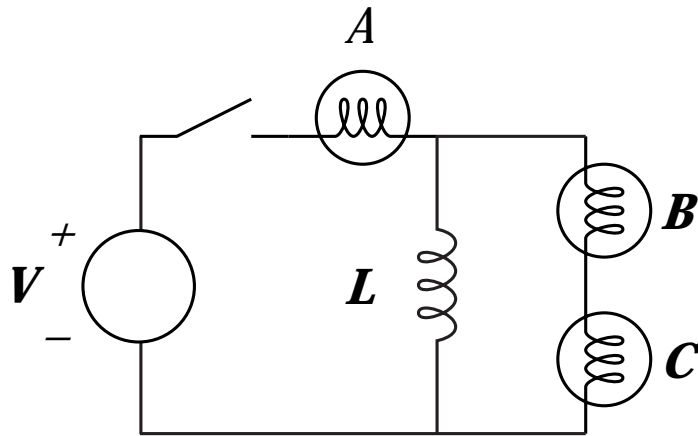


# Inductive Circuits I

## Concept Test

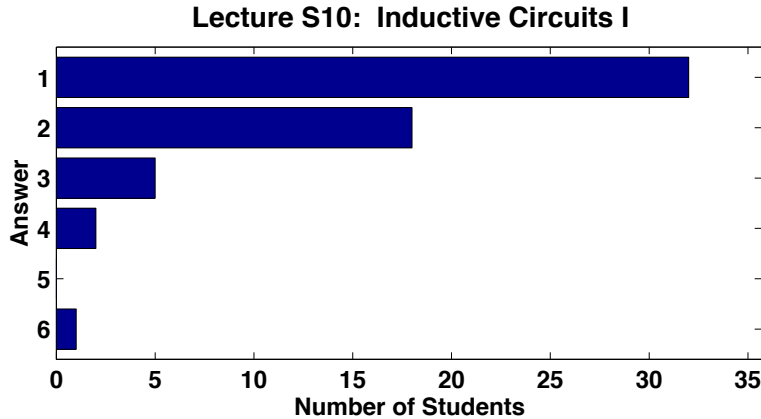


In the circuit above, what happens immediately after the switch is closed?

1. All three bulbs glow evenly initially
2. All three bulbs glow initially, but  $A$  is brighter than  $B$  and  $C$
3. All three bulbs glow initially, but  $A$  is dimmer than  $B$  and  $C$
4. Only bulb  $A$  glows
5. Only bulbs  $B$  and  $C$  glow
6. Nothing happens

# Inductive Circuits I

## Solution

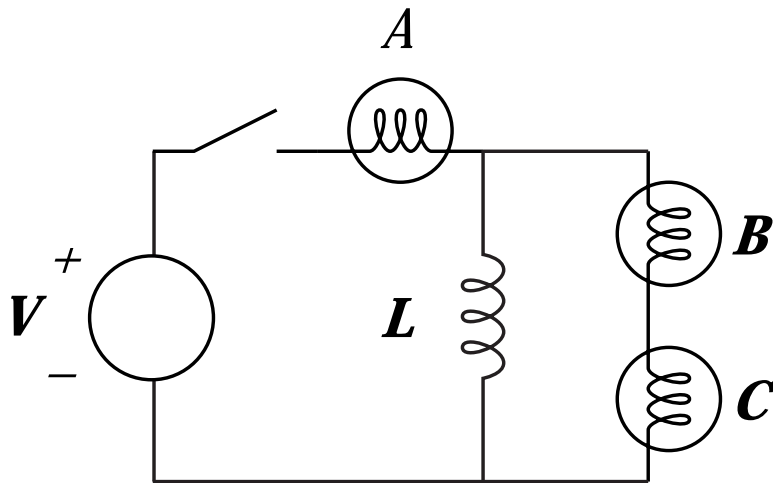


The correct answer is #1. Immediately before the switch is closed, the current through  $L$  is zero. Inductors resist current change, so immediately after the switch is closed, the inductor current is zero — it briefly looks like an open circuit. So the current flow through  $A$  is the same as through  $B$  and  $C$ .

The class did pretty well on this one, with a majority answering correctly.

# Inductive Circuits II

## Concept Test

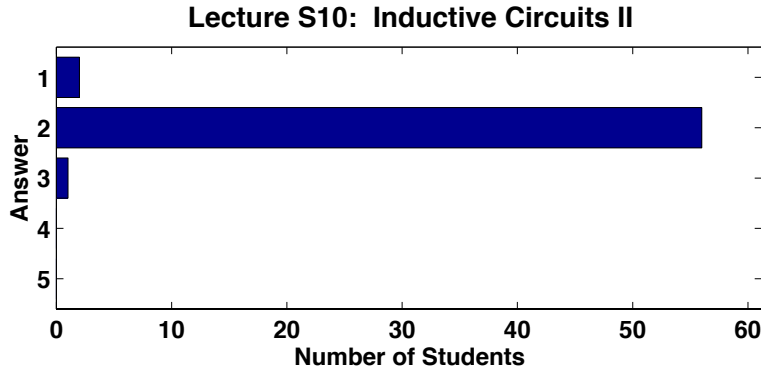


In the circuit above, what happens to each bulb over time after the switch is closed?

1.  $A$  dims, and  $B$  and  $C$  brighten
2.  $A$  brightens, and  $B$  and  $C$  dim
3. All three bulbs brighten
4. All three bulbs dim
5. Nothing happens

# Inductive Circuits II

## Solution

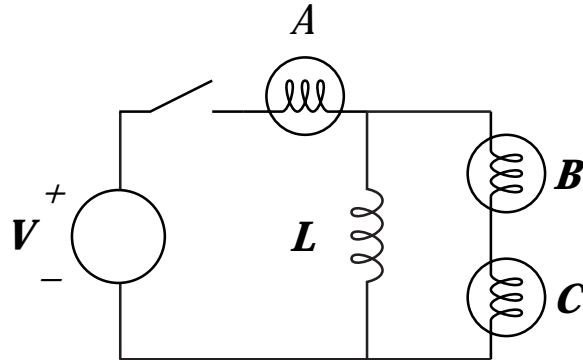


The correct answer is #2. For bulbs  $B$  and  $C$  to glow, there must be a voltage across them. This voltage is the same as the potential across  $L$ . The potential difference induces current to flow through the inductor, reducing the current flow through  $B$  and  $C$ .  $v = L \frac{di}{dt}$ , so  $\frac{di}{dt}$  is nonzero whenever  $v$  is. So the current through the inductor keeps increasing, until the voltage across the two bulbs decreases to zero. At that point, all the voltage ( $V$ ) is across  $A$ , whereas earlier, it had been across all three bulbs. So there is 3 times more voltage across  $A$ , and it brightens.  $B$  and  $C$  dim, and eventually go out, as the current through them goes to zero.

I messed this one up — I told the class the answer inadvertently.

# Inductive Circuits III

## Concept Test

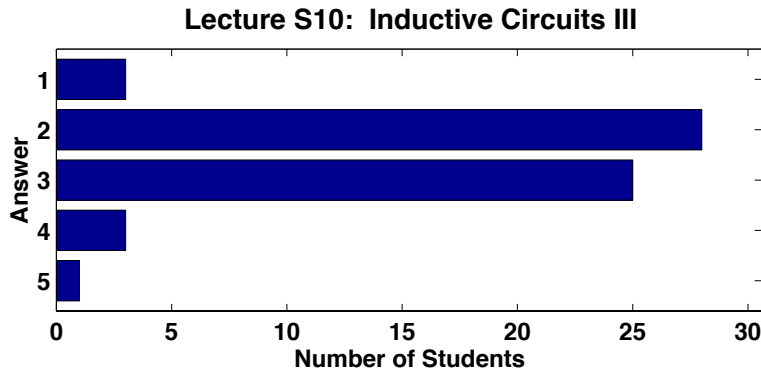


In the circuit above, the switch is left closed for a very long time, so that  $A$  is glowing, and  $B$  and  $C$  are dark. The switch is then suddenly opened. What happens to each bulb after the switch is opened?

1. All the bulbs are dark.
2.  $A$  goes out.  $B$  and  $C$  initially glow, then dim. The intensity of  $B$  and  $C$  is less than the original intensity of  $A$ .
3.  $A$  goes out.  $B$  and  $C$  initially glow, then dim. The intensity of  $B$  and  $C$  is the same as the original intensity of  $A$ .
4.  $A$  goes out, and nothing happens to  $B$  and  $C$ .
5. Nothing happens.

# Inductive Circuits III

## Solution



The correct answer is #3. After the switch is opened, no current can flow through  $A$ , because  $A$  is in series with the switch. However, the inductor current cannot change instantaneously, so the same amount of current that had been flowing through  $A$  flows through both  $B$  and  $C$ . (This is the only path the current can take.) Because the current flow is the same, the brightness of each of the two bulbs is the same as the brightness that  $A$  had had. The potential difference across the bulbs causes the inductor current to decrease, until eventually it is zero, and the bulbs  $B$  and  $C$  dim and go out.

Note that after the switch is opened, the voltage across *each* bulb is the same as the voltage across  $A$ , namely,  $V$ . Moreover, the potential is higher at the *bottom* node of each bulb, rather than the top node, because the current is flowing *up*, not down. So the total potential across the two is  $2V$ .

Many students answered #2, perhaps reasoning that the voltage across  $A$  was evenly divided across the two bulbs.

**But the inductor acts as a current source, not a voltage source.**