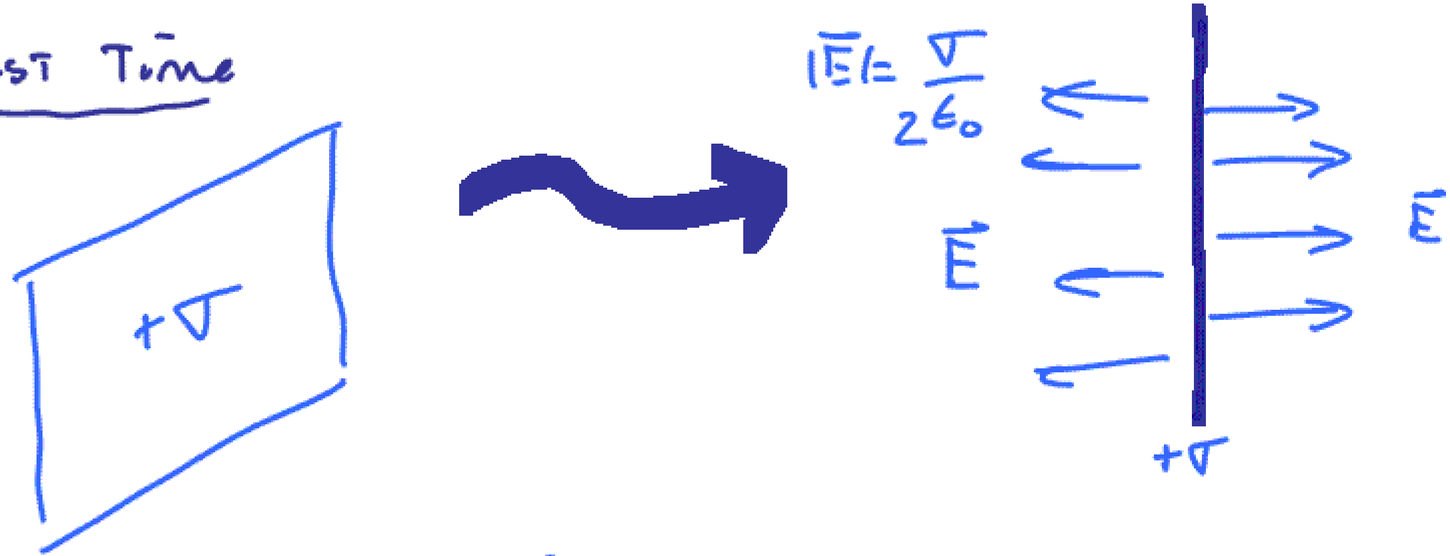
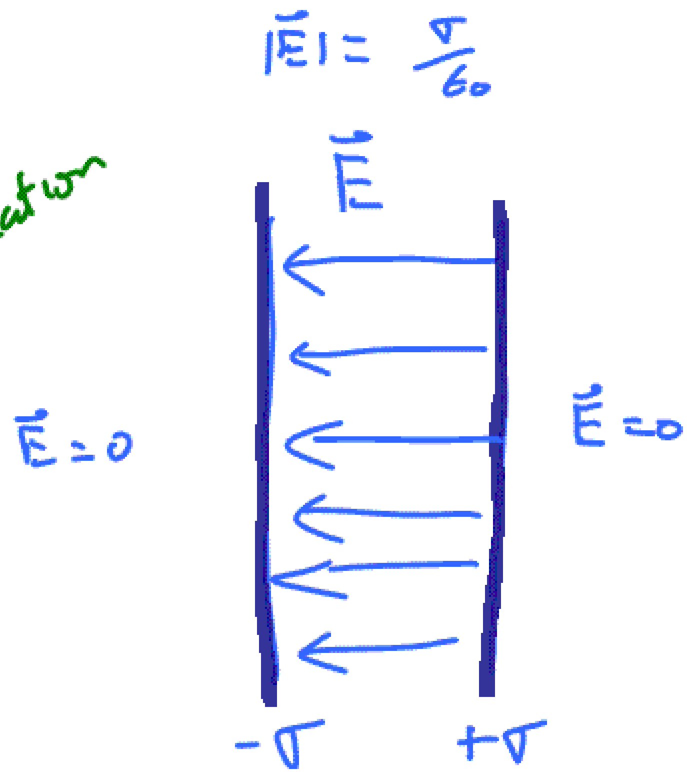
Physics 142 – October 2, 2007

- Exam this Thursday
  - Formula sheet to be included now on web
- Possible Q+A Session
  - 11–12 AM wed ?
  - 12:30 – 1:30 wed ?
  - } Not sure abt rm availability
- Presentation suggestions
  - Adding "planetary magnetic fields"

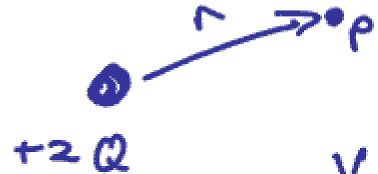
Last Time



Parallel plate configuration (capacitor)

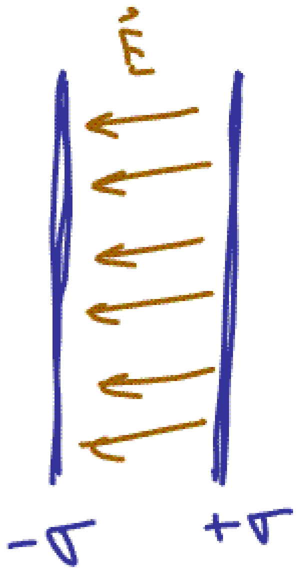


$$V_P = \frac{kQ}{r}$$



$$V_P = \frac{2kQ}{r}$$

$$V \propto Q$$



$\Delta V_{\text{bet plates}} \sim \vec{E} \cdot \vec{\Delta x}$

$$E \sim \frac{\sigma}{\epsilon_0}$$

Double charge → Double E

→ Double ΔV

$$V \propto Q$$

Only depends on geometry

$Q = CV$

$\equiv$ Capacitance

Capacitance is a measure of charge a system can hold at a certain potential or potential difference

-or-

Measure of potential (or potential difference seen) for given charge

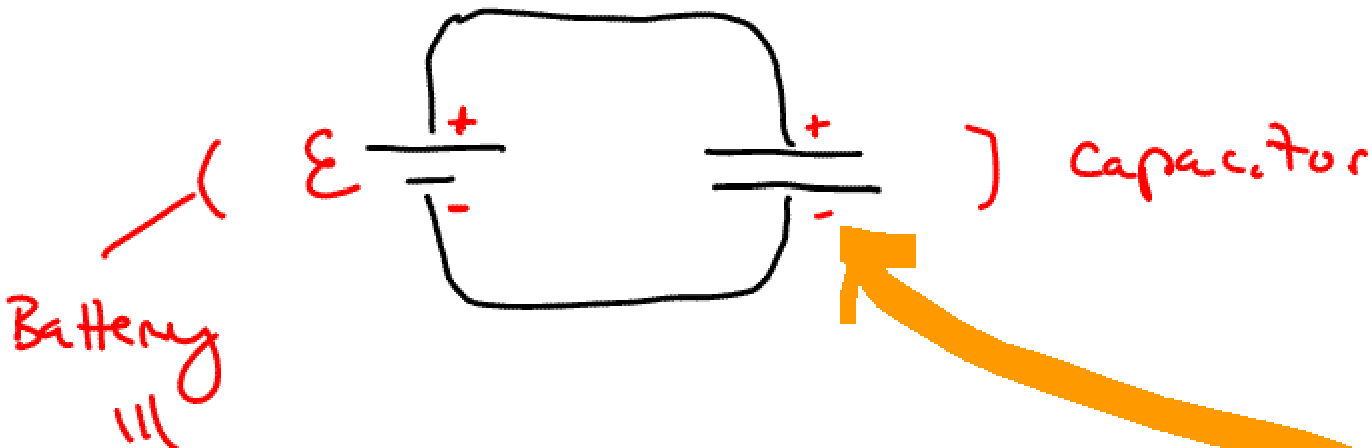
Distinct

C symbol for capacitance

C symbol for Coulomb

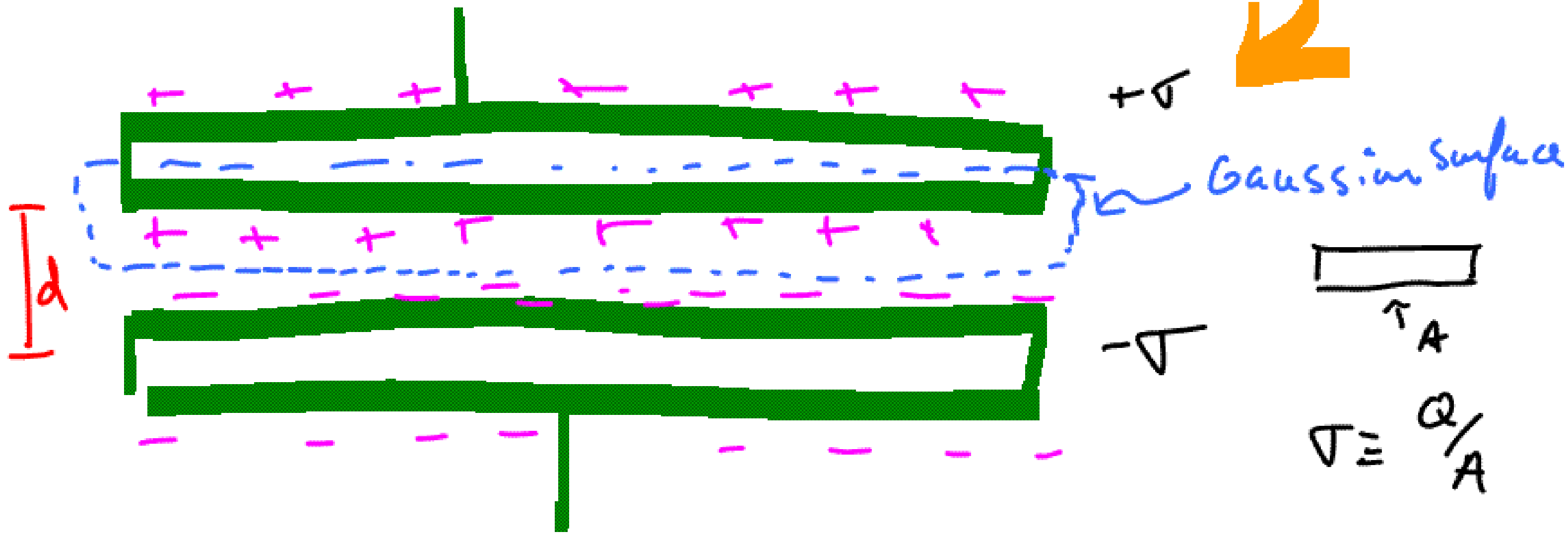
c symbol for speed of light

Capacitor acts as a resevoir of charge



EMF ≡ Electromotive force

$\mathcal{E}$ maintains constant potential diff between Terminals



$\sigma = Q/A$

Find expression for capacitance of system

$$\int_{surf} \vec{E}\cdot d\vec{A} = \frac{Q_{enc}}{\epsilon_0}$$

$$|\vec{E}|\,A = \frac{\sigma A}{\epsilon_0}$$

$\uparrow$

$\frac{\sigma}{\epsilon_0}$

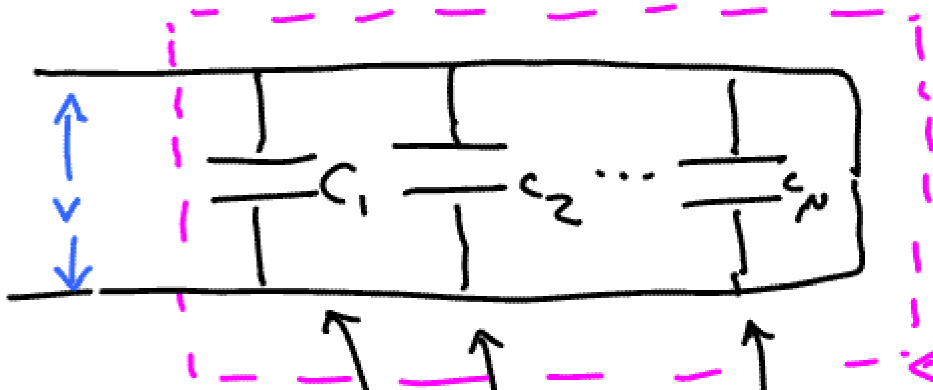
$$Q_{encl} = |E|\,A\,\epsilon_0$$

$$V = \frac{W}{q} = \frac{Fd}{q} = Ed$$

$$C = \frac{Q}{V} = \frac{|\vec{E}|\,A\,\epsilon_0}{|\vec{E}|\,d} = \frac{A\,\epsilon_0}{d}$$

geometry only

$\perp$ = perpindicular



capacitor in $//$ = parallel

single capacitor w/ cap. C

$$\text{TOTAL } Q = Q_1 + Q_2 + \cdots + Q_N$$

$$Q = CV$$

$$Q_1 = C_1 V$$

$$Q_2 = C_2 V$$

$$\vdots$$

$$Q_N = C_N V$$

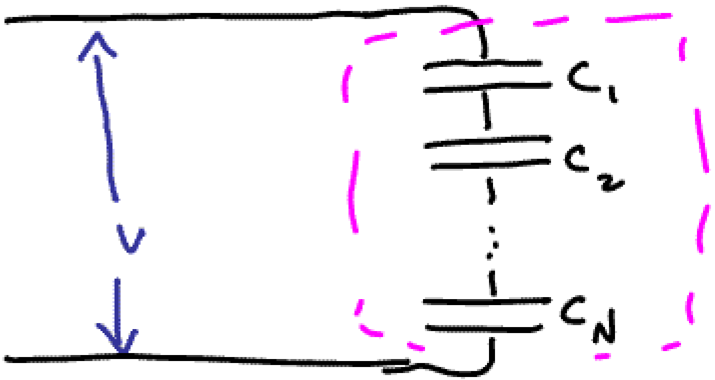
$$Q = CV = C_1 V + C_2 V + \cdots + C_N V$$

$$C = C_1 + C_2 + \cdots + C_N$$

$$C = \sum_i C_i$$

capacitors in $||$

Capacitors in Series



$$Q = CV$$

$$Q = C_1 V_1$$

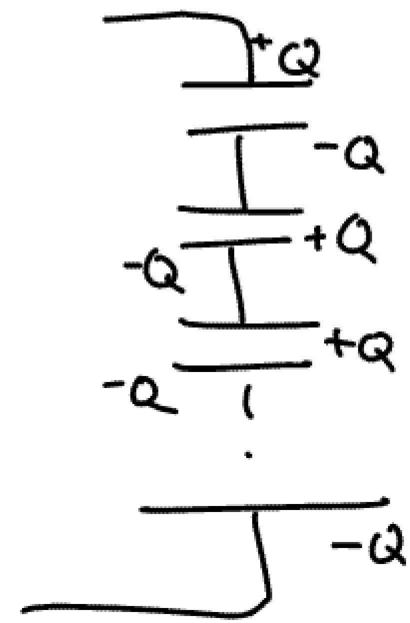
$$Q = C_2 V_2$$

$$\vdots$$

$$Q = C_N V_N$$

$$V = V_1 + V_2 + \cdots + V_N$$

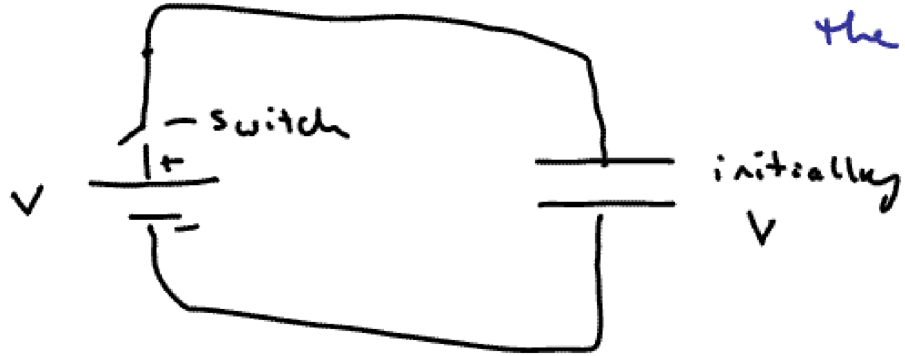
$$\frac{Q}{C} = \frac{Q}{C_1} + \frac{Q}{C_2} + \cdots + \frac{Q}{C_N}$$



$$\frac{1}{C} = \sum_i \frac{1}{C_i}$$

capacitors in series

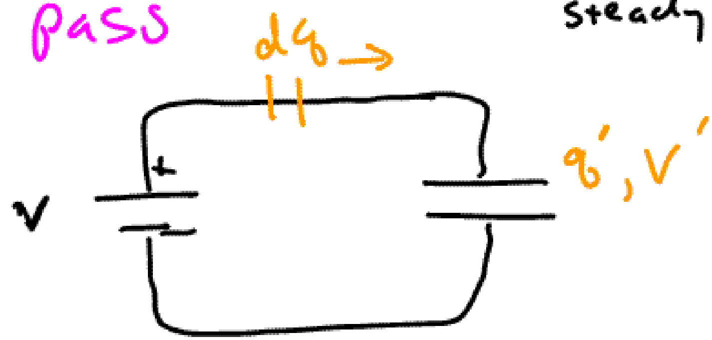
How Much work to fully charge the capacitor



close switch

Time pass

NOT steady STATE



$dw = v' dq'$

$q' = C v'$

↑ geometry

$Q = CV$

$$dw = \frac{q'}{C} dq' \qquad W = \int_0^Q \frac{q'}{C} dq' = \frac{1}{C}\frac{Q^2}{2} = \frac{C^2 V^2}{C\,2} = \frac{1}{2} C V^2$$

Energy Stored by a capacitor $= \frac{1}{2} C V^2$ or $\frac{Q^2}{2C}$

Capacitor Stores Energy in $\vec{E}$!

Energy density of $\vec{E}$?

$$u_E = \frac{U \text{ TOT Energy}}{\text{volume bet plates}} \quad \begin{matrix} \to \frac{1}{2}CV^2 \\ \to Ad \end{matrix}$$

$$u_E = \frac{\frac{1}{2}CV^2}{dA}$$

C for // plates $= \frac{\epsilon_0 A}{d}$

$$= \frac{\frac{1}{2}\frac{\epsilon_0 A}{d}V^2}{dA} = \frac{\epsilon_0}{2}\frac{V^2}{d^2}$$

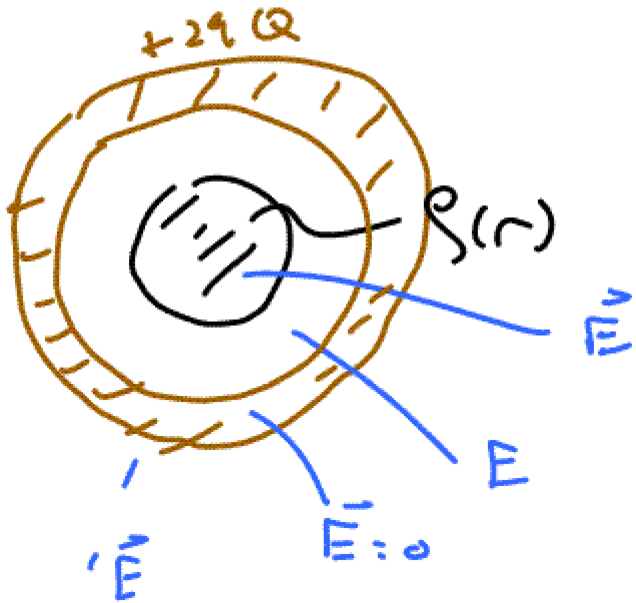
$V \sim Ed$

$$= \frac{\epsilon_0}{2}E^2$$

Specific system but result is general!

$$u_E = \frac{\epsilon_0}{2} E^2$$

Energy density of Electric field



TOTAL Energy Stored

$$U = \int_{vol} u \, dv$$

can determine Energy stored in a system if you know $|\vec{E}|$ Everywhere.