

Name (printed) _____

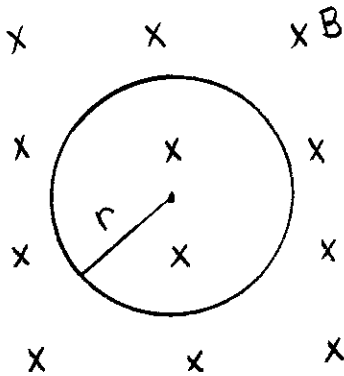
Name (signature as on ID) _____

Lab Section _____

Final Exam

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

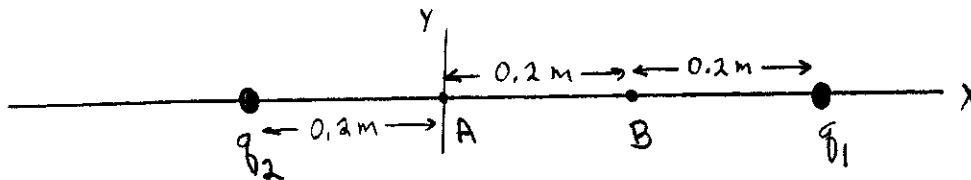
(8 pts) 1. A circular loop of wire with radius $r = 0.20$ m and resistance $R = 0.40 \Omega$ is in a uniform magnetic field directed into the page as shown in the sketch. At $t = 0$ the magnetic field is $B = 6.00$ T and it then decreases at a constant rate of $\Delta B/\Delta t = -0.40$ T/s. What are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



Ans. $I =$ _____

direction _____

(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. $E =$ _____
 direction _____

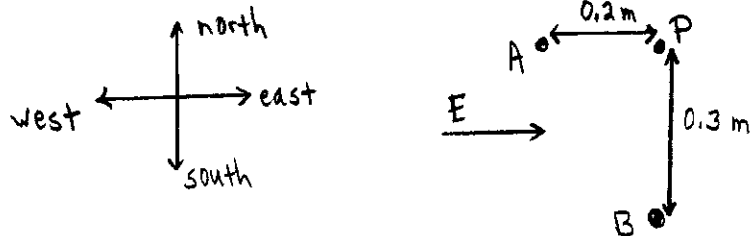
b) Point A is at the origin and point B is on the x axis, at $x = 0.20$ m. What is the potential difference $V_A - V_B$ between points A and B, and which point, A or B, is at higher potential?

Ans. $V_A - V_B =$ _____
 point at higher potential is _____

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. _____

(8 pts) 3. The electric field in a region of space is constant in both magnitude and direction. The field has magnitude $E = 4.0 \times 10^3 \text{ N/C}$ 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. _____

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

Ans. _____

(6 pts) 4.

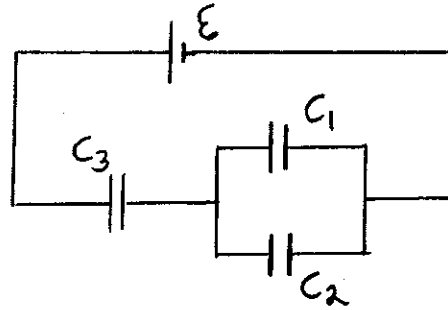
a) What is the energy in eV of a photon that has wavelength 500 nm?

Ans. _____

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

Ans. _____

(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. $q_2 =$ _____

$q_3 =$ _____

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

Ans. $V_1 =$ _____

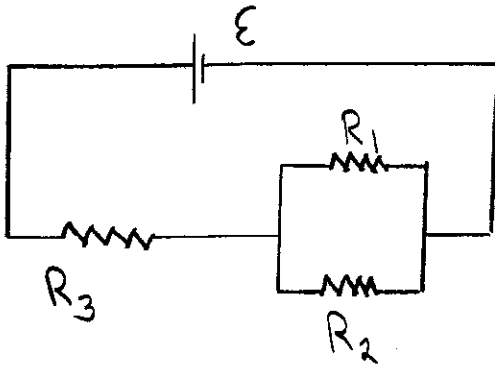
$V_2 =$ _____

$V_3 =$ _____

c) What is the emf of the battery?

Ans. _____

(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?

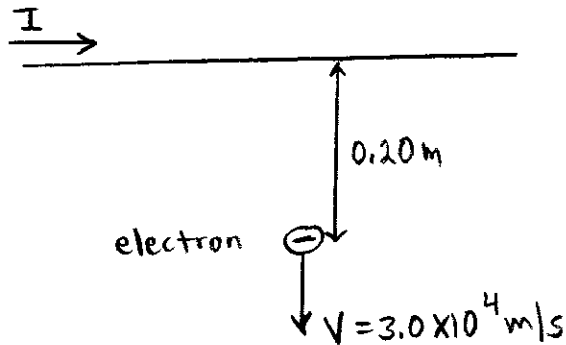
Ans. $P_2 =$ _____

$P_3 =$ _____

b) What is the emf of the battery?

Ans. _____

(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. $B =$ _____
 direction _____

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

Ans. $F =$ _____
 direction _____

(9 pts) 8. An ac source is connected in series with a resistor $R = 200 \Omega$ and a capacitor with $C = 4.0 \times 10^{-6} \text{ F}$. 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. _____

b) What is the source frequency, in Hz?

Ans. _____

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

Ans. _____

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

Ans. _____

(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. _____

b) Is the image upright or inverted?

Ans. _____

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

Ans. _____

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

Ans. _____

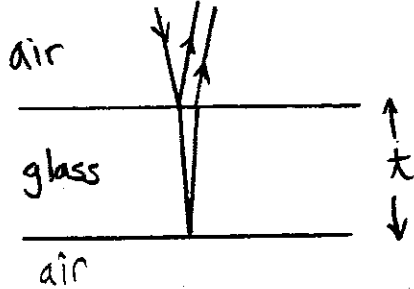
e) Is the mirror converging ($f > 0$) or diverging ($f < 0$)?

Ans. _____

(5 pts) 10. Find the binding energy in MeV of the isotope ${}^3_2\text{He}$. The atomic mass of ${}^3_2\text{He}$ is 3.016029 u.

Ans. _____

(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. _____

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

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

Ans. _____

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

Ans. _____