Physics 112, spring 2015 Exam 40 pts

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RULES

You may use an equation sheet with whatever you want on both sides, you may not use a tablet or a smartphone or a laptop as a calculator. Do not forget to include direction in all answers.

Problems

1: (15 pts) Consider the circuit in figure A (see following page).

A)Determine the equivalent resistance of the circuit and the total current drawn by the circuit. (4 pts)

B)Determine the voltage drop across resistors A, B, and C. (3 pts)

C)Treat each resistor like a light bulb where the power drawn is proportional to the brightness of the bulb. Determine the power dissipated across resistors A, B, and C and rank the lightbulbs in terms of brightest to least bright. (4 pts)

D) Now, assume the circuit is cut at the X mark. What happens to the light bulbs? (1 pt)

E) Now, assume the circuit is cut at the O mark. Bulb B goes off in this case. Rank the remaining bulbs from brightest to dimmest and defend your ranking. You can explain this qualitatively or calculate it explicitly. (3 pts)

2: (10 pts) See figure B on the following page. A long straight wire carries a 10 ampere current in the southward direction. A proton is traveling at $10^5 m/s$ in the westerly direction when it is 10 cm away from the wire.

A) Calculate the magnitude and direction of the magnetic field at the location of the proton due to the wire. (5 pts)

B) Calculate the magnitude and the DIRECTION of the force the proton experiences at this location. (3 pts)

C) Calculate the acceleration the proton experiences at this point. (1 pt)

3: (10 pts) See figure C on the following page. A circular wire conductor with a radius of 2 cm and 10 turns is initially placed in a uniform magnetic field of 10 Teslas oriented perpendicular to the plane of the loop. The magnetic field is turned off over the course of 5 seconds.

A) Calculate the average induced emf due to the change in flux through the loop. (6 pts)

B) Determine the direction of the induced current in the conductor as the magnetic field is changing. (2 pts)

C) Calculate the torque experienced by the loop due to the external field and induced current at 2.5 seconds. (2 pts)

4: (5 pts) A proton is shot into a region between two parallel plates (See Figure D) with a velocity of 10^5 m/s. The region has a uniform magnetic field of 10 Teslas. Sketch the trajectory of the proton (1 pt). Next, another proton is sent into this region with the same velocity and magnetic field but a potential difference is initialized creating an electric field between the plates that points in

the southerly direction. What magnitude of the electric field will allow the proton to pass through without a deflection in it's trajectory? (3 pts). Sketch what the trajectory of the second proton would be if you increased the electric field strength beyond this value. (1 pt)

Extra Credit. If the potential initialized is 10^5 volts what is the plate separation? (2 pts)

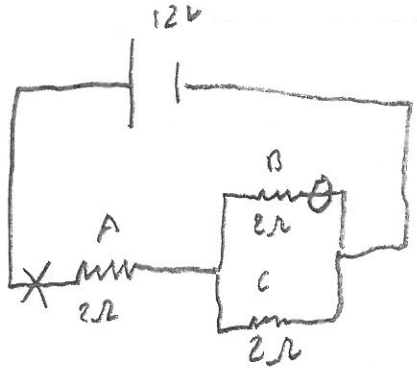
$m_e = 9.1 \times 10^{-31} kg$

$m_p = 1.67 \times 10^{-27} kg$

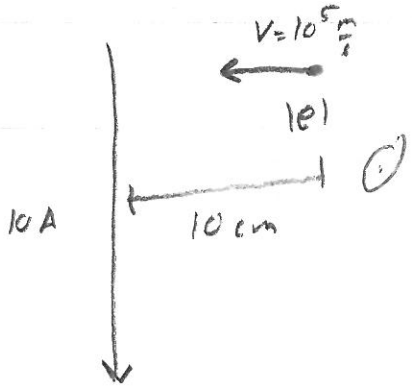
$|e| = 1.6 \times 10^{-19} C$

$\mu_0 = 4\pi \times 10^{-7} Tm/A$

A.



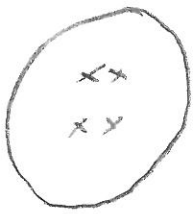
B.



C.

T= 0

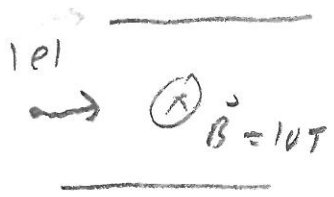
B= 10 T



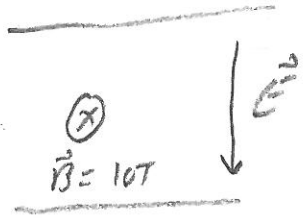
T= 5^- S

B= 0 T

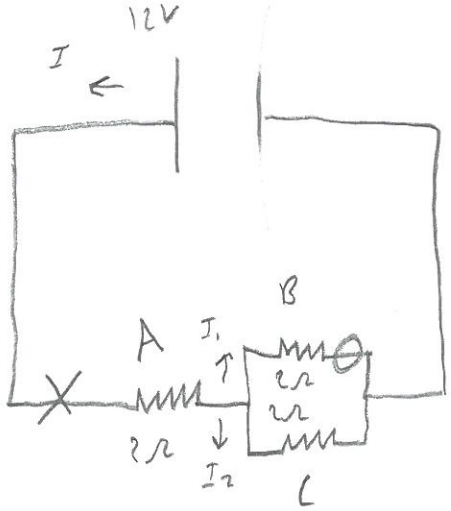
D. 1.



2.



#1,



$R_{eq} = 2\Omega + \left(\frac{1}{2\Omega} + \frac{1}{2\Omega}\right)^{-1} = 2\Omega + 1\Omega = 3\Omega$ 2

$I_{Tot} = \frac{V_{Tot}}{R_{eq}} = \frac{12V}{3\Omega} = 4A$ 2

5

$\Delta V_A = I_{Tot} R_A = 2\Omega \cdot 4A = 8$ Volts

$\Delta V_B = 4$ Volts $= \Delta V_C$] 3

$I_1 = I_2 = 2A$

$P_A = 8$ Volts $\cdot 4A = 32$ W 1

$P_B = P_C = 8$ Watts 2] $P_{Total} = 48$ Watts $A > B = C$ 2 1

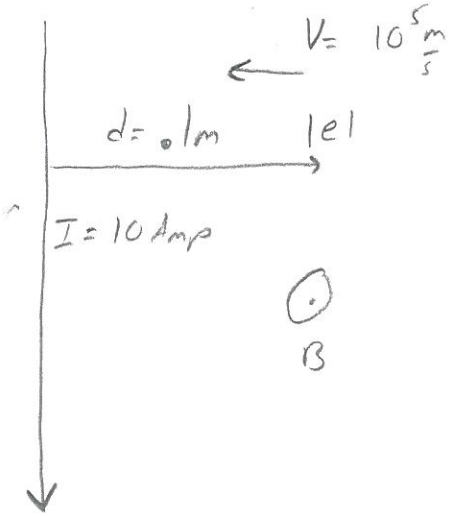
If cut at X → circuit dies 1

If cut at O $R_{eq} \rightarrow 4\Omega$ $I_{Total} \rightarrow 3$ Amp

A gets dimmer C gets brighter $A = C$

2 1

#2,



1. $|B| = \frac{\mu_0 I}{2\pi d} = \frac{4\pi \cdot 10^{-7} \cdot 10}{2\pi \cdot 10^{-1}} = 2 \cdot 10^{-5}$ T 5

$F = |e| v B = 1.6 \cdot 10^{-19} C \cdot 10^5 \frac{m}{s} \cdot 2 \cdot 10^{-5}$ T

$F = 3.2 \cdot 10^{-14}$ N ↑ 2 1

$F = 3.2 \cdot 10^{-14}$ $N = ma$

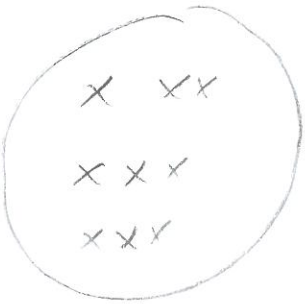
$a = \frac{3.2 \cdot 10^{-14}}{9.1 \times 10^{-31}} \frac{m}{s^2} \approx \frac{1}{3} \cdot 10^{12} \frac{m}{s^2}$ $2 \cdot 10^{8}$ m/s² 1

$1.67 \cdot 10^{-27}$

#3.) $r = .02\,m$ $N = 10$ $A = 1.26 \cdot 10^{-3}\,m^2$

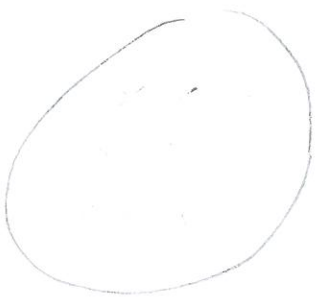
$T = 0$

$B = 10\,T$



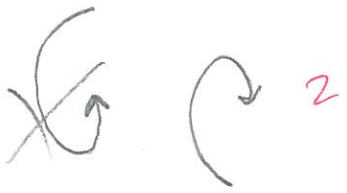
$T = 5$ seconds

$B = 0\,T$



$$\mathcal{E} = -N\frac{\Delta\Phi}{\Delta T} = \frac{-N}{5\text{ seconds}}\left[0 - B_1 A\right] = \frac{10}{5}\cdot 10 \cdot 1.26\cdot 10^{-3}\,V = 2.52\cdot 10^{-2}\,V$$

6



2

$T = 0$ 2

#4 1

$qvB = qE$

$vB = E$

$E = 10^6\,\frac{N}{C}$ 3

2

$\mathcal{E}\Delta x = V$ $\frac{V}{E} = \Delta x = 10^{-1}\,m$