PHY 232C – EXAM 2 **Form 1** July 15, 2003

All your answers should appear on the bubble sheets. Please fill in the circles on the sheets using a number 2 pencil. Use the margins or the backs of your exam pages for scratch paper. You may take these exam pages with you when you leave.

Constants:

The charge on an electron is -1.6×10^{-19} C

$\frac{1}{4\pi\varepsilon_0} = 9 \times 10^9$ N·m^2/C^2

permeability $\mu_0 = 4\pi \times 10^{-7}$ T·m/A

$c = 3.0 \times 10^8$ m/s

Near point of a normal human eye: 25 cm

1. What is the time required for radio waves to travel to the moon and back? The radius of the moon's orbit is 3.84×10^8 meters.
   a. 23.0 seconds
   b. 1.28 seconds
   c. 3.14 seconds
   d. 5.12 seconds
   (e.) 2.56 seconds

$c = \frac{x}{t}$

$t = \frac{x}{c} = \frac{2 \times 3.84 \times 10^8 m}{3 \times 10^8 m/s}$

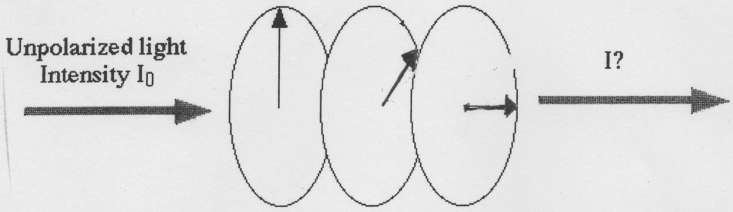
$t = 2.56$ sec

2. Three polarizers, the axes of which are 45 degrees apart, pass unpolarized light as shown below. Which of the following statements is TRUE?
   (a.) $I = 0.125 I_0$ and the light is polarized
   b. $I = 0.125 I_0$ and the light is not polarized
   c. $I = 0.25 I_0$ and the light is polarized
   d. $I = 0.25 I_0$ and the light is not polarized
   e. $I = 0$

$I = \frac{1}{2} (\cos 45^\circ)^2 (\cos 45^\circ)^2 I_0$

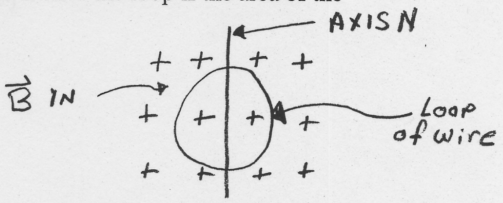
$I = \frac{1}{8} I_0 = 0.125 I_0$

Polarized



3. A single loop of wire is placed in a magnetic field directed into the page. Which of the statement below (a through d) is FALSE, if statements a through d are all true, choose e.

   a. A voltage will be induced in the coil if the coil is rotated about axis N at a constant angular velocity.
   b. A voltage will be induced in the coil if the magnitude of the magnetic field is increased.
   c. A voltage will be induced in the coil if the magnitude of the magnetic field is decreased.
   d. A current will flow counterclockwise around the loop if the area of the loop is increased.
   (e.) All of the above statements are true.

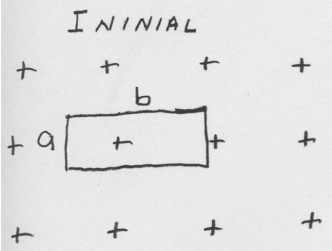


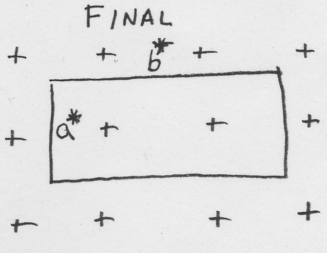
4. You are looking down on a single coil in a constant magnetic field B = 1.4 T which points directly into the page. The dimensions the coil go from a = 10 cm and b = 12 cm, to a* = 17 cm and b* = 24 cm in t = 0.024 seconds. The coil has resistance that remains constant at 1.5 ohms. What would be the magnitude of the induced current?

   a. 1.12×10^4 A
   b. 1.12×10^2 A
   (c.) 1.12 A
   d. 2.69×10^{-2} A
   e. No current is induced in the wire

$$V = \left|\frac{\Delta \Phi}{\Delta t}\right| = \frac{B(a^*b^* - ab)}{\Delta t}$$

$$V = IR \qquad I = \frac{V}{R} = \frac{B(a^*b^* - ab)}{R\Delta t}$$



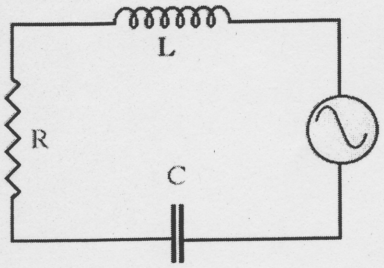


$$= \frac{1.4T[(.17m)(.24m) - (.1m)(.12m)]}{(1.5\Omega)(0.024sec)}$$

$$= 1.12A$$

5. A series RLC circuit like the one below is running at the resonance frequency with V = 210 volts rms (or effective.) What is the rms voltage across the inductor if R = 190 ohms, L = 22 H, and C = 0.75 μF? (HINT: The voltage drops across L and C are equal and opposite at resonance.)

a. 210 volts
b. 22 volts
c. 24 volts
d. 5990 volts
e. Not enough information is given to answer this question.



At Resonance

$V_{supply} = I R$

$I = \frac{V_s}{R}$

Res. freq. $\omega_0 = \frac{1}{\sqrt{LC}}$

$V_L = I X_L$

$= I \omega L = I \frac{1}{\sqrt{LC}} L = I \sqrt{\frac{L}{C}}$

$= \frac{V_s}{R} \sqrt{\frac{L}{C}} = \frac{210V}{190\Omega} \sqrt{\frac{22H}{0.75 \times 10^{-6} F}}$

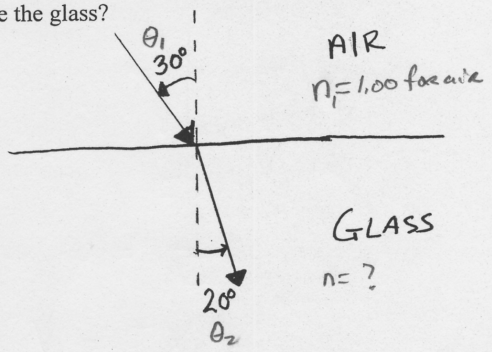
$= 5990V$

6. In a step up transformer the output AC voltage appearing across the secondary is larger than the input AC voltage supplied to the primary. Point out the **incorrect** statement:

a. Number of turns of the secondary coil winding is higher than the number of turns of the primary coil winding.
b. The transformer will not work with direct current
c. The power input to the primary is slightly greater than the power output from the secondary
d. Since the transformer has no moving parts, there is no energy loss to friction, so it loses very little energy in power conversion.
e. The AC current output in the secondary winding is larger than the AC current input in the primary winding.

7. Red laser light traveling in air strikes a piece of glass at an angle of incidence of 30 degrees as shown in the diagram below. The angle of refraction is observed to be 20 degrees as shown in the diagram below. If the wavelength of the laser light is 632.8nm in air, what is its wavelength inside the glass?

   a. 923.9 nm
   b. 432.9 nm
   c. 686.6 nm
   d. 583.2 nm
   e. 632.8 nm



$n_1 \sin\theta_1 = n_2 \sin\theta_2$

$\sin\theta_1 = n_2 \sin\theta_2$

$\sin\theta_1 = \frac{\lambda_0}{\lambda_m} \sin\theta_2$

$n_2 = \frac{c}{v_2} = \frac{\lambda_0 f}{\lambda_m f} = \frac{\lambda_0}{\lambda_m}$

$\lambda_m = \lambda_0 \frac{\sin\theta_2}{\sin\theta_1}$

$= 632.8\text{nm}\left(\frac{\sin 20^\circ}{\sin 30^\circ}\right) = 432.9\text{nm}$

8. An object is placed at a distance of R in front of a concave mirror, where R is the radius of curvature of the mirror. The image will be:

   a. real, inverted and magnified
   b. virtual, upright and magnified
   c. real, inverted and the same size as the object
   d. virtual, upright and the same size as the object
   e. virtual, upright and reduced

$\frac{1}{p} + \frac{1}{q} = \frac{1}{f} = \frac{2}{R}$

$\frac{1}{R} + \frac{1}{q} = \frac{2}{R}$

$\frac{1}{q} = \frac{1}{R} \Rightarrow q = R$

image is Real, Same Size, Inverted

$M = -\frac{q}{p} = -1$

9. A farsighted physics student cannot read his Lon-Capa assignments unless he is 80 cm from his monitor, but no closer. What power corrective lenses should he use so that the corrected near point is 25 cm?
   a. -1.25 diopters
   b. -2.75 diopters
   c. 1.25 diopters
   d. 2.75 diopters
   e. 0.36 diopters

$$\frac{1}{p} + \frac{1}{q} = D$$

$$\frac{1}{.25m} + \frac{1}{-.8m} = D$$

$$D = 2.75 \text{ diopters}$$

10. A 12 cm long microscope has a 0.333 cm objective lens. The microscope needs to have a magnification of 280. What focal length of the ocular lens will accomplish this?
   a. 3100 cm
   b. 31 cm
   c. 3.2 cm
   d. 0.032 cm

$$m = \frac{25L}{f_1 f_2}$$

$$f = \frac{25L}{f_1 m} = \frac{(25cm)(12cm)}{(.333cm)(280)} = 3.2cm$$