PHYS 102 Midterm Examination #2 (version B)

July 20, 2012

Time: 50 minutes

Last Name : Key

First Name : _____

Student No. : _____

Computing ID : _____

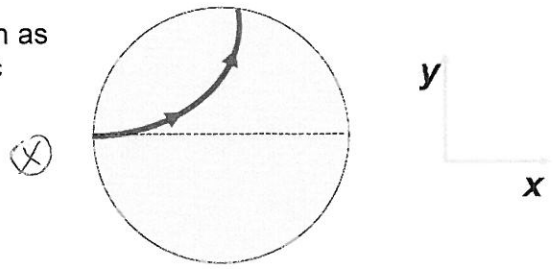
	score	*Maximum*
Multiple Choice		*5*
Written # 6		*5*
Written # 7		*5*
Written # 8		*5*
Total		*20*

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

D

1. A proton beam enters a magnetic field region as shown below. What is the direction of the magnetic field *B*?

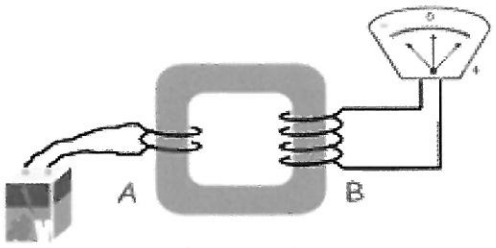
A) +*y*
B) –*y*
C) +*x*
D) –*z* (into page)
E) +*z* (out page)



E

2. A 12-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) 48V.
(B) 24V.
(C) 12 V.
(D) 6V.
(E) zero.



C

3. 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)?

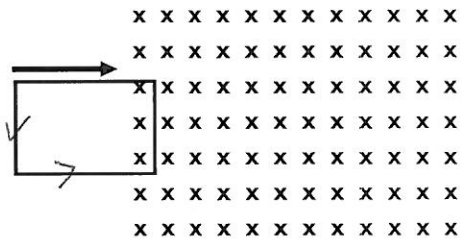
(A) Half of the image is formed.
(B) The whole image is formed, but brighter.
(C) The whole image is formed, but dimmer.
(D) No image is formed.
(E) The image is not affected at all.

B

4. A wire loop is moving into a uniform magnetic field. What is the direction of the induced current?

A) clockwise
B) counterclockwise
C) no induced current
D) It depends on the size of the loop.
E) It depends on the strength of the field.

CCW



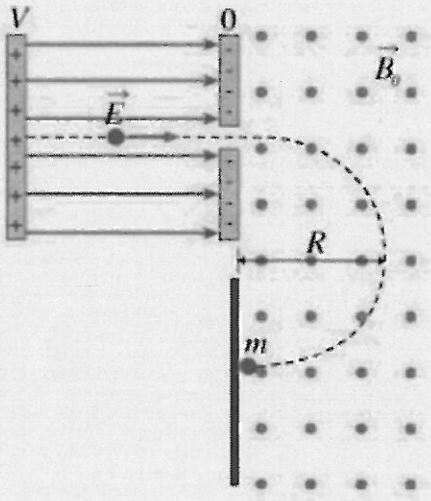
A

5. In a double-slit experiment, if the slits are moved farther apart, the interference pattern

A) shrinks together
B) spreads out
C) stays the same
D) disappears
E) becomes a single-slit diffraction pattern

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

6. A mass spectrometer consists of two regions as shown in the figure below. In the first region an electric field accelerates the ion and in the second the ion follows a circular arc in a magnetic field. After being accelerated to a speed of 1.60×10^5 m/s , the particle enters the uniform magnetic field of strength 0.700 T and travels in a circle of radius 30.0 cm. Find the mass/charge ratio for this particle m/q.



magnetic force $\vec{F}_B = q\vec{v}\times\vec{B}$

$$F_B = qvB$$

uniform circular motion.

$$\vec{F} = m\vec{a}$$

$$qvB = m\frac{v^2}{R}$$

$$\frac{m}{q} = \frac{BR}{v}$$

$$= \frac{0.700\times0.300}{1.60\times10^5}$$

$$= 1.31\times10^{-6}\ \text{kg/C}$$

7. A conducting rod of mass *m* is in contact with two vertical conducting rails separated by a distance *L*, as shown in the figure below. The entire system is immersed in a uniform magnetic field of magnitude *B* pointing into the page. Assuming the rod slides without friction,

(a. 1pt) Describe the motion of the rod after it is released from rest.

(b. 1pt) What is the direction of the induced current (clockwise or counterclockwise) in the circuit? Indicate the direction of current in the diagram.

(c. 3pts) Find the speed of the rod after it has fallen for a long time.

a). $t=0$: (initially). free fall.

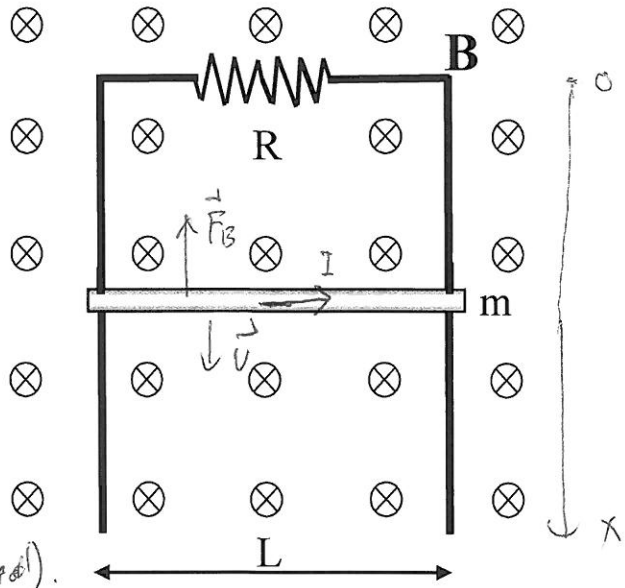
$t>0$. $v>0$.

$$|\mathcal{E}| = \frac{d\Phi}{dt} = BL\frac{dx}{dt} = BLv$$

current: $I = \frac{\mathcal{E}}{R} = \frac{BLv}{R}$

magnetic force: $F_B = IL\cdot B$

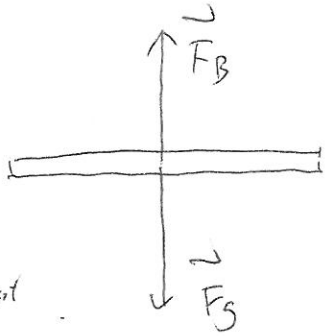
$$= \frac{B^2L^2v}{R} \quad \text{(upward)}.$$



F_B will partially cancel $F_g = mg$.

∴ the rod falls with a smaller and smaller acceleration.

until: $F_B = F_g$, i.e. $F_{net} = 0$. v = constant.



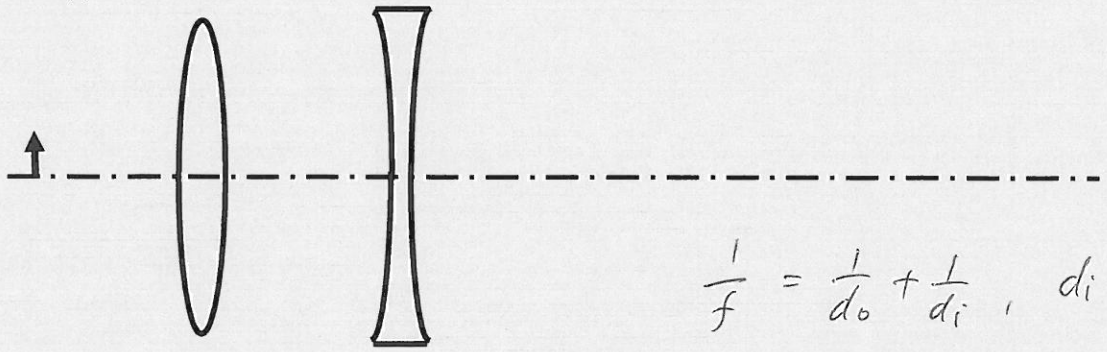
∴ the rod will fall at a constant speed eventually.

b) ccw.

c) $F_g = F_B$. $mg = \frac{B^2L^2v}{R}$. $v = \frac{mgR}{B^2L^2}$.

8. Lens A in the figure below is a converging lens with a focal length of $f_A = 20$ cm. An object is placed 30 cm to its left. Lens B, which is a diverging lens with a focal length of $f_B = -50$ cm, lies 40 cm to the right of lens A.
(a.3pts) Calculate the location and magnification of the final image formed by the combination of the two lenses.
(b.2pts) Use a ray diagram to verify your results of (a). You may draw your own diagram.

$f_A = 20$ cm $F_B = -50$ cm .



$$\frac{1}{f} = \frac{1}{d_o} + \frac{1}{d_i}, \quad d_i = \frac{d_o \cdot f}{d_o - f}$$

Lens A Lens B

a) . $d_{oA} = 30$ cm, $f_A = 20$ cm .

$$d_{iA} = \frac{d_{oA} \cdot f_A}{d_{oA} - f_A} = \frac{30 \times 20}{30 - 20} = 60 \text{ cm}; \qquad m_A = -\frac{d_{iA}}{d_{oA}} = -\frac{60}{30} = -2 .$$

$$d_{oB} = -|60 - 40| = -20 \text{ cm} .$$

$$d_{iB} = \frac{d_{oB} f_B}{d_{oB} - f_B} = \frac{(-20)(-50)}{(-20) - (-50)} = \frac{1000}{30} = 33.3 \text{ cm} .$$

$$m_B = -\frac{d_{iB}}{d_{oB}} = -\frac{33.3}{-20} = 1.67 .$$

$$m = m_A m_B = (-2)(1.67) = -3.33$$