

**Official Starting Equations**  
**PHYS 2135, Engineering Physics II**

**From PHYS 1135:**

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

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

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

**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:**

$$\vec{F} = k \frac{q_1 q_2}{r_{12}^2} \hat{r}_{12} \quad \vec{E} = k \frac{q}{r^2} \hat{r} \quad \vec{F} = q\vec{E} \quad \Delta V = -\int_i^f \vec{E} \cdot d\vec{s}$$

$$U = k \frac{q_1 q_2}{r_{12}} \quad V = k \frac{q}{r} \quad \Delta U = q\Delta V \quad E_x = -\frac{\partial V}{\partial x}$$

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

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

**Circuits:**

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

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

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

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

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

### Magnetic Force, Field and Inductance:

$$\begin{aligned}\vec{F} &= q(\vec{E} + \vec{v} \times \vec{B}) & \vec{F} &= I\vec{L} \times \vec{B} & \Phi_B &= \int \vec{B} \cdot d\vec{A} & \oint \vec{B} \cdot d\vec{A} &= 0 \\ \oint \vec{B} \cdot d\vec{s} &= \mu_0 I_{\text{enclosed}} & \vec{\mu} &= NI\vec{A} & \vec{\tau} &= \vec{\mu} \times \vec{B} & U_{\text{dipole}} &= -\vec{\mu} \cdot \vec{B} \\ \vec{B} &= \frac{\mu_0 q \vec{v} \times \hat{r}}{4\pi r^2} & d\vec{B} &= \frac{\mu_0 I d\vec{s} \times \hat{r}}{4\pi r^2} & \mathcal{E} &= -N \frac{d\Phi_B}{dt} & \oint \vec{E} \cdot d\vec{s} &= -\frac{d\Phi_B}{dt} \\ \oint \vec{B} \cdot d\vec{s} &= \mu_0 I_{\text{enclosed}} + \mu_0 \epsilon_0 \frac{d\Phi_E}{dt} & B &= \frac{\mu_0 I}{2\pi r} & B &= \mu_0 nI\end{aligned}$$

### Electromagnetic Waves:

$$\begin{aligned}I &= \frac{P}{A} & u &= \frac{1}{2}(\epsilon_0 E^2 + \frac{B^2}{\mu_0}) = \epsilon_0 E^2 = \frac{B^2}{\mu_0} & \langle u \rangle &= \frac{1}{4}(\epsilon_0 E_{\text{max}}^2 + \frac{B_{\text{max}}^2}{\mu_0}) = \frac{1}{2}\epsilon_0 E_{\text{max}}^2 = \frac{B_{\text{max}}^2}{2\mu_0} \\ \frac{E}{B} &= c = \frac{1}{\sqrt{\epsilon_0 \mu_0}} & \vec{S} &= \frac{1}{\mu_0} \vec{E} \times \vec{B} & I &= \langle S \rangle = c \langle u \rangle & \langle P_{\text{rad}} \rangle &= \frac{I}{c} \text{ or } \frac{2I}{c} \\ k &= \frac{2\pi}{\lambda} & \omega &= 2\pi f & T &= \frac{1}{f} & v &= f\lambda = \frac{\omega}{k} = \frac{c}{n}\end{aligned}$$

### Optics:

$$\begin{aligned}I &= I_{\text{max}} \cos^2 \phi & \theta_r &= \theta_i & n &= \frac{c}{v} = \frac{\lambda_0}{\lambda_n} & n_r \sin \theta_r &= n_i \sin \theta_i \\ \frac{1}{s} + \frac{1}{s'} &= \frac{1}{f} & m &= \frac{y'}{y} = -\frac{s'}{s} & \frac{1}{f} &= (n-1) \left( \frac{1}{R_1} - \frac{1}{R_2} \right) & f &= \frac{R}{2} \\ \frac{n_a}{s} + \frac{n_b}{s'} &= \frac{n_b - n_a}{R} & m &= \frac{y'}{y} = -\frac{n_a s'}{n_b s} & \Delta L &= m\lambda & \Delta L &= \left(m + \frac{1}{2}\right)\lambda \\ \Delta L &= d \sin \theta & \phi &= 2\pi \left(\frac{\Delta L}{\lambda}\right) & I &= I_0 \cos^2 \frac{\phi}{2} & R &= \frac{\lambda}{\Delta \lambda} = Nm \\ m\lambda &= a \sin \theta & \beta &= \frac{2\pi}{\lambda} a \sin \theta & I &= I_0 \left[ \frac{\sin(\beta/2)}{\beta/2} \right]^2\end{aligned}$$

### Integral:

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

# PHYS 2135

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| <b>Total</b> |
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End Material Test  
May 10, 2023

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.   B  

2.   B  

3.   C  

4.   D  

5.   E  

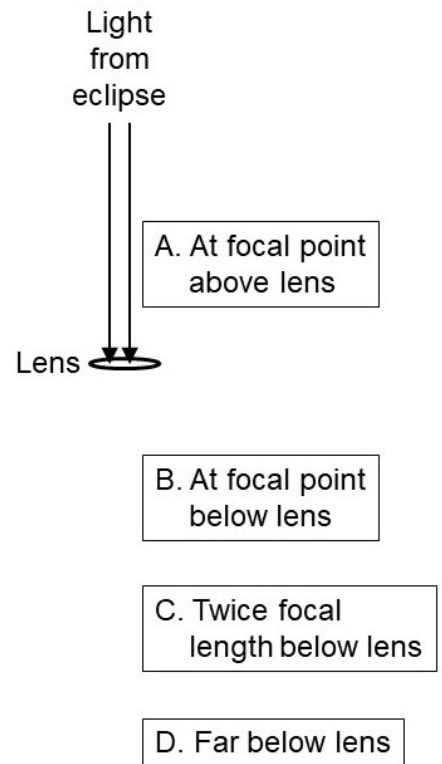
6.   B  

7.   A  

8. \_\_\_\_\_

## End Material Test

1. A thin lens is used to project a solar eclipse onto a sheet of paper, as illustrated. At which approximate location should the sheet of paper be placed so that the projection is in focus?
- [A] At the focal point above the lens  
[B] At the focal point below the lens  
[C] Twice the focal length below the lens  
[D] Far below the lens.

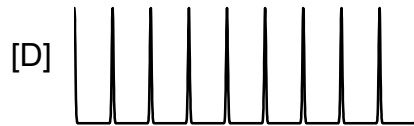
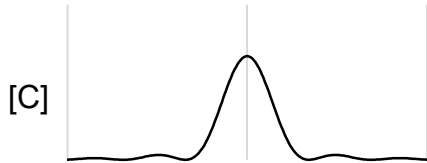
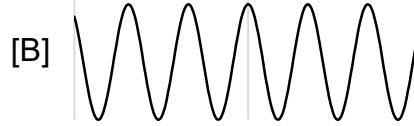


2. A person wears contacts to correct their nearsightedness (difficulty focusing on distant objects). Which illustration best illustrates the shape of their contact lens?



3. A laser shines on a narrow slit producing an interference pattern on a screen beyond the slit. The narrow slit is then made even narrower. How does the resulting spacing between bright fringes compare to the original spacing between bright fringes?
- [A] The new fringe separation is less than the original.  
[B] The new fringe separation is the same as the original.  
[C] The new fringe separation is more than the original.  
[D] The answer cannot be determined from the given information.

4. Four intensity spectra are shown. Which is due to a diffraction grating?



5. The “rainbow” pattern seen on a thin layer of oil in a parking lot is due to which of the following factors?

- [A] Sunlight contains all colors of light.
- [B] The thickness of the oil varies.
- [C] The angle at which the colors are seen varies.
- [D] Different colors of light have different wavelengths.
- [E] All of the above.

6. An object is placed at the center of curvature of a concave mirror. The magnification of the object is ...

- [A] -2      [B] -1      [C] 0      [D] +1      [E] +2

7. A laser with wavelength  $\lambda_0$  shines on a pair of slits separated by a distance  $d$  yielding the first bright fringe at  $y_1$ . The pair of slits is replaced by a single slit of width  $a$  yielding the first bright fringe at  $y_1$ . How do  $d$  and  $a$  compare?

- [A]  $d < a$
- [B]  $d = a$
- [C]  $d > a$
- [D] The relative magnitudes of  $d$  and  $a$  cannot be determined from the given information.

8. **[8 Free points.]** The best reason for giving free points is ...

- [A] to save students from doing one more problem.
- [B] to save faculty from grading one more problem.
- [C] to save red ink.