Electrostatics

Electric charge – property of matter that allows it to be accelerated by an electric force

– two types: positive (+)
negative (−)

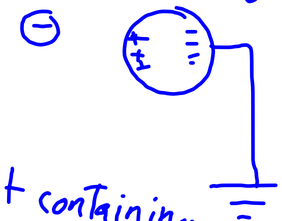
– Total charge in a closed system is conserved
(charge cannot be created or destroyed)

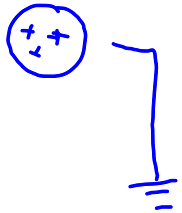
– quantized.
(multiple of e
↑ charge on electron

Conductors — materials in which charges move freely (metals)

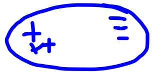
insulators — materials in which charges do not move freely (non-metals)

Induction — The charging of an uncharged object due to the proximity of a charged object.





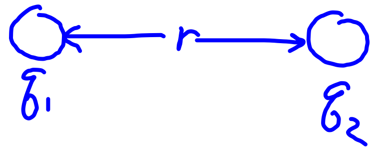
Dipole — object containing two electric "poles"



Polarization — the induced separation of charges (creation of a dipole) in an electrically neutral object.

Coulomb's Law

$$F = \frac{k q_1 q_2}{r^2}$$



$$k = 8.99 \times 10^9 \frac{Nm^2}{C^2} \qquad k = \frac{Fr^2}{q^2}$$

C = Coulomb = unit of charge

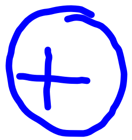
Charge on electron = -1.6×10^{-19} C

Q. Force between two charges is F. If the separation between the charges is doubled, what is the new force between the charges?

A. $F = \frac{k q_1 q_2}{r^2}$

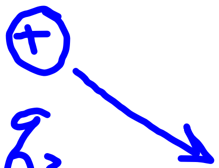
$$F_{new} = \frac{k q_1 q_2}{r_{new}^2} = \frac{k q_1 q_2}{(2r)^2} = \frac{k q_1 q_2}{4r^2} = \frac{1}{4} F$$

Electric Field = Force per charge



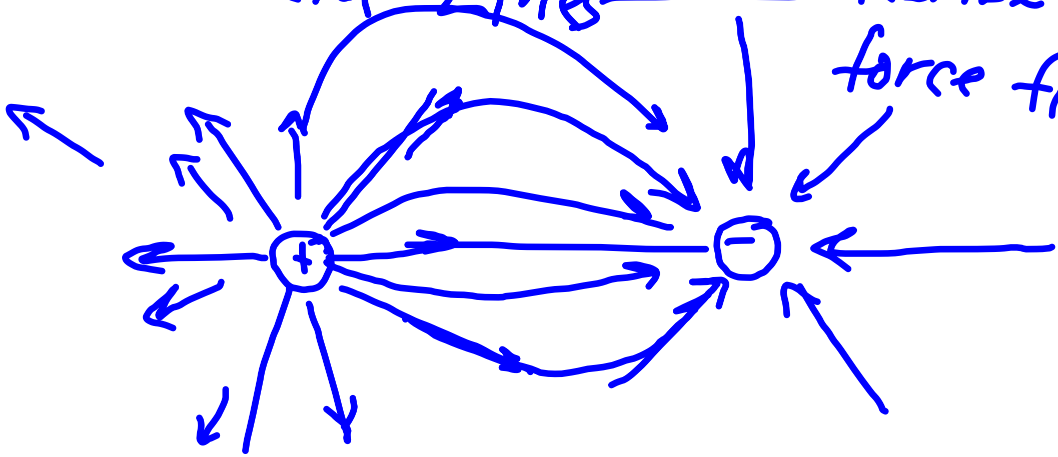
q_1

$E = \dfrac{F}{q_2} = \dfrac{k\,q_1}{r^2}$

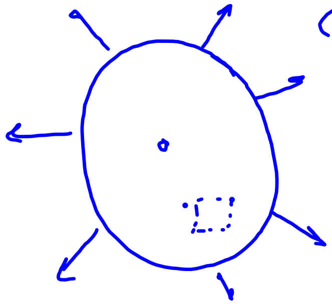


q_2

Electric Field Lines — desribe electric force field



Gauss' Laws – Given the electric field at each point of a closed surface, it is possible to determined the <u>net</u> charge within the surface.



Electric flux – $E\Delta A$

↑ electric field (E)

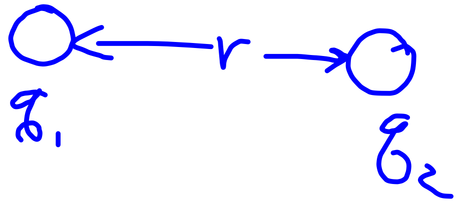
↑ area through which electric field passes (ΔA)

$$\sum E_{\perp}\Delta A = 4\pi k\, Q_{enclosed}$$

↑ Gauss' Law

Potential Energy between charges

$$U = \frac{k q_1 q_2}{r}$$



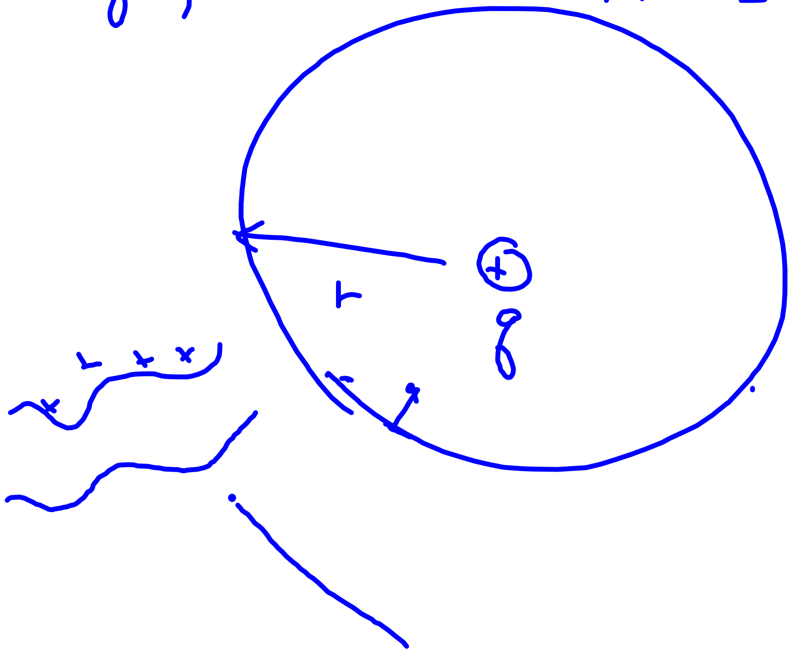
$$V = \frac{U}{q_2} = \frac{k q_1}{r}$$ = Potential Energy per charge due to charge q_1

= "potential"

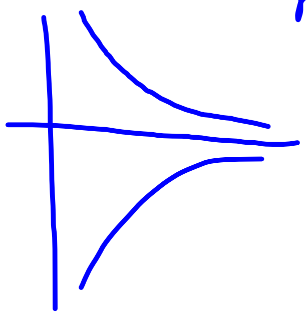
"Potential" = potential energy per charge

unit of potential = volt = $\frac{\text{Joule}}{\text{Coulomb}}$

Equipotential Surfaces



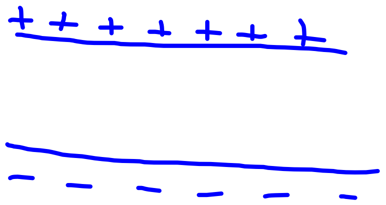
$$V = \frac{kq}{r}$$



- Electric field lines are perpendicular to equipotential surfaces.

- When a particle moves on a equipotential surface, its potential energy is unchanged.

Capacitor – circuit element that stores electric charge



} V = potential difference between plates

pot'l energy of cap

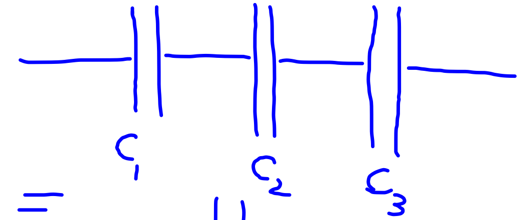
$U = VQ$ ← charge on capacitor ? No. Need $\frac{1}{2}$

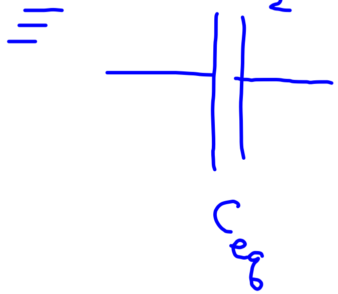
$$U = \frac{1}{2} VQ$$

$$C = \frac{Q}{V}$$ = def of capacitance

$$U = \frac{1}{2} C V^2$$ = energy required to charge a capacitor (with capacitance C) to voltage V

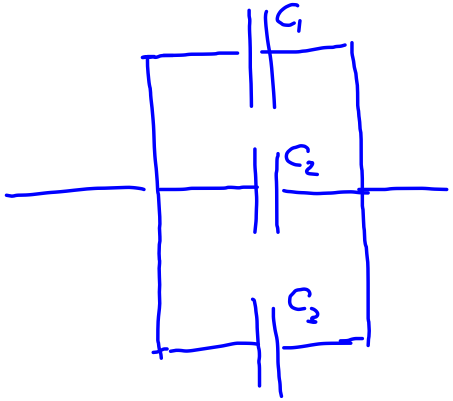
Capacitors in Series

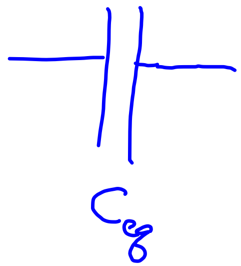




$$\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}$$

Capacitors in parallel





$$C_{eq} = C_1 + C_2 + C_3$$