Physics 160 Practice Exam I

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- You may have a sheet of handwritten notes that is one side of an 8.5" × 11" sheet of paper.
- Be sure to give units when it is relevant.
- To insure maximum credit you should solve each problem in formula form before “plugging in” numbers.
- The answer to the problems can be given in formula form or numerically as you prefer.
- If you choose to give the answer in formula form, be sure that the numerical values and units of the variables used are clearly stated. Correct formulas with incorrect “known” values will not earn full credit.
- Use the blank page facing the problem as scratch paper.
- Use well drawn pictures whenever they are relevant; they help you to think and the grader to understand your thinking.
- On the problem page show only the relevant formulas in the step-by-step logical order you used. Show all work.
- The important thing is to show that you know how to think, not the final numerical result.
- If you are struggling with a problem, it will help your grade to explain your thinking in words, even if you cannot get a complete answer. Partial credit will be given for partial solutions.
- As a general test-taking rule, you should never change an answer you have written unless you are absolutely certain that it is incorrect.
I. Quick Questions

A. Two concentric spherical conductors of radii \( r_1 = 0.2 \, \text{m} \) and \( r_2 = 0.3 \, \text{m} \) have equal but opposite charges of magnitude \( Q = 3.0 \, \text{nC} \). The potential difference between the spheres is 45 \( \text{V} \). What is the total stored energy in the spheres? What is the potential difference if the magnitude of the charge on each sphere is doubled?

B. An electron starts from rest and is accelerated across a region by a potential difference of 15 \( \text{kV} \). What is its kinetic energy in electron Volts (eV) after it has been accelerated?

C. A certain parallel plate capacitor has a capacitance of 12 \( \text{pF} \). If a second parallel plate capacitor is manufactured with a plate area double that of the first and a separation half that of the first, and contains a dielectric with dielectric constant 2, what is the capacitance of this second capacitor?

D. A 2 \( \Omega \) resistor connected to a battery has a 3 A current flowing through it for ten minutes. How much energy is drained from the battery during that time?

E. A particle of charge 4.15 \( \mu \text{C} \) and mass \( 4.55 \times 10^{-25} \text{kg} \) moves with constant velocity through a region in which there is an electric field \( \vec{E} = 4.4 \times 10^4 \text{iV/m} \) and a magnetic field \( \vec{B} = 0.250 \text{j} + 0.500 \text{k} \, \text{T} \). What is the velocity of the particle?
II. Electric Fields & Potentials

A uniformly charged, infinite plane has a charge density of $\sigma$ Coulombs per square meter and lies in the x-y plane. A cylindrical Gaussian surface of height $h$ and cross-sectional area $A$ is placed about a portion of the plane. Answer the following questions.

(i) In what direction does the electric field point? Answer with a sentence.

(ii) Calculate the electric flux through the Gaussian surface in terms of the electric field $E = |\vec{E}|$ and the dimensions of the Gaussian surface.

$$\Phi_E = \text{________________________}$$

(iii) How much charge is enclosed by the Gaussian surface?

$$Q_{encl} = \text{________________________}$$

(iv) Use Gauss’ Law to find the magnitude of the electric field.

$$|\vec{E}| = \text{________________________}$$

(v) If the electric potential is $V(x, y, z) = -(20 \text{ V/m}) |z|$, find the electric field.

$$\vec{E} = \text{________________________}$$

(vi) From your answer above, find $\sigma$.

$$\sigma = \text{________________________}$$

(vii) Evaluate $\int_{r_1}^{r_2} \vec{E} \cdot d\vec{l}$ for $r_1 = 0$ and $r_2 = (2i + 3j + 4k) \text{ m}$.

$$\int_{r_1}^{r_2} \vec{E} \cdot d\vec{l} = \text{________________________}$$
A battery is connected through a switch \( S \) to a 47,000 \( \mu \)F capacitor and a resistor \( R \). When the switch \( S \) is open, the voltmeter reads 1.5400 V. Immediately when the switch is closed, the voltmeter reading drops to 1.4808 V and the ammeter reads 740.4 mA. After 0.100 s, the voltmeter reads 1.5187 V and the ammeter reads 266.3 mA. Assume that the two meters are ideal, so they don’t affect the circuit.

(i) Find the EMF of the battery.

\[ \mathcal{E} = \underline{ } \]

(ii) What is the internal resistance of the battery?

\[ r = \underline{ } \]

(iii) What is the resistance of the resistor \( R \)?

\[ R = \underline{ } \]

(iv) What is the power output of the battery immediately after the switch is closed?

\[ P = \underline{ } \]

(v) What is the voltage drop across the capacitor 0.100 s after the switch is closed?

\[ V_C = \underline{ } \]

(vi) How much charge is on the capacitor 0.100 s after the switch is closed?

\[ q = \underline{ } \]
IV. Magnetic Forces

A planar loop of wire, shown to the left, lies in the x-y plane and encloses an area of 0.370 m\(^2\). The wire carries a 2.34 A current in the direction shown. The wire loop sits in a uniform magnetic field \( \vec{B} = -0.750 \, \text{j} + 0.250 \, \text{k} \, \text{T} \). Answer the following questions.

(i) What is the magnetic moment of the current loop? Be sure to answer with a vector.

\[ \vec{\mu} = \text{______________________________} \]

(ii) What torque does the magnetic field exert on the wire loop?

\[ \vec{\tau} = \text{______________________________} \]

(iii) Assuming that the potential energy of the wire loop is zero when the magnetic field lies within the plane of the loop, what is the potential energy of the loop?

\[ U = \text{______________________________} \]

(iv) What is the net force on the loop?

\[ \sum \vec{F} = \text{______________________________} \]