PY106 Fall 2022 Quiz 2

Yang Jeong Yong

TOTAL POINTS

19 / 20

QUESTION 1

Problem 1 (Circuits) 5 pts

1.1 Part (a) 2 / 2

✓ **+ 2 pts** **Correct: R_eq=10.**

1: (A) Middle branch: 6||3 = 2 in series with 1 =3

2: (B) Right branch: 4 series 3 = 6

3: (A) branch || (B) branch = 3||6 = 2

4: Continuing, 2 in series with 8 = 10

+ 1 pts Half of above correct

+ 0.5 pts Less than have of above correct but showed some correct work

+ 0 pts Incorrect or blank

1.2 Part (b) 1 / 1

✓ **+ 1 pts** **Correct: I=ΔV/R = (90 V)/(10 Ohms) = 9 Amps**

+ 1 pts Incorrect, but carryover from Part (a): I = ΔV/R = (90 V)/R where R was incorrect from before.

+ 0 pts Incorrect or blank

1.3 Part (c) 1 / 1

✓ **+ 1 pts** **Correct: ΔV=IR = (9A)(8 Ohms) = 72 V**

+ 1 pts Incorrect, but carryover from Part (a) or (b): ΔV=IR where I and R were incorrect from before.

+ 0 pts Incorrect or blank

1.4 Part (d) 1 / 1

✓ **+ 1 pts** **Correct: 4A. Current from battery is 9A.**

1: From (a), the middle and right parallel branches are 6 ohm and 3 ohm equivalent resistance, respectively. Current splits (6/9)(9A)=6A down middle branch.

2: In the parallel elements in the bottom of the middle branch, current splits (6/9)(6A) = 4A to 3 ohm resistor

+ 0.5 pts One step correct, or consistent with carryover from prior result

+ 0 pts Incorrect or blank

QUESTION 2

Problem 2 (Capacitors) 3 pts

2.1 Part (a) 1 / 1

✓ **+ 1 pts** **Correct: C=Q/ΔV -> Q=CΔV = (2.0 F)(6.0 V)=12 Coulomb charge**

+ 0 pts Incorrect

2.2 Part (b) 1 / 1

✓ **+ 1 pts** **Correct: 1/3.**

1: When connected to the battery, ΔV remains constant

2: U=1/2 C(ΔV)^2. We are changing some of the structure of the capacitor, so we look at that equation which tells us that C is proportional to kappa* A/d. Cf = 1/3 Ci (because kappa final is 1/3 kappa initial).

3: The only variable that changes in for the energy is C. Thus, Uf = 1/3 Ui

+ 0.2 pts Knew that ΔV was constant for this situation.

+ 0.2 pts Understood C changed and calculated it correctly Cf=1/3Ci

+ 0 pts Incorrect or blank

2.3 Part (c) 1 / 1

✓ **+ 1 pts** **Correct: 1. |ΔV|=Ed -> E=|ΔV|/d**

Since the capacitor remains connected to the battery and the distance between the plates is not changing, ΔV = constant and d = constant, so the electric field magnitude remains constant

+ 0.2 pts Knew that ΔV was constant for this

situation.

+ **0 pts** Incorrect or blank

QUESTION 3

Problem 3 (Charges in B Field) 5 pts

3.1 Charge signs 3 / 3

✓ **+ 3 pts** **Correct: 1 is positive. 2 and 3 are negative. RHR**

+ **2 pts** Two are correct, one incorrect

+ **1 pts** One is correct, two incorrect.

+ **0 pts** Incorrect or blank

3.2 Magnitude of Q of Particle 3 1 / 1

✓ **+ 1 pts** **Correct: 6Q. $$R=mv/qB$$. $$B/m = v/QR$$=constant**
Compare 1 and 3 for charge:
$$(6v)/(Q_2)(2) = 18v/(Q_3)(3)$$

Solve: $$Q3=2(Q_2)=2*(3Q)=6Q$$

+ **0.5 pts** Set up the problem but determined incorrect radii or otherwise set up the equality incorrectly or a math error which led to an incorrect final result

+ **0 pts** Incorrect or blank

3.3 Speed of Particle 2 1 / 1

✓ **+ 1 pts** **Correct: $$R=mv/qB$$. $$B/m = v/QR$$ = constant. Compare 1 and 3 for speed.**

$$(6v)/(Q)(2)=(v_2)/(3Q)(1)$$

Solve: $$v_2=9v$$

+ **0.5 pts** Set up the problem but determined incorrect radii or otherwise set up the equality incorrectly or a math error which led to an incorrect final result

+ **0 pts** Incorrect or blank

QUESTION 4

B field from wires 7 pts

4.1 Part (a) 2 / 2

✓ **+ 2 pts** **Correct: Distance from corner to center of square using distances given is $$\sqrt2$$ cm**

$$B_1 =[\mu_0 I_1]/ [2 \pi r] = [4 \pi \times 10^-7 \times (6 A)] / [2 \pi \sqrt2]$$ Tesla

$$(12/\sqrt2)\times 10^-7$$ Tesla

Multiply top and bottom by $$\sqrt2$$ which leads to the final result of $$6\sqrt2 \times 10^-7$$ Tesla

Or if this is multiplied out: $$8.48 \times 10^-7$$ Tesla

+ **1 pts** Incorrect radius or other math errors that led to a final incorrect result.

+ **0 pts** Incorrect or blank

4.2 Part (b) 1 / 1

✓ **+ 1 pts** **Correct: Toward bottom left corner, from right hand curl rule.**

+ **0 pts** Incorrect

4.3 Part (c) 2 / 2

✓ **+ 2 pts** **Correct: $$12 \times 10^-7$$ Tesla**

The vector from the top right wire leads to a magnetic field vector at the center with the same magnitude as the other one (from a), but in a direction pointing toward the bottom right corner (right hand curl rule). These two vectors are perpendicular to one another.

Resulting vector magnitude is the square root of the sum of the squares of each magnitude.

+ **1.2 pts** Determined two vectors were of the same magnitude and perpendicular, but math errors that led to a final incorrect result.

+ **0.5 pts** On the right track, but did not qualify for the above two rubric items and did not lead to the final correct result.

+ **0 pts** Incorrect or blank

4.4 Part (d) 1 / 1

✓ **+ 1 pts Correct: Down, determined by the fact that the two vectors were of the same magnitude and perpendicular.**

+ **0 pts** Incorrect or blank

4.5 Part (e) 0 / 1

+ **1 pts** Correct: Right. Use right hand rule: B field down, current out of the page, force right.

+ **1 pts** Incorrect. An answer that would be correct given an incorrect net B field from part (d)

✓ **+ 0 pts Incorrect or blank**

PY106 Quiz 2 October 19, 2022

NAME: Jeongyong Yang **ID NUMBER:** U95912941

Show your work and put final answers in the boxes provided. You must show work to earn credit.

PROBLEM 1 – 5 points - *See figure on the attached sheet*

[2 points] (a) Determine the equivalent resistance of this circuit.

6&3 → $\frac{1}{6}+\frac{1}{3}=\frac{1}{2}$ → 2 (parallel)
1&2 → 1+2 = 3 (series)
2&4 → 2+4 = 6 (series)
3&6 → $\frac{1}{6}+\frac{1}{3}=\frac{1}{2}$ → 2 (parallel)
8&2 → 8+2 = 10 (series)

R_{eq} = 10 Ω

[1 point] (b) Determine the current provided to the circuit by the battery.

$V = IR$

$I = \frac{V}{R} = \frac{90}{10} = 9$

I = 9 A

[1 point] (c) Determine the magnitude of the voltage drop across the 8 Ω resistor?

$V = IR$ $V = (9)(8) = 72$

$|\Delta V_8|$ = 72 V

[1 point] (d) Determine the current through the 3 Ω resistor?

$V = IR$
↳ 18 V left
$18 = I_1 R_{1+6+3} = I_1(3)$
$I_1 = 6$

$V = IR$
$V = 6(1)$
$V = 6$
18 − 6 = 12 V left

$12 = I_3(3)$
$I_3 = 4$

I_3 = 4 A

PROBLEM 2 – 3 points

[1 point] (a) A parallel-plate capacitor is connected to a 6.0 V battery. The capacitance of the capacitor is 2.0 F. Determine the magnitude of the charge stored by the capacitor.

$C = \frac{Q}{\Delta V}$ $Q = C \cdot \Delta V$
$= 2 \cdot 6 = 12$

|Q| = 12 C

A parallel-plate capacitor is connected to a battery. There is a dielectric material, with $\kappa = 3.0$, completely fills the space between the plates. The initial energy stored in the capacitor is U_i and the initial magnitude of the net electric field between the plates of the capacitor is E_i. **With the battery still connected to the capacitor,** the dielectric material is removed from the capacitor (so the dielectric constant changes from 3.0 to 1.0). ***For (b-c), express your answer as a whole number or fraction.***

[1 point] (b) How does the final energy stored U_f compare to the initial stored energy U_i.

↓ $C = \frac{K A \varepsilon_0}{d}$ ↓ $C \to \frac{1}{3}C$ $Q \to \frac{1}{3}Q$
$V \to V$

$U = \frac{1}{2}Q\Delta V \to U = \frac{1}{2}\left(\frac{1}{3}Q\right)\Delta V$
$U \to \frac{1}{3}U$ $= \frac{1}{6}Q\Delta V$

U_f = 1/3 U_i

[1 point] (c) How does the final magnitude of electric field in the capacitor E_f compare to the initial electric field E_i.

$E = \frac{\Delta V}{d} \to \frac{\Delta V}{d} \to$ no change

E_f = 1 E_i

PROBLEM 3 – 5 points - ***See figure on the attached sheet***

In the table, fill in the sign of the charge of each particle (use + or −) as well as the missing information for particles 2 and 3.

Particle	Sign of charge	Magnitude of charge	Speed
1	+	Q	6v
2	−	3Q	9V
3	−	2Q	18v

$F=ma$

$\frac{mv^2}{r}=qvB$

$\frac{mv}{r}=qB$

$q=\frac{mv}{rB}$

Particle 1: $Q=\frac{m(6v)}{2(B)}=\frac{3mv}{B}$

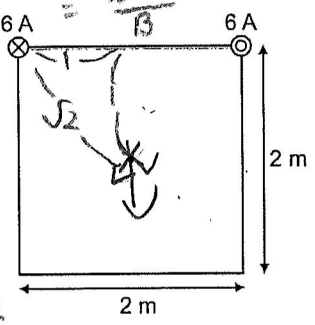
$3Q=\frac{9mv}{B}=\frac{xmv}{B}$

$x=9$

$v=\frac{qrB}{m} \rightarrow 6v=\frac{Q(2)B}{m}$ $\quad 18v\rightarrow\frac{6QB}{m}=\frac{xQ(3)B}{m}$

$x=2$

" $2: 3Q=\frac{m(xv)}{1(B)}=\frac{xmv}{B}$



PROBLEM 4 – 7 points - ***See figure on the attached sheet plus you may find it helpful to draw vectors in the duplicated figure at right.***

[2 points] (a) For **just the wire at the top left corner**, determine the magnitude of the magnetic field produced by that at the center of the square (as marked in the figure). Express your answer in terms of $\sqrt{2}$, if necessary.

$x\rightarrow\frac{\mu_0 I}{2\pi r}\cos(45)=\frac{2\times10^{-7}(6)}{\sqrt{2}}\left(\frac{\sqrt{2}}{2}\right)=6\times10^{-7}$ $\quad y\rightarrow\frac{\mu_0 I}{2\pi r}\sin(45)=\frac{2\times10^{-7}(6)}{\sqrt{2}}\left(\frac{\sqrt{2}}{2}\right)=6\times10^{-7}$

$\sqrt{(6\times10^{-7})^2+(6\times10^{-7})^2}$

$6\sqrt{2}\times10^{-7}$

$B_1 = 6\sqrt{2}\times10^{-7}$ T

[1 point] (b) What direction is the field at the center of the square, from just the wire at the top left corner?

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[✓] toward the bottom left corner [ ] toward the top right corner

[2 points] (c) Determine the **magnitude of the net magnetic field** at the center of the square, created by the two wires.

$x\rightarrow\frac{2\times10^{-7}\cdot6}{\sqrt{2}}\cos(45)-\frac{2\times10^{-7}\cdot6}{\sqrt{2}}\cos(45)=0$

$y\rightarrow\frac{2\times10^{-7}\cdot6}{\sqrt{2}}\sin(45)+\frac{2\times10^{-7}\cdot6}{\sqrt{2}}\sin(45)=2\left(\frac{2\times10^{-7}\cdot6}{\sqrt{2}}\right)\left(\frac{\sqrt{2}}{2}\right)=12\times10^{-7}=1.2\times10^{-6}$

$B_{net} = 1.2\times10^{-6}$ T

[1 point] (d) What **direction** is net field at the center of the square, from the two wires?

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[ ] toward the bottom left corner [ ] toward the top right corner [ ] none of these

[1 point] (e) A third wire, parallel to the first two, is now placed at the center of the square. It carries a current that is directed out of the page. What **direction** is the net force per unit length on this third wire?

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[ ] toward the bottom left corner [ ] toward the top right corner [ ] none of these