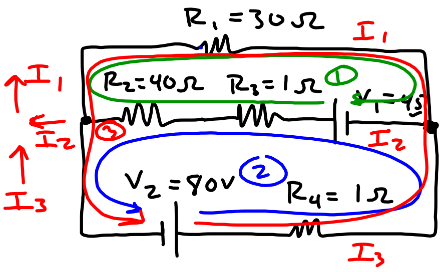
Kirchhoff's Practice



Calculate the current in each branch.

(1) $+V_1 - I_2R_3 - I_2R_2 - I_1R_1 = 0$

(2) $+V_2 - I_3R_4 + V_1 - I_2R_3 - I_2R_2 = 0$

(3) $+V_2 - I_3R_4 - I_1R_1 = 0$

$$I_2 + I_3 = I_1$$

* We are basically done with Physics at this point... now on to Mathland!

$$V_2 - I_3R_4 - (I_2 + I_3)R_1 = 0$$
$$V_2 - I_3R_4 - I_2R_1 - I_3R_1 = 0$$
$$I_2 = \frac{1}{R_1}(V_2 - I_3R_4 - I_3R_1)$$

$$V_2 - I_3R_4 - I_2(R_3 + R_2) + V_1 = 0$$
$$V_2 - I_3R_4 - \left[\frac{1}{R_1}(V_2 - I_3R_4 - I_3R_1)\right](R_3 + R_2) + V_1 = 0$$
$$V_2 - I_3R_4 - \left(\frac{V_2}{R_1} - \frac{I_3R_4}{R_1} - \frac{I_3\cancel{R_1}}{\cancel{R_1}}\right)(R_3 + R_2) + V_1 = 0$$
$$V_2 - I_3R_4 - \frac{V_2(R_3+R_2)}{R_1} + \frac{I_3R_4(R_3+R_2)}{R_1} + I_3(R_3+R_2) + V_1 = 0$$
$$-I_3R_4 + I_3\frac{R_4(R_3+R_2)}{R_1} + I_3(R_3+R_2) = -V_1 - V_2 + \frac{V_2(R_3+R_2)}{R_1}$$
$$I_3\left[-R_4 + \frac{R_4(R_3+R_2)}{R_1} + (R_3+R_2)\right] = -V_1 - V_2 + \frac{V_2(R_3+R_2)}{R_1}$$
$$I_3 = \frac{-V_1 - V_2 + \frac{V_2(R_3+R_2)}{R_1}}{-R_4 + \frac{R_4(R_3+R_2)}{R_1} + R_3 + R_2}$$
$$= \frac{-45V - 80V + \frac{80V(1\Omega + 40\Omega)}{30\Omega}}{-1\Omega + \frac{1\Omega(1\Omega + 40\Omega)}{30\Omega} + 1\Omega + 40\Omega}$$
$$= \frac{-45V - 80V + 109.33V}{-1\Omega + 1.37\Omega + 1\Omega + 40\Omega}$$
$$= \frac{-15.67V}{41.37\Omega}$$
$$= -0.38A$$ * Not quite 1.7A ...

CAPACITORS

- Store energy as an electric field.
  - Doesn't happen instantaneously, but does happen very quickly.
  - We can use the timing aspect to control circuits.

- Equations:

$$Q = C\,|\Delta V|$$

Q → charge; C → capacitance; $|\Delta V|$ → electric potential

$$C = \frac{K \varepsilon_0 A}{d}$$

C → capacitance

ε_0 → permittivity of free space (constant)

K → dielectric constant

A → area

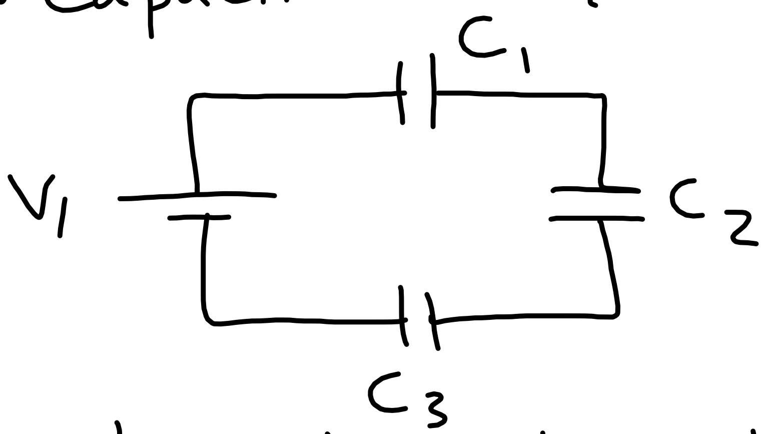
d → distance between plates

- Energy stored in a capacitor:

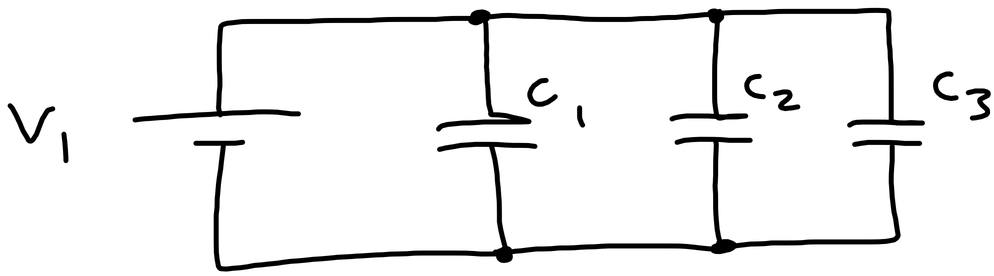
$$U_c = \frac{1}{2} Q \Delta V$$

$$U_c = \frac{1}{2} C (\Delta V)^2$$

- Capacitor - Only Circuit



$$\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} \qquad \frac{1}{C_s} = \sum_i \frac{1}{C_i}$$



$$C_{eq} = C_1 + C_2 + C_3$$

$$C_p = \sum_i C_i$$