Official Starting Equations
PHYS 2135, Engineering Physics II

From PHYS 1135:

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

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

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

Constants:

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

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

Electric Force, Field, Potential and Potential Energy:

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

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

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

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

Circuits:

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

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

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

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

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

Magnetic Force, Field and Inductance:

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

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

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

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

Electromagnetic Waves:

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

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

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

Optics:

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

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

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

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

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

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
December 13, 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. An object placed in front of a mirror produces a virtual image. Considering the options of a plane mirror, convex mirror or concave mirror, select the correct statement.

[A] The mirror must be a concave mirror.
[B] The mirror must be a convex mirror.
[C] The mirror could be a plane mirror, convex mirror or concave mirror.
[D] The mirror could be a convex mirror or a concave mirror, but not a plane mirror.

2. An object is placed infinitely far from a converging lens. Select the correct statement.

[A] The image will be at the focal point on the opposite side of the lens from the object.
[B] The image will be a virtual image on the same side of the lens as the object.
[C] The image will be infinitely far from the lens on the opposite side of the lens from the object.
[D] The image will be a real image at the location of the lens.

3. A technician intends to make a converging lens with a focal length $f_{intended}$ out of a material with index of refraction $n_{intended}$ The technician mistakenly uses a material with index of refraction $n_{actual} > n_{intended}$, but does everything else correctly. The actual lens has a focal length f_{actual}. Select the correct statement.

[A] $f_{actual} < f_{intended}$
[B] $f_{actual} = f_{intended}$
[C] $f_{actual} > f_{intended}$
[D] The relative size of the two focal lengths cannot be determined from the given information.

4. A light source shining on a diffraction grating produces a pair of spectrum lines on a screen that overlap. Select the option that might be used to resolve the two lines.

[A] Move the screen closer to the diffraction grating.
[B] Move the screen farther away from the diffraction grating.
[C] Replace the diffraction grating with one with fewer lines per mm.
[D] Replace the diffraction grating with one with more lines per mm.

5. A laser shining on a pair of slits produces the first bright fringe above the central maximum at a distance y_{1B} above the central maximum and the second dark fringe above the central maximum at a distance y_{2D} above the central maximum. Select the correct statement. [Assume the angles are sufficiently small enough to use the small angle approximation.]

[A] $y_{2D} = \frac{4}{3} y_{1B}$

[B] $y_{2D} = \frac{3}{2} y_{1B}$

[C] $y_{2D} = 2 y_{1B}$

[D] $y_{2D} = \frac{5}{2} y_{1B}$

6. A laser shining on a single slit produces a first order bright fringe on a screen a distance y_0 from the central maximum. The single slit is replaced by a wider single slit producing a first order bright fringe on the screen a distance y_f from the central maximum. Select the correct statement.

[A] $y_f < y_0$
[B] $y_f = y_0$
[C] $y_f > y_0$
[D] The relative sizes of y_f and y_0 cannot be determined from the given information.

7. A laser with wavelength λ shines normally on a thin film with index of refraction n_f. The film is on a plate with index of refraction $n_p < n_f$. Which equation gives the thicknesses of film that will result in maximum reflection?

[A] $t = \frac{m\lambda}{2n_f}$

[B] $t = \frac{m\lambda}{2n_p}$

[C] $t = \frac{\left(m+\frac{1}{2}\right)\lambda}{2n_f}$

[D] $t = \frac{\left(m+\frac{1}{2}\right)\lambda}{2n_p}$

8. **[8 Free points.]** [Some mildly clever nonsense.]

[A] [Punny physics statement.]
[B] [More punishment.]
[C] [Punultimate option.]
[D] $\Omega\pi\tau\iota o\nu\ \upsilon\sigma\iota\nu\gamma\ \epsilon\nu\gamma\lambda\iota o\eta\ \tau\epsilon\rho\mu\sigma\ \alpha\nu\varsigma\ \gamma\rho\epsilon\epsilon\kappa\ \lambda\epsilon\tau\tau\epsilon\rho\varsigma.$