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Discussion 3: Electrodynamics

Instructions : Upload your work as a pdf document. All responses must be typed.

1. Lenz's law

Question 1. The diagram below shows a copper wire loop held in place near a solenoid. The switch in the circuit containing the solenoid is initially open.
a. Use Lenz' law to predict whether current will flow through the wire of the loop in each of the following cases.

- Just after the switch has been closed,
- A long time after switch has been closed,
- Just after the switch has been opened, and
- A long time after the switch has been opened.

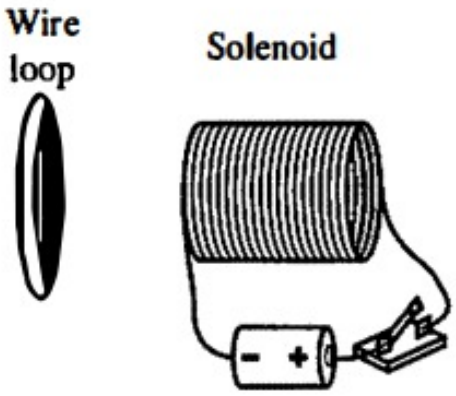

FIGURE 1. Copper loop and solenoid.

Question 2. In each of the diagrams below for Case A and Case B, the position of a loop is shown at two times, t_0 and $t_0 + \Delta t$. The loop starts from rest in each case and is displaced to the right in Case A and to the left in Case B. Draw a separate diagram to indicate:

- The direction of the induced current through the wire of the loop,
- The sign of the flux due to external magnetic field, and
- the sign of the induced flux.

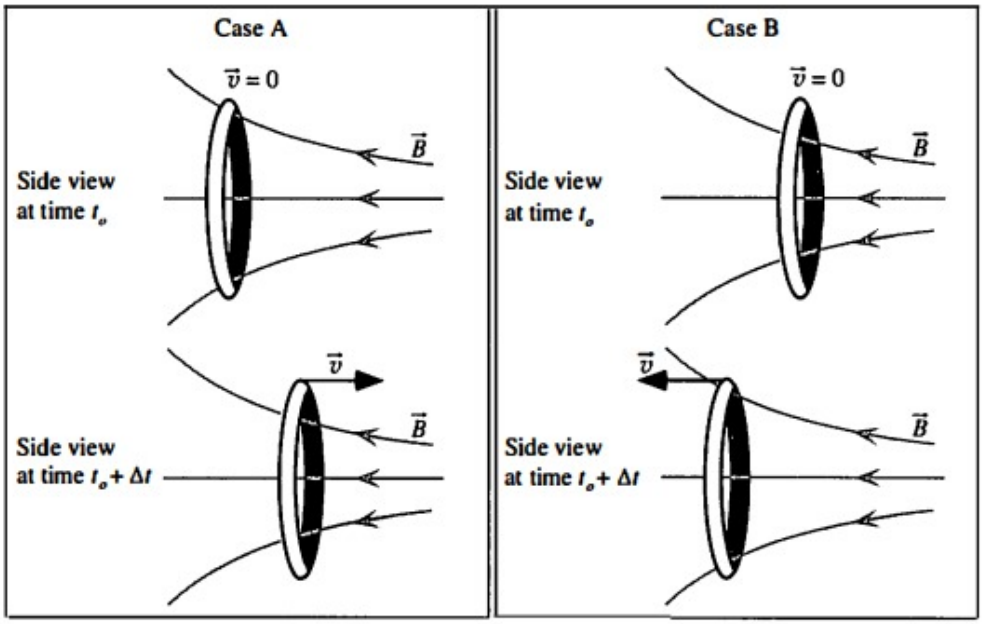

FIGURE 2. Case A and Case B

2.1. **Faraday's law**

Question 3. Five loops are formed of same copper wire and has same cross-sectional. Loops 1-4 are identical; loop 5 has the same height as the others but is longer. At the instant shown in Figure 3, all the loops are moving at the same speed in the directions indicated. There is a uniform magnetic field pointing out of the page in region I; in region II there is no magnetic field . Ignore any interactions between the loops.

- For any loop that has an induced current, indicate the direction of that current.
- Rank the magnitudes of the emfs around the loops.
- Rank the magnitudes of the currents in the loops .

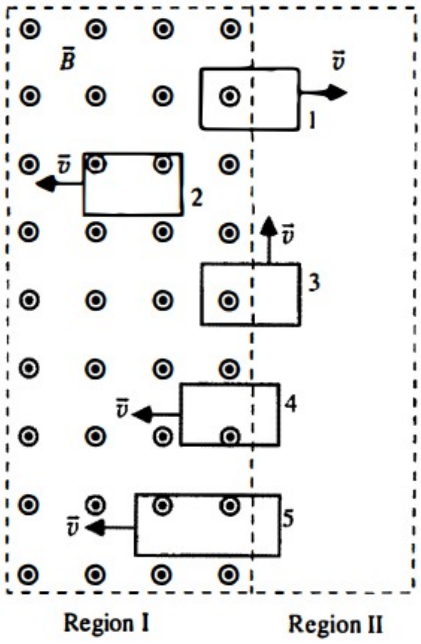

FIGURE 3. Region I and Region II

Question 4. Three loops, all made of same type of wire are placed near the ends of identical solenoids as shown in Figure 4. The solenoids are connected in series. Assume that the magnetic field near the end of each of the solenoids is uniform. Loop 2 consists of two turns of a single wire that is twice as long as the wire used to make loop 1. Loop 3 is made of a single wire that is half as long as the wire used to make loop 1.
Just after the switch has been closed, the current through the battery begins to increase. Imagine the period of time when the current is increasing and answer the following questions:

- Let V represent the induced emf of loop 1. Find the induced emf in each of the other loops in terms of V.
- Let R represent the resistance of loop 1. Find the resistance of each of the other loops in terms of R.
- Find the current induced through the wire of each of the loops in terms of V and R.

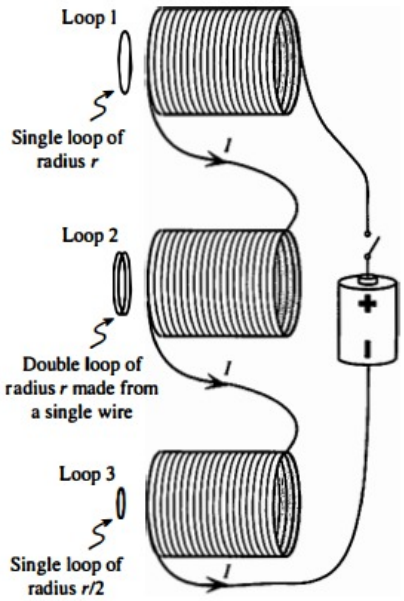

FIGURE 4. Schematic

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