Phys 2120-4 10/1/12

Note Title 10/1/2012

Electric Circuits

Kirchhoff Rules !!

Apply rules until you have enough indpt. eqns.

Junction $\sum I_{in} = \sum I_{out}$

Loop : Sum up all voltage drops & gains $= 0$

Assign currents to each branch

25.25

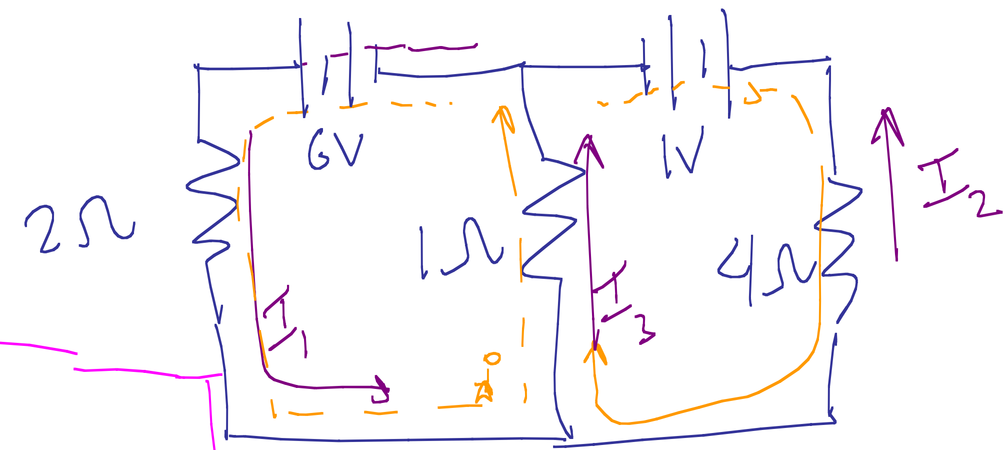
Basic eqns

Junctions:

$$-I_1 + I_2 + I_3 = 0$$

$$+6\,V - (2\Omega)\,I_1 - (1\Omega)\,I_3 = 0$$

$$1\,V + (4\Omega)\,I_2 - (1\Omega)\,I_3 = 0$$



Set of linear equations p.?

3x3

Sub'd

$$6V - 3I_1 + I_2 = 0$$

Add & subtract

$$1V + 5I_2 - I_1 = 0$$

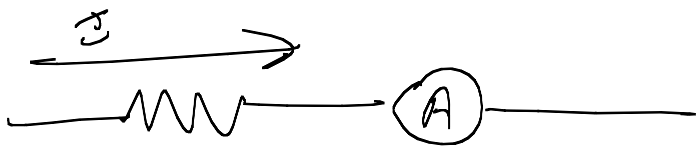
$$\boxed{I_2 = 0.214\text{ A} \qquad I_1 = 2.07\text{ A} \qquad I_3 = 1.86\text{ A}}$$

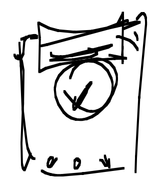
More stuff

Measurements of quantities

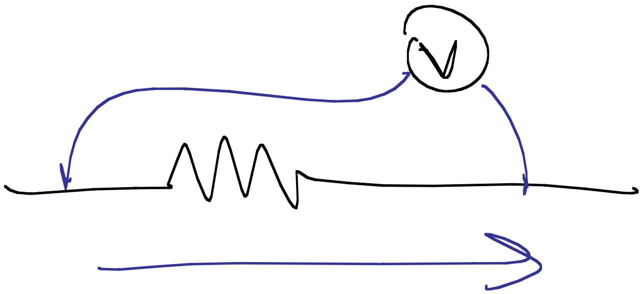
Ammeters & Voltmeter

Current

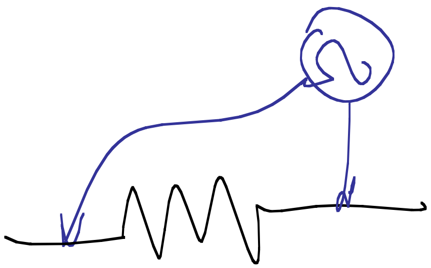




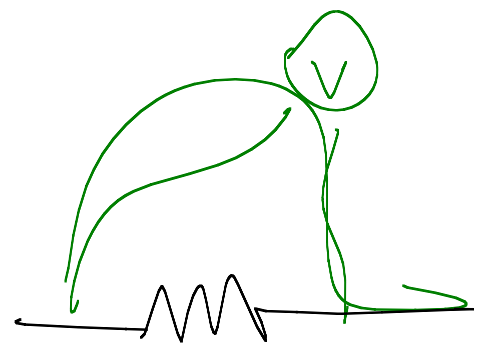
Multimeter



Reads out potential diff.

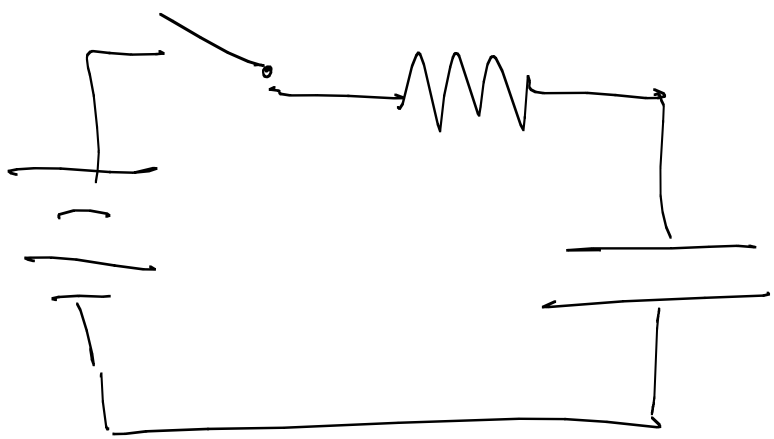


Ohmmeter

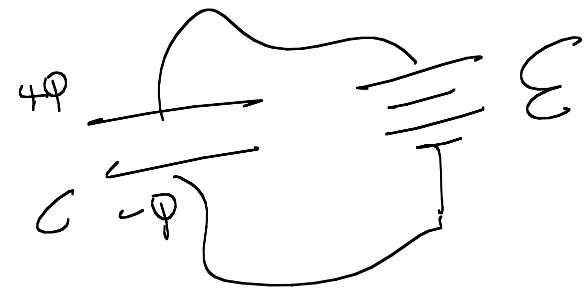


Low resistance

Capacitor in Circuit

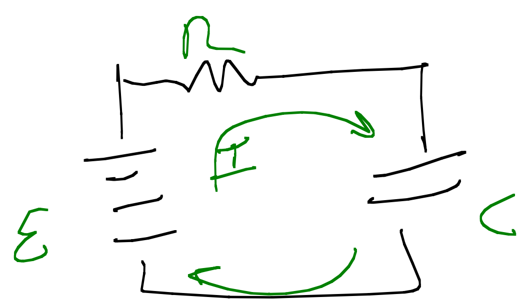


I big initially
eventually dies off

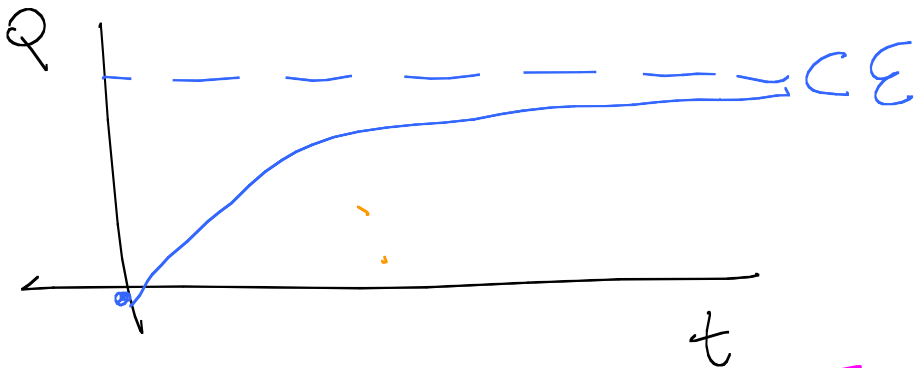


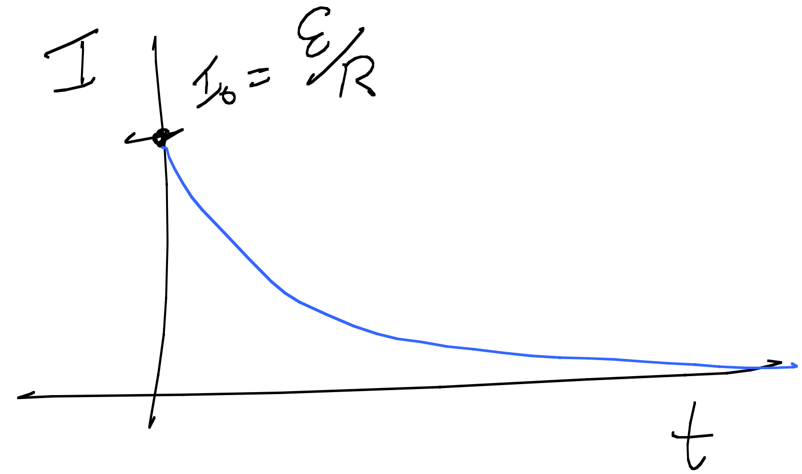
$C\mathcal{E} = Q$

Close switch



Eventually,
charged

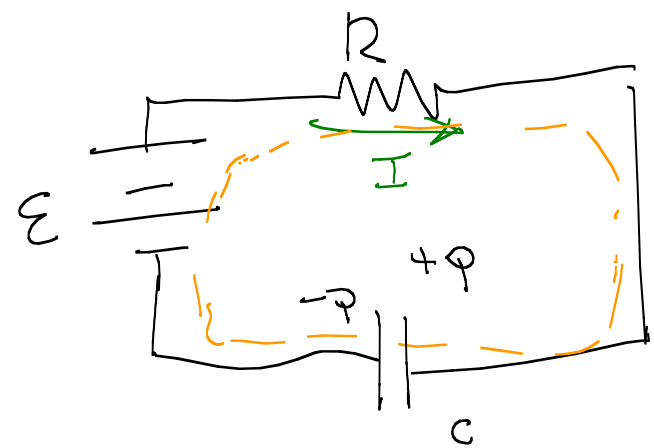




$$\boxed{+\mathcal{E} - IR - \frac{Q}{C} = 0}$$

$I(t) \quad Q(t)$

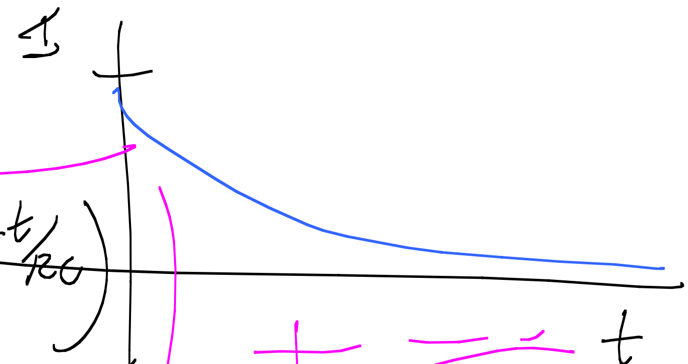
Take driv.



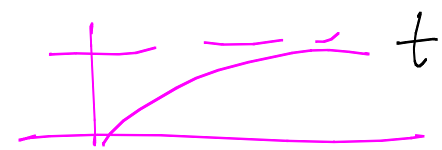
$$-\frac{dI}{dt}R - \frac{1}{C}I = 0 \qquad \frac{dQ}{dt} = I$$

$$\frac{dI}{dt} = -\frac{1}{RC}I \qquad I = I_0 e^{-t/RC} \qquad I_0 = \mathcal{E}/R$$

$$\boxed{I = \frac{\mathcal{E}}{R} e^{-t/RC}}$$

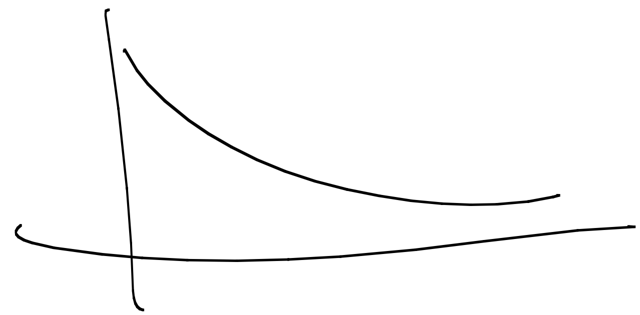


$$V_C = Q/C = \mathcal{E} - IR = \boxed{\mathcal{E}\left(1 - e^{-t/RC}\right)}$$



$$I = I_0 e^{-t/RC}$$

$$= I_0 e^{-t/\tau}$$



$\tau = RC$ time constant of RC circuit

$$e^{-t/\tau}$$

t small, product is ≈ 1

t comp'ble to τ

t large comp'd to τ exp is small

2.5.31 Show that RC has units of time seconds?

$$[RC] = \frac{\cancel{\text{Volt}}}{\text{Amp}} \cdot \frac{\text{Coul}}{\cancel{\text{Volt}}} = \frac{\cancel{\text{Coul}}}{\cancel{\text{Coul}}/\text{sec}} = \text{sec}$$

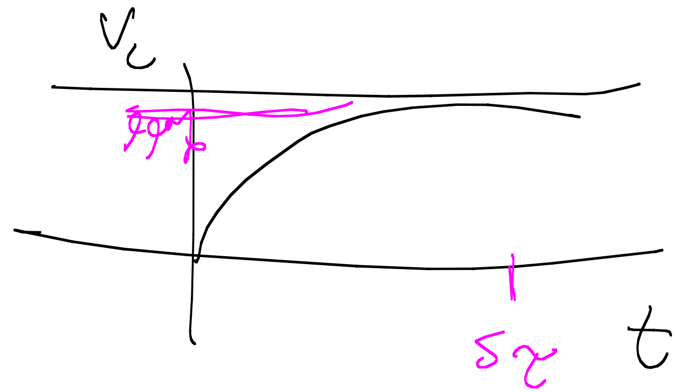
ohm's Law

$V = IR$

$Q = CV$

2.5.33 Show that a capacitor is charged to approx. 99% of applied voltage in 5 time constant

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



$$Q_c = V_c C = C\mathcal{E}\left(1 - e^{-t/RC}\right)$$

When is $V_c = 99\%\ \mathcal{E}$?

$$\cancel{\mathcal{E}}\left(1 - e^{-t/RC}\right) = 0.99\,\cancel{\mathcal{E}}$$

ln b

$$0.01 = e^{-t/RC}$$

$$-t/RC = -4.6$$

$$t = 4.6\,RC$$