Pre-Health Post-Baccalaureate Program
PHY2054 Study Guide & Practice Problems

Date:

10/12 - 10/16

Topics Covered:

Capacitors
RC Circuits

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Capacitors

- A ==capacitor== refers to a pair of conductors separated by an insulated layer

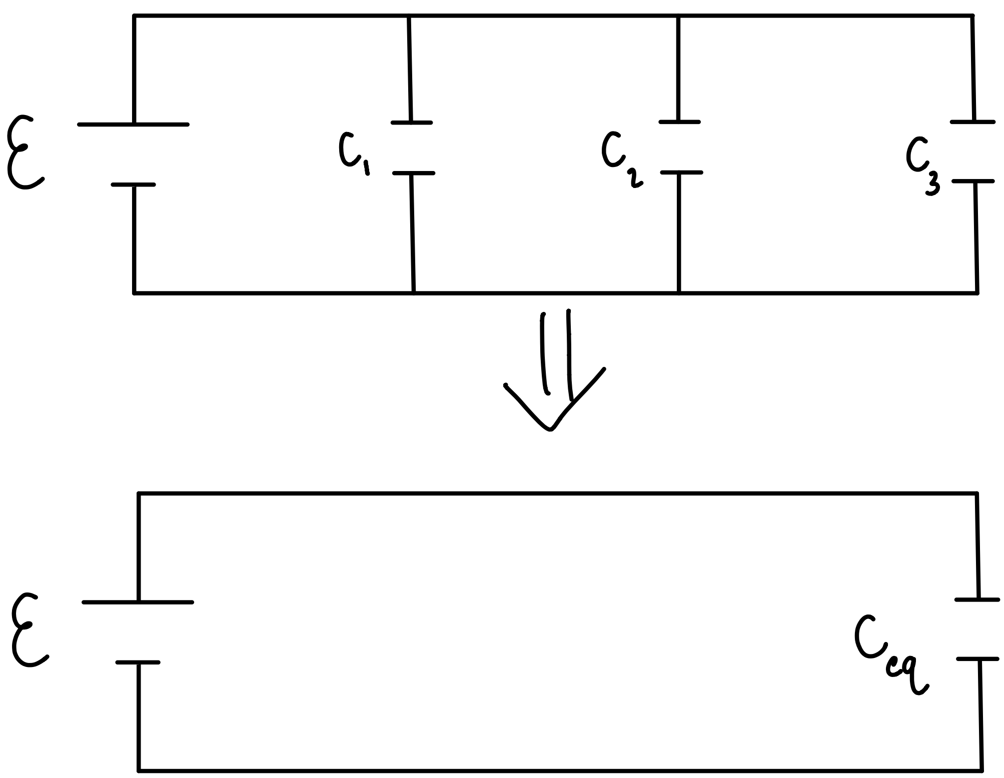
- Capacitors charge when attached to a battery, therefore increasing the potential difference until reaching the point $\Delta V_c = \varepsilon$

- At this point of full charge, the charge on each plate of the capacitor is $Q = C\Delta V$

Capacitors in Parallel

- when thinking about equivalent capacitance, we are going to do the opposite of what we did to find equivalent resistance
- For capacitors in parallel, the equivalent capacitance equals the sum of the individual capacitors:

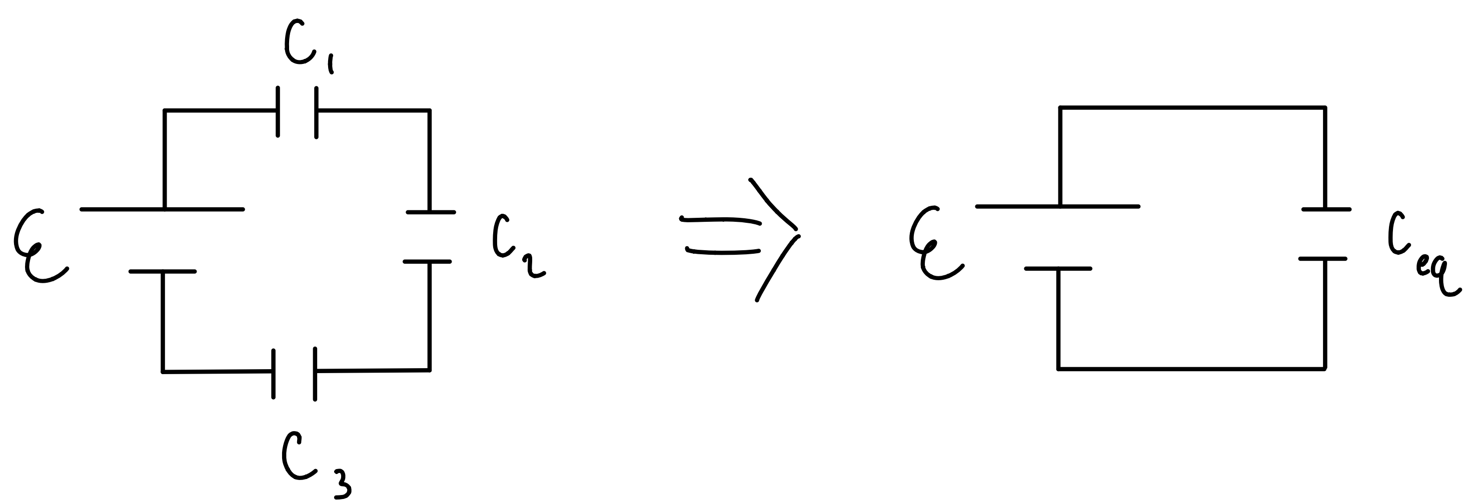
$$C_{eq_{par.}} = C_1 + C_2 + C_3 + \dots + C_N$$



Capacitors in Series

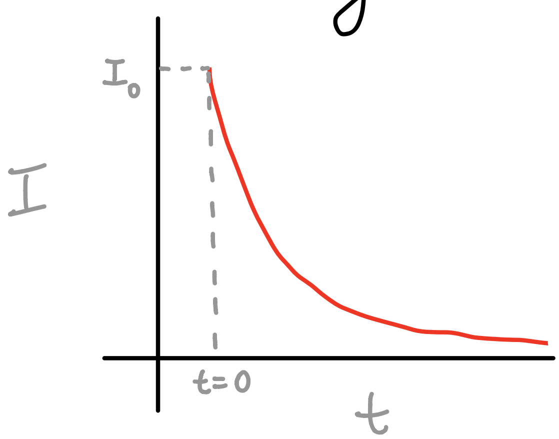
- For capacitors in series, the equivalent capacitance equals the inverse of the sum of the inverse of the individual capacitors (was that confusing? I confused myself just writing it. If so, see the below formula).

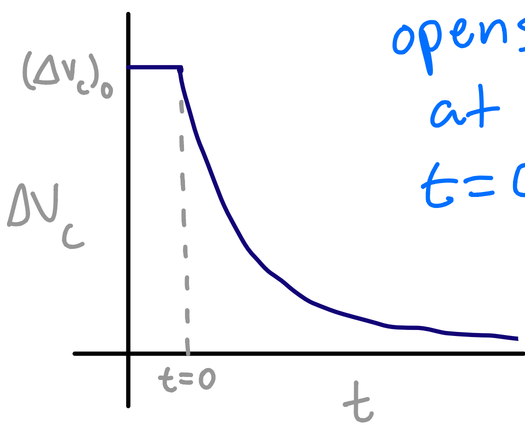
$$C_{eq_{ser.}} = \left(\frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} + \cdots + \frac{1}{C_n}\right)^{-1}$$



RC Currents

- We have dealt with circuits in which the current is constant... but what if the current changes with respect to time due to a charging or discharging capacitor?
- Starting with a fully charged capacitor, the initial current (driven by the capacitor) and the capacitor voltage (separation of charge) begin high, and exponentially decrease over time as the capacitor discharges





* switch opens at $t=0$

- Current and voltage in a discharging RC circuit are mathematically modeled as:

$$I = I_0 e^{-\frac{t}{RC}}$$

$$\Delta V_C = (\Delta V_C)_0 e^{-\frac{t}{RC}}$$

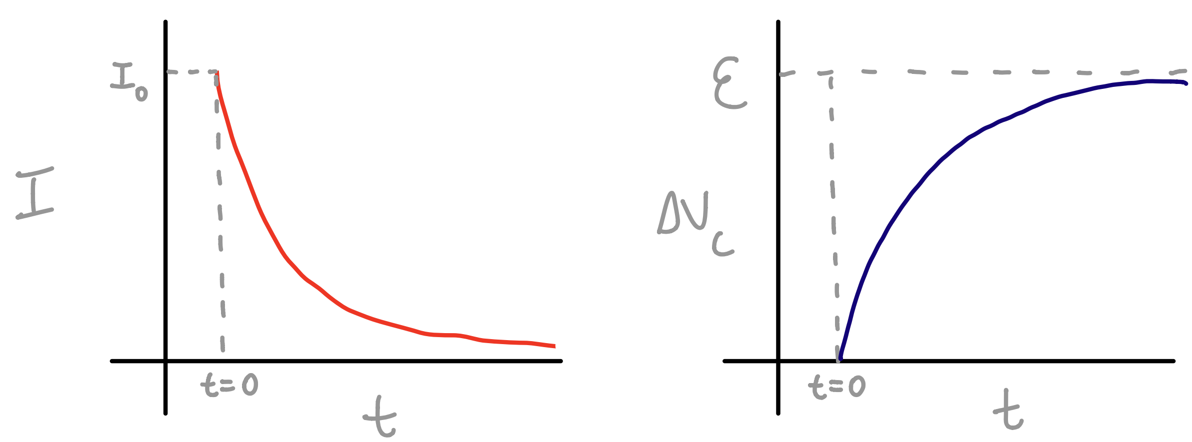
Where:

$t \rightarrow$ time (s)

$R \rightarrow$ resistance (Ω)

$C \rightarrow$ capacitance (F)

- On the other hand, if we have a discharged capacitor, our dynamic slightly changes:
  - The battery's potential difference increases over time while charging.
  - The potential difference opposes the current, so the current decreases over time.



* switch closes at t=0

- Current and voltage in a charging RC circuit are mathematically modeled as:

$$I = I_0 e^{-\frac{t}{RC}}$$

$$\Delta V_c = \mathcal{E}\left(1 - e^{-\frac{t}{RC}}\right)$$