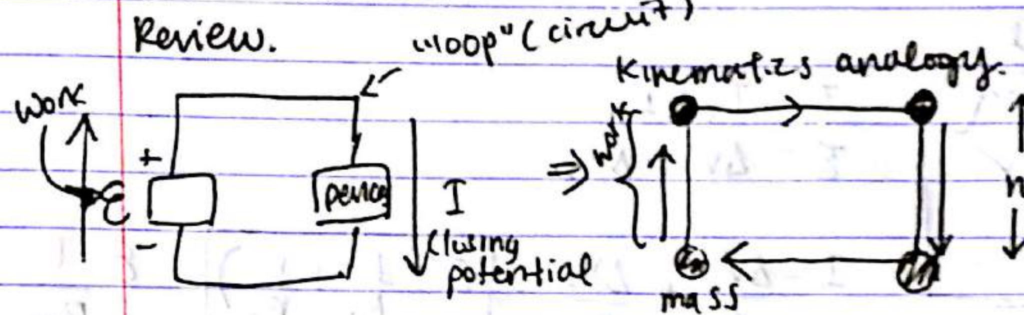
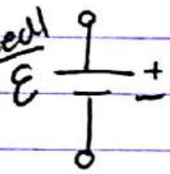
More Circuits!

Review.



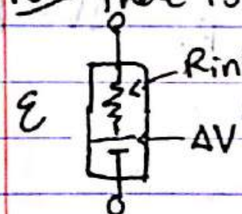
$\mathcal{E}$ = electromotive force = work per unit charge $= \Delta V$

ideal



(W directly related to $\mathcal{E}$)

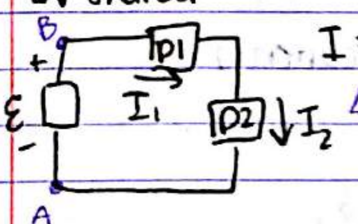
real there is internal resistance



Rint. reduces the current that $\mathcal{E}$ can supply.

Series

ΔV shared



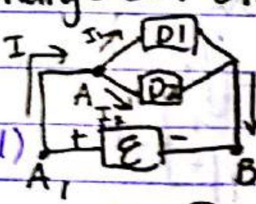
$I = I_1 = I_2$

$\Delta V_{AB} = \mathcal{E} = \Delta V_1 + \Delta V_2$

(energy is conserved)

Parallel

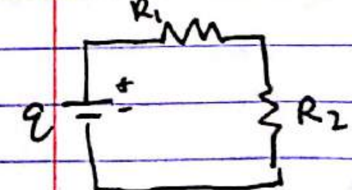
Charge (I) shared



$I = I_1 + I_2$ (charge is conserved)

$\mathcal{E} = \Delta V_{A_1B_1} = \Delta V_1 = \Delta V_2$

R-Series

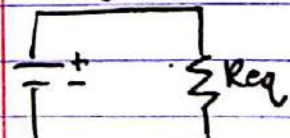


$I = I_1 = I_2$

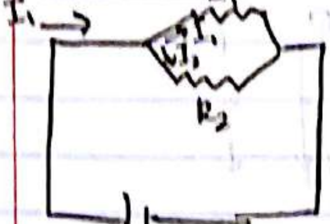
$\mathcal{E} = \Delta V_1 + \Delta V_2 = I_1R_1 + I_2R_2$

$\boxed{\mathcal{E} = I(R_1 + R_2)} = I R_{eq}$, $R_{eq} = R_1 + R_2 = \sum_{i=1} R_i$

⇓



R-Parallel



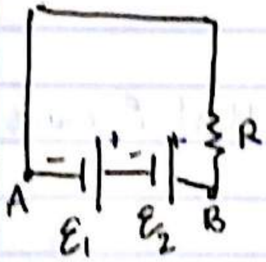
$I = I_1 + I_2$

$\mathcal{E} = \Delta V_1 = \Delta V_2$

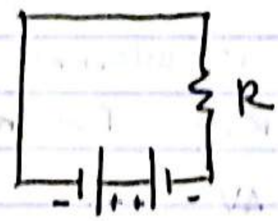
$$I = \frac{\Delta V_1}{R_1} + \frac{\Delta V_2}{R_2} = \boxed{\mathcal{E}\left(\frac{1}{R_1} + \frac{1}{R_2}\right)} = \mathcal{E}\,\frac{1}{R_{eq}}$$

$$\therefore \frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} = \sum_i \frac{1}{R_i}$$

$\mathcal{E}$-Series

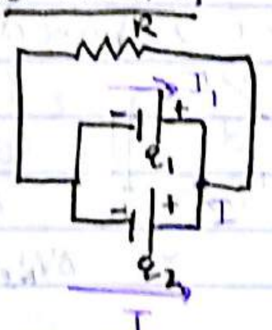


$\Delta V = \mathcal{E}_1 + \mathcal{E}_2$



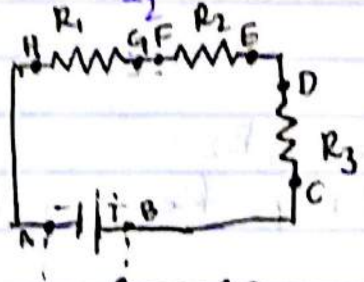
$\Delta V = \mathcal{E}_1 - \mathcal{E}_2$

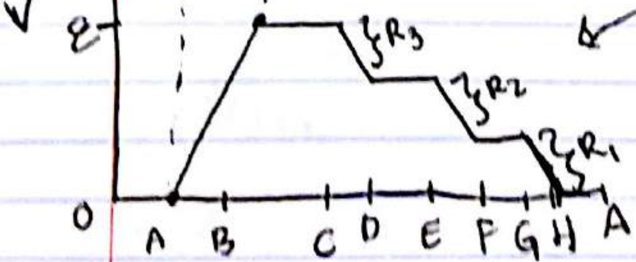
$\mathcal{E}$-Parallel



$I = I_1 + I_2$

(can provide more energy-current)



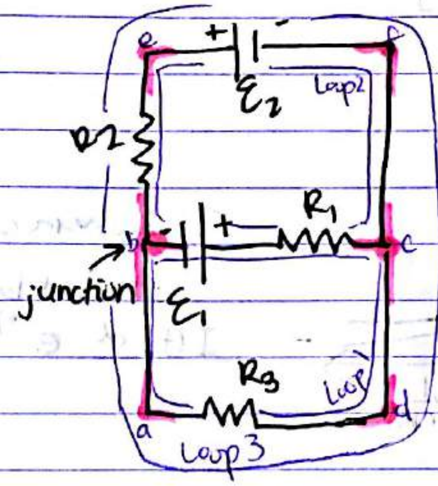


So energy is conserved.

Kirchhoff's Loop Law (Rule 2)

1) Charge is conserved ($I = I_1 + I_2 + \ldots$)

2) Energy is conserved ($\Delta V = \Delta V_1 + \Delta V_2 + \ldots$)



Charge is consered @ a Junction

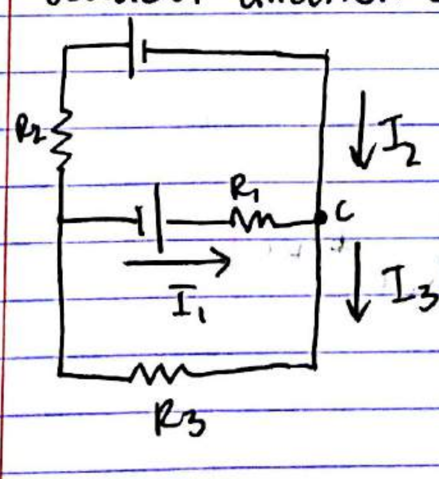
Energy is consered @ a Loop

- junctions w/ lots of wires are helpful. (b & c)

- choose small loops (ex. aefda doesn't help much.)

$\boxed{\text{Junction: } \sum_{i\,\text{junction}} I_{i\,in} = \sum_{i\,\text{junction}} I_{out}}$ $\boxed{\text{Loop: } \underbrace{\sum_{i\,\text{loop}} \Delta V_i = 0}_{\text{must be closed loop.}}}$

- Decide on direction of travel (clockwise)



*these directions are assumptions - stay consistent

- correct for direction based on $I > 0$ or $I < 0$.

@ Junction C

$I_1 + I_2 = I_3$

@ Loop abcda

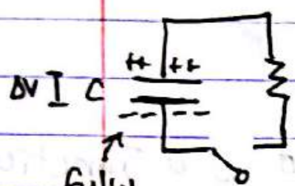
$\mathcal{E}_1 - R_1 I_1 - R_3 I_3 = 0$

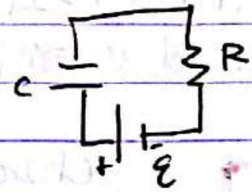
@ Loop befcb

$-\mathcal{E}_2 + R_1 I_1 - \mathcal{E}_1 - I_2 R_2 = 0$

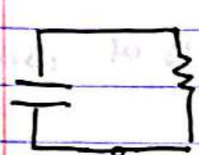
against direction of I_1

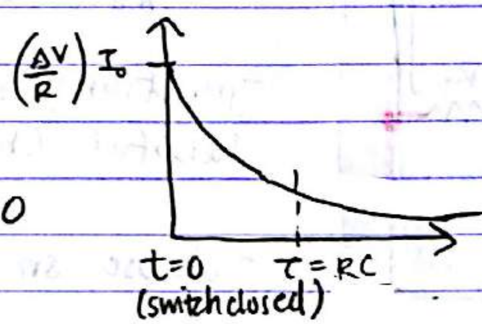
RC Circuit





fully chgd $\Rightarrow \Delta V$





τ is when current is reduced by $\approx 37\%$

$I(t) \propto e^{-t/RC}$

close $\rightarrow I \neq 0$

$I_0 = \dfrac{Q}{CR}$

$\Delta V - IR = 0$ $\qquad I = -\dfrac{dQ}{dt}$

$\dfrac{Q}{C} - IR = 0$

$\dfrac{Q}{C} + \dfrac{dQ}{dt} R = 0$

$-R\dfrac{dQ}{dt} = \dfrac{Q}{C}$

$\displaystyle\int_{Q_0}^{Q} \frac{dQ}{Q} = \int_0^t -\frac{dt}{RC} = \ln\frac{Q}{Q_0} = \frac{-t}{RC}$

$$\boxed{\therefore\ Q(t) = Q_0 e^{-t/RC}}$$