EXAM 2

Print your name and section clearly on all five pages. (If you do not know your section number, write your TA's name.) Show all work in the space immediately below each problem. **Your final answer must be placed in the box provided**. Problems will be graded on reasoning and intermediate steps as well as on the final answer. Be sure to include units wherever necessary, and the direction of vectors. **Each problem is worth 25 points**. In doing the problems, try to be neat. Check your answers to see that they have the correct dimensions (units) and are the right order of magnitudes. You are allowed one 5" x 8" note card and no other references. The exam lasts exactly one hour.

(Do not write below)

SCORE:

Problem 1: __________

Problem 2: __________

Problem 3: __________

Problem 4: __________

TOTAL: __________

Possibly useful information:

$$\varepsilon_0 = 8.85 \times 10^{-12} C^2 N^{-1} m^{-2}$$
$$\mathrm{k} = 8.99 \times 10^9 \mathrm{Nm^2C^{-2}}$$

electron mass m_e = 9.1 × 10^{-31} kg

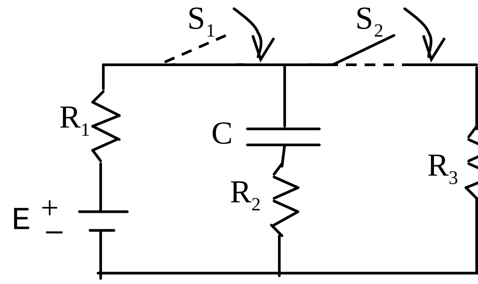
elementary charge e = 1.6 × 10^{-19} C

acceleration due to earth's gravity g=9.8 ms^{-2}

First Name: ____________________ Last Name: _____________________ Section: __________

PROBLEM 1

In the circuit shown the resistors are R_1 = 53 Ω, R_2 = 77 Ω, R_3 = 49 Ω. The capacitor, which starts out uncharged, has C = 23 μF, and the applied emf E = 4.5 V. At time t=0 the switch S_1, which has been open for a long time, is closed. (The switch S_2 stays open at this point.)



a. What is the voltage drop across resistor R_1 right after switch S_1 is closed? *(5 pts.)*

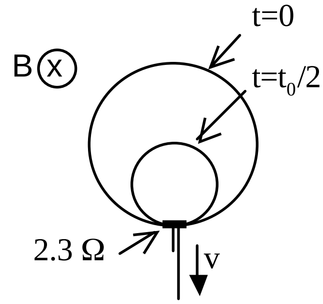
b. What is the voltage drop across the capacitor a long time after the switch S_1 has been closed, with S_2 left open? *(5 pts.)*

c. If the capacitor is uncharged at time t=0, at what time is the voltage drop across the capacitor half of the value in part (b)?

d. After the switch S_1 has been closed a long time, the switch S_1 is now reopened. (Switch S_2 is still open at this point.) How much energy is stored in the capacitor at this time? *(5 pts.)*

e. After a long additional time, switch S_2 is closed with switch S_1 kept open. How much power is dissipated in the resistor R_2 just after S_2 is closed? *(5 pts.)*

PROBLEM 2



A circular loop is in a magnetic field B=3.7 T directed into the page. At t=0 the loop radius $r=r_0=0.15$ m, and a force is applied to the loop so that the loop remains circular and its radius is time dependent: $r(t)=r_0-(r_0/t_0)t$ with t_0 = 3.1 s. The resistance of the loop, R, is 2.3 Ω.

a. Find the magnitude of the emf induced around the ring at time $t=t_0/2$. *(5 pts.)*

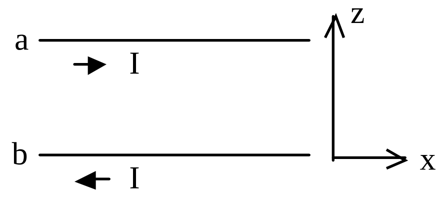
b. Find the magnitude of the current around the ring at time $t=t_0/2$. *(5 pts.)*

c. Is the direction of the current flow in the loop at time $t=t_0/2$ clockwise or counterclockwise? *(5 pts.)*

d. What is the power dissipated in the loop at time $t=t_0/2$? *(5 pts.)*

e. What is the magnitude of the force required to decrease the radius at the rate given at time $t=t_0/2$? *(5 pts.)*

PROBLEM 3



Two very long straight parallel wires carrying current I = 650 A in opposite directions are in the earth's gravitational field. The mass per unit length of the wires λ is 0.033 kg/m. The lower wire is supported and stationary at height z=0, and both wires point in the x-direction, with y=0.

a. What is magnitude of the magnetic field from wire b at wire a when wire a is a distance 0.015 m above wire b? *(5 pts.)*

b-c. There is a height z* such that when wire a is at z=z*, y=0 the net total force on wire a (gravitational plus magnetic) is zero (recall wire b is at y=z=0). Find the magnitude of z* and specify whether z*>0 (wire a above wire b) or z*<0 (wire a below wire b). *(10 pts.)*

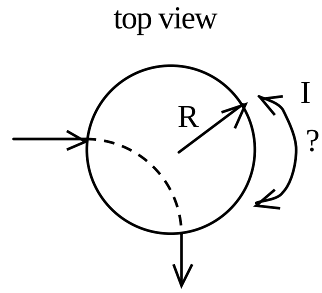
magnitude of z*	z*>0?

d. For the situation in part (b-c), what is the magnitude of the total magnetic field at height z=z*/2? *(5 pts.)*

e. For the situation in part (b-c), what is the magnitude of the total magnetic field at height z=z*/3? *(5 pts.)*

PROBLEM 4

An empty solenoid has a current I=0.17 A flowing in the wire wound around it and has n=1600 turns/m. An electron (mass m = m_e = 9.1×10^{-31} kg, charge q = -e = -1.6×10^{-19} C) enters from the west with speed v=1.6×10^{7}m/s and leaves going south, as shown. The radius of curvature of the electron motion is equal to R, the solenoid radius. You may neglect fringing fields.



a. What is magnitude of the magnetic field in the solenoid? *(5 pts))*

b. What is the magnitude of the magnetic force on the electron while it is inside the solenoid? *(5 pts.)*

c. Is the current I around the solenoid flowing counterclockwise or clockwise?

d. What is the radius of curvature of the electron motion inside the solenoid? *(5 pts.)*

e. If the current I is increased to 0.39 A and iron ($\mu=5000\mu_0$) inserted into the solenoid, what is then the magnitude of the magnetic field in the solenoid? *(5 pts.)*