PHYS 102 Midterm Examination #2 (version A)

November 19, 2010

Time: 50 minutes

Last Name : Key

First Name : _____

Student No. : _____

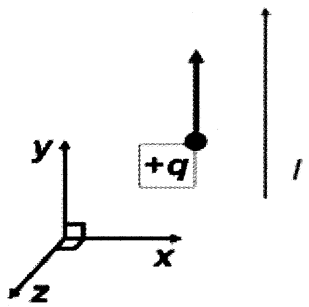
Computing ID : _____

	score	*Maximum*
Multiple Choice		***5***
Written # 1		***5***
Written # 2		***5***
Written # 3		***5***
Total		***20***

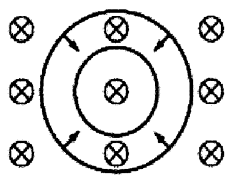
Part I (Multiple choice questions. 1 mark each .)

C 1. Can a magnetic field be used to stop a moving charged particle?
(A) Yes, because the magnetic field exerts a force on the particle .
(B) No, because the magnetic field does not exert a force on the particle.
(C) No, because the magnetic force is perpendicular to the velocity of the particle.
(D) It depends on the strength of the magnetic field.
(E) It depends on the direction of the magnetic field.

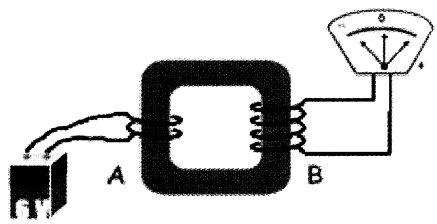
E 2. A positive charge moves parallel to a wire that carries a current as shown in the figure. What is the direction of the force acting on the charge?
(A) +z (out of page)
(B) -z (into page)
(C) -y
(D) -x
(E) +x



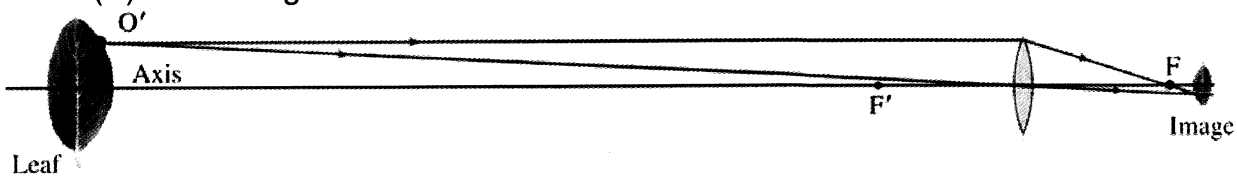
A 3. If a coil is shrinking in a constant magnetic field pointing into the page, in what direction is the induced current?
(A) Clockwise
(B) Counterclockwise
(C) No current
(D) The direction of current varies periodically.
(E) Cannot be determined.



C 4. A 6-V battery is connected to one side of a transformer. Compared to the voltage drop across coil A, the voltage across coil B is:
(A) greater than 6 V.
(B) less than 6 V.
(C) zero.
(D) 6 V.
(E) negative.



B 5. What happens to the image of an object if the top half of a lens is covered by a piece of cardboard (see the figure below)?
(A) Half of the image is formed.
(B) The whole image is formed, but dimmer.
(C) The whole image is formed, but brighter.
(D) No image is formed.
(E) The image is not affected at all.



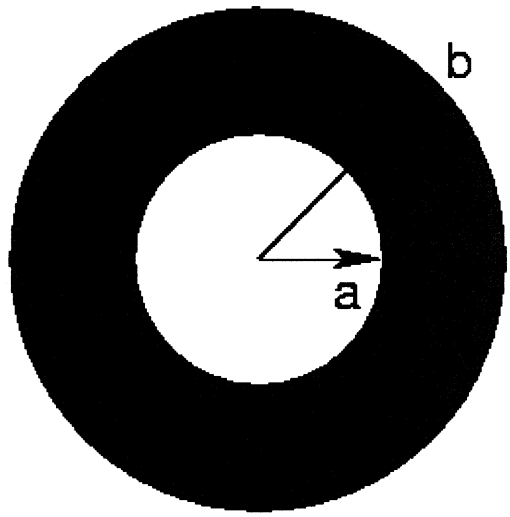
Part II (Full solution questions, 5 marks each. **SHOW ALL WORK FOR FULL MARKS.**)

6. The figure below shows the cross-section of a hollow cylindrical conductor with radii a = 2.00 cm and b = 4.00 cm which carries a current 10.0 Amps uniformly spread over its cross-section.

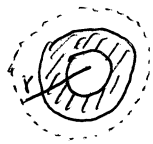
2 (a) Find the magnitude of the magnetic field at a distance of 5.00 cm from the axis.

2 (b) Find the magnitude of the magnetic field at a distance of 3.00 cm from the axis.

1 (c) Find the magnitude of the magnetic field at a distance of 1.00 cm from the axis.

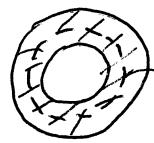


Ampere's Law: $\sum_C \vec{B}\cdot\Delta\ell = \mu_0 I_{encl.}$

(a)  C. $r > b$,

$B \cdot 2\pi r = \mu_0 I$. $(I = 10.0\ A)$

$$B = \frac{\mu_0 I}{2\pi r} = \frac{4\pi \times 10^{-7} \times 10}{2\pi \times 0.05} = 4.0 \times 10^{-5}\ T.$$

(b). $b > r > a$  C.

$$I_{encl.} = \frac{I(\pi r^2 - \pi a^2)}{\pi b^2 - \pi a^2}$$

$$B 2\pi r = \mu_0 I_{encl.} = \mu_0 I\left(\frac{r^2 - a^2}{b^2 - a^2}\right)$$

$$B = \frac{\mu_0 I}{2\pi r}\left(\frac{r^2 - a^2}{b^2 - a^2}\right)$$

$$= \frac{4\pi \times 10^{-7} \times 10}{2\pi \times 0.03}\left[\frac{(0.03)^2 - (0.02)^2}{(0.04)^2 - (0.02)^2}\right]$$

$$= 2.78 \times 10^{-5}\ T.$$

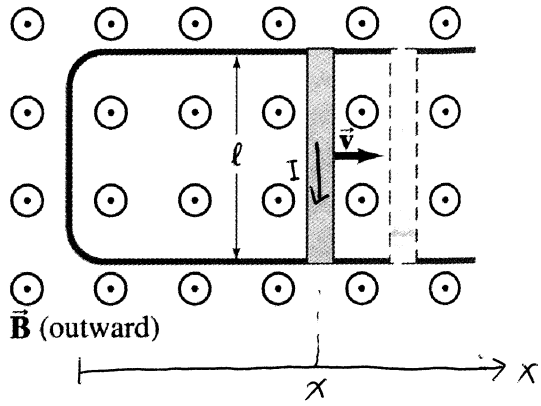
(c). $r < a$.  C. $I_{encl.} = 0$

$B = 0$.

7. In the figure below, the rod moves to the right with a speed of 1.20 m/s and has a resistance of 2.5 Ω. The rail separation is l=0.20m. The magnetic field is 0.40 T and pointing out of the page. The resistance of the U-shaped conductor is negligible.

3 (*a*) Determine the magnitude and direction of the induced current in the rod.

2 (*b*) Calculate the external force needed to keep the rod's velocity constant.



(a) $\mathcal{E}_{emf} = -\frac{d\Phi}{dt} = -B\frac{dA}{dt}$

$A = \ell x$

$\mathcal{E}_{emf} = -B\ell\frac{dx}{dt} = -B\ell v$

$I = \frac{|\mathcal{E}_{emf}|}{R} = \frac{B\ell v}{R}$

$= \frac{0.40 \times 0.20 \times 1.20}{2.5} = 0.0384\,A \approx 0.038\,A$

Direction: downward in the rod. i.e, clockwise.

(b) $F = BI\ell\sin\theta$, $\theta = 90°$,

$= BI\ell$

$= 0.40 \times 0.0384 \times 0.20$

$= 3.07 \times 10^{-3}\,N$

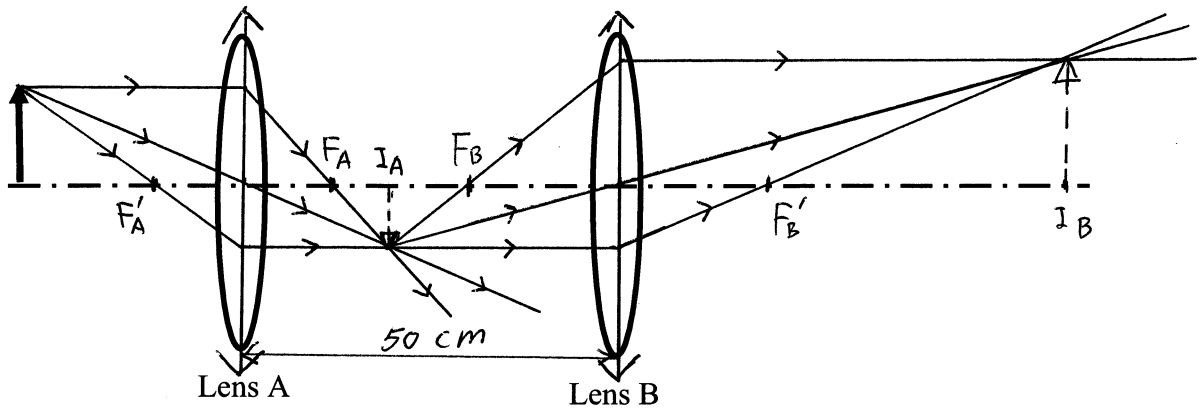
$\approx 3.1 \times 10^{-3}\,N$

8. Two converging lenses, A and B, are 50cm apart. The focal length of lens A is 12cm and the focal length of lens B is 20cm. An object is placed 30 cm in front of lens A.

2 (a) Draw a ray diagram showing the position of the final image. You may draw your own diagram.

3 (b) Calculate the position and magnification of the final image.

(a)



(b) $d_{oA} = 30$ cm, $f_A = 12$ cm. $\frac{1}{d_i} + \frac{1}{d_o} = \frac{1}{f}$

$$d_{iA} = \frac{d_{oA} f_A}{d_{oA} - f_A} = \frac{30 \times 12}{30 - 12} = 20 \text{ cm}.$$

$$d_{oB} = 50 - 20 = 30 \text{ cm}, \quad f_B = 20 \text{ cm}$$

$$d_{iB} = \frac{d_{oB} f_B}{d_{oB} - f_B} = \frac{30 \times 20}{30 - 20} = 60 \text{ cm}$$

$$m_A = -\frac{d_{iA}}{d_{oA}} = -\frac{20}{30} = -0.667$$

$$m_B = -\frac{d_{iB}}{d_{oB}} = -\frac{60}{30} = -2.$$

$$m = m_A m_B = 1.33.$$

The final image is larger, upright, located 60 cm to the right of lens B.