Physics 202 MWF 10:20 Spring 2006 (Ford)

Name (printed) With Answers

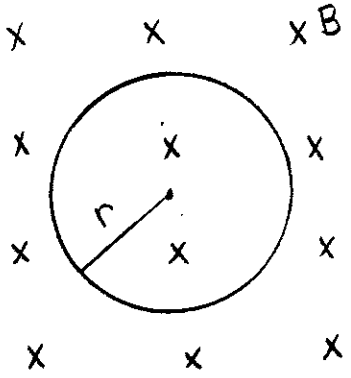
Name (signature as on ID)_____

Lab Section_____

Final Exam

Show all your work. Partial credit will be given if earned. Write your answers in the blanks provided.

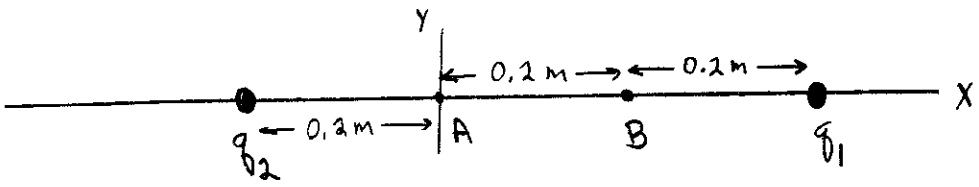
(8 pts) 1. A circular loop of wire with radius $r = 0.20$ m and resistance $R = 0.40\ \Omega$ is in a uniform magnetic field directed into the page as shown in the sketch. At $t = 0$ the magnetic field is $B = 6.00$ T and it then decreases at a constant rate of $\Delta B/\Delta t = -0.40$ T/s. What are the magnitude and direction of the induced current in the loop at $t = 2.0$ s? (The direction is either clockwise or counterclockwise).



Ans. $I =$ 0.126 A

direction clockwise

(12 pts) 2. Two point charges are placed on the x axis and held in place. $q_1 = +5.0 \times 10^{-9}$ C is at $x = +0.40$ m and $q_2 = -3.0 \times 10^{-9}$ C is at $x = -0.20$ m.



a) What is the net electric field (magnitude and direction) at the origin due to these two point charges?

Ans. $E =$ 956 N/C

direction −X

b) Point A is at the origin and point B is on the x axis, at $x = 0.20$ m. What is the potential difference $V_A - V_B$ between points A and B, and which point, A or B, is at higher potential?

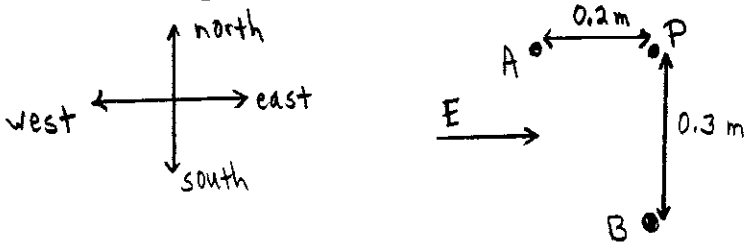
Ans. $V_A - V_B =$ −180 V

point at higher potential is B

c) A small object with net charge $q_3 = -6.0 \times 10^{-9}$C is released from rest at the origin. What is its kinetic energy when it reaches point B?

Ans. 1.08×10^{-6} J

(8 pts) 3. The electric field in a region of space is constant in both magnitude and direction. The field has magnitude $E = 4.0 \times 10^3$ N/C and its direction is toward the east. The electric potential at point P is 200 V. What is the electric potential at the following points:



a) point A, which is 0.20 m due west of point P?

Ans. 1000 V

b) point B, which is 0.30 m due south of point P?

Ans. 200 V

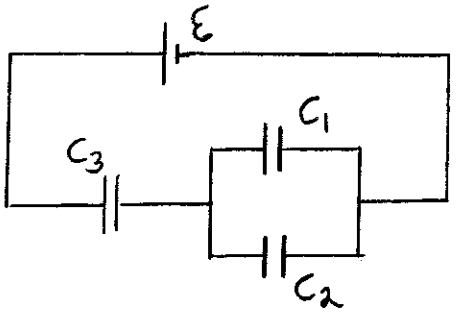
(6 pts) 4.
a) What is the energy in eV of a photon that has wavelength 500 nm?

Ans. 2.49 eV

b) What is the energy in eV of an electron that has wavelength 500 nm?

Ans. 6.03×10^{-6} eV

(9 pts) 5. Consider the capacitor network shown in the sketch. The capacitors have all reached their final charges. $C_1 = 8.0 \times 10^{-6}$ F, $C_2 = 3.0 \times 10^{-6}$ F, and $C_3 = 6.0 \times 10^{-6}$ F. The charge on C_1 is $q_1 = 5.0 \times 10^{-4}$ C.



a) What are the charges q_2 and q_3 on C_2 and C_3?

Ans. $q_2 =$ 1.88X10^{-4}C

$q_3 =$ 6.88X10^{-4}C

b) What are the voltages V_1, V_2 and V_3 across each capacitor?

Ans. $V_1 =$ 62.5V

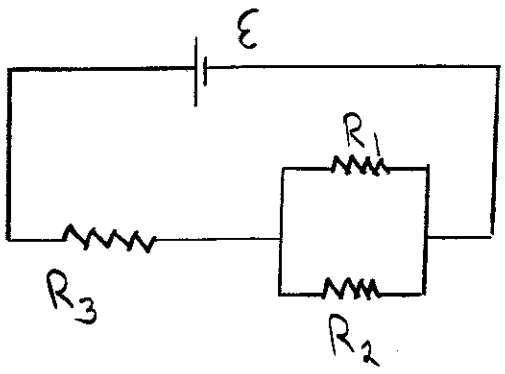
$V_2 =$ 62.5 V

$V_3 =$ 115V

c) What is the emf of the battery?

Ans. 177 V

(9 pts) 6. Consider the resistor network shown in the sketch. $R_1 = 4.0\ \Omega$, $R_2 = 2.0\ \Omega$, and $R_3 = 6.0\ \Omega$. R_1 is dissipating electrical energy at a rate of 16.0 W.



a) What are the rates P_2 and P_3 at which R_2 and R_3 are dissipating electrical energy?

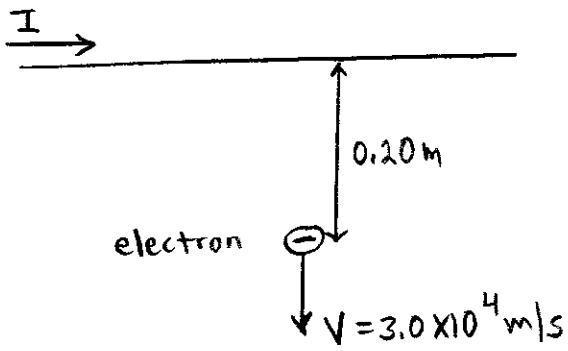
Ans. $P_2 =$ 32 W

$P_3 =$ 216 W

b) What is the emf of the battery?

Ans. 44 V

(9 pts) 7. An electron is moving in the vicinity of a long straight wire. The current in the wire is $I = 5.0$ A, in the direction shown in the sketch. Consider the instant when the electron is 0.20 m from the wire and moving away from it with a speed of 3.0×10^4 m/s.



a) What are the magnitude and direction of the magnetic field of the wire at the location of the electron?

Ans. $B =$ 5×10^{-6} T

direction ⊗ into page

b) What are the magnitude and direction of the force that the current in the wire exerts on the electron?

Ans. $F =$ 2.4×10^{-20} N

direction to the left

(9 pts) 8. An ac source is connected in series with a resistor $R = 200\ \Omega$ and a capacitor with $C = 4.0 \times 10^{-6}$ F. The rms voltage across the resistor is 400 V and the rms voltage across the capacitor is 500 V.

a) What is the rms voltage of the source?

Ans. 640 V

b) What is the source frequency, in Hz?

Ans. 159 Hz

c) What is the phase angle between the source voltage and the current?

Ans. -51.3°

d) Does the source voltage lag or lead the current?

Ans. lags

(9 pts) 9. An object 2.0 mm tall is 16.0 cm to the left of a spherical mirror. The image formed by the mirror is 4.0 mm tall and is to the right of the mirror.

a) Is the image real or virtual?

Ans. virtual

b) Is the image upright or inverted?

Ans. upright

c) What is the distance of the image from the mirror?

Ans. 32.0 cm

d) What is the focal length f of the mirror?

Ans. +32.0 cm

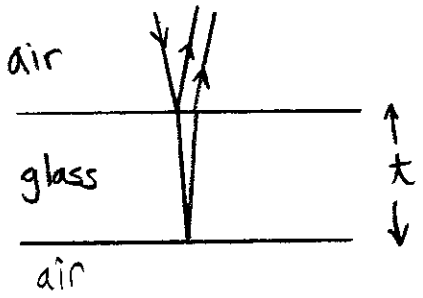
e) Is the mirror converging ($f > 0$) or diverging ($f < 0$)?

Ans. converging

(5 pts) 10. Find the binding energy in MeV of the isotope ${}^{3}_{2}\mathrm{He}$. The atomic mass of ${}^{3}_{2}\mathrm{He}$ is 3.016029 u.

Ans. 7.72 MeV

(8 pts) 11. Light of wavelength 400 nm in air is incident perpendicularly on a very thin piece of glass. The glass has $n = 1.50$ and there is air on both sides of the glass. What is the smallest nonzero thickness t of the piece of glass for which light reflected from the two surfaces of the glass will interfere destructively?



Ans. 133 nm

(8 pts) 12. The isotope $^{47}_{20}$Ca undergoes β^- decay.

a) How many protons are in the daughter nucleus that is produced by this decay?

Ans. 21

b) If a sample containing 2.24 g of $^{47}_{20}$Ca has an activity of 5.30×10^{16} Bq, what is the half-life of $^{47}_{20}$Ca?

Ans. 4.3 days = 3.73×10^5 s