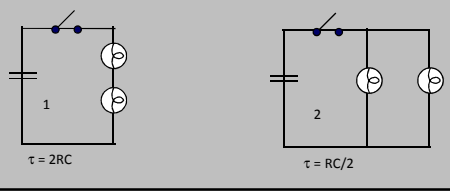
Example

Time Constant Demo

Each circuit has a 0.5 F capacitor charged to 9 Volts.
When the switch is closed:

- **Which system will be brightest?**
- **Which lights will stay on longest?**
- **Which lights consume more energy?**

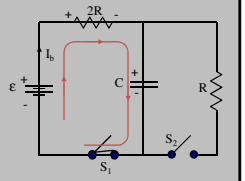


τ = 2RC τ = RC/2

Checkpoint
RC Circuits 1 & 3

Both switches are initially open, and the capacitor is uncharged.
What is the current through the battery just after switch S_1 is closed?

1) $I_b = 0$
2) $I_b = \varepsilon/(3R)$
3) $I_b = \varepsilon/(2R)$
4) $I_b = \varepsilon/R$



Both switches are initially open, and the capacitor is uncharged.
What is the current through the battery after switch 1 has been closed a long time?

1) $I_b = 0$ 2) $I_b = V/(3R)$ 3) $I_b = V/(2R)$ 4) $I_b = V/R$

Example

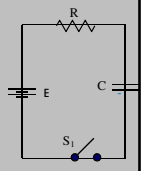
Practice

Calculate current immediately after switch is closed:

Calculate current after switch has been closed for 0.5 seconds:

Calculate current after switch has been closed for a long time:

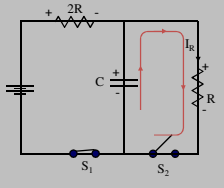
Calculate charge on capacitor after switch has been closed for a long time:

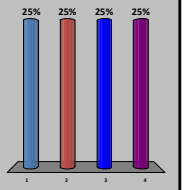


R=10Ω
C=30 mF
E =20 Volts

Both switches are closed. What is the final charge on the capacitor after the switches have been closed a long time?

1. Q = 0
2. Q = C ε /3
3. Q = C ε /2
4. Q = C ε





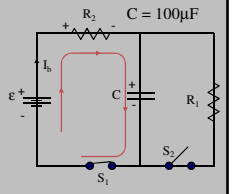
Example

Charging: Intermediate Times

Calculate the charge on the capacitor 3×10^{-3} seconds after switch 1 is closed.

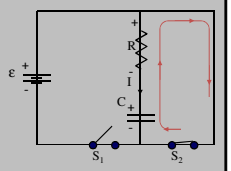
$q(t) = q_\infty(1-e^{-t/RC})$

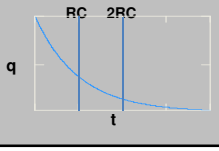
$R_1 = 20\ \Omega$
$R_2 = 40\ \Omega$
$\varepsilon = 50$ Volts
$C = 100\mu F$



RC Circuits: Discharging

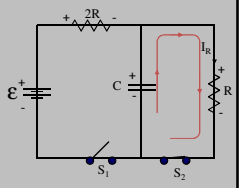
- KLR: _____
- Just after…: _____
  - Capacitor is still fully charged
- Long time after: _____
- Intermediate (more complex)
  - $q(t) = q_0\, e^{-t/RC}$
  - $I_c(t) = I_0\, e^{-t/RC}$





Checkpoint RC Circuits 5

- After switch 1 has been closed for a long time, it is opened and switch 2 is closed. What is the current through the right resistor just after switch 2 is closed?



1) $I_R = 0$
2) $I_R = \varepsilon/(3R)$
3) $I_R = \varepsilon/(2R)$
4) $I_R = \varepsilon/R$

After being closed for a long time, the switch is opened. What is the charge Q on the capacitor 0.06 seconds after the switch is opened?

1. 0.368 q_0
2. 0.632 q_0
3. 0.135 q_0
4. 0.865 q_0