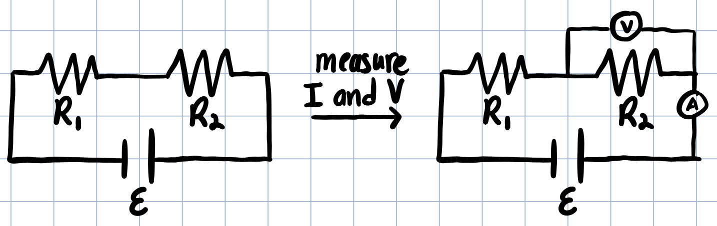
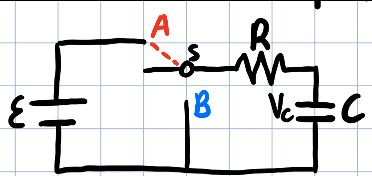
Ammeters & Voltmeters

- Ammeters measure current and are denoted by —Ⓐ— whereas voltmeters measure voltage and are denoted by —Ⓥ—



- However, they are also objects and have their own resistance; to make as little change to the original circuit as possible, ammeter should have as little R as possible whereas voltmeter has as large as possible

RC Circuits: resistor + capacitor



- Switching to position A

  Loop Law: $\varepsilon - IR - \frac{q}{C} = 0$

  $\rightarrow \varepsilon - \frac{dq}{dt}R - \frac{q}{C} = 0 \rightarrow dt = \frac{R\,dq}{\varepsilon - \frac{q}{C}} \rightarrow t = -RC\ln\left(1 - \frac{Q}{\varepsilon C}\right)$

  So Q, the charge on the capacitor, equals $\varepsilon C(1 - e^{-t/RC})$

  $I = \frac{dQ}{dt} = \frac{\varepsilon}{R}e^{-t/RC}$

  $V_c = \frac{Q}{C} = \varepsilon(1 - e^{-t/RC})$

  At $t = \infty$, $I = 0$ so $V_R = 0$ so $V_c = \varepsilon$!

  If $Q = 0$, C acts like it's not there and if $I = 0$, R acts like it's not there!

  RC is important! $RC = \tau$, time constant = time to decay 37% (e^{-1}) of initial or time to grow 63% of final

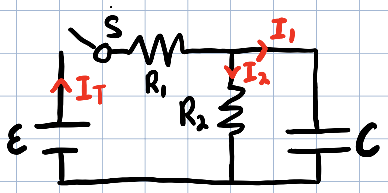
- After that, switch to position B

  $-IR - \frac{q}{C} = 0 \rightarrow \frac{dq}{dt}R + \frac{q}{C} = 0 \rightarrow -\frac{dq\,RC}{q} = dt \rightarrow t = -RC\ln\left(\frac{Q}{Q_0}\right) \rightarrow Q = Q_0 e^{-t/RC}$

  $I = \frac{dQ}{dt} = -\frac{Q_0}{RC}e^{-t/RC}$; negative b/c discharging

$$V_c = \frac{Q}{C} = \frac{Q_0}{C} e^{-t/RC}$$

- Example:



At $t=0$, C is uncharged and S open. Close S.

What is I_T right after S is closed? $\frac{\varepsilon}{R_1}$; no current through R_2

What is I_1 right after S is closed? I_T; least resistance

I_T tends to $\frac{\varepsilon}{R_1+R_2}$ as C charges and approaches infinite resistance

Graphs: