PHY2054 General Physics II

Section 611820

Prof. Douglas H. Laurence

Exam 2 (Chapters 21 − 23)

April 8, 2019

Name: ______________________________

Instructions:

This exam is composed of **10 multiple choice questions** and **4 free-response problems**. To receive a perfect score (100) on this exam, 3 of the 4 free-response problems must be completed. The fourth free-response problem **may not** be answered for extra credit. Each multiple choice question is worth 2.5 points, for a total of 25 points, and each free-response problem is worth 25 points, for a total of 75 points. This means that your exam will be scored out of 100 total points, which will be presented in the rubric below. **Please do not write in the rubric below; it is for grading purposes only.**

Only scientific calculators are allowed – do not use any graphing or programmable calculators.

For multiple choice questions, no work must be shown to justify your answer and no partial credit will be given for any work. However, for the free response questions, **work must be shown to justify your answers.** The clearer the logic and presentation of your work, the easier it will be for the instructor to follow your logic and assign partial credit accordingly.

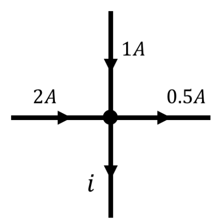
The exam begins on the next page. **The formula sheet is attached to the end of the exam.**

Exam Grade:

Multiple Choice	
Problem 1	
Problem 2	
Problem 3	
Problem 4	
Total	

MULTIPLE CHOICE QUESTIONS

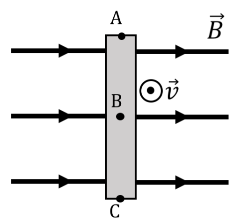
1. Three, 1Ω resistors are connected to one another. Which connection would give the largest possible equivalent resistance?
   - (a) All three in series
   - (b) All three in parallel
   - (c) A mixture of series and parallel connections
   - (d) Can't be answered without specifics
2. Two resistors are made out of copper: a long, thin resistor and a short, fat resistor. Compared to the long/thin resistor, the short/fat resistor has
   - (a) A larger resistance and resistivity
   - (b) A larger resistance, but the same resistivity
   - (c) A smaller resistance and resistivity
   - (d) A smaller resistance, but the same resistivity



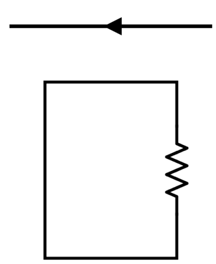
3. What is the unknown current i in the figure above?
   - (a) 0.5A
   - (b) 1.5A
   - (c) 2.5A
   - (d) 3.5A
4. What is the maximum energy stored by a 0.5F capacitor connected to a 10V battery?
   - (a) 0.0025J
   - (b) 0.25J
   - (c) 2.5J
   - (d) 25J
5. An electron moves into the page in a magnetic field pointing upward. What direction is the magnetic force on this electron?
   - (a) Left
   - (b) Right
   - (c) Into the page
   - (d) Out of the page

6. A proton initially moves to the right in the presence of a uniform magnetic field out of the page. Which option correctly describes the motion of the proton?
   (a) To the right, at a constant speed
   (b) To the right, at an increasing speed
   (c) Clockwise in a circle, at a constant speed
   (d) Counterclockwise in a circle, at a constant speed

7. Two parallel wires carrying currents in the same direction will produce a force on each other that is:
   (a) Attractive
   (b) Repulsive
   (c) Neither attractive nor repulsive
   (d) No force will be produced in this situation



8. A conductor moves out of the page in a horizontal magnetic field, as shown above. An electron placed at point B will do what?
   (a) Move to point A
   (b) Stay at point B
   (c) Move to point C
   (d) Unable to answer question without more information



9. In the above figure, the wire carries a current that is increasing. In what direction will the induced current move through the loop?
   (a) Clockwise
   (b) Counterclockwise
   (c) Out of the page
   (d) Into the page

10. A uniform magnetic field B exists in some region of space A. If a loop of wire is entirely within the region A, what direction does an induced current flow through the loop if it's moved to the right?

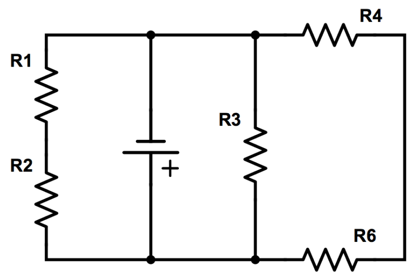
    (a) Clockwise

    (b) Counterclockwise

    (c) No induced current is produced so long as the loop is entirely in region A

    (d) Not enough information is provided to answer the question

FREE-RESPONSE PROBLEMS



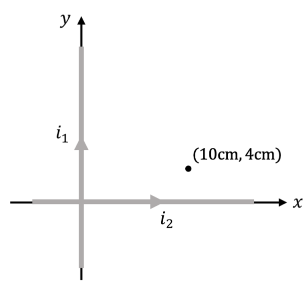
1. In the circuit above, $R_1 = 1\Omega$, $R_2 = 3\Omega$, $R_3 = 2\Omega$, $R_4 = 1\Omega$, $R_6 = 2\Omega$, and the battery is 5V. *Note: the figure accidentally mislabels the last resistor, so there is no resistor R_5; it jumps from R_4 to R_6.*

   (a) What is the current produced by the battery?

   (b) What is the current through R_1?

   (c) What is the voltage across R_3?

   (d) How much power is produced by R_6?



2. As shown the figure above, two very long wires carry perpendicular currents, with $i_1 = 1000\text{A}$ and $i_2 = 500\text{A}$.

(a) Determine the magnetic field, both magnitude and direction, of wire 1 at the point identified in the figure.

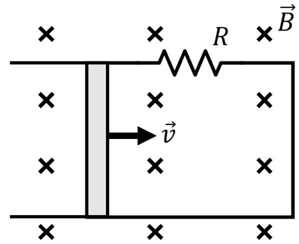
(b) Determine the magnetic field, both magnitude and direction, of wire 2 at the point identified in the figure.

(c) What is the total magnetic field, both magnitude and direction, at the point identified in the figure?

3. A circular loop of wire, with a radius $R = 15$cm, carries a current of 150A in the clockwise direction.

   (a) What is the magnetic field, both magnitude and direction, at the center of the loop?

   (b) If a proton is at the center of the loop, moving upward at a speed $v = 2500$ m/s, what is the magnetic field on the proton, both magnitude and direction?



4. A conductor of length 10cm moves to the right at 1000 m/s in the presence of a uniform 0.5 T magnetic field, as shown in the figure above. The conductor slides along wires connected to a resistor with $R = 10\Omega$.

(a) What is the magnitude of the induced voltage on the resistor in the above circuit?

(b) What is the magnitude of the induced current on the resistor?

(c) In what direction does the current move through the resistor?

(d) If you wanted to produce a current of 3A, to the left through the resistor, at what velocity and in what direction should the conductor be moved?

FORMULA SHEET

- Vectors:

$$\vec{A} \cdot \vec{B} = AB\cos\theta = A_x B_x + A_y B_y + A_z B_z$$

$$\left|\vec{A} \times \vec{B}\right| = AB\sin\theta$$

- Physics I Formulae:

$$\sum \vec{F} = m\vec{a}$$

$$W = \vec{F} \cdot \Delta\vec{x}$$

$$W_{tot} = \Delta K$$

$$W_{cons} = -\Delta U$$

$$K = \frac{1}{2}mv^2$$

$$K_i + U_i = K_f + U_f$$

- Electric Forces and Fields:

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

$$\left.\begin{aligned} k &= 8.99 \times 10^{9}\ \frac{\mathrm{Nm}^2}{\mathrm{C}^2} \\ \epsilon_0 &= 8.85 \times 10^{-12}\ \frac{\mathrm{F}}{\mathrm{m}} \end{aligned}\right\} \quad k = \frac{1}{4\pi\epsilon_0}$$

$$Q = Ne$$

$$F = k\frac{q_1 q_2}{r^2}$$

$$\vec{F} = q\vec{E}$$

$$E = k\frac{q}{r^2}$$

$$\Phi_E = \vec{E} \cdot \vec{A}$$

$$\Phi_{tot} = \frac{q_{enc}}{\epsilon_0}$$

$$\lambda = \frac{Q}{L} \quad \text{or} \quad \sigma = \frac{Q}{A} \quad \text{or} \quad \rho = \frac{Q}{V} \quad \text{(charge densities)}$$

- Electric Potential Energy and Electric Potential:

$$U = k\frac{q_1 q_2}{r}$$

$$\phi = k\frac{q}{r}$$

$$U = q\phi \quad \text{and} \quad \Delta U = q\Delta\phi$$

$$E_{av} = \frac{\Delta\phi}{\Delta x}$$

$$V = \Delta\phi$$

- Capacitance:

$$Q = CV$$

$$\left.\begin{aligned} C &= \epsilon_0 \frac{A}{d} \\ E &= \frac{\sigma}{\epsilon_0} \end{aligned}\right\} \text{Parallel plate capacitors}$$

$$U = \frac{1}{2}\frac{Q^2}{C} = \frac{1}{2}CV^2 = \frac{1}{2}QV$$

- Direct Current Circuits

$$R = \rho \frac{L}{A}$$

$$V_R = iR$$

$$P = Vi = i^2 R = \frac{V^2}{R}$$

$$\sum_{\text{loop}} V = 0 \ \text{(Kirchhoff's Loop Rule)}$$

$$\sum i_{\text{in}} = \sum i_{\text{out}} \ \text{(Kirchhoff's Junction Rule)}$$

$$R_{\text{eq}} = R_1 + R_2 + R_3 + ... \ \text{(series)}$$

$$\frac{1}{R_{\text{eq}}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + ... \ \text{(parallel)}$$

$$\frac{1}{C_{\text{eq}}} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} + ... \ \text{(series)}$$

$$C_{\text{eq}} = C_1 + C_2 + C_3 + ... \ \text{(parallel)}$$

- Magnetism

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

$$\vec{B} = \frac{\mu_0}{4\pi}\frac{q\vec{v} \times \vec{r}}{r^3} \ \text{(point charge)}$$

$$B = \frac{\mu_0 i}{2\pi r} \ \text{(long wire)}$$

$$B = \frac{\mu_0 i}{2R} \ \text{(center of a loop)}$$

$$B = \mu_0 \frac{N}{L} i = \mu_0 n i \ \text{(center of a solenoid)}$$

$$\vec{F}_B = q\vec{v} \times \vec{B} \ \text{(point charge)}$$

$$\vec{F}_B = i\vec{l} \times \vec{B} \ \text{(wire)}$$

- Electromagnetic Induction

$$\Phi_B = \vec{B} \cdot \vec{A} = BA\cos\theta$$

$$V_{\text{ind}} = \frac{\Delta \Phi_B}{\Delta t}$$