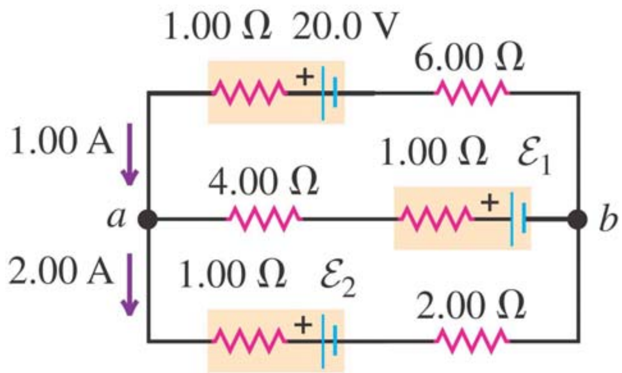
Roster ID: ______________________

Physics 272 - Section 1. Practice Midterm II
There are 4 problems. Each is assigned 25 points.
Show your work.



Problem 1: **25 points** – Considering the circuit diagram above:

(a) Write down 2 unique loop equations.

(b) Using these equations, solve for the 2 EMFs (ε_1, ε_2) in the problem. **Make sure to indicate your final result.**

(c) What is the voltage between nodes a and b.

Problem 2: 25 points

A loop of wire with radius 1cm is lying in the x-y plane, with its center at the origin and carrying a current of 10A in the counter-clockwise direction as viewed from the +z axis.

(a) Sketch a diagram of this configuration and indicate the **direction** and **magnitude** of the magnetic moment.

(b) What is the magnetic field vector at the coordinates (x,y,z) = (0cm,0cm,-1cm) ?

(c) In order to balance the magnetic field at this location, an infinite wire carrying current I_2 is placed 10cm away from the origin. Indicate the necessary location and current direction to exactly oppose (have same magnitude but opposite direction B field at (x,y,z) = (0cm,0cm,-1cm))

(d) What is the magnitude of this current I_2?

Problem 3: 25 points

The magnetic field in a certain region of space is given by $\vec{B} = 0.080\,\hat{\mathbf{i}}$ T. A proton is shot into this field with velocity $2 \times 10^5\,\hat{\mathbf{i}} + 3 \times 10^5\,\hat{\mathbf{j}}$ m/s. (Note $e = 1.6 \times 10^{-19}$ C, $m_p = 1.67 \times 10^{-27}$ kg).

a) Find the force on the proton (in component form).

b) Find the proton's acceleration (in component form).

c) Sketch *the shape* of the path that the proton follows.

Problem 4: 25 points

(a) **[5 pts]** You want to measure the current through and the voltage across a resistor. **How should you connect an ammeter and voltmeter?** You have three choices: (i) connect both in series; (ii) connect the ammeter in parallel and the voltmeter in series; (iii) connect the voltmeter in parallel and the ammeter in series. *Sketch the correct configuration.*

(b) **[5 pts]** You are working on your car and accidently touch both terminals of your car's 12V battery with a crescent wrench (resistance $\approx 1 \times 10^{-4}\ \Omega/\text{m}$, and the space between the battery terminals is $\approx$ 30cm). **How much power would the wrench dissipate?**

(*Note:* fortunately the current is usually limited to a few hundred Amperes, or you would be toast)

(c) **[10 pts]** A power cable and the current that it carries goes from West to East. Assume that the Earth's magnetic field goes from South to North. Sketch this configuration and indicate the *direction* of force and *write an expression* for the force per unit length on this cable.

(d) **[5 pts]** A ^{7}Li nucleus with a charge of $+3e$, mass 7u and a proton with charge $+e$ and mass 1u are both moving in a plane perpendicular to a magnetic field B. *The two particles have the same momentum.* What is the **ratio** of their radii of curvatures ?