hat{r}$ $\quad \vec{F} = q\vec{E}$ $\quad \Delta V = -\int_i^f \vec{E} \cdot d\vec{s}$

$U = k\frac{q_1q_2}{r_{12}}$ $\quad V = k\frac{q}{r}$ $\quad \Delta U = q\Delta V$ $\quad E_x = -\frac{\partial V}{\partial x}$

$\vec{p} = q\vec{d}$ (from – to +) $\quad \vec{\tau} = \vec{p} \times \vec{E}$ $\quad U_{\text{dipole}} = -\vec{p} \cdot \vec{E}$

$\Phi_E = \int_S \vec{E} \cdot d\vec{A}$ $\quad \oint_S \vec{E} \cdot d\vec{A} = \frac{q_{\text{enclosed}}}{\epsilon_0}$ $\quad \lambda \equiv \frac{\text{charge}}{\text{length}}$ $\quad \sigma \equiv \frac{\text{charge}}{\text{area}}$ $\quad \rho \equiv \frac{\text{charge}}{\text{volume}}$

Circuits:

$C = \frac{Q}{V}$ $\quad \frac{1}{C_T} = \sum \frac{1}{C_i}$ $\quad C_T = \sum C_i$ $\quad C_0 = \frac{\epsilon_0 A}{d}$ $\quad C = \kappa C_0$

$U = \frac{1}{2}CV^2 = \frac{1}{2}\frac{Q^2}{C} = \frac{1}{2}QV$ $\quad I = \frac{dq}{dt}$ $\quad J = \frac{I}{A}$ $\quad \vec{J} = nq\vec{v}_d$

$\vec{J} = \sigma\vec{E}$ $\quad V = IR$ $\quad R = \rho\frac{L}{A}$ $\quad \sigma = \frac{1}{\rho}$ $\quad \rho = \rho_0[1 + \alpha(T - T_0)]$

$\sum I = 0$ $\quad \sum \Delta V = 0$ $\quad \frac{1}{R_T} = \sum \frac{1}{R_i}$ $\quad R_T = \sum R_i$ $\quad P = IV = \frac{V^2}{R} = I^2R$

$Q(t) = Q_{\text{final}}\left[1 - e^{-t/\tau}\right]$ $\quad Q(t) = Q_0 e^{-t/\tau}$ $\quad \tau = RC$

Magnetic Force, Field and Inductance:

$\vec{F} = q(\vec{E} + \vec{v} \times \vec{B})$ $\quad$ $\vec{F} = I\vec{L} \times \vec{B}$ $\quad$ $\Phi_B = \int \vec{B} \cdot d\vec{A}$ $\quad$ $\oint \vec{B} \cdot d\vec{A} = 0$

$\oint \vec{B} \cdot d\vec{s} = \mu_0 I_{\text{enclosed}}$ $\quad$ $\vec{\mu} = NI\vec{A}$ $\quad$ $\vec{\tau} = \vec{\mu} \times \vec{B}$ $\quad$ $U_{\text{dipole}} = -\vec{\mu} \cdot \vec{B}$

$\vec{B} = \frac{\mu_0}{4\pi} \frac{q\vec{v} \times \hat{r}}{r^2}$ $\quad$ $d\vec{B} = \frac{\mu_0 I}{4\pi} \frac{d\vec{s} \times \hat{r}}{r^2}$ $\quad$ $\mathcal{E} = -N \frac{d\Phi_B}{dt}$ $\quad$ $\oint \vec{E} \cdot d\vec{s} = -\frac{d\phi_B}{dt}$

$\oint \vec{B} \cdot d\vec{s} = \mu_0 I_{\text{enclosed}} + \mu_0 \epsilon_0 \frac{d\phi_E}{dt}$ $\quad$ $B = \frac{\mu_0 I}{2\pi r}$ $\quad$ $B = \mu_0 n I$

Electromagnetic Waves:

$I = \frac{P}{A}$ $\quad$ $u = \frac{1}{2}\left(\epsilon_0 E^2 + \frac{B^2}{\mu_0}\right) = \epsilon_0 E^2 = \frac{B^2}{\mu_0}$ $\quad$ $\langle u \rangle = \frac{1}{4}\left(\epsilon_0 E_{\max}^2 + \frac{B_{\max}^2}{\mu_0}\right) = \frac{1}{2}\epsilon_0 E_{\max}^2 = \frac{B_{\max}^2}{2\mu_0}$

$\frac{E}{B} = c = \frac{1}{\sqrt{\epsilon_0 \mu_0}}$ $\quad$ $\vec{S} = \frac{1}{\mu_0} \vec{E} \times \vec{B}$ $\quad$ $I = \langle S \rangle = c\langle u \rangle$ $\quad$ $\langle P_{\text{rad}} \rangle = \frac{I}{c}$ or $\frac{2I}{c}$

$k = \frac{2\pi}{\lambda}$ $\quad$ $\omega = 2\pi f$ $\quad$ $T = \frac{1}{f}$ $\quad$ $v = f\lambda = \frac{\omega}{k} = \frac{c}{n}$

Optics:

$I = I_{\max} \cos^2 \phi$ $\quad$ $\theta_r = \theta_i$ $\quad$ $n = \frac{c}{v} = \frac{\lambda_0}{\lambda_n}$ $\quad$ $n_r \sin\theta_r = n_i \sin\theta_i$

$\frac{1}{s} + \frac{1}{s'} = \frac{1}{f}$ $\quad$ $m = \frac{y'}{y} = -\frac{s'}{s}$ $\quad$ $\frac{1}{f} = (n-1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$ $\quad$ $f = \frac{R}{2}$

$\frac{n_a}{s} + \frac{n_b}{s'} = \frac{n_b - n_a}{R}$ $\quad$ $m = \frac{y'}{y} = -\frac{n_a s'}{n_b s}$ $\quad$ $\Delta L = m\lambda$ $\quad$ $\Delta L = \left(m + \frac{1}{2}\right)\lambda$

$\Delta L = d \sin\theta$ $\quad$ $\phi = 2\pi\left(\frac{\Delta L}{\lambda}\right)$ $\quad$ $I = I_0 \cos^2 \frac{\phi}{2}$ $\quad$ $R = \frac{\lambda}{\Delta\lambda} = Nm$

$m\lambda = a \sin\theta$ $\quad$ $\beta = \frac{2\pi}{\lambda} a \sin\theta$ $\quad$ $I = I_0 \left[\frac{\sin(\beta/2)}{\beta/2}\right]^2$

Integral:

$\int \frac{du}{(u^2 + a^2)^{3/2}} = \frac{u}{a^2\sqrt{u^2 + a^2}} + c$

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PHYS 2135

Total

End Material Test
May 11, 2022

Name: ____________________

Recitation: _______

Do not open test until instructed to do so by the proctors. When instructed to open the test, remove only the Cover Sheet and Official Starting Equations from the test packet.

Write clearly on this page the answer you believe is the best or most nearly correct answer. You may also record the answers on your Official Starting Equations sheets for later comparison with the answer key, which will be posted after all students have taken the test. When you finish both the End Material Test and the Final Exam, turn both into the test proctor with all pages, including this page, stapled together. You may keep the Official Starting Equations sheets or leave them with the test proctor to be recycled.

Calculators are not allowed!

Each question is worth 6 points, except question 8 which is worth 8 points.

Your Answers:

1. _________ **5.** _________

2. _________ **6.** _________

3. _________ **7.** _________

4. _________ **8.** _________

End Material Test

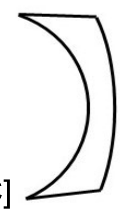
1. A person standing in front of a plane mirror sees their own image. The image is

[A] real and in front of the mirror.
[B] real and behind the mirror.
[C] virtual and in front of the mirror.
[D] virtual and behind the mirror.

2. An object is placed in front of a convex spherical mirror far from the mirror ($s \gg |f|$). The image produced is

[A] upright and smaller than the object.
[B] upright and larger than the object.
[C] inverted and smaller than the object.
[D] inverted and larger than the object.

3. A particular person is near-sighted (able to see close objects easily, but has difficulty focusing on distant objects). Select the lens that is most likely to be prescribed for this person.

[A] 
[B] 
[C] 
[D] 

4. 402nm and 406nm light are to be resolved using a diffraction grating. Determine the number of lines that need to be illuminated to resolve the light in first order.

[A] 101 lines
[B] 202 lines
[C] 404 lines
[D] 808 lines

5. A laser shines upon a narrow slit producing an interference pattern on a distant screen. The width of the central bright fringe is w. Which of the following is approximately equal to the width of the next adjacent bright fringe?

[A] $\frac{1}{2}w$ [B] $\frac{2}{3}w$ [C] $2w$ [D] $\frac{3}{2}w$

6. A red 630nm laser shines on a pair of narrow slits producing an interference pattern on a distant screen with a separation between bright fringes of L_r. The red laser is replaced by a violet 445nm laser producing a separation between bright fringes of L_v. Select the correct statement.

[A] $L_r < L_v$
[B] $L_r = L_v$
[C] $L_r > L_v$
[D] The relative sizes of L_r and L_v cannot be determined from the given information.

7. A thin film of unknown material (n_f) lies on top of a diamond ($n_D = 2.4$). Noting the refraction of light striking the film it can easily be seen that $1 < n_f \leq n_D$. The smallest thickness for which 480nm light striking the film is minimally reflected is 100nm. Determine the index of refraction of the film.

[A] $n_f = 1.2$
[B] $n_f = 1.5$
[C] $n_f = 1.6$
[D] $n_f = 2.4$

8. **[8 Free points.]** Select the correct statement.

[A] Upon reflection, physics humor is the most intense.
[B] Lenses Law states that the more one illuminates a problem, the more negative the problem appears.
[C] Deterrence of light infractions is not an applied physics topic.
[D] This problem statement is back by popular demand.