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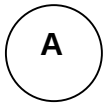
EMI 3C: CIRCULAR LOOPS WITHIN A SOLENOID

EMI3C—RT1: CIRCULAR LOOPS WITHIN A SOLENOID

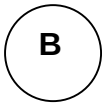
The figures below show six situations where circular loops of wire are placed inside six solenoids. The solenoids, which have uniform fields in their interiors, are concentric with the loops but have larger diameters. The circular loops vary in diameter, which of course means they have different areas. We are told the areas for the loops as well as the **INDUCED** current in each loop as a result of a change in the strength of the field within the solenoid. (Assume all loops have the same resistance.)

Rank these situations, from greatest to least, on the basis of the change in current per unit time in the solenoids that produced the induced currents in the circular loops.



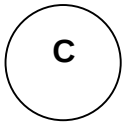
$A = 24\ cm^2$

$I = 8\ mA$



$A = 24\ cm^2$

$I = 6\ mA$

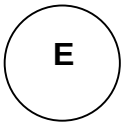


$A = 32\ cm^2$

$I = 8\ mA$

$A = 16\ cm^2$

$I = 8\ mA$



$A = 32\ cm^2$

$I = 6\ mA$

$A = 16\ cm^2$

$I = 4\ mA$

Greatest 1 _____ 2 _____ 3 _____ 4 _____ 5 _____ 6 _____ Least

OR, The change in current per unit time is the same for ALL SIX solenoids. _____

OR, There is no change in current in any of the solenoids. _____

Please carefully explain your reasoning.

How sure were you of your ranking? (circle one)

Basically Guessed					Sure				Very Sure
1	2	3	4	5	6	7	8	9	10

EMI3C—WBT1: CIRCULAR LOOPS WITHIN A SOLENOID

Construct a physical situation to which the following relation could apply.

$$12\ \text{mA} = \frac{(\mu_0)(800\ \frac{\text{turns}}{\text{cm}})(I_2 - I_1)}{3\ \text{msec}}(\pi)(4\ \text{cm})^2\ \frac{1}{6\Omega}$$

EMI3c—WWT1: Circular Loops within a Solenoid

What, if anything, is wrong with the following situation?

A circular wire loop that is inside, and concentric with, a solenoid will have an induced current if the current in the solenoid changes.

EMI3C—TT1: CIRCULAR LOOPS WITHIN A SOLENOID

Something is wrong with the situation described below. **Identify the problem and explain how to correct it.**

> A circular wire loop that is inside, and concentric with, a solenoid has an induced current in it. Consequently, we know that the current in the solenoid must be increasing.

EMI3C—CCT1: CIRCULAR LOOPS WITHIN A SOLENOID

The statements below are about a situation where a circular wire loop is inside and concentric with a large solenoid.

Student A: ***"If the current in the solenoid changes, there will be an induced current in the wire loop because the magnetic field will change."***

Student B: ***"Changing the current in the solenoid will not produce an induced current since the magnetic field will still be uniform."***

Student C: ***"Changing the current in the solenoid will have no effect on any current in the wire if they are not connected together."***

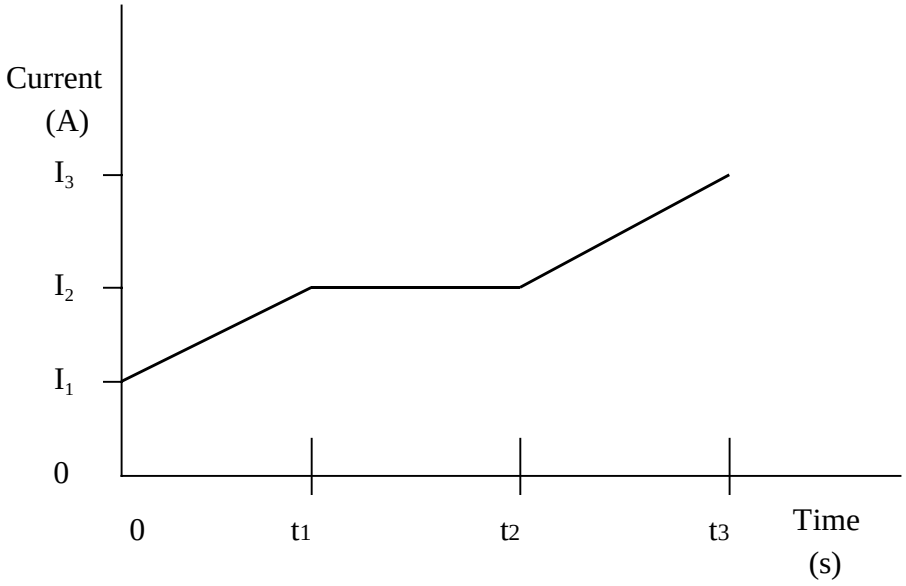
With which, if any, of these students do you agree?

Student A _____ Student B _____ Student C_____ Disagree with all_____

Carefully explain your reasoning.

EMI3c—CRT1: Circular Loops within a Solenoid

The graph below shows how the current in a large solenoid of length L, diameter D, and n turns per unit length changes during a certain time interval. Write the specific expression(s) for the induced current in a circular wire loop of resistance R and diameter d, which is inside the solenoid, concentric with it, and at the center of the solenoid.



0 to t_1:

t_1 to t_2:

t_2 to t_3:

EMI3C—PET1: CIRCULAR LOOPS WITHIN A SOLENOID

A solenoid with a large diameter has a current I_1 in it. A circular wire loop of smaller diameter is placed inside the solenoid with the axis of the loop parallel to the axis of the solenoid. The wire loop is connected to an ammeter. The current in the solenoid increases to three times its initial value during a 50-millisecond time interval.

What will we observe on the ammeter? Explain.

EMI3C—QRT1: CIRCULAR LOOPS WITHIN A SOLENOID

A wire loop is placed inside and concentric with a large diameter solenoid. The solenoid has an initial current I in it. The initial current decreases to half in a time interval Δt. This change will produce an induced current I_{Ind} in the wire loop.

Explain how each of the changes described below would affect the induced current in the wire loop.

The solenoid current decrease occurs in a longer time than the time above.

The diameter of the wire loop is doubled but the loop is still inside the solenoid.

The diameter of the solenoid is increased.

The current decrease in the solenoid occurs in less than the original time interval.

The initial solenoid current is three times the value above but decreases to half in the same time interval.

EMI3C—M/MCT1: CIRCULAR LOOPS WITHIN A SOLENOID

A student is working with a situation where a solenoid (n = 120 turns / m) with a large radius, r = 12 cm, has a current of 4 A in it. A circular wire loop of smaller radius, r = 5 cm, is placed inside the solenoid with the axis of the loop parallel to the axis of the solenoid. The wire loop is connected to an ammeter. The current in the solenoid increases to three times its initial value during a 50-millisecond time interval. The resistance of the wire loop is 15 ohms. The student performs the calculation below for the induced current in the loop.

Is this calculation meaningful or meaningless?

$$I = \frac{(\mu_0)(120\text{m}^{-1})(12\text{A} - 4\text{A})(\pi)(.05\text{m})^2}{(5 \times 10^{-3}\ \text{s})(15\Omega)}$$

Explain fully.