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

(5 pts) **Problem 1.** A 1.0m length of metal wire is connected to a 1.5V battery and a current of 5.0mA flows through it. What is the diameter of the wire? (The resistivity of the metal is $2.24 \times 10^{-8}\Omega \cdot m$.

(a) 9.7μm
(b) 4.9μm
(c) 15μm
(d) 2.2μm

(5 pts) **Problem 2.** What is the equivalent resistance of the combination illustrated in the figure?

(a) 25.1Ω
(b) 55.3Ω
(c) 5.4Ω
(d) 123Ω

(5 pts) **Problem 3.** The positive charge in the figure below is moving to the right and experiences a vertical (upward) magnetic force. In which direction is the magnetic field?

(a) to the right
(b) to the left
(c) upward
(d) out of the page
(e) into the page

\[ \vec{B} \text{ must be perpendicular to both } \vec{F} \text{ and } \vec{v}. \text{ So } \vec{B} \text{ is either out of the page or into the page. From Right-hand } \\sqrt{V} \text{ rule, it should be going into the page.} \]
(5 pts) Problem 4. The two coils shown in the figure are parallel to each other and are connected to batteries. Coil A is held in place but coil C is free to move. After the switch S is closed, coil C will initially move

(a) toward coil A
(b) away from coil A
(c) upward
(d) downward

two parallel wires attract each other when the currents they carry are on the same direction.

Notice! Problem is three-dimensional!

(5 pts) Problem 5. As shown in the figure, a bar is in contact with a pair of parallel rails and is in motion with velocity \( v \). A uniform magnetic field is present. The induced current through the resistor \( R \) is

\[ \vec{B} \text{ is going into the page, and magnetic flux is increasing for the circuit} \]

From Lenz's law, induced current should oppose this change by providing an opposite direction induced magnetic flux, that is,

(a) zero
(b) from a to b
(c) from b to a
(d) not possible to determine with these data
On the following problems show all your work. Partial credit will be given if earned.

(30 pts) Problem 6. In the circuit shown in the figure, all capacitors are initially uncharged when the switch \( S \) is suddenly closed. Find

(a) the maximum reading of the ammeter (15pts)
(b) the maximum charge of the \( 5.00 \mu F \) capacitor (15pts)

\[
I_{\text{max}} = \frac{\varepsilon}{R} = \frac{125 \text{ V}}{50 \Omega} = 2.5 \text{ A}
\]

\[
\frac{1}{C_1} = \frac{1}{10} + \frac{1}{30} \Rightarrow C_1 = 6.67 \mu F
\]

\[
C_2 = 7.0 \mu F + 6.67 \mu F = 13.67 \mu F
\]

\[
\frac{1}{C_3} = \frac{1}{5} + \frac{1}{13.67} \Rightarrow C_3 = 3.66 \mu F
\]

\[
C_3 = \frac{Q_{\text{max}}}{V} \Rightarrow Q_{\text{max}} = 3.66 \mu C \cdot 125 \text{ V} = 457.5 \mu C
\]
(30 pts) Problem 7. Two round concentric metal wires lie on a tabletop one inside the other. The inner wire has a diameter of 20.0 cm and carries a clockwise current of 12.0 A, as viewed from above. The outer wire has a diameter of 30.0 cm.

a) what must be the magnitude of the current in the outer wire so that the net magnetic field due to this combination of wires is zero at the common center of the wires? (15 pts)

b) what is the direction of this current as viewed from above? (15 pts)

\[ B_{\text{inner}} = \frac{\mu_0 I_{\text{inner}}}{2 \pi r_1} = \frac{\mu_0 (12 \text{ A})}{20.0 \text{ cm}} \]

and \( B_{\text{inner}} \) is going into the page.

So the outer wire should provide a magnetic field with same magnitude but opposite direction.

\[ B_{\text{outer}} = B_{\text{inner}} \]

\[ B_{\text{outer}} = \frac{\mu_0 I_{\text{outer}}}{2 \pi r_2} = \frac{\mu_0 (12 \text{ A})}{30.0 \text{ cm}} \]

\[ \Rightarrow I_{\text{outer}} = 18.0 \text{ A} \]

And the current must be counterclockwise, so that two magnetic fields with same magnitude can be cancelled by each other.
Problem 8. A small circular ring is inside a larger loop that is connected to a battery and a switch, as shown in the figure. Use Lenz's law to find the direction of the current induced in the small ring.

a) just after switch $S$ is closed; (5pts)

b) after $S$ has been closed for a long time; (5pts)

c) just after $S$ has been reopened after being closed for as long time. (5pts)

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A) change of $B$ is: From 0 to an outgoing $\mathbf{B}$, it's an increase. Lenz's law says the induced current will oppose this change, so the induced current is clockwise.

b) After a long time, current in this circuit doesn't change, so no any induced currents in this case.

c) after reopen, $B$ changes from a certain value to zero. A decrease in $B$ will cause an increase in the induced current, which will oppose this change by providing a magnetic field with the same direction. So induced current is counterclockwise.