

UNIVERSITY OF SASKATCHEWAN
Department of Physics and Engineering Physics

Physics 111.6
MIDTERM TEST #4

March 4, 2004

Time: 90 minutes

NAME: _____ STUDENT NO.: _____
(Last) Please Print (Given)

LECTURE SECTION (please circle):

- 01 Dr. A. Robinson
- 02 B. Zulkoskey
- 03 Dr. R. McWilliams
- C15 F. D. ...

INSTRUCTIONS:

1. You should have a test paper, formula sheet, and an OMR sheet. The test paper consists of 9 pages. **It is the responsibility of the student to check that the test paper is complete.**
2. Enter your name and STUDENT NUMBER on the OMR sheet.
3. The test paper, the formula sheet and the OMR sheet must all be submitted.
4. The test paper will be returned. The formula sheet and the OMR sheet will NOT be returned.

PLEASE DO NOT WRITE ANYTHING ON THIS TABLE

QUESTION NO.	MAXIMUM MARKS	MARKS OBTAINED
Part A	10	
Part B	10	
C1	5	
C2	5	
C3	5	
TOTAL	35	

continued on page 2 ...

- B5. An object is placed 22.0 cm from a converging lens whose focal length is 45.0 cm. Calculate the lateral magnification, including the proper sign.

ALTERNATIVE EXAM
ANSWERS

ANSWERS FOR PART B

ENTER THE ANSWERS FOR THE PART B PROBLEMS IN THE BOXES BELOW.

THE ANSWERS MUST BE EXPRESSED TO THREE SIGNIFICANT FIGURES AND THE UNITS MUST BE GIVEN.

ONLY THE ANSWERS WILL BE MARKED. THE SOLUTIONS WILL NOT BE MARKED.

B1

B2

B3

B4

B5

PART A

1. B

2. D

3. C

4. C

5. A

6. C

7. E

8. E

9. D

10. E

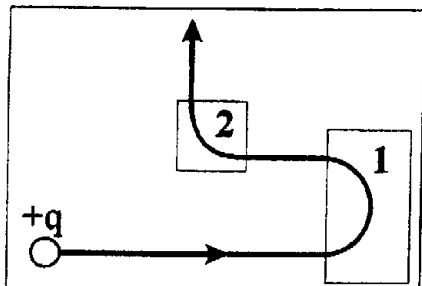
continued on page 7 ...

PART A

FOR EACH OF THE FOLLOWING QUESTIONS IN PART A, ENTER THE MOST APPROPRIATE RESPONSE ON THE OMR SHEET.

- A1. A positive charge travels through two regions that have magnetic fields directed into (\otimes) or out of (\odot) the page. Determine the direction of the magnetic field in each region that would deflect the charge along the path shown in the diagram.

B



- (A) \otimes, \otimes
 (B) \otimes, \odot
 (C) \odot, \odot
 (D) \odot, \otimes
 (E) none of the above

Use right hand rule

$$P = I^2 R ; P_1 = I_1^2 R ; P_2 = \left(\frac{I_1}{3}\right)^2 R = \frac{I_1^2 R}{9} = \frac{P_1}{9}$$

- A2. If the current flowing in a resistor which obeys Ohm's Law is reduced by a factor of 3, then the power dissipated by the resistor is reduced by a factor of

C

- (A) $\sqrt{3}$. (B) 3. (C) 9. (D) 27. (E) 81.

- A3. Which one of the following statements is true concerning a resistor through which ac current is flowing?

D

- (A) The current flows in one direction only. F
 (B) The instantaneous power dissipated by the resistor is always greater than zero. F
 (C) The RMS voltage is zero at certain times. F
 (D) The instantaneous voltage is zero at certain times. T
 (E) The current and voltage reach their peak values at different times. F

- A4. A wire of resistance R ohms is divided into 6 segments of equal length, which are then connected in parallel. The equivalent resistance in ohms is

A

- (A) $\frac{R}{36}$. (B) $\frac{R}{6}$. (C) $6R$. (D) $36R$. (E) $6R - 36$.
 each segment is $\frac{R}{6} \Omega$. $R_p = \left(\frac{1}{R/6} + \frac{1}{R/6} + \frac{1}{R/6} + \frac{1}{R/6} + \frac{1}{R/6} + \frac{1}{R/6}\right)^{-1}$

- A5. Two charged particles move in the same direction with respect to a uniform magnetic field. Particle 1 travels three times faster than particle 2, but each experiences the same magnetic force. The ratio q_1/q_2 of the magnitudes of the charges on the particles is

C

- (A) 1/9. (B) 1/6. (C) 1/3. (D) 3/1. (E) 9/1.

$$F = qvB \sin \theta$$

$$q_1 v_1 B_1 \sin \theta_1 = q_2 v_2 B_2 \sin \theta_2$$

$$\frac{q_1}{q_2} = \frac{v_2}{v_1} = \frac{v_2}{3v_2} = \frac{1}{3}$$

A6. Which one of the following statements is true concerning the magnetic force, F , acting on charged particles in a magnetic field, B ?

E

- (A) F is maximum if the particle is stationary. F
 (B) F is zero if the particle moves in a direction perpendicular to B . F given by RHR.
 (C) F is maximum if the particle moves in a direction parallel to B . F
 (D) F acts in the direction of motion for positively-charged particles. F
 (E) F depends on the component of the particle's velocity that is perpendicular to B . τ

$F = qvB \sin\theta$, dir'n of \vec{F}

A7. A charged particle of mass m and charge q , moving with a velocity v which is perpendicular to an applied magnetic field B , moves in a circular trajectory of radius r such that

C

- (A) $r = \frac{qB}{mv}$ (B) $r = \frac{vB}{qm}$ (C) $r = \frac{mv}{qB}$ (D) $r = \frac{B}{mvq}$ (E) $r = \frac{mq}{Bv}$

$\sin\theta = 1$

A8. Which one of the following is not part of the electromagnetic spectrum?

D

- (A) visible light
 (B) thermal radiation
 (C) television signals
 (D) sound
 (E) microwaves

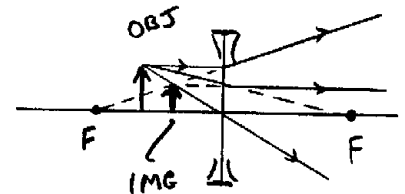
$F_{mag} = ma_c$
 $qvB = \frac{mv^2}{r}$

$r = \frac{mv}{qB}$

A9. An object is placed a distance d_o from a diverging lens of focal length f , such that $d_o < |f|$. Which of the following statements concerning the image is correct?

E

- (A) The image is real, inverted, and larger than the object.
 (B) The image is virtual, inverted, and larger than the object.
 (C) The image is real, inverted, and smaller than the object.
 (D) The image is virtual, inverted, and smaller than the object.
 (E) The image is virtual, upright, and smaller than the object.



A10. A beam of light initially in water strikes a water-air interface at an angle of incidence that is greater than the critical angle. Which of the following statements is correct?

E

- (A) All of the light refracts into the air and the angle of refraction is greater than the angle of incidence.
 (B) All of the light refracts into the air and the angle of refraction is less than the angle of incidence.
 (C) All of the light refracts into the air and the angle of refraction equals the angle of incidence.
 (D) The light is partially reflected and partially transmitted at the water-air interface.
 (E) The light is totally internally reflected.

def'n of critical angle.

PART B

FOR EACH OF THE FOLLOWING PROBLEMS, WORK OUT THE SOLUTION IN THE SPACE PROVIDED AND ENTER YOUR ANSWERS ON PAGE 6.

ONLY THE ANSWERS WILL BE MARKED. THE SOLUTIONS WILL NOT BE MARKED.

- B1. A television set uses 75.0 W of power and is switched on for 6.00 hours a day. If the cost of energy is \$0.115 per kilowatt-hour, calculate the cost to watch TV each day.

$$E = P \cdot t$$

$$\text{cost} = E \cdot \text{cost per unit of energy}$$

$$\text{cost} = P \cdot t \cdot \text{unit cost}$$

$$\text{cost} = (75.0 \text{ W}) (6.00 \text{ h}) \times \frac{\$ 0.115}{\text{kWh}} \times \frac{1 \text{ kWh}}{1000 \text{ W} \cdot \text{h}}$$

$$\text{cost} = \boxed{\$ 0.0518}$$

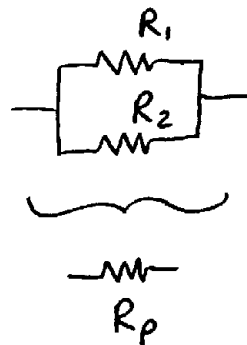
- B2. The equivalent resistance for two resistors when connected in parallel is 10.0Ω . The resistance of one of the resistors is 21.5Ω . Calculate the resistance of the other resistor.

$$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2}$$

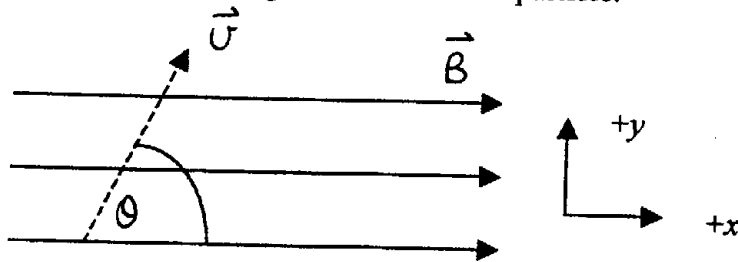
$$\frac{1}{R_2} = \frac{1}{R_p} - \frac{1}{R_1}$$

$$R_2 = \left(\frac{1}{R_p} - \frac{1}{R_1} \right)^{-1}$$

$$R_2 = \left(\frac{1}{10.0 \Omega} - \frac{1}{21.5 \Omega} \right)^{-1} = \boxed{18.7 \Omega}$$



- B3. A charged particle is moving in a magnetic field of magnitude 2.50 T directed along the positive x axis. The velocity of the particle 2.98×10^6 m/s directed 60.0° counter-clockwise from the positive x axis. The magnitude of the charge on the particle is 1.61×10^{-19} C. Calculate the magnitude of the magnetic force on the particle.

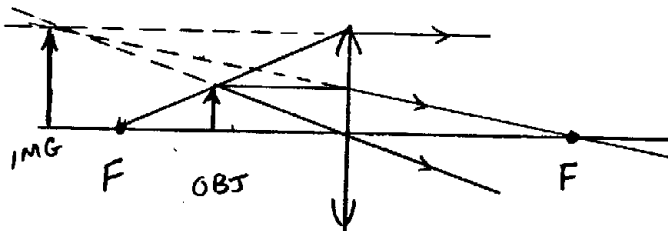


$$F = |q_0| v B \sin \theta$$

$$F = (1.61 \times 10^{-19} \text{ C}) (2.98 \times 10^6 \text{ m/s}) (2.50 \text{ T}) (\sin 60.0^\circ)$$

$$F = 1.04 \times 10^{-12} \text{ N}$$

- B4. An object is placed 23.5 cm from a converging lens whose focal length is 45.0 cm. Calculate the lateral magnification, including the proper sign.



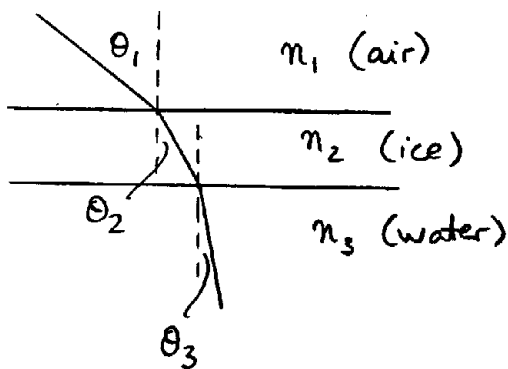
$$m = -\frac{d_i}{d_o} ; \frac{1}{f} = \frac{1}{d_o} + \frac{1}{d_i}$$

$$d_i = \left(\frac{1}{f} - \frac{1}{d_o} \right)^{-1}$$

$$m = -\frac{\left(\frac{1}{f} - \frac{1}{d_o} \right)^{-1}}{d_o} = -\frac{\left(\frac{1}{45.0 \text{ cm}} - \frac{1}{23.5 \text{ cm}} \right)^{-1}}{23.5 \text{ cm}} = +2.09$$

agrees with ray diagram
 (upright, enlarged
 continued on page 6 ...
 image)

B5. A ray of sunlight hits a frozen lake at an angle of incidence of 45.0° . Calculate the angle (measured from the normal) at which the ray enters the water beneath the ice. ($n_{\text{ice}} = 1.31$, $n_{\text{water}} = 1.33$)



Applying Snell's Law at each interface:

$$n_1 \sin \theta_1 = n_2 \sin \theta_2 = n_3 \sin \theta_3$$

$$\therefore \sin \theta_3 = \frac{n_1 \sin \theta_1}{n_3}$$

$$\theta_3 = \text{inv sin} \left(\frac{n_1 \sin \theta_1}{n_3} \right) = \text{inv sin} \left(\frac{1.00 \sin 45.0^\circ}{1.33} \right)$$

$$\theta_3 = 32.1^\circ$$

ANSWERS FOR PART B

ENTER THE ANSWERS FOR THE PART B PROBLEMS IN THE BOXES BELOW.

THE ANSWERS MUST BE EXPRESSED TO THREE SIGNIFICANT FIGURES AND THE UNITS MUST BE GIVEN.

ONLY THE ANSWERS WILL BE MARKED. THE SOLUTIONS WILL NOT BE MARKED.

B1

B2

B3

B4

B5

PART C

IN EACH OF THE FOLLOWING QUESTIONS, GIVE THE COMPLETE SOLUTION AND ENTER THE FINAL ANSWER IN THE BOX PROVIDED.

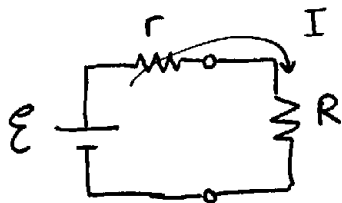
THE ANSWERS MUST BE EXPRESSED TO THREE SIGNIFICANT FIGURES AND THE UNITS MUST BE GIVEN.

SHOW YOUR WORK - NO CREDIT WILL BE GIVEN FOR ANSWERS ONLY. EQUATIONS NOT PROVIDED ON THE FORMULA SHEET MUST BE DERIVED.

C1. A battery delivers a current of 1.45 A to a light bulb that has a resistance of 8.32 Ω . The power being dissipated by the internal resistance of the battery is 2.71 W.

(a) Calculate the internal resistance of the battery.

1.29 Ω



$$P = I^2 r$$

$$r = \frac{P}{I^2} = \frac{2.71 \text{ W}}{(1.45 \text{ A})^2} = 1.29 \Omega$$

(b) Calculate the EMF of the battery.

13.9 V

$$\mathcal{E} = I(r + R)$$

$$\mathcal{E} = (1.45 \text{ A})(1.29 \Omega + 8.32 \Omega) = 13.9 \text{ V}$$

(c) Calculate the power dissipated in the light bulb.

17.5 W

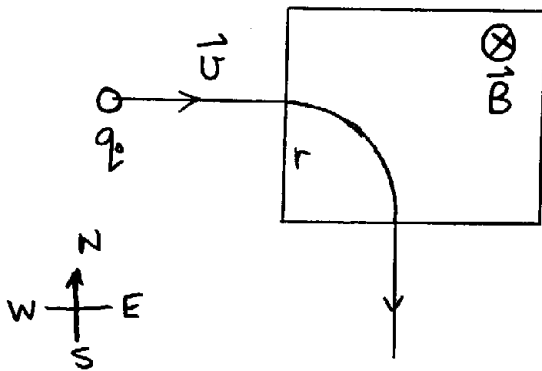
$$P = I^2 R = (1.45 \text{ A})^2 (8.32 \Omega)$$

$$P = 17.5 \text{ W}$$

C2. A charged particle of mass 7.20×10^{-8} kg is traveling due East at 185 m/s when it enters a region with a uniform magnetic field of 0.310 T directed vertically down. The charge completes $\frac{1}{4}$ of a circle of radius 23.7 m before leaving the region of magnetic field and traveling due South. The particle's motion is always perpendicular to the magnetic field.

(a) Calculate the magnitude of the force on the particle.

$\sin \theta = 1$



Newton II:

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

$$F_{\text{mag}} = ma_c$$

$$F_{\text{mag}} = \frac{mv^2}{r}$$

$1.04 \times 10^{-4} \text{ N}$

$$F_{\text{mag}} = \frac{(7.20 \times 10^{-8} \text{ kg})(185 \text{ m/s})^2}{23.7 \text{ m}}$$

$$F_{\text{mag}} = 1.04 \times 10^{-4} \text{ N}$$

(b) Calculate the magnitude and sign of the charge on the particle.

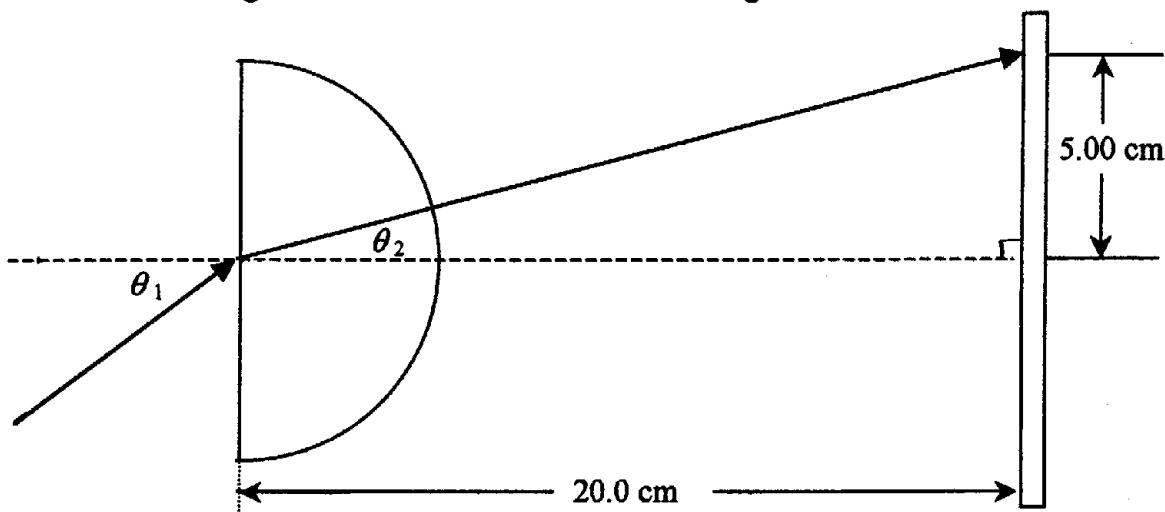
$$F_{\text{mag}} = |q_0| v B \sin \theta$$

$-1.81 \times 10^{-6} \text{ C}$

$$|q_0| = \frac{F_{\text{mag}}}{v B \sin \theta} = \frac{1.04 \times 10^{-4} \text{ N}}{(185 \text{ m/s})(0.310 \text{ T})(1)} = 1.81 \times 10^{-6} \text{ C}$$

From RHR, q_0 is $-ve$

C3. Consider a semicircular disk of radius 4.00 cm made of glass with an index of refraction of 1.52. A beam of light strikes the disk as shown in the diagram.



(a) Calculate the time required for the beam of light to travel through the glass.

$$2.03 \times 10^{-10} \text{ s}$$

$$x = vt \text{ and } n = \frac{c}{v} \Rightarrow t = \frac{xn}{c}$$

$$t = \frac{(0.0400 \text{ m})(1.52)}{3.00 \times 10^8 \text{ m/s}} = 2.03 \times 10^{-10} \text{ s}$$

(b) Calculate the angle of incidence, θ_1 , for which the beam of light will hit the indicated point on the screen.

$$21.6^\circ$$

$$\text{From geometry, } \tan \theta_2 = \frac{5.00 \text{ cm}}{20.0 \text{ cm}} \Rightarrow \theta_2 = 14.04^\circ$$

$$\text{From Snell's Law, } n_1 \sin \theta_1 = n_2 \sin \theta_2$$

$$\theta_1 = \text{inv sin} \left(\frac{n_2 \sin \theta_2}{n_1} \right) = \text{inv sin} \left(\frac{1.52 \sin (14.04^\circ)}{1} \right) = 21.6^\circ$$

END OF EXAMINATION