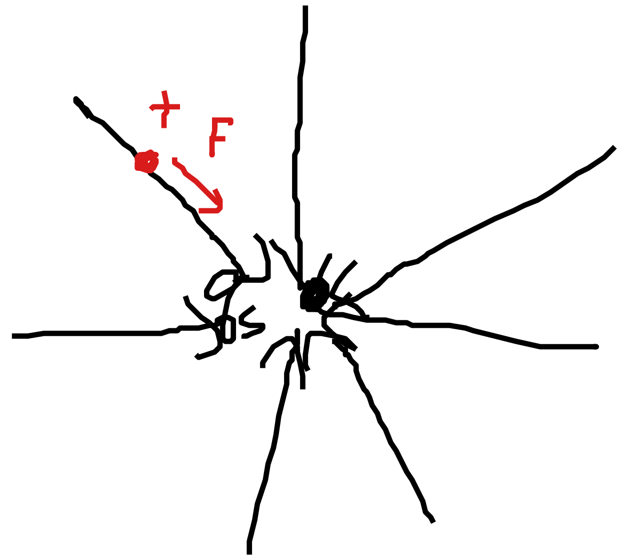
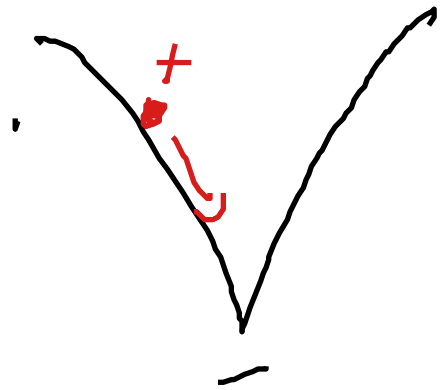
Electric Field $\vec{E}$

- points downhill
- $\vec{E}_{avg} = \frac{\Delta V}{d}$ (steepness)
- $\vec{F} = q_T \vec{E}$ WWPD

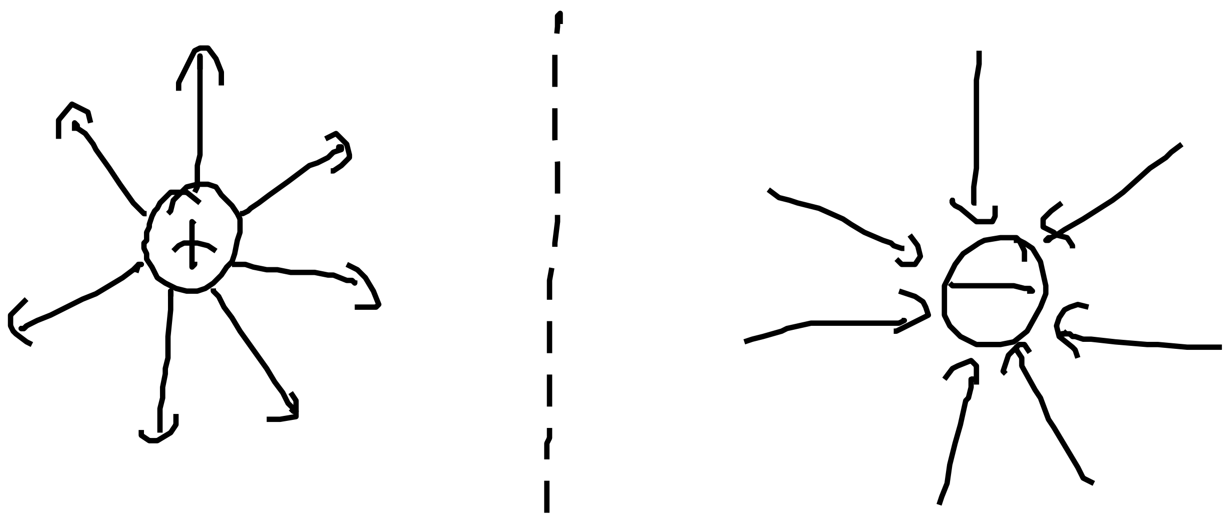
  $q_T > 0$: $\vec{F}$ & $\vec{E}$: same direction

  $q_T < 0$: $\vec{F}$ & $\vec{E}$ opposite directions
- $\vec{E}$ is perpendicular to equipotential lines





+ & - attract



Electric Field Lines

Start at positive charges

stop at negative charges

For a single point charge q_s

$$\vec{F} = q_T \vec{E}$$

$$F = k \frac{|q_s q_T|}{d^2}$$

$$\vec{E} = \frac{\vec{F}}{q_T} = k \frac{q_s}{d^2}$$ away if $q_s > 0$, towards if $q_s < 0$

$$F = k\left|\frac{q_s q_t}{d^2}\right|$$

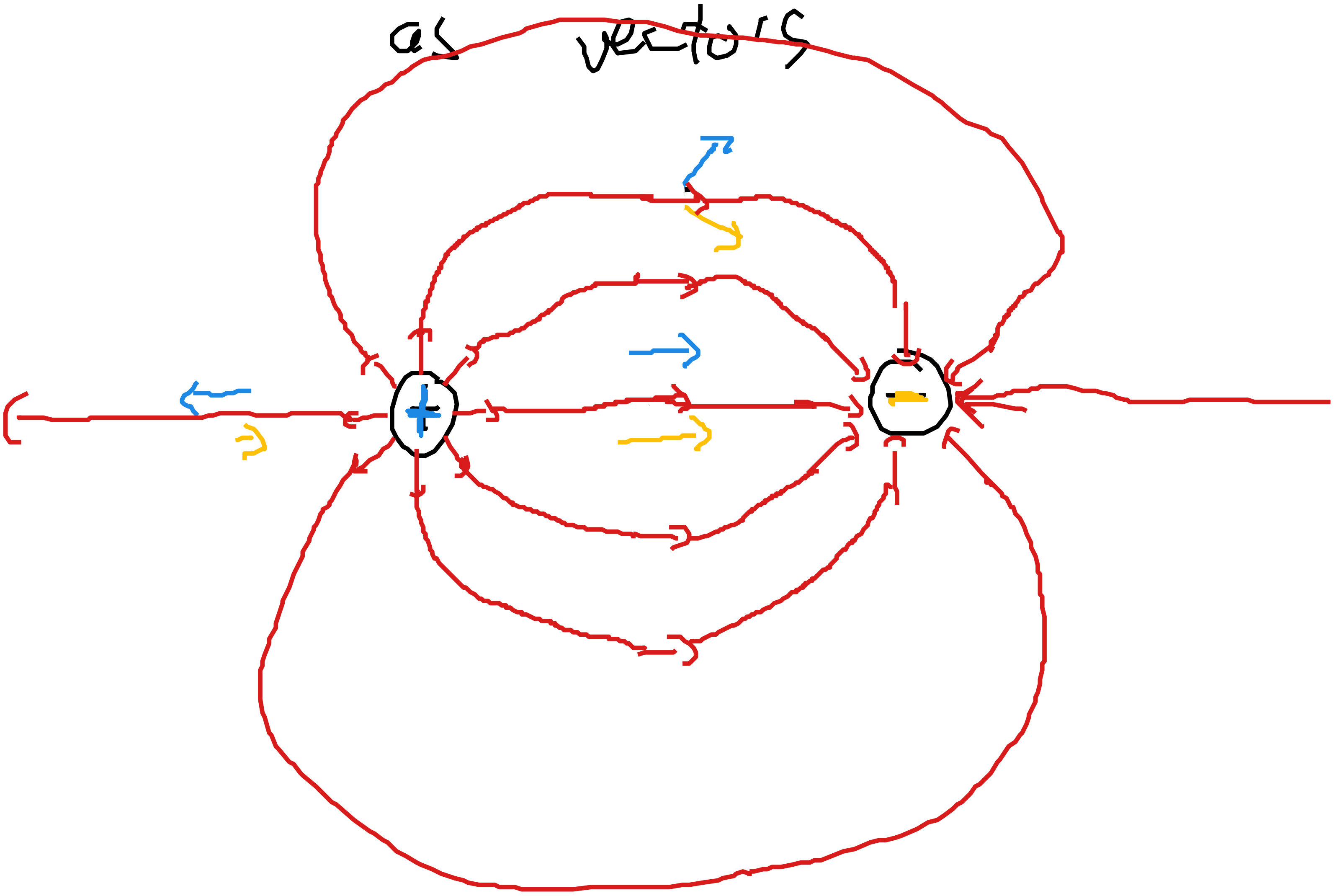
$$E = k\left|\frac{q_s}{d^2}\right|$$

← sign = direction (for vectors) so figure out direction separately

$$PE = k\frac{q_s q_t}{d}$$

$$V = k\frac{q_s}{d}$$

Electric Fields are additive as vectors

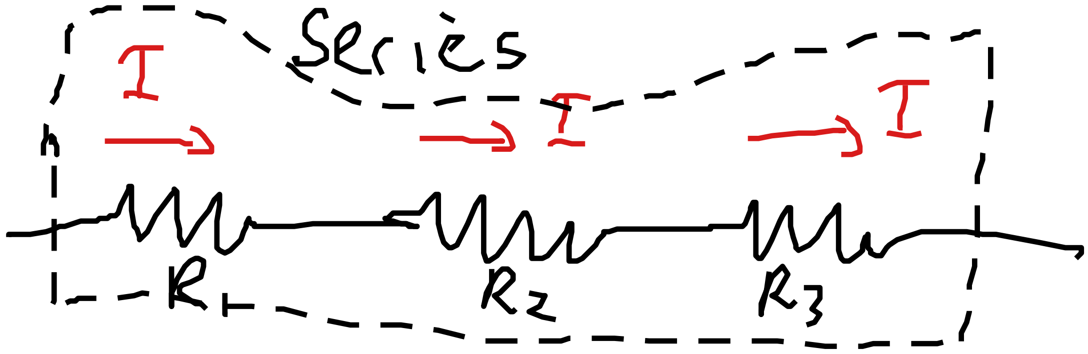


Electric Dipole Field

Electric Dipole: 2 charges +q & −q

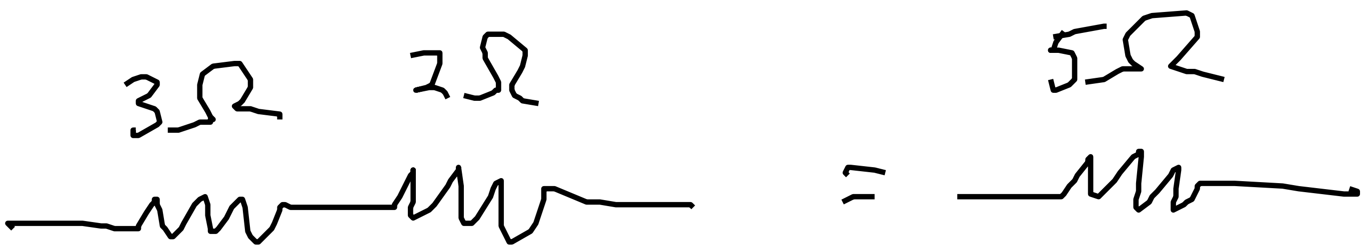
Field: lobed shape

Back to circuits for a moment...

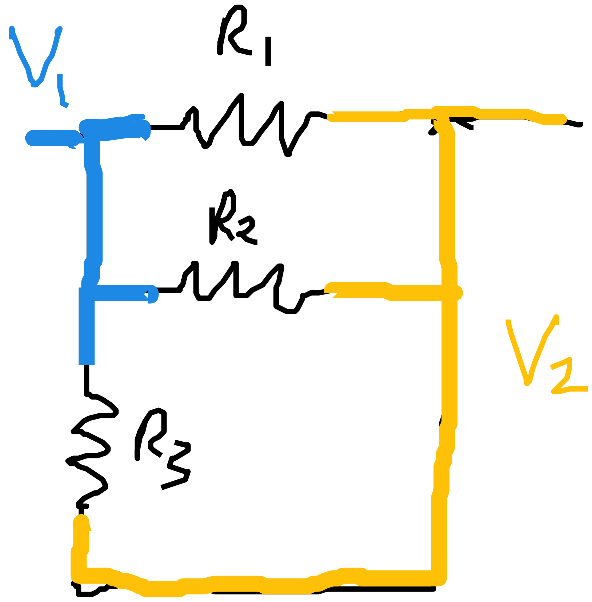


same as

$$R_{eq} = R_1 + R_2 + R_3 + \ldots$$



Parallel



ΔV is same across all

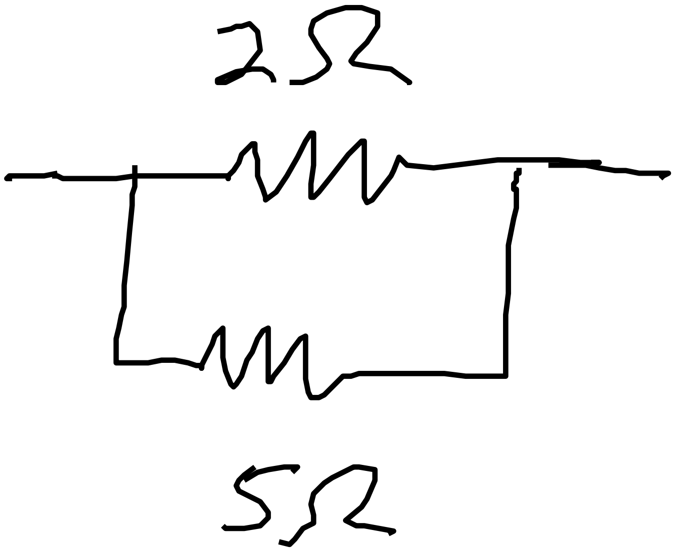
$$\Delta V = V_1 - V_2$$

$$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

Conductance $G = \frac{1}{R}$

"how easy it is for current"

$$I = G\Delta V$$



R_{eq}?

not $\frac{1}{7}$ you know better

$$\frac{1}{R_{eq}} = \frac{1}{2\Omega} + \frac{1}{5\Omega}$$

$$= \frac{5}{10\Omega} + \frac{2}{10\Omega}$$

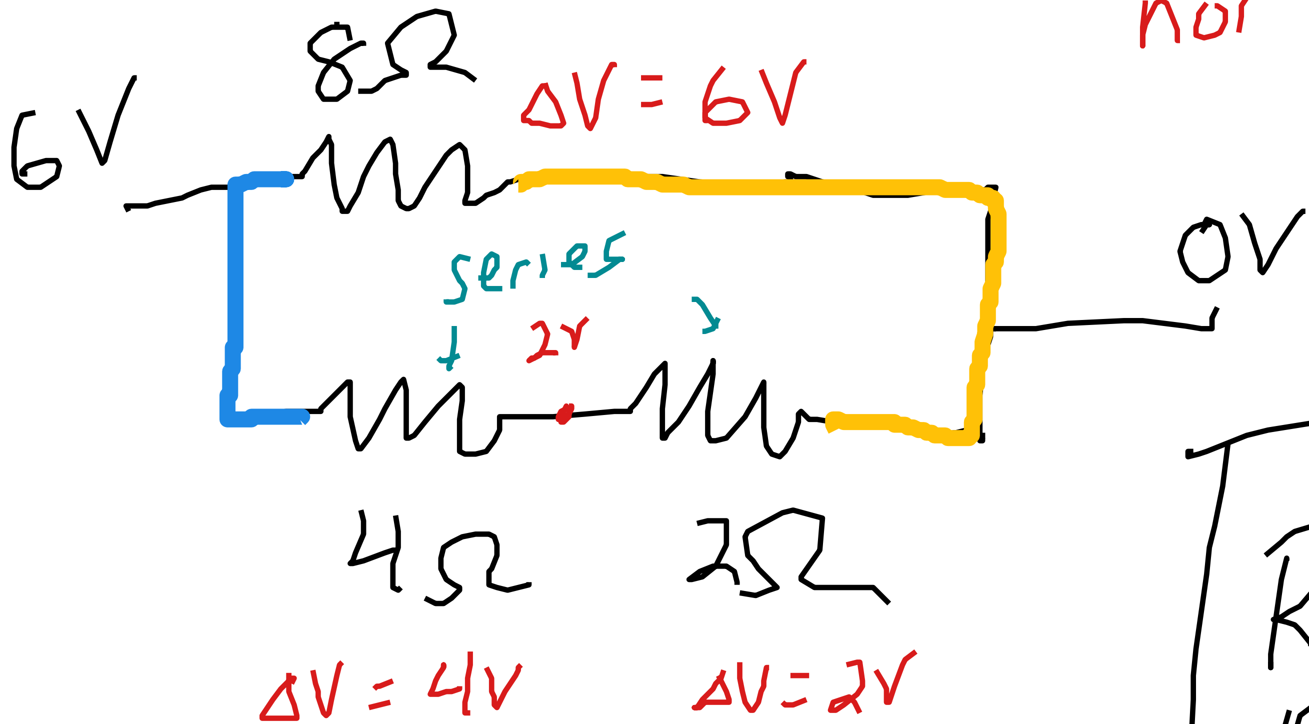
Don't forget to flip!

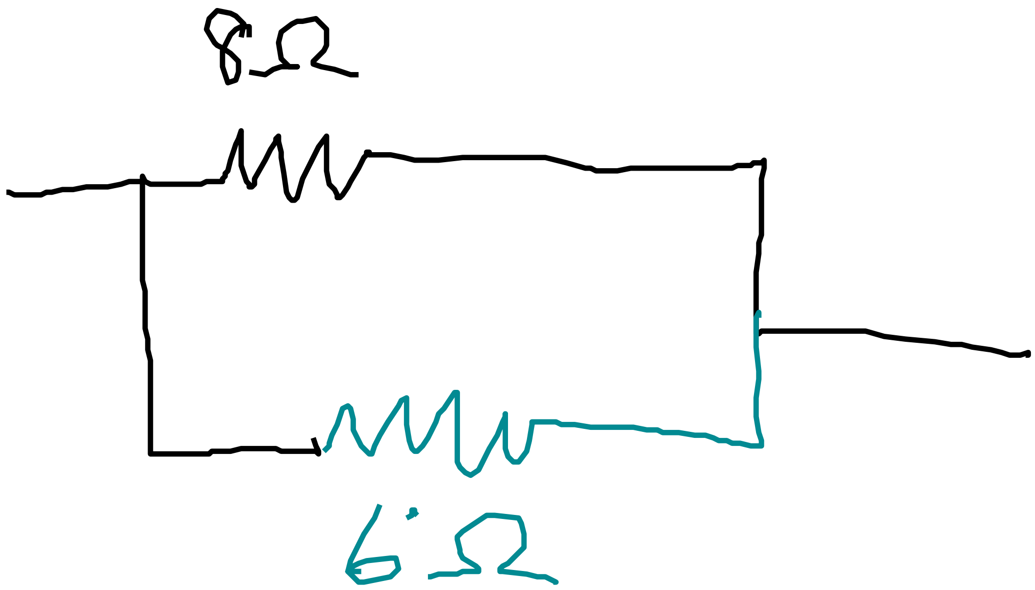
$$\frac{1}{R_{eq}} = \frac{7}{10\Omega} = 0.7/\Omega$$

$$R_{eq} = \frac{1}{0.7}\Omega = 1.43\Omega$$

not in parallel

Resistance Reduction

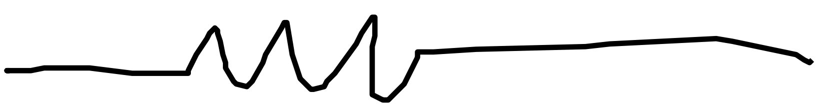




$$\frac{1}{R_{eq}} = \frac{1}{8} + \frac{1}{6}$$

$$= \frac{3+4}{24}$$

$$R_{eq} = \frac{24}{7}$$



$$R_{eq} = \frac{24}{7}\,\Omega$$

$$= 3\tfrac{3}{7}\,\Omega$$