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:

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

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

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

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

$Q(t) = Q_{\text{final}}\left[1 - e^{-t/\tau}\right]$ $Q(t) = Q_0e^{-t/\tau}$ $\tau = RC$

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 15, 2021

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. __________

2. __________

3. __________

4. __________

5. __________

6. __________

7. __________

8. __________

End Material Test

1. A plane mirror produces an image. Which of the following statements is true.

[A] The image is reversed front to back.
[B] The image is reversed left to right.
[C] The image is reversed up to down.
[D] The image is not reversed in any dimension.

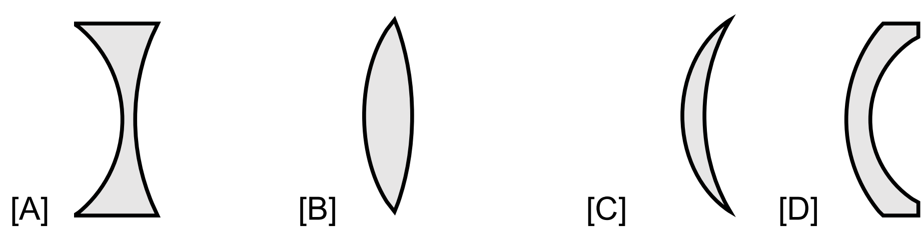
2. An object is placed in front of a concave spherical mirror halfway between the focal point and the center of curvature. Select the true statement.

[A] The image is behind the mirror.
[B] The image is between the mirror and the focal point.
[C] The image is between the focal point and the center of curvature.
[D] The image is between the center of curvature and infinity.

3. An object is placed in front of a converging lens halfway between the lens and the focal point. Select the true statement.

[A] The image is virtual and smaller than the object.
[B] The image is virtual and larger than the object.
[C] The image is real and smaller than the object.
[D] The image is real and larger than the object.

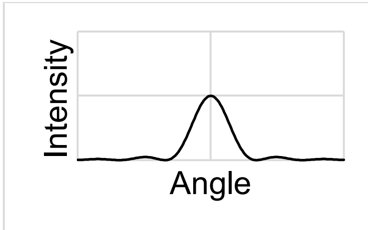
4. A lens is created with $R_2 > R_1 > 0$. Which of the figures could represent the lens?

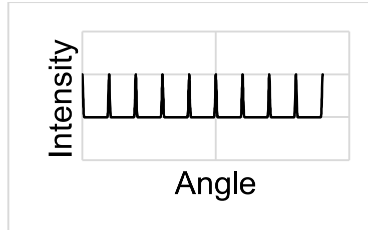


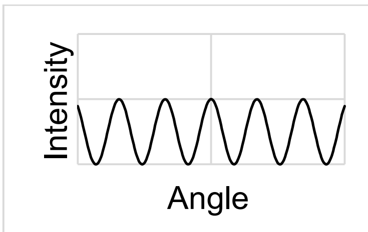
5. Light of wavelength λ_1 shines on a pair of narrow slits producing an image with bright fringes separated by Δy_1. The light source is replaced with another light source with $\lambda_2 > \lambda_1$ yielding an image with bright fringes separated by Δy_2. Select the correct statement.

[A] $\Delta y_2 < \Delta y_1$
[B] $\Delta y_2 = \Delta y_1$
[C] $\Delta y_2 > \Delta y_1$
[D] The relative size of Δy_2 relative to Δy_1 cannot be determined from the given information.

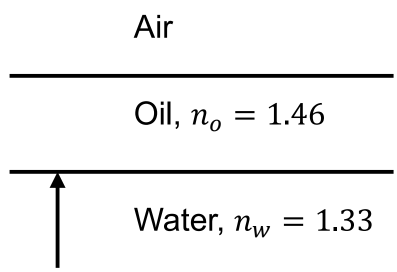
6. Determine which of the given intensity distributions is due to a single narrow slit.

[A] 

[B] 

[C] 

7. A thin film of olive oil of thickness t is on the surface of a container of water. Light of wavelength λ (λ determined in air) originating in the water is normally incident on the water-oil boundary. Which condition is necessary for the light to be minimally reflected back into the water?



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

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

[C] $2t = \frac{m\lambda}{n_w}$

[D] $2t = \frac{m\lambda}{n_o}$

8. **[8 Free points.]** Select all true statements.

[A] Upon reflection, optical concepts began to converge when I was most focused.

[B] The instructor's Covid mask must have produced a thin material interference pattern. There were locations of constructive communication where the intensity was the greatest.

[C] The instructor's magnified sense of his powers of imagination are virtual, not real.

[D] We should wave goodbye to these light attempts at humor.