5C-F21 Midterm 3 (remote)

CLAIRE HATHAWAY

TOTAL POINTS

30 / 30

QUESTION 1

10 pts

1.1 1 / 1

✓ **- 0 pts** Correct

- 1 pts incorrect

1.2 1 / 1

✓ **- 0 pts** Correct

- 1 pts incorrect

1.3 1 / 1

✓ **- 0 pts** Correct

- 1 pts incorrect

1.4 1 / 1

✓ **- 0 pts** Correct

- 1 pts incorrect

1.5 1 / 1

✓ **- 0 pts** Correct

- 1 pts incorrect

1.6 1 / 1

✓ **- 0 pts** Correct

- 1 pts incorrect

1.7 1 / 1

✓ **- 0 pts** Correct

- 1 pts incorrect

1.8 1 / 1

✓ **- 0 pts** Correct

- 1 pts incorrect

1.9 1 / 1

✓ **- 0 pts** Correct

- 1 pts incorrect

1.10 1 / 1

✓ **- 0 pts** Correct

- 1 pts incorrect

QUESTION 2

20 pts

2.1 2 / 2

✓ **- 0 pts** Correct

- 1 pts Labeled charges incorrectly

- 1 pts drew electric field lines incorrectly

2.2 2 / 2

✓ **- 0 pts** Correct

- 2 pts incorrect

2.3 2 / 2

✓ **- 0 pts** Correct

- 2 pts incorrect

2.4 14 / 14

✓ **- 0 pts** Correct

- 4 pts Did not calculate the velocity correctly

- 4 pts Did not calculate kinetic energy correctly

- 3 pts Did not use U = K

- 1 pts Did not apply U=qV correctly

- 10 pts correct answer but no work shown

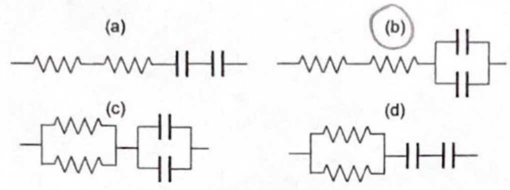
- 1 pts Calculation error

Problem 1

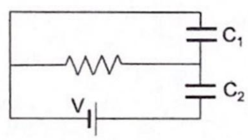
(10 points)

(each multiple-choice question has only one correct answer)

1. Which of the following circuits requires the longest time to fully charge all capacitors when connecting a battery across the two ends?



2. Consider the circuit shown below. Which of the following statements is true regarding the charge on the two capacitors?



(a) Both capacitors are discharged.

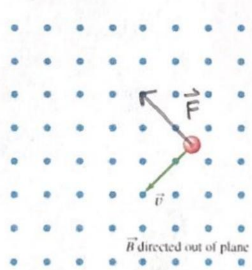
(b) Both capacitors are fully discharged.

(c) C_1 is fully charged and C_2 is discharged.

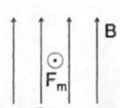
(d) C_2 is fully charged and C_1 is discharged.

3. Draw the vector that represents the magnetic force on the positive charge moving at velocity $\vec{v}$ in a magnetic field.

+



4. An electron moving through a magnetic field experiences a magnetic force F_m as shown in the figure. Which arrow best represents the direction of motion?

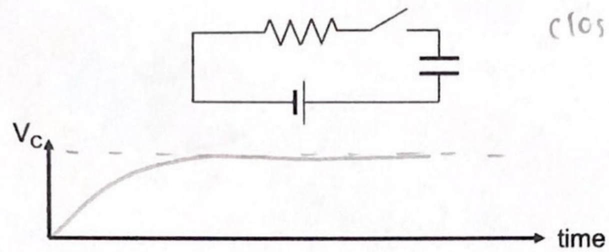


reverse answer!

(a) ↓ (b) ↑ (c) ← (d) → (e) v=0

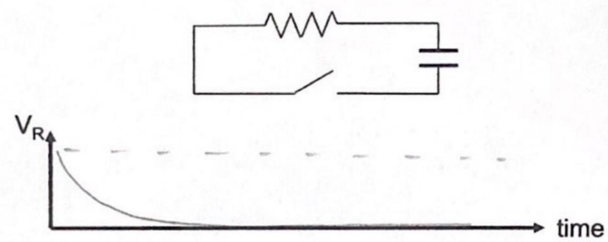
5. The capacitor in the circuit shown is discharged. Sketch the voltage between the capacitor plates as a function of time when you close the switch (t=0).

close switch → charge

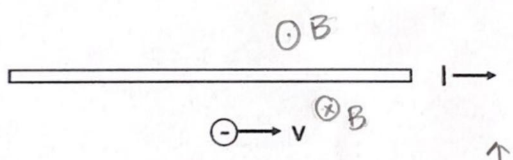


6. The capacitor in the circuit shown is charged. Sketch the voltage drop across the resistor as a function of time after you close the switch.

close switch → discharge



7. A current I flows through an infinitely long straight wire from left to right as shown. An electron moves parallel to the wire from left to right. In what direction does the magnetic force acting on the electron point?



↑ w/ ⊕ so ↓ w/ ⊖

(a) Up.

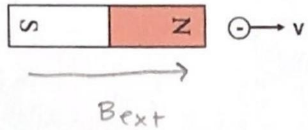
(b) Down.

(c) Into the board.

(d) Out of the board.

(e) The the right.

8. An electron moves away from the north pole of a bar magnet exactly along the symmetry axis of the magnet as shown. In which direction does the magnetic force point?



(a) Up

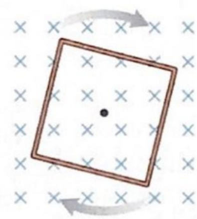
(b) Down.

(c) Into the board

(d) The magnetic force is zero.

parallel?

9. A square loop is rotating in the plane of the page around an axis through its center. A uniform magnetic field is directed into the page? The induced current ...



$B_{ext} \otimes$

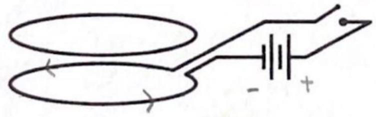
No change in $B, A, \cos\theta$ so no induced current?

(a) flows clockwise.

(b) flows counterclockwise.

(c) is zero.

10. The two loops of wire in the figure are stacked one agove the other. What is the direction of the current in the upper loop (when viewed from above), immediately after the switch is closed (and before the current settles)?



(a) Clockwise.

(b) Counterclockwise.

(c) There is no induced current.

b/c w/ Lenz's law induced opposite of current

$B = 3.5 \text{ KG} = 3.5 \times 10^3 \text{ G} = 0.35 \text{ T}$

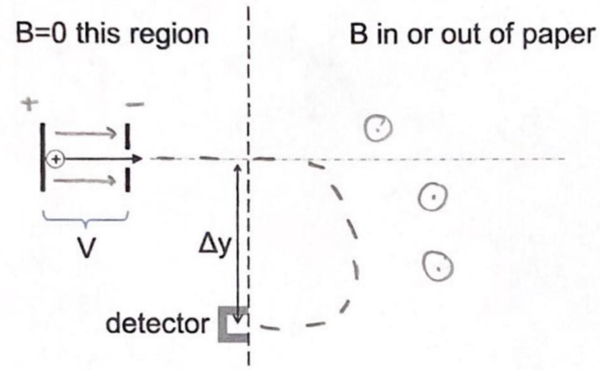
$\Delta y = 15 \text{ cm} = 15 \times 10^{-2} \text{ m}$

Problem 2

(20 points)

Consider a simplified mass spectrometer as shown in the figure. A plate capacitor with voltage V between the plates accelerates positively charged particles from rest. The space to the right of the dashed vertical line has a homogenous magnetic field of 3.5 kG. The region to the left of the line has no magnetic field. A particle detector collects particles entering from the right and is positioned a distance of Δy=15 cm below the center of the capacitor. You may ignore gravity.

E=0 everywhere else besides within ⊕ & ⊖ plates



(a) Label the sign of the charge on the plates AND sketch the electric field everywhere in the figure above. *(2 points)*

(b) Sketch the trajectory of a particle from the initial position all the way to the detector. *(2 points)*

(c) Does the magnetic field on the right side point into the board or out of the board? *(2 points)*

into the board **out of the board**

(d) If you accelerate singly charged carbon ions C^+ (m=2.0×10^{-26} kg) what voltage do you need between the plates so that the ions hit the detector? *(14 points)*

$r = \frac{mv}{qB}$ $\quad r = \frac{d}{2} = \frac{15\times10^{-2}}{2} = 0.075 \text{ m}$

$\uparrow$

$v = \frac{rqB}{m} = \frac{(0.075 \text{ m})(1.6\times10^{-19} \text{ C})(0.35 \text{ T})}{(2\times10^{-26} \text{ kg})} = 210000 \text{ m/s}$

$K = \frac{1}{2}mv^2 = \frac{1}{2}(2\times10^{-26} \text{ kg})(210000)^2 = 4.41\times10^{-16}$

$K = U = 4.41\times10^{-16}$

(use additional space on next page)

(extra space)

$U = qV \rightarrow V = \frac{U}{q} = \frac{4.41 \times 10^{-16}}{1.6 \times 10^{-19}} = \boxed{2756.25\ V}$