Multiple choice questions. Circle the correct answer. No work needs to be shown and no partial credit will be given.

(6 pts) 1. A rectangular wire loop with area 0.060 m² and resistance 0.80 Ω is at rest in a uniform magnetic field. The loop has a constant clockwise current $I = 2.0$ A. The magnetic field has a constant magnitude and direction. $B = 0.50$ T and the magnetic field is directed into the page, as shown in the sketch. For the axis shown in the sketch, the magnitude of the torque on the current loop is

(a) 0.060 N·m
(b) 0.048 N·m
(c) zero
(d) 1.20 N·m
(e) 1.60 N·m
(f) none of these answers

(6 pts) 2. A long straight wire carries constant current $I$ in the direction shown in the sketch. A circular loop of wire is near the wire and moving away from it with constant speed $v$. The current induced in the loop of wire is

(a) counterclockwise
(b) clockwise
(c) zero

(6 pts) 3. A long straight wire carries constant current $I$ in the direction shown in the sketch. A circular loop of wire is near the wire and is moving parallel to the wire with constant speed $v$. The current induced in the loop of wire is

(a) clockwise
(b) counterclockwise
(c) zero
(6 pts) 4. A region of space has a uniform magnetic field $B$ that is directed into the page, as shown in the sketch. A rectangular loop of wire with area $A$ and resistance $R$ is moving out of the field region with speed $v$ but is only partly in the field. At this instant the current induced in the loop is

(a) zero  \hspace{1cm} (b) clockwise  \hspace{1cm} (c) counterclockwise

(6 pts) 5. Two coils are wound on the same cardboard tube, as shown in the sketch. When the resistance $R_1$ in circuit #1 is decreased at a constant rate, the induced current in circuit #2

(a) is zero  \hspace{1cm} (b) flows through $R_2$ from right to left  \hspace{1cm} (c) flows through $R_2$ from left to right

(6 pts) 6. A small particle with negative charge is sent with velocity $v$ into the space between two large parallel metal plates, as shown in the sketch. If the magnetic field in the region between the plates is directed out of the page, what must be the direction of the uniform electric field between the plates if the particle is to pass through the region undeflected?

(a) to the left  \hspace{1cm} (b) to the right  \hspace{1cm} (c) into page  \hspace{1cm} (d) out of page  \hspace{1cm} (e) toward top of page  \hspace{1cm} (f) toward bottom of page

(6 pts) 7. At an instant when the current through an inductor is $i = 4.0$ A and the current through the inductor is increasing at a rate of $\Delta i/\Delta t = +0.50$ A/s, the voltage across the inductor is 8.0 V. The resistance of the inductor is negligible. What is the self-inductance of the inductor?

(a) 2.0 H  \hspace{1cm} (b) 32.0 H  \hspace{1cm} (c) 16.0 H  \hspace{1cm} (d) 8.0 H  \hspace{1cm} (e) 4.0 H  \hspace{1cm} (f) none of these answers
Show all your work for partial credit. Write your answers in the blanks provided.

(16 pts) 8. In the rectangular region shown in the sketch there is a uniform magnetic field. A small particle with mass $m = 4.0 \times 10^{-12}$ kg and negative charge $q = -8.0 \times 10^{-6}$ C enters the field with velocity $v = 5.0 \times 10^4$ m/s in the direction shown. The particle travels with constant speed along the semicircular path shown in the sketch. The radius of the path is $R = 0.40$ m. What are the magnitude and direction of the magnetic field in the region?

Ans. $B = 0.0625 \text{T}$

direction out of the page
(12 pts) 9. A circuit consists of an emf of 48 V, a resistor with $R = 8.0 \, \Omega$, an inductor with $L = 2.0 \, \text{H}$, and a switch, all connected in series. At time $t$ after the switch is closed, the current in the inductor is increasing at the rate $\Delta i/\Delta t = 5.0 \, \text{A/s}$. At this instant, what is the current in the resistor?

\[ \text{Ans. } 4.75 \, \text{A} \]

(12 pts) 10. A capacitor with initial charge $Q = 8.0 \times 10^{-6} \, \text{C}$ and capacitance $C = 4.0 \times 10^{-12} \, \text{F}$ is connected to an inductor with $L = 0.20 \, \text{H}$ as shown in the sketch and the switch is closed at $t = 0$. The resistance of the circuit is negligible. Recall that for a capacitor, $V = Q/C$ and $U = QV/2 = CV^2/2 = Q^2/(2C)$.

(a) During the current oscillations that occur after the switch is closed, what is the maximum current through the inductor?

\[ \text{Ans. } 8.94 \, \text{A} \]

(b) What is the charge on the capacitor when the current through the inductor has its maximum value?

\[ \text{Ans. } \text{ZERO} \]
(18 pts). 11. Three long, straight and parallel wires carry currents as shown in the sketch. Wire #3 is midway between the other two wires, 0.20 m from each of them.

\[ \text{wire #1: } I_1 = 7.0 \text{ A} \]
\[ \text{wire #2: } I_2 = 3.0 \text{ A} \]
\[ \text{wire #3: } I_3 = 2.0 \text{ A} \]

(a) What are the magnitude and direction of the net magnetic field at the location of wire #3 due to the currents in wires 1 and 2?

Ans. \( B = 1.0 \times 10^{-6} \text{ T} \)

direction \( \text{into page} \)

(b) What are the magnitude and direction of the net force on a 2.0 cm section of wire #3 exerted by the other two wires. Show the direction of the net force on the sketch.

Ans. \( F = 4.0 \times 10^{-7} \text{ N} \)

direction \( \text{toward wire #2} \)