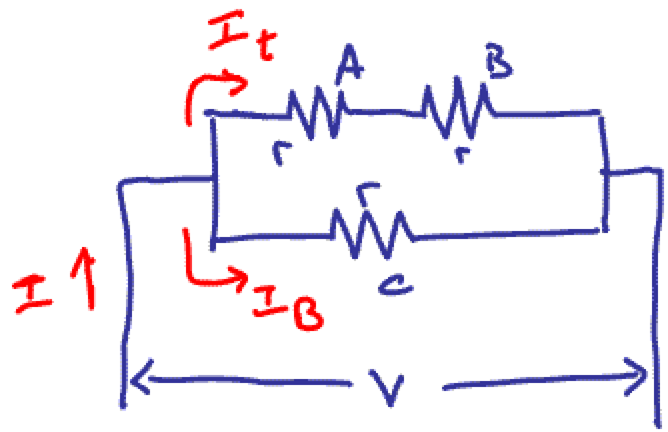
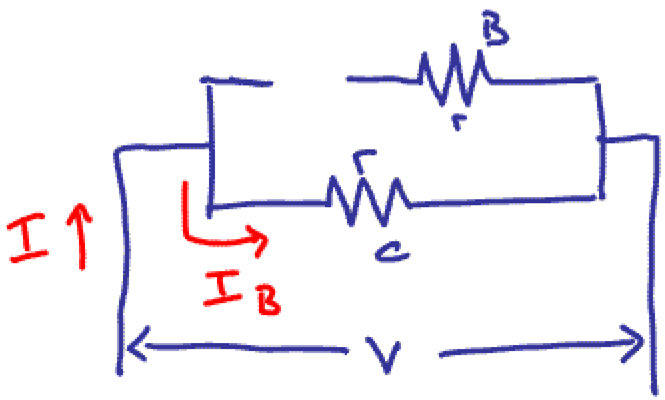
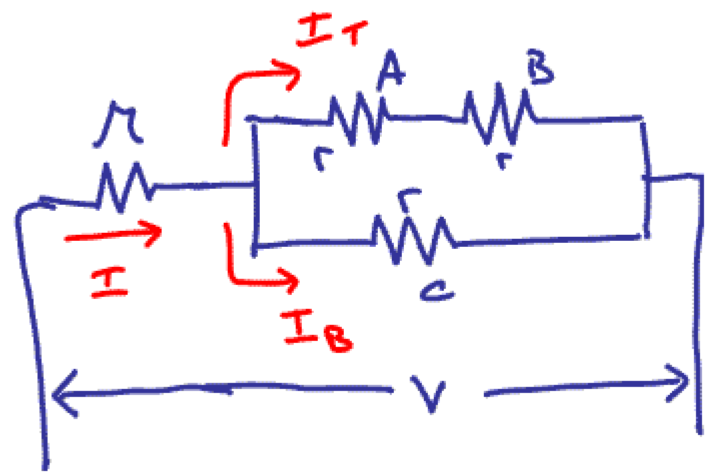
Physics 114 – February 25, 2010

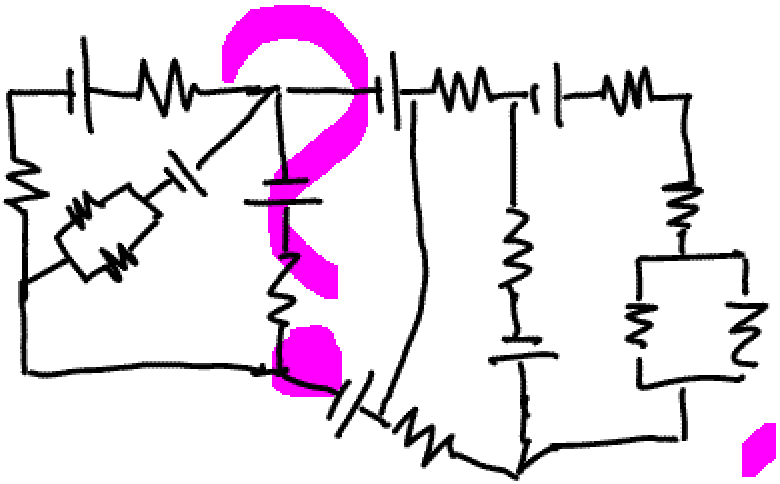
last time





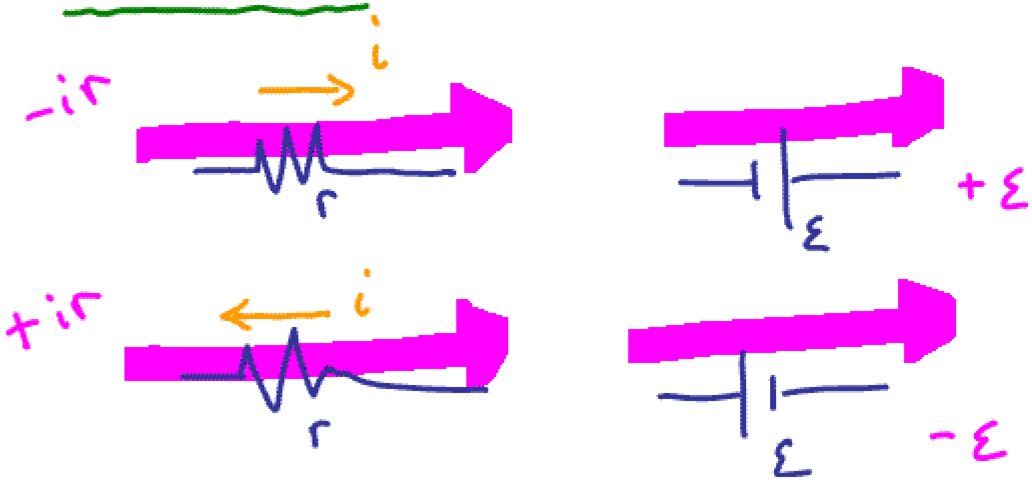


Kirchoff's Rules :



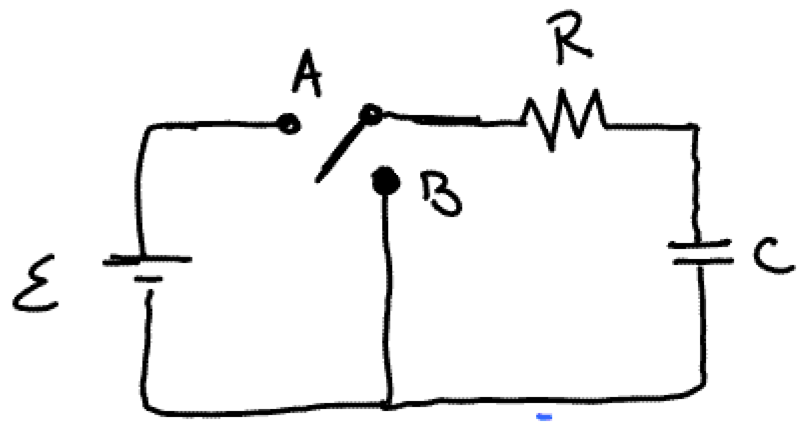
- Assign currents
- Select independent loops
- $\Sigma i = 0$ at junctions
- $\Sigma V = 0$ around loops
- N equations, N unknowns
  - Solve algebra for unknowns

Conventions

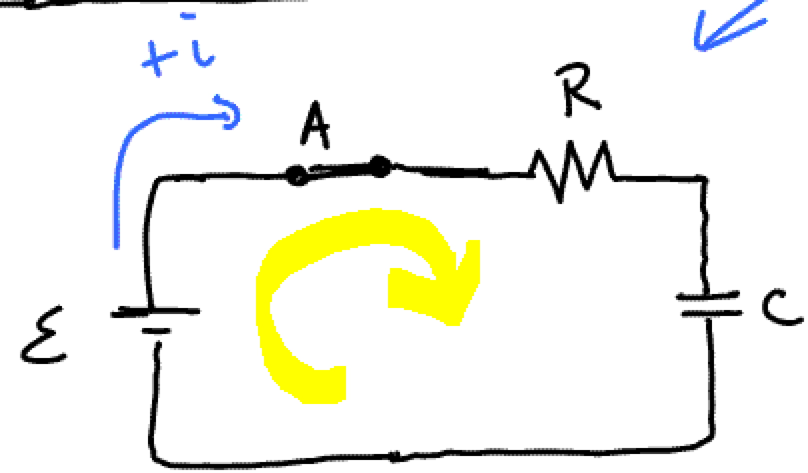


Be consistent
Be careful

RC circuits



Charging RC circuit



$Q = CV$

$\Sigma V = 0$

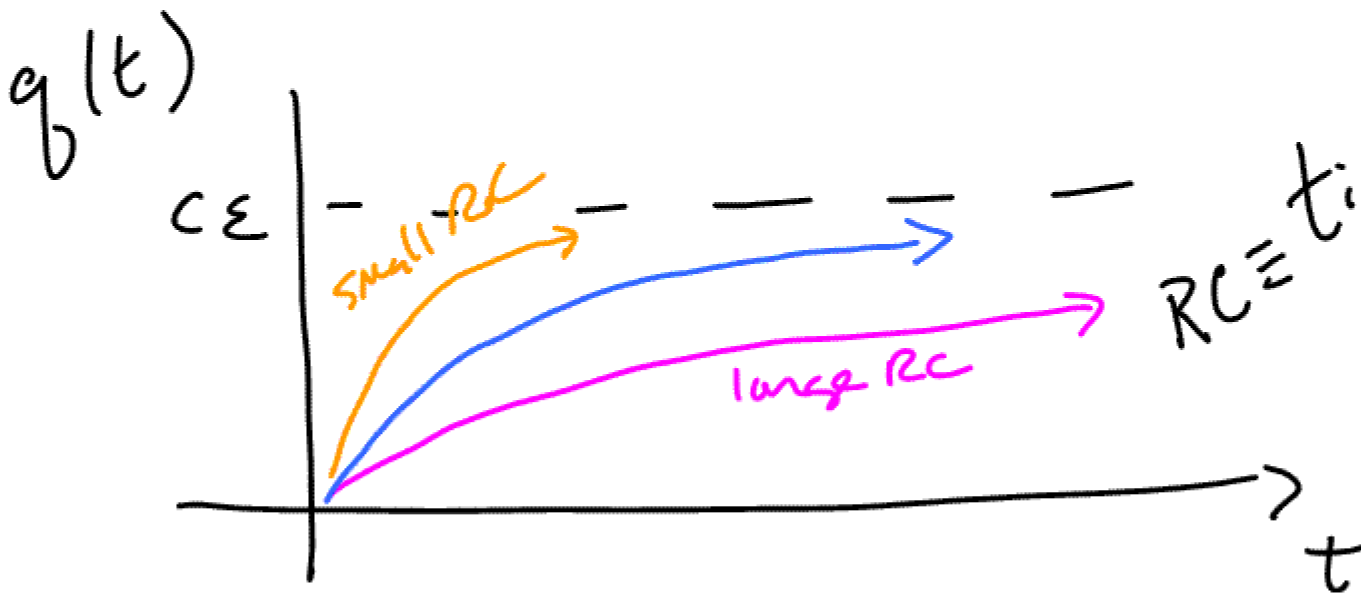
$$0 = \mathcal{E} - \underbrace{iR}_{V_R} - \underbrace{q/C}_{V_C}$$

$$0 = \mathcal{E} - \frac{dq}{dt}R - q/C$$

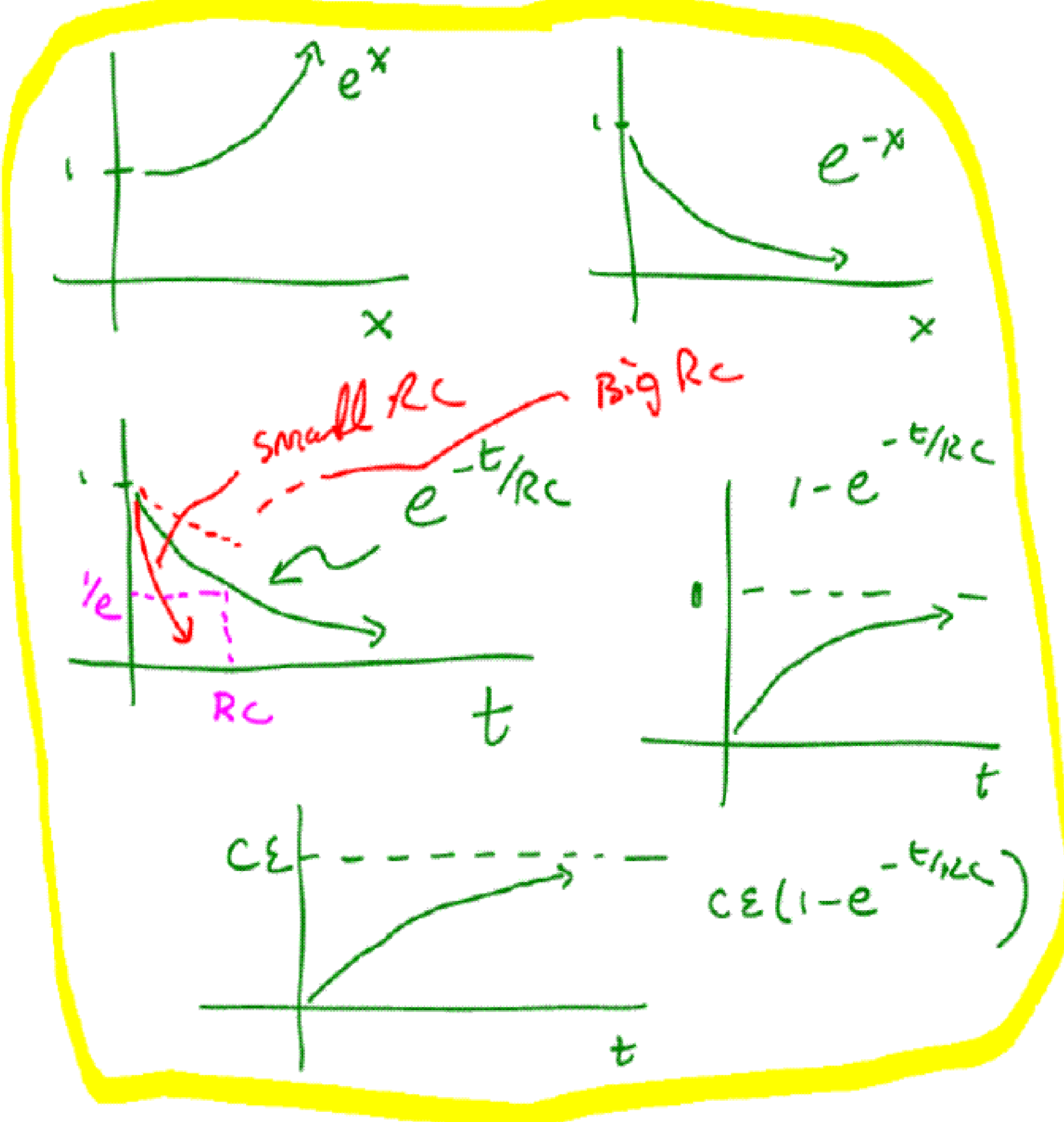
Time dependent

$$q \longrightarrow q(t)$$

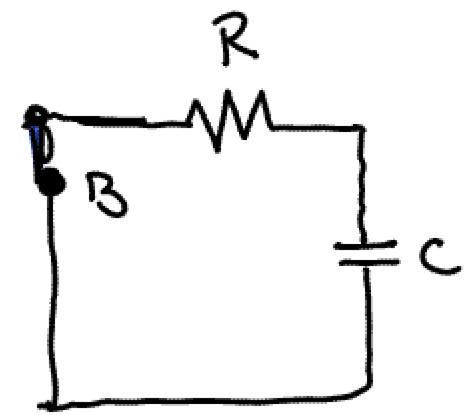
$$q(t) = C\mathcal{E}\left(1 - e^{-t/RC}\right)$$



$RC \equiv$ time CONSTANT



e^x
1
x
1
e^{-x}
x
small RC
Big RC
1
$e^{-t/RC}$
1/e
RC
t
$1-e^{-t/RC}$
1
t
$C\mathcal{E}$
$C\mathcal{E}(1-e^{-t/RC})$
t



Capacitor already charged

→ discharging RC circuit

$$0 = \underbrace{\cancel{\varepsilon}}_{0} - iR - q/C$$

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

$$\frac{dq}{dt} = -q/RC$$

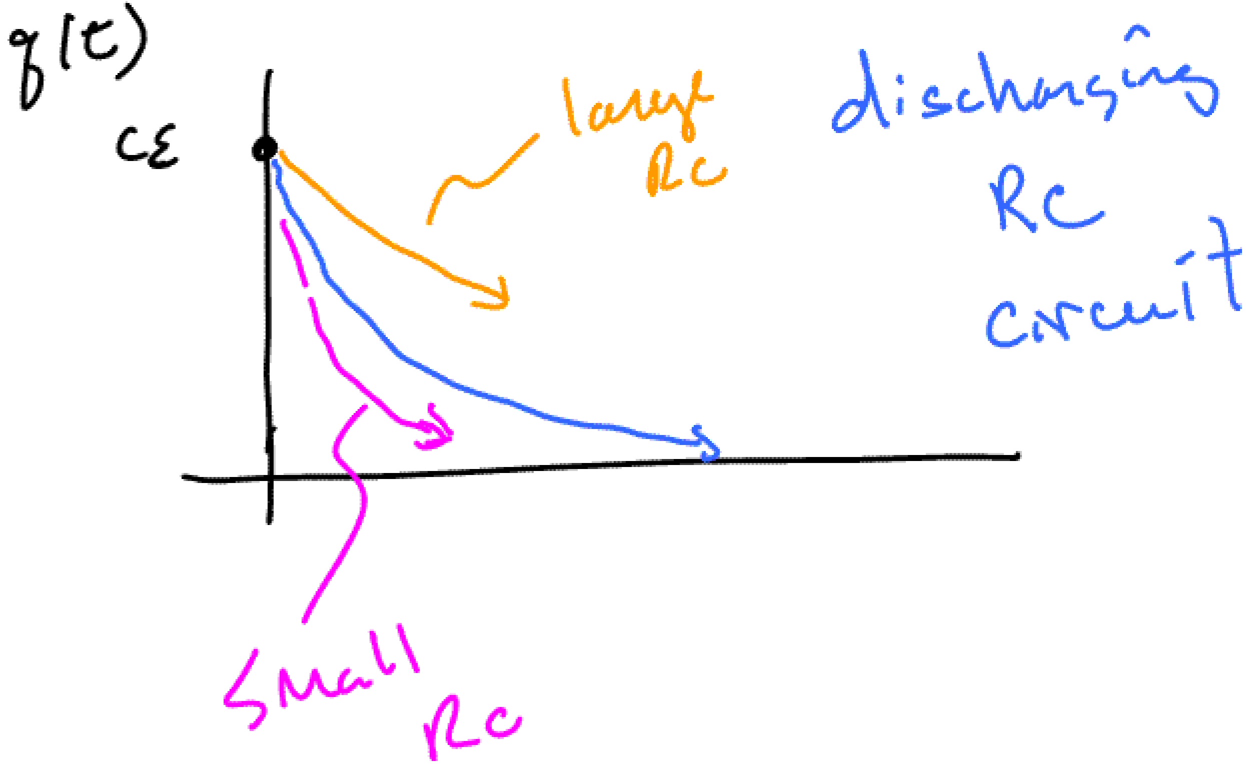
$$\frac{dq}{q} = -dt/RC$$

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

$$\ln q/q_0 = -t/RC$$

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

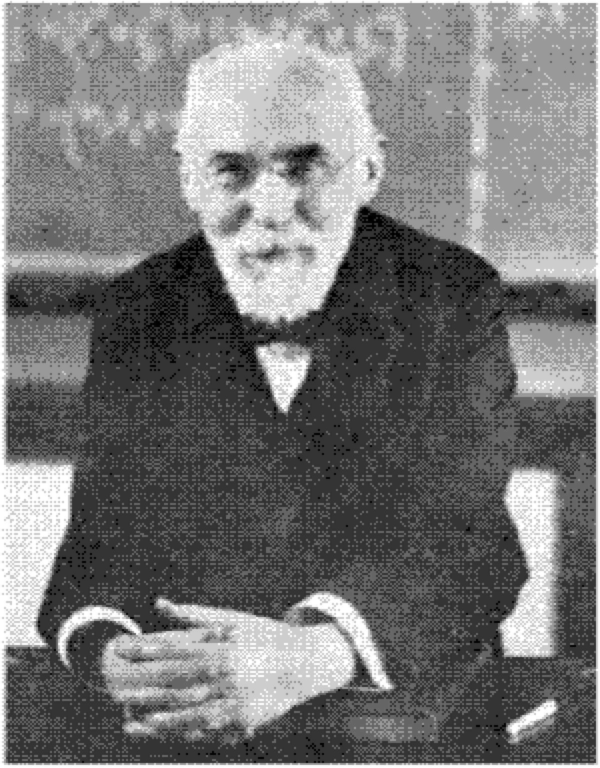
$$q(t) = q_0 e^{-t/RC} = C\mathcal{E} e^{-t/RC}$$


q(t)
CE
large RC
small RC
discharging RC circuit

Magnetism

Lorentz Force law

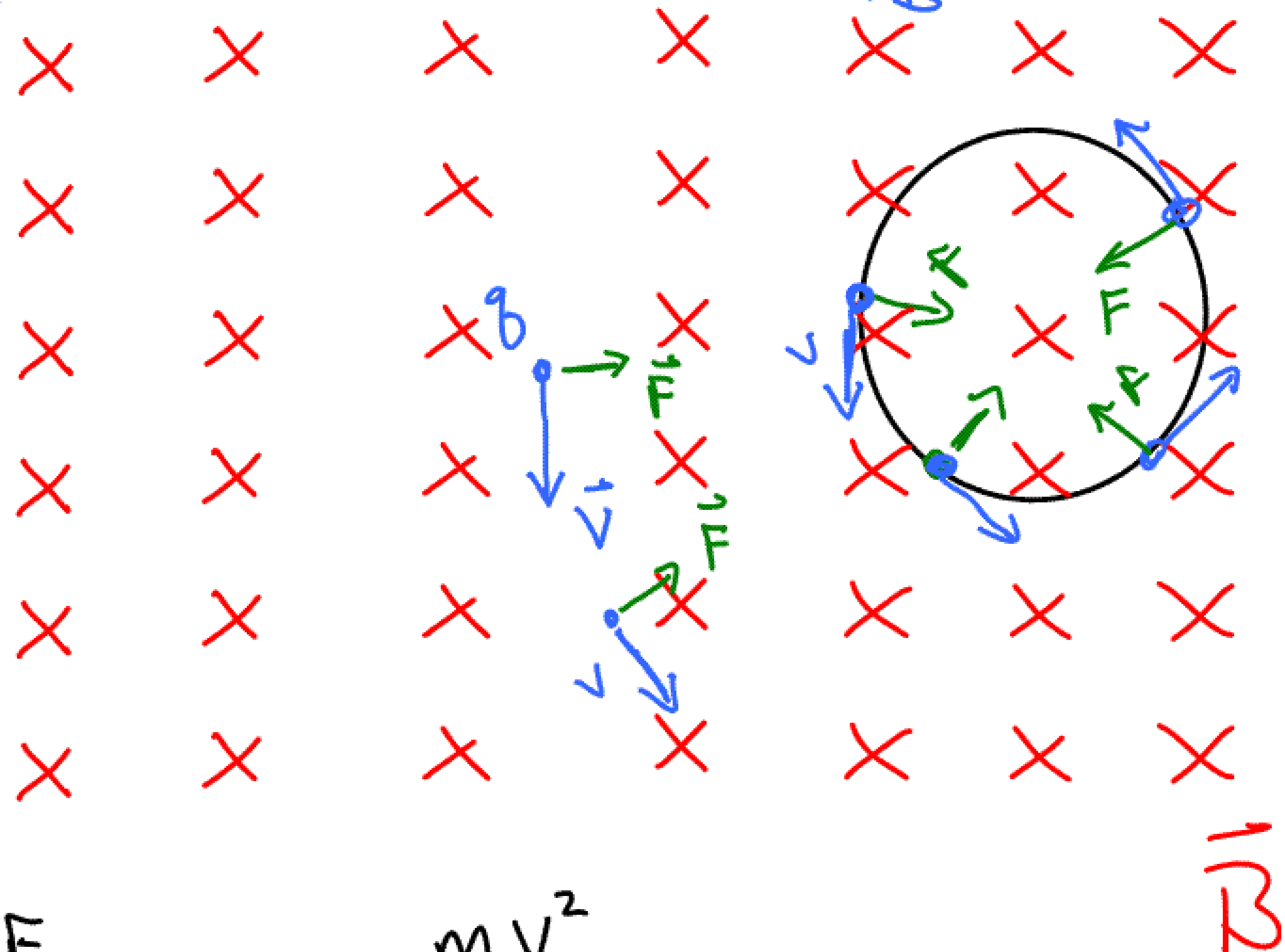
$$\boxed{\vec{F} = q\vec{E} + q\vec{v} \times \vec{B}}$$



Hendrik Antoon Lorentz
(1853 - 1928)

Dutch - 1902 Nobel Prize

$$|\vec{A}\times\vec{B}| = |\vec{A}||\vec{B}|\sin\theta$$



$$F_{centripetal} = \frac{mv^2}{R}$$

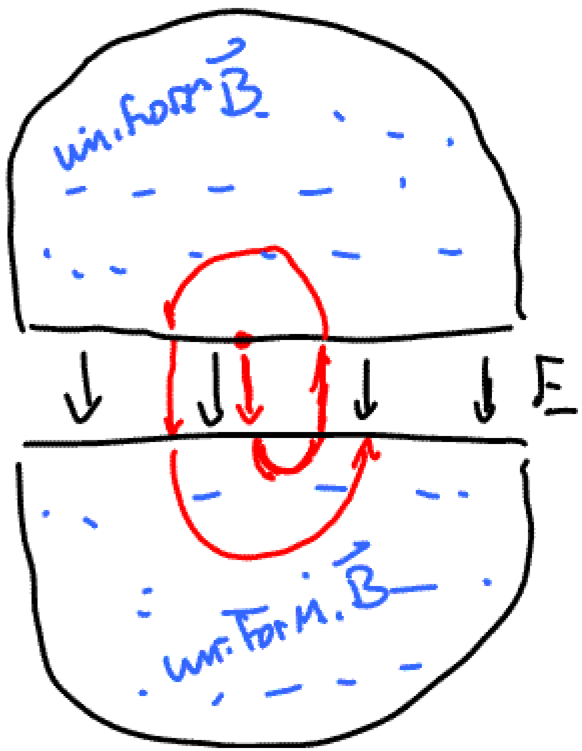
$$|\vec{F}_{magnetic}| = q|\vec{v}\times\vec{B}| = qvB$$

$$\frac{mv^2}{R} = qvB$$

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

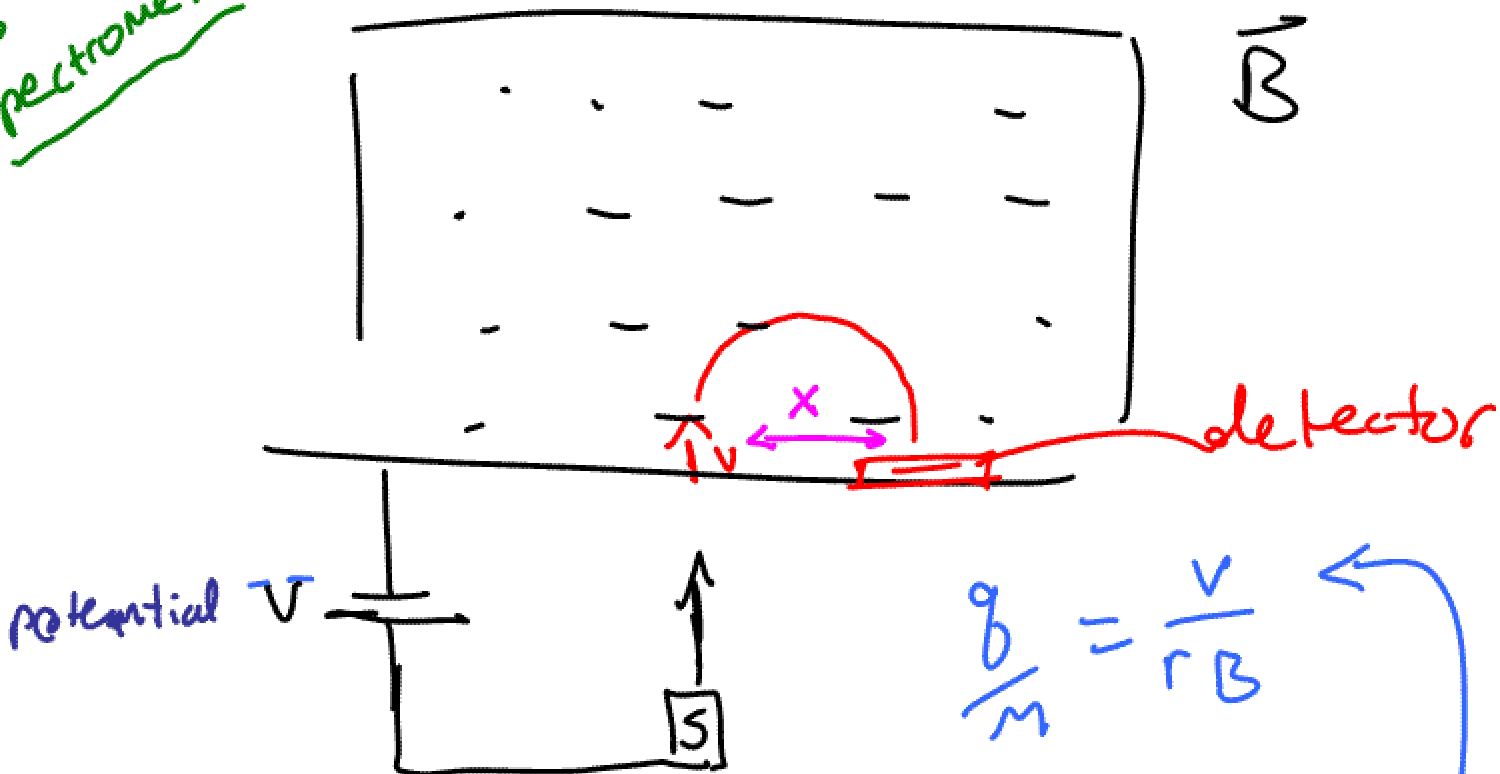
Early type of Particle Accelerator

cyclotron



$\vec{E}$ flips direction as particles move through gap successive trips

mass spectrometer



$$\frac{q}{m} = \frac{v}{rB}$$

$$\frac{1}{2}mv^2 = qV$$

$$v = \sqrt{\frac{2qV}{m}}$$

$$\frac{m}{q} = \frac{B^2 x^2}{8V}$$

$\frac{\text{mass}}{\text{charge}}$ ratio can be determined by position that particle hits the detector (given by x)