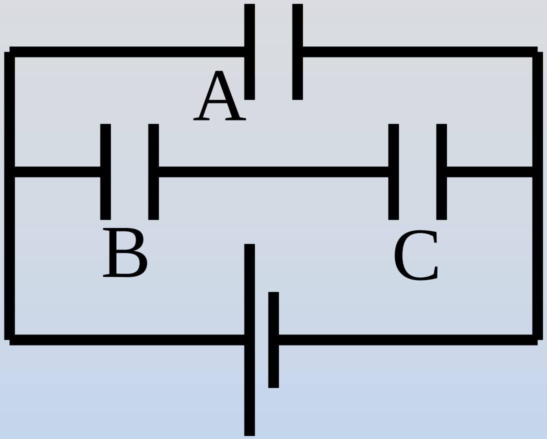
Concept Question: Capacitors

Three identical capacitors are connected to a battery.

The battery is then disconnected.

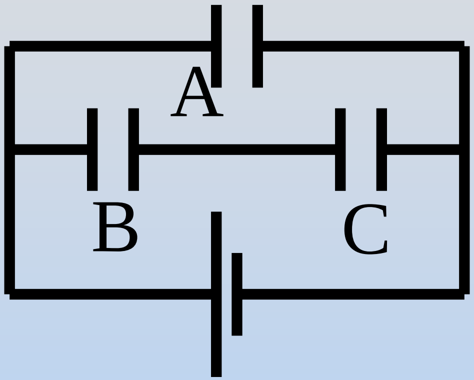


How do the charge on A, B & C compare before and after the battery is removed?

BEFORE;	AFTER
1. $Q_A = Q_B = Q_C$;	No Change
2. $Q_A = Q_B = Q_C$;	$Q_A > Q_B = Q_C$
3. $Q_A = Q_B = Q_C$;	$Q_A < Q_B = Q_C$
4. $Q_A > Q_B = Q_C$;	No Change
5. $Q_A > Q_B = Q_C$;	$Q_A = Q_B = Q_C$
6. $Q_A < Q_B = Q_C$;	No Change
7. $Q_A < Q_B = Q_C$;	$Q_A = Q_B = Q_C$

Concept Question Answer: Capacitors

Answer: 4. $Q_A > Q_B = Q_C$; No Change



Initially:

Potential across A is sum of drops across B & C.

By symmetry $V_B = V_C \rightarrow V_A > V_B = V_C$

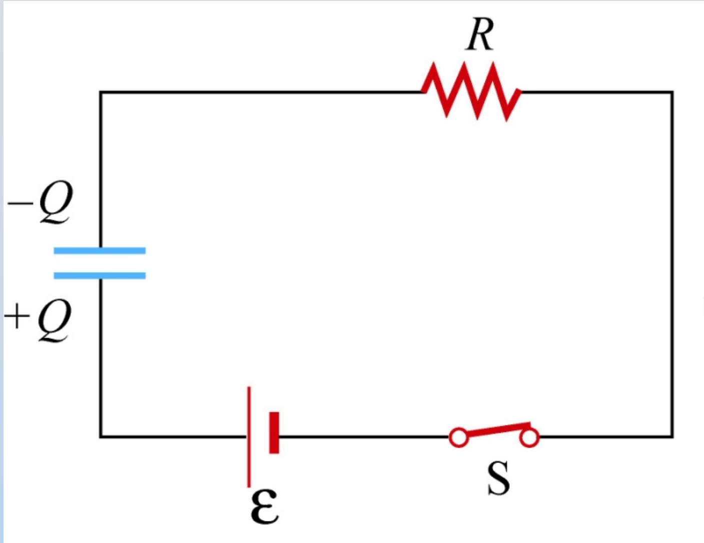
$$Q = CV \rightarrow Q_A > Q_B = Q_C$$

When battery is disconnected

There is no reason for the potential to change or charge to flow so it doesn't.

Concept Question: RC Circuit

An uncharged capacitor is connected to a battery, resistor and switch. The switch is initially open but at t = 0 it is closed. A very long time after the switch is closed, the current in the circuit is

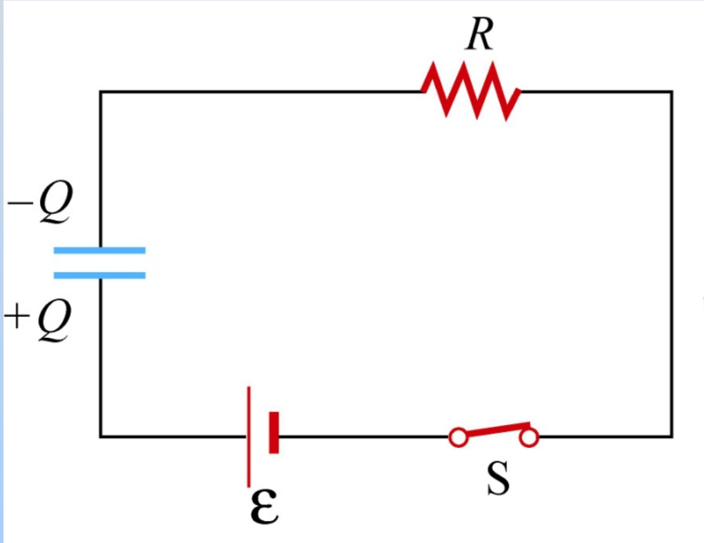


1. Nearly zero
2. At a maximum and decreasing
3. Nearly constant but non-zero
4. I don't know

Concept Question Answer: RC Circuit

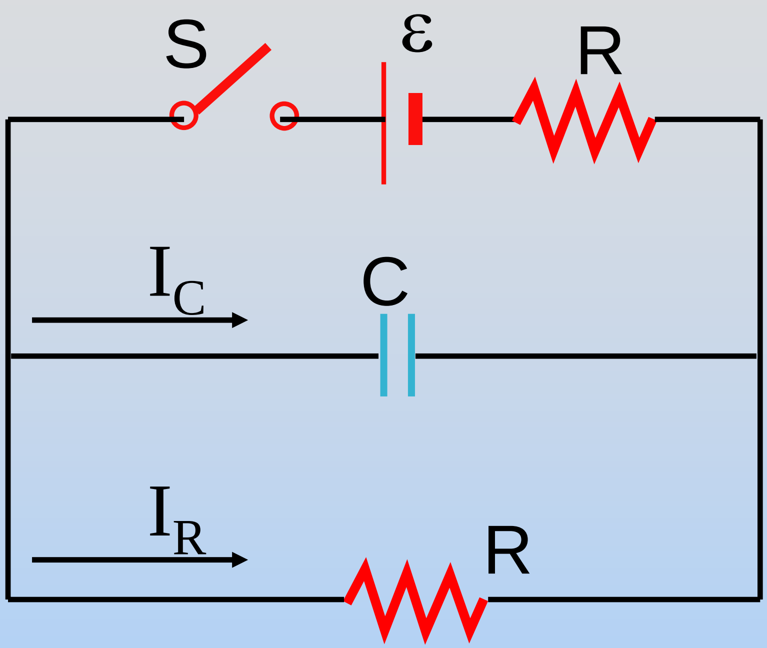
Answer: 1. After a long time the current is 0

Eventually the capacitor gets "full" – the voltage increase provided by the battery is equal to the voltage drop across the capacitor. The voltage drop across the resistor at this point is 0 – no current is flowing.



Concept Question: RC Circuit

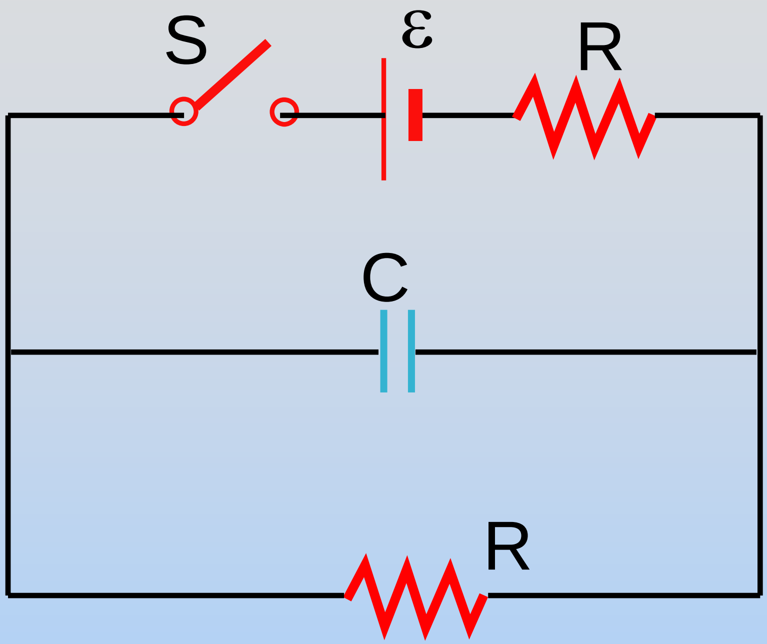
Consider the circuit at right, with an initially uncharged capacitor and two identical resistors. At the instant the switch is closed:



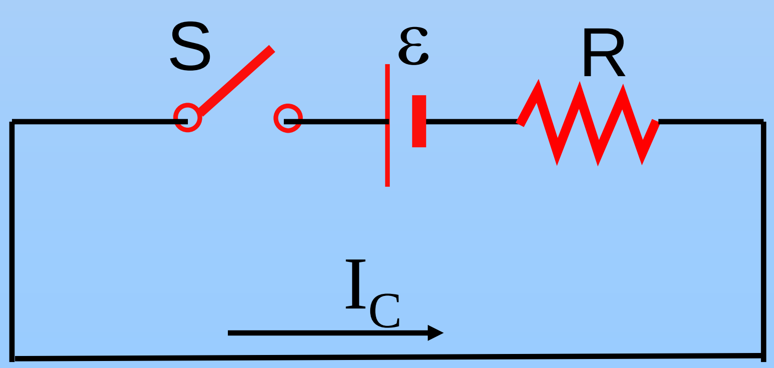
1. $I_R = I_C = 0$
2. $I_R = \varepsilon/2R; \quad I_C = 0$
3. $I_R = 0; \quad I_C = \varepsilon/R$
4. $I_R = \varepsilon/2R; \quad I_C = \varepsilon/R$
5. I don't know

Concept Question Answer: RC Circuit

Answer: 3. $I_R = 0$; $I_C = \varepsilon/R$

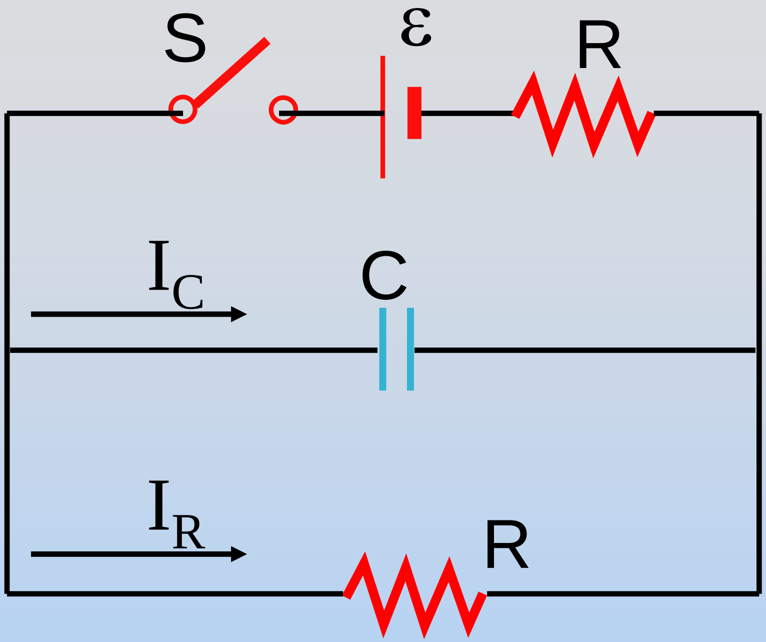


Initially there is no charge on the capacitor and hence no voltage drop across it – it looks like a short. Thus all current will flow through it rather than through the bottom resistor. So the circuit looks like:



Concept Question: RC Circuit

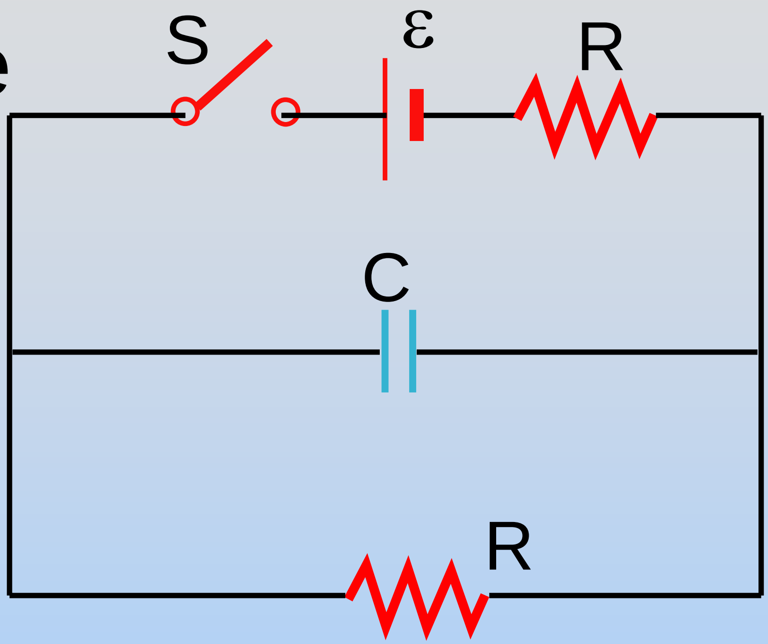
Now, after the switch has been closed for a very long time, it is opened. What happens to the current through the lower resistor?



1. It stays the same
2. Same magnitude, flips direction
3. It is cut in half, same direction
4. It is cut in half, flips direction
5. It doubles, same direction
6. It doubles, flips direction
7. None of the above

Concept Question Answer: RC Circuit

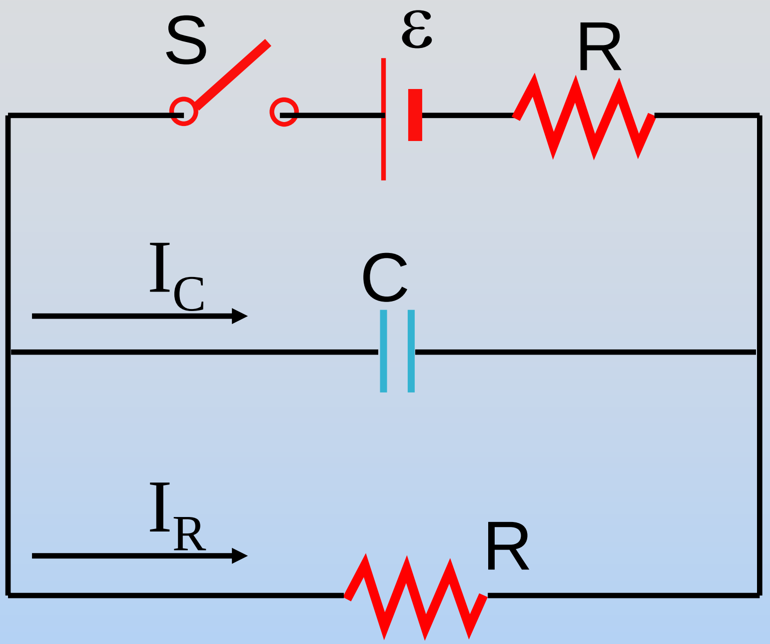
Answer: 1. It stays the same



The capacitor has been charged to a potential of ε/2, so when it is responsible for pushing current through the lower resistor it pushes a current of ε/2R, in the same direction as before (its positive terminal is also on the left)

Concept Question: Current Thru Capacitor

In the circuit at right the switch is closed at $t = 0$. At t = ∞ (long after) the *current through the capacitor* will be:

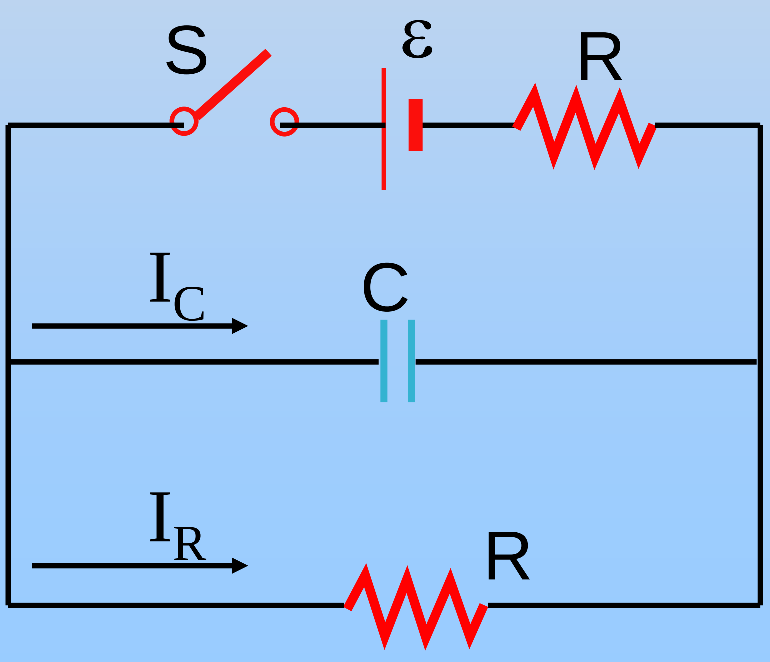


1. $I_C = 0$
2. $I_C = \varepsilon / R$
3. $I_C = \varepsilon / 2R$
4. I don't know

Concept Question Answer: I Thru Capacitor

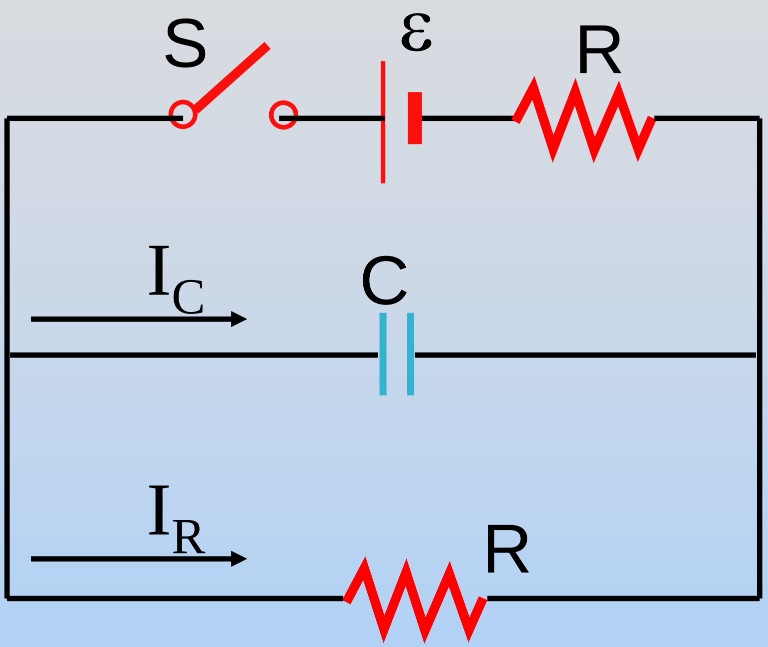
Answer: 1. $I_C = 0$

After a long time the capacitor becomes "fully charged." No more current flows into it.



Concept Question: Current Thru Resistor

In the circuit at right the switch is closed at *t* = 0. At t = ∞ (long after) the *current through the lower resistor* will be:

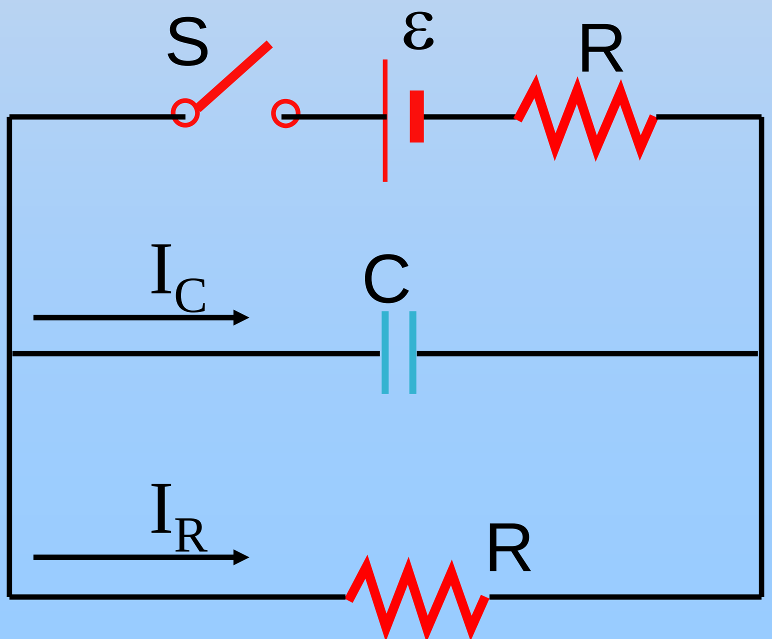


1. $I_R = 0$
2. $I_R = \varepsilon / R$
3. $I_R = \varepsilon / 2R$
4. I don’t know

Concept Question Answer: I Thru Resistor

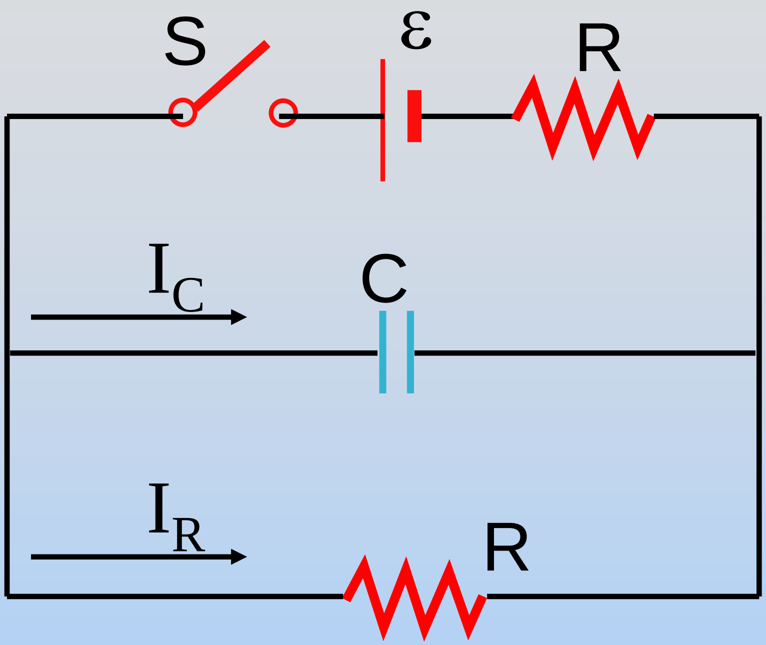
Answer: 3. $I_R = \varepsilon / 2R$

Since the capacitor is “full” we can remove it from the circuit, and all that is left is the battery and two resistors. So the current is ε/2R.



Concept Question: Opening Switch in RC Circuit

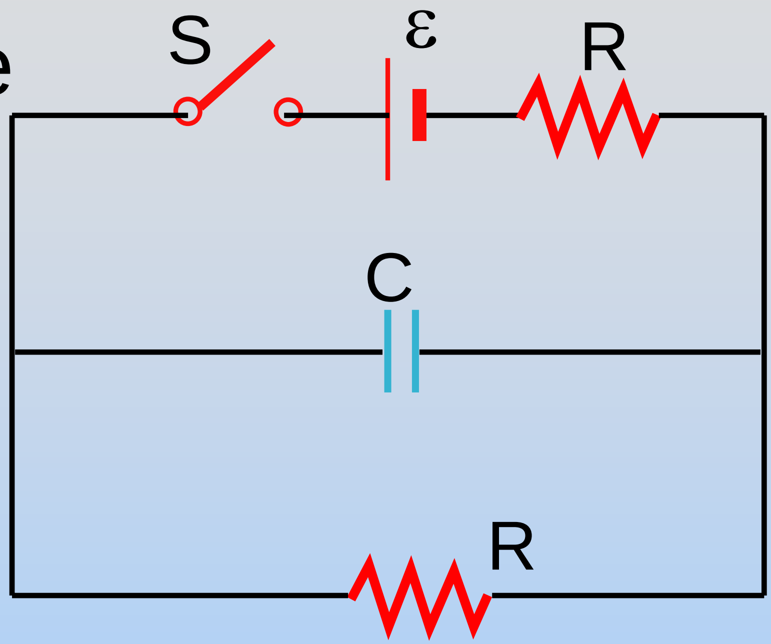
Now, after the switch has been closed for a very long time, it is opened. What happens to the current through the lower resistor?



1. It stays the same
2. Same magnitude, flips direction
3. It is cut in half, same direction
4. It is cut in half, flips direction
5. It doubles, same direction
6. It doubles, flips direction
7. None of the above.

Concept Question Answer: Opening Switch

Answer: 1. It stays the same



The capacitor has been charged to a potential of ε/2, so when it is responsible for pushing current through the lower resistor it pushes a current of ε/2R, in the same direction as before (its positive terminal is also on the left)

Concept Question: Voltage/Current in RC

Starting from a point in time where the voltage across the battery (V_B) & across the capacitor (V_C) as well as the current (I) are all zero, what happens when the battery is 'turned on'?

1. I jumps up then decays as V_C rises
2. V_C jumps up then decays as I rises
3. I & V_C both jump up then decay
4. I & V_C both gradually rise
5. I don't know

Concept Question Answer: V/I in RC

Answer: 1. I jumps up, then decays as V_C rises

I is proportional to the voltage across the resistor ($V_R = I R$). $V_R + V_C = V_B$. So as V_C increases V_R must decay, meaning that I must decay.

But why does V_C take time to rise up, while V_R, V_B can jump up quickly?