

## PHY114 S09 MidTerm Exam 2

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**12:30 pm to 1:45 pm**

**Please write your workshop number and your workshop leader's name at the top of your answer book.**

**Each of the four questions carry the same number of points.**

**Derive a formula for the answer before you put in the numbers. This will help you to get partial credit if your final numerical answer is wrong.**

**Put a box around your final answer for each question.**

Give answers to two significant digits.

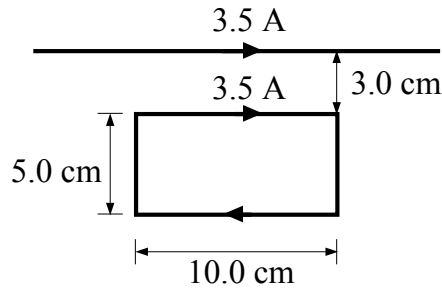
The magnitude of the charge on an electron is  $1.6 \times 10^{-19}C$

The mass of the proton is  $1.67 \times 10^{-27}kg$  .

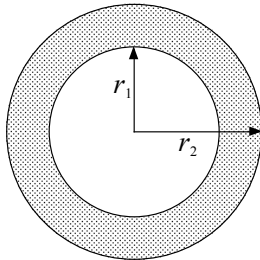
Electric permittivity of the vacuum is  $\epsilon_0 = 8.85 \times 10^{-12}C^2N^{-1}m^{-2}$ .

Magnetic permeability of the vacuum is  $\mu_0 = 4\pi \times 10^{-7}TmA^{-1}$ .

1. [25 points] Protons move clock-wise in a horizontal circle of radius 4.65 cm in a 0.535 T magnetic field. The magnetic field is in a direction perpendicular to the plane of the proton's orbit. What is their speed? What is the direction of the magnetic field? What is the magnitude of the electric field that can make them move in a straight-line? What is the direction in which it must be applied?
2. [25 points] A rectangular loop of wire is placed next to an infinitely long straight wire, as shown in the figure below. There is a current of 3.5 A in both wires. Find the magnitude and the direction of the net force on the loop.



3. [25 points] A cylindrical conductor has a concentric cylindrical cavity in it: it is shaped like a pipe with finite thickness.



The inner radius of the conductor is  $r_1$  and the outer radius of the conductor is  $r_2$  and the total current flowing down the length of the conductor is  $I$ . Assume that the current is uniformly distributed inside the conductor. What is the magnitude of the magnetic field inside the cavity? What is it at a distance  $r$  from the axis of the cylinder, when  $r_1 < r < r_2$ ? What is the magnetic field at a distance  $r > r_2$ ?

4. [25 points total]
  - [9 points] A  $4.0 \mu\text{F}$  capacitor, a  $2.3 \text{ k}\Omega$  resistor, and a  $12.6 \text{ V}$  source are connected in series. Starting from the state in which the capacitor is uncharged, how long does it take for the current to drop from its initial value to  $1.20 \text{ mA}$ ?
  - [8 points] How would you arrange two identical resistors and two identical batteries, connected together in a single circuit, to get maximum total power dissipated in the circuit? You must explain your answer and include an appropriate diagram.
  - [8 points] Consider an electron in a uniform, constant, magnetic field. If the electron is initially at rest, will the magnetic field cause it to move? Consider now an electron in a uniform, constant, electric field. If the electron is initially at rest, will the electric field cause it to move? You **must** explain your answers.