UNIVERSITY OF SASKATCHEWAN
Department of Physics and Engineering Physics

Physics 111.6
<u>MIDTERM TEST #4</u>

March 15, 2007   Time: 90 minutes

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

LECTURE SECTION (please check):

❑   01   Dr. R. Pywell

❑   02   B. Zulkoskey

❑   03   Dr. A. Robinson

❑   C15   F. Dean

<u>INSTRUCTIONS:</u>

1. You should have a test paper, a 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 <u>STUDENT NUMBER</u> 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 <u>NOT</u> be returned.

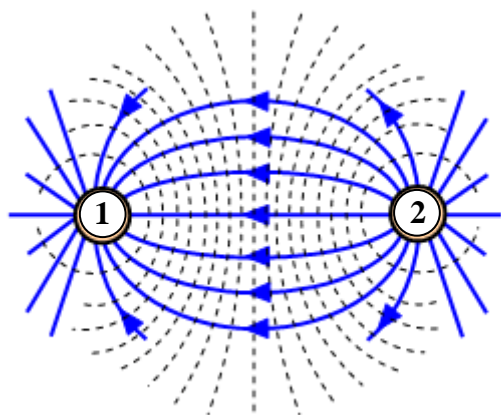### *PLEASE DO NOT WRITE ANYTHING ON THIS TABLE*

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

PART A

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

A1.   The diagram shows the electric field lines between two charges. Which one of the following statements is **TRUE**?


(A) Charge 1 and charge 2 are both positive.

(B) Charge 1 is positive and charge 2 is negative.

(C) Charge 1 and charge 2 are both negative.

(D) Charge 1 is negative and charge 2 is positive.

(E) The signs of the charges cannot be determined from the diagram.

A2.   The 'electron Volt' (eV) is a unit of

(A) potential.   (B) current.   (C) charge.   (D) power.   (E) energy.

A3.   Which one of the following statements best describes the motion of a negatively charged object that is released from rest at a point in space where there is a non-zero electric field? (Other forces such as gravity and friction are negligible.)

(A) The initial acceleration of the object is in the direction of the electric field.
(B) The object will not move unless the absolute electric potential is non-zero at that point in space.
(C) The object will move with constant velocity.
(D) The object will move towards a place where the electric potential is greater than at its initial position.
(E) The object will begin to move along an equipotential surface.

A4.   An electrical circuit has three resistors of 12.0 Ω, 14.0 Ω and 16.0 Ω connected in parallel. Which one of the following statements is **FALSE**?

(A) The equivalent resistance is less than 12.0 Ω.
(B) The potential difference across each resistor is the same.
(C) The current flowing through each resistor is different.
(D) The equivalent resistance is greater than 16.0 Ω.
(E) The total power dissipated in the three resistors is equal to the power dissipated in the equivalent resistance.

A5.   Which one of the following is **NOT** part of the electromagnetic spectrum?

(A) ultraviolet light   (B) infrared radiation   (C) X-rays
(D) FM radio waves   (E) sound waves in air

A6. Consider a real battery of emf E and internal resistance r. The values of E and r are constant. Which one of the following statements correctly describes the effect of decreasing the resistance of an external circuit connected to the battery?

   (A) The current drawn from the battery increases and the voltage across the battery's terminals also increases.
   (B) The current drawn from the battery increases and the voltage across the battery's terminals decreases.
   (C) The current drawn from the battery increases and the voltage across the battery's terminals remains constant.
   (D) The current drawn from the battery decreases and the voltage across the battery's terminals also decreases.
   (E) The current drawn from the battery decreases and the voltage across the battery's terminals increases.

A7. You are holding a positively-charged ball while standing at the Earth's magnetic equator, where the direction of the magnetic field is horizontal and points due North. You now drop the ball. The initial direction of the magnetic force acting on the ball is
   (A) UP.
   (B) DOWN.
   (C) EAST.
   (D) SOUTH.
   (E) undefined. There is no magnetic force acting on the ball as it falls.
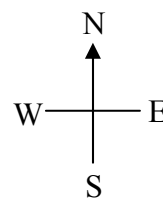
A8. A ray of light travelling in a medium with index of refraction n_1 strikes the interface to a medium with index of refraction n_2 as shown. Which one of the following statements is **TRUE**?
   (A) If the ray follows path 1 then $n_2 = n_1$.
   (B) If the ray follows path 2 then $n_2 < n_1$.
   (C) If the ray follows path 3 then $n_2 > n_1$.
   (D) If the ray follows path 4 then $n_2 < n_1$.
   (E) If the ray is totally internally reflected and follows path 5, then $n_2 > n_1$.
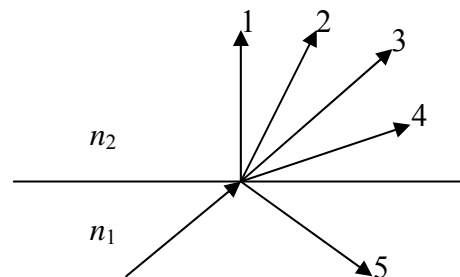
A9. White light enters a glass prism, but the colour components of the light are observed to emerge from the prism. Which one of the following statements best explains this observation?
   (A) The separation of white light into its colour components is due to the increase in the speed of light within the glass.
   (B) Some of the colour components of the white light are absorbed by the glass and only the remaining components are observed.
   (C) The index of refraction of the glass depends on the wavelength, so the colour components are refracted at different angles.
   (D) Only some of the colour components are refracted by the glass; and these are the only ones that are observed.
   (E) White light is separated into its colour components by total internal reflection within the prism.

A10.   Which one of the following statements is **TRUE** concerning how a camera is different from the human eye?

(A)   A camera always forms an inverted image, the eye does not.
(B)   A camera always forms a real image, the eye does not.
(C)   A camera uses a fixed focal length lens, the eye does not.
(D)   The magnification of a camera has a magnitude that is always greater than one, the eye does not have this restriction.
(E)   All of the lenses in a camera are always diverging lenses, the eye lens is not.

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 proton is released from rest in a region of space where there is a uniform electric field with magnitude 60.0 V/m. Calculate the kinetic energy (in <u>Joules</u>) of the proton after it has moved a distance of 0.250 m.

B2.   During a lightning strike from a cloud to the ground, a current of 2.50×10^4 A flows for a time of 35.5 μs. Calculate the magnitude of the electric charge that is transferred.

B3. Calculate the wavelength (in metres) of the radio waves produced by a radio station that is broadcasting at a frequency of 95.1 MHz.

B4. A plate glass window (index of refraction, $n = 1.55$) has a thickness of 4.25 mm. A ray of light strikes the window perpendicular to its surface. Calculate the time for the light ray to pass through the glass.

B5.   When you look at the moon through an astronomical telescope with an objective lens of focal length 35.0 cm you see an image of the moon that appears to be 28.0 times larger than when you do not use the telescope. Calculate the focal length of the eyepiece lens in the telescope.

ANSWERS FOR PART B

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

THE ANSWERS MUST CONTAIN 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 CONTAIN THREE SIGNIFICANT FIGURES AND THE UNITS MUST BE GIVEN.

NO CREDIT WILL BE GIVEN FOR ANSWERS ONLY, <u>SHOW AND EXPLAIN YOUR WORK</u>. EQUATIONS NOT PROVIDED ON THE FORMULA SHEET MUST BE DERIVED.

C1. A small spherical drop of oil in a Millikan oil drop apparatus is held motionless in a vacuum by an electric field. The drop has a charge of $-24e$ and a radius of 5.38×10^{-7} m. The density of the oil is 856 kg/m^3.

   (a)   Draw a free body diagram of the forces acting on the oil drop.

   (b)   Calculate the magnitude and direction of the electric field required to hold the drop motionless.

magnitude:

direction:

C2.   A cyclotron is a device used for accelerating charged particles such as protons. In a cyclotron, a magnetic field that is perpendicular to the velocity of the particles is used to keep them in circular trajectories while an alternating applied voltage is used to increase the speed of the particles.

Consider particles of mass m and charge q moving in a cyclotron in a magnetic field B. Let r be the radius of the circular path when the particles have a speed v.

(a) Derive an expression for the speed of the particles in the cyclotron in terms of m, q, B, and r. (You may ignore the effect of the applied alternating voltage.)

$v =$

(b) Derive an expression for the time it takes the particles to make one circular orbit in the cyclotron, in terms of m, q, and B.
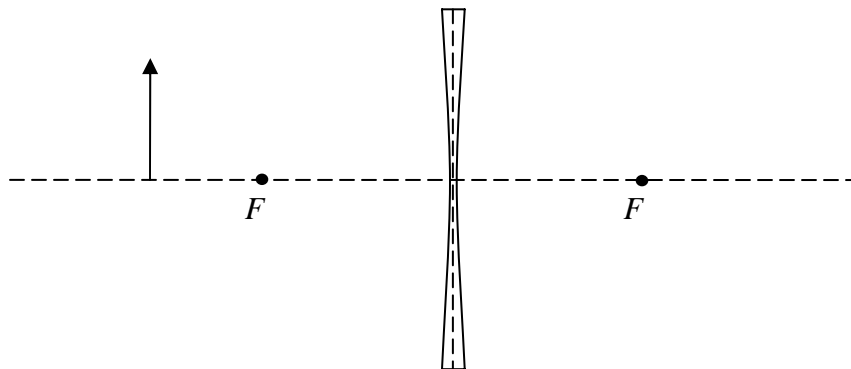
$T =$

(c) The required frequency of the alternating accelerating voltage is the inverse of the orbit time determined in (b). Calculate the required frequency when a cyclotron is being used to accelerate protons and the applied magnetic field is 1.73 T.

C3. Please note that the following two questions are independent of one another.

   (a) Hercule Poirot looks at a hair of length 9.00 mm with his magnifying glass (a converging
        lens). He holds the magnifying glass a distance of 8.50 cm from the hair. The image of the
        hair formed by the lens is 22.0 mm long and appears to be right side up. Calculate the focal
        length of Poirot's magnifying glass.

   (b) The diagram below shows an arrow placed in front of a diverging lens. The focal points of
        the lens are shown by the points labelled F. On the diagram draw <u>three</u> rays to locate the
        image of the arrow.

F F

END OF EXAMINATION