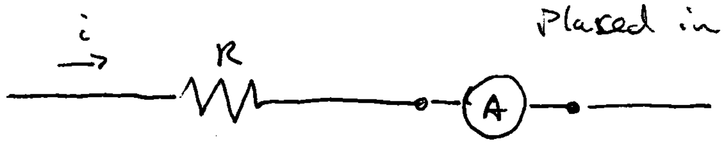
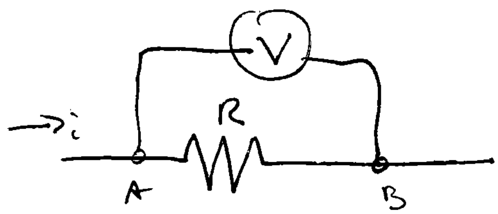
Measure currents w/ Ammeter



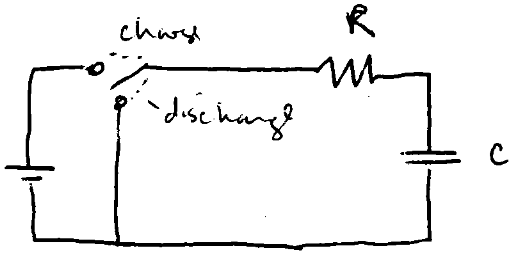
Placed in series at pt where you want to Measure current

Measure Voltage drops w/ voltmeter



Placed in parallel across The two pts where you want to measure ΔV

RC Circuits



When switch in charging position

$$\Sigma V = 0 \qquad \mathcal{E} - \underset{\substack{\uparrow \\ V_R}}{iR} - \underset{\substack{\uparrow \\ V_C}}{q/C} = 0$$

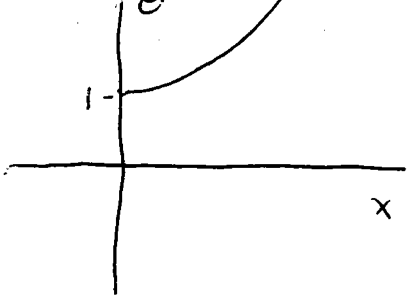
q is a function of Time

Differential Equation $<$ $\quad \mathcal{E} = \frac{dq}{dt} R + q/C$

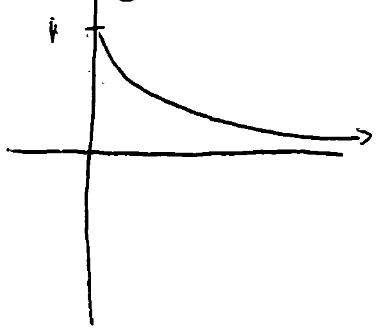
↳ has soln $\quad q = C\mathcal{E}(1 - e^{-t/RC})$

Substitute in and work out

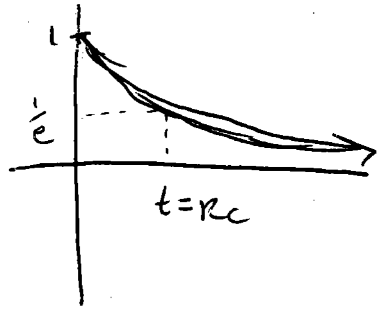
e^x



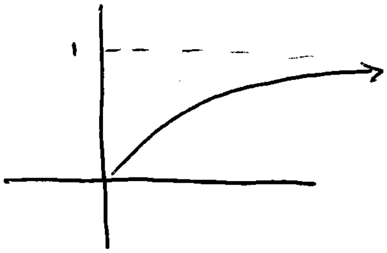
e^{-x}



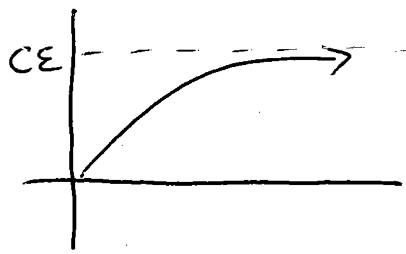
$e^{-t/RC}$



$1-e^{-t/RC}$



$q = C\mathcal{E}(1-e^{-t/RC})$



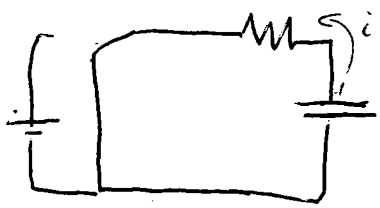
$CV = q$!

$RC \equiv$ time CONSTANT

If RC large, takes a long time to charge up capacitor
" " small, " short " "

$\tau = RC$ = Time it takes to charge up to within $\frac{1}{e}$ of final value

Now discharge



$$\frac{q}{C} - iR = 0 \qquad i = -\frac{dq}{dt}$$

$$\frac{q}{C} + \frac{dq}{dt}R = 0$$

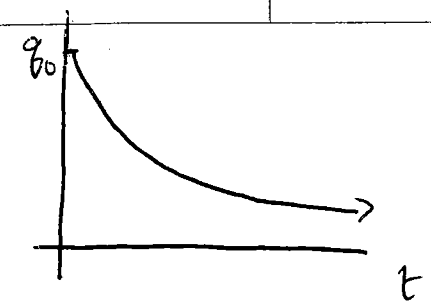
$$\frac{q}{C} = -\frac{dq}{dt}R$$

$$\int_0^t \frac{dt}{RC} = -\int_{q_0}^{q} \frac{dq}{q}$$

$$-\frac{t}{RC} = \ln\frac{q}{q_0}$$

$$e^{-t/RC} = q/q_0$$

$$q = q_0 e^{-t/RC}$$



again RC dictates how fast
charge drains off

Know $q(t)$ can calculate $i(t)$
$V(t)$ across resistor
$V(t)$ across capacitor
Stored Energy (t) in capacitor
etc.
⋮

Magnetism - Magnetostatics

Put in a good Magnetic field Demo!

There exists a Magnetic field - can effect charged particles

$$\vec{F} = q\,\vec{V} \times \vec{B}$$

B units $\quad 1\text{ Tesla} = 1\,\frac{N}{A \cdot M}$ $\quad$ SI

common unit of cgs system = gauss $\quad$ CGS

$$1\text{ Gauss} = 10^{-4}\text{ Tesla}$$

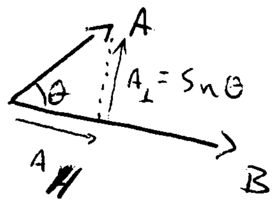
B fields effect Moving charges

You think of Magnets affecting other Magnets or iron

Well - at a Microscopic level it simplifies to ...

$$\vec{F} = q\,\vec{V} \times \vec{B}$$

The cross product



$$|A \times B| = \underbrace{|A| \sin\theta}_{A_\perp}\ |B|$$

Know this

F $\perp$ to plane containing $\vec{A}$ and $\vec{B}$

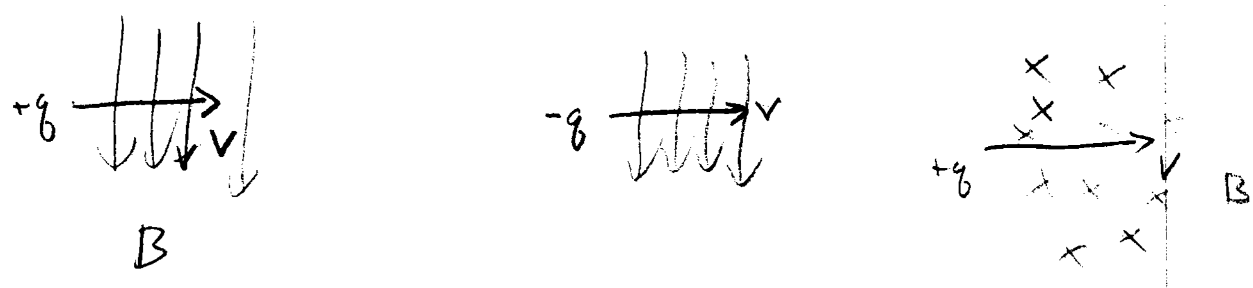
use right-hand rule to get direction

right-hand rule - Put fingers of Right hand along direction of 1^{st} vector and curl them into the 2^{ND} Thumb points along direction of $A \times B$

⇒ Ask students to do a couple of Examples

$$\vec{F} = q\vec{V} \times \vec{B}$$

↑ NOT direction, dependence on Sign of charge

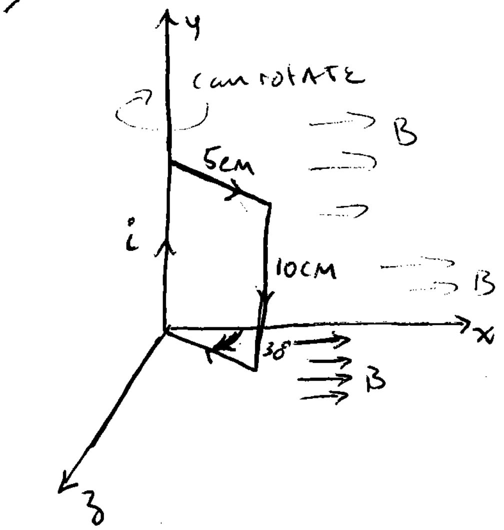


Charged Particles in Magnetic fields

$$\vec{F} = q\vec{E} + q\vec{V} \times \vec{B} \qquad \text{Lorentz force law}$$

F on a charge

$$\vec{F} = L\vec{i} \times \vec{B} \qquad \text{Force on a wire}$$



$\vec{B}$ uniform and in $\hat{x}$ direction $= (0.5\ \text{Tesla})\hat{x}$

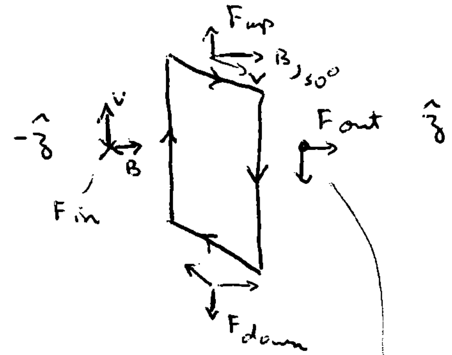
Loop - rectangular cross section

$i = 0.1$ Amp

$B = 0.5$ Tesla

Hinged at y axis

What is Torque on wire loop About y axis?



$$\vec{\tau} = \sum \vec{r}_i \times \vec{F}_i$$

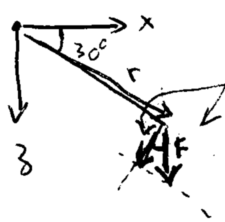
$$\vec{\tau} = F\cos(30)\, r \quad \text{down } (-\hat{y})$$

$$= iLB\cos 30\, r$$

$$\vec{\tau} = (.1\,A)(.1\,m)(.5\,T)(\cos 30)(.05\,m)(-\hat{y})$$

$$\vec{\tau} = \qquad N\!\cdot\!m\ (-\hat{y})$$

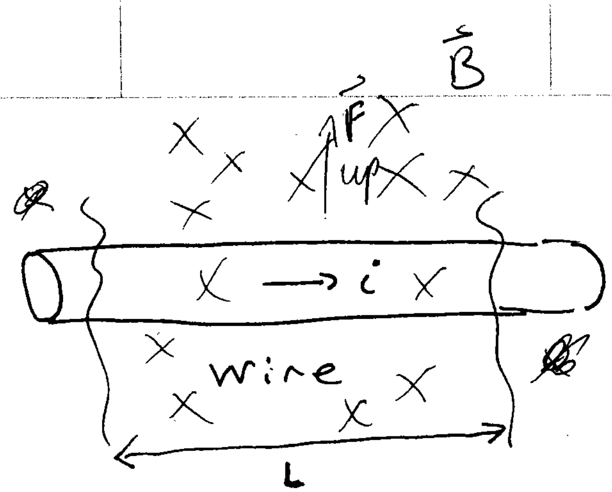
From Top



F component $\perp$ to $\vec{r}$ is $F\cos\theta$

$A = \text{Coul}/s$

$$\frac{\text{coul}}{s}\, m\, \frac{N \cdot s}{\text{Coul}\, m}\, m = N \cdot m$$



$$\vec{F}_{wire} = (q\, V_d \times B)\; n\, A\, L$$

drift velocity of charges

x sectional Area of wire

charges/unit volume

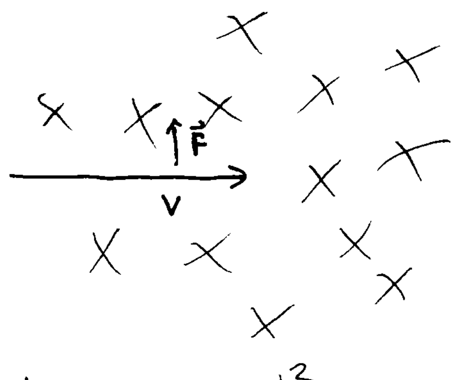
$$i = n\, q\, V_d\, A$$

$\#/vol$ $\quad$ $\frac{dx}{dt}$

$$\vec{F}_{wire} = L\vec{i} \times \vec{B}$$

Watch signs of charge

<u>Charged particle Moving $\perp$ to uniform Magnetic field</u>



$\vec{F} \perp ds$ at all Times
No work done

also for nonuniform field or no $\perp$

F always at rt angle to V

$$q V B = m\frac{V^2}{R}$$

$$R = \frac{mV}{qB}$$

Know how to think thru this