Physics 142 - September 23, 2014

- Heads up - Exam 1 Two weeks from now . . .
- Homeworks
- How did Thursday's lecture work for you ?
- Questions from last Thursday's lecture ?

Last Time

Gauss' Law examples

Any questions on Gauss' Law ?

Started discussion of Energy + Potential

Man of the Hour

1 Volt = 1 Joule/Coulomb

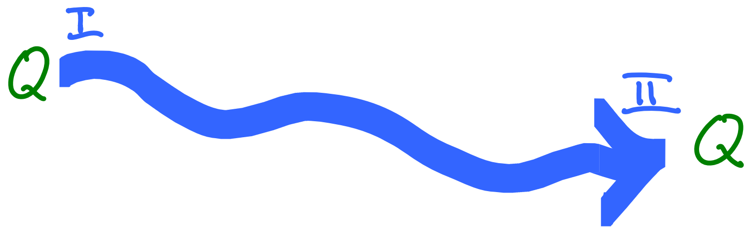
Count Alessandro Giuseppe Antonio Anastasio Volta

Como, Lombardy, Italy

1745 – 1827

Invented the Voltaic pile forerunner of the modern battery

hopefully this man didn't go thru his whole life this pissed off



$\dfrac{\text{Work}}{\text{Charge}}$ to move Q from I → II is potential difference

Δ Energy of system $\equiv \Delta U$

$$\frac{W}{q} = -\frac{\Delta U}{q} \equiv \text{Potential difference}$$

well defined

V or ΔV or $V_{\mathrm{I}\,\mathrm{II}}$ or $V_{\mathrm{II}} - V_{\mathrm{I}}$

Absolute potential requires that a "zero" be defined

units → Joules/Coulomb

Specifically last Time

Calculated work to move q_0 from point A to point B

$$W = k q_0 Q \left[\frac{1}{R_B} - \frac{1}{R_A} \right]$$

$$\Delta V = \frac{W}{q_0} = kQ \left[\frac{1}{R_B} - \frac{1}{R_A} \right]$$

Suppose we did

instead ?

Electrostatics (Electromagnetism)
is a conservative force

$\hookrightarrow$ potential difference is PATH Independent

Calculated work to move q_0 from point A to point B

$$W = kq_0Q\left[\frac{1}{R_B} - \frac{1}{R_A}\right]$$

Let $A \to \infty$

$$W_{q_0 \text{ at } B} = \frac{kq_0Q}{R_B}$$

Absolute pot. of chg Q $V = kQ/R_B$

Electric Potential

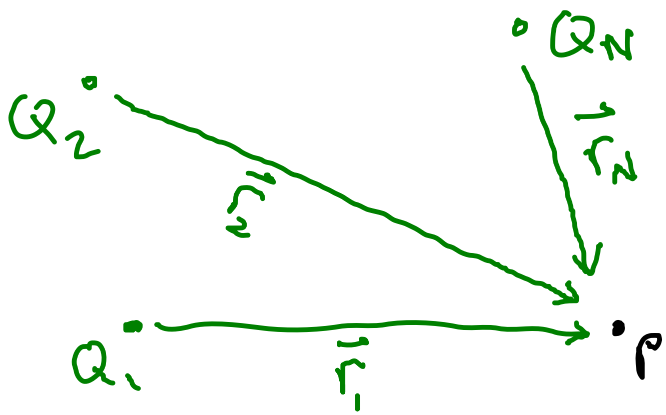
let $V = 0$ at ∞

Potential of point chg

$$Q \xrightarrow{\vec{r}} \cdot P$$

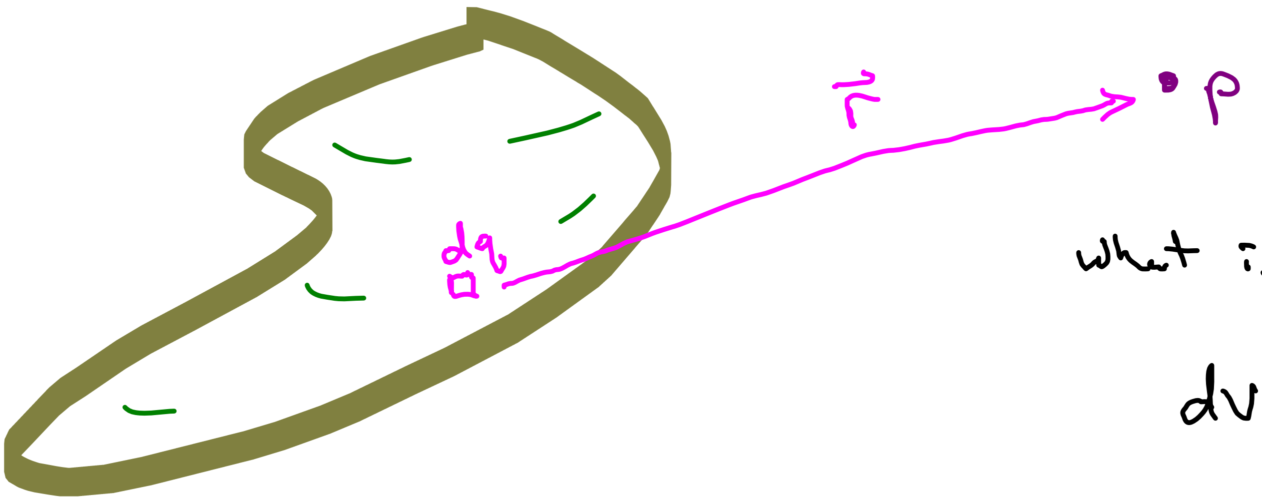
$$V_P = \frac{kQ}{r}$$

System of discrete charges



$$V_P = \sum_{i=1 \text{ to } N} \frac{kQ_i}{r_i}$$

Scaler sum of potentials



what is dV_p at pt P

$$dV_p = \frac{k\,dq}{r}$$

$$V_p = \int_{\substack{\text{chg}\\ \text{distribution}}} \frac{k\,\overbrace{dq}^{\rho\, dV}}{r}$$

why care?

$$\boxed{E_s = -\frac{dv}{ds}}$$

$V(x)$ $\qquad E_x = -\frac{dv}{dx}$

$V(x,y,z)$

$$\vec{E} = \hat{i}E_x + \hat{j}E_y + \hat{k}E_z$$

$$\vec{E} = \hat{i}\left(-\frac{dv}{dx}\right) + \hat{j}\left(-\frac{dv}{dy}\right) + \hat{k}\left(-\frac{dv}{dz}\right)$$

in multi dimensional problem $\frac{\partial V}{\partial s} = \frac{dV}{ds}$ where all other variables are treated as CONSTANT

$2xy^2$ $\quad \frac{\partial f}{\partial x} = 2y^2$

$\frac{\partial f}{\partial y} = 4xy$

Gradient

$$\vec{E} = \hat{i}\left(-\frac{\partial V}{\partial x}\right) + \hat{j}\left(-\frac{\partial V}{\partial y}\right) + \hat{k}\left(-\frac{\partial V}{\partial z}\right)$$

$$\vec{E} \equiv -\vec{\nabla} V \qquad \vec{\nabla} \equiv \hat{i}\frac{\partial}{\partial x} + \hat{j}\frac{\partial}{\partial y} + \hat{k}\frac{\partial}{\partial z}$$

"vector operator" $\equiv$ "Del"

Deposit Q

How does it get distributed?

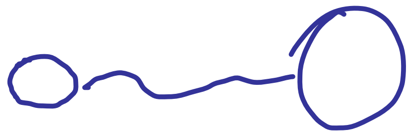
2 conducting spheres connected by conducting wire

(a) $\dfrac{Q_1}{Q_2} = \dfrac{R_2^2}{R_1^2}$ 1

(c) $\dfrac{Q_1}{Q_2} = \dfrac{R_2}{R_1}$ 1

(b) $\dfrac{Q_1}{Q_2} = \dfrac{R_1^2}{R_2^2}$ 2/3

(d) $\dfrac{Q_1}{Q_2} = \dfrac{R_1}{R_2}$ 1/4



$$\frac{kQ_1}{r_1} = \frac{kQ_2}{r_2}$$

$$\frac{Q_1}{Q_2} = \frac{r_1}{r_2}$$

where does breakdown occur?

(a) between large spheres 3

(b) between small spheres 5

(c) between both sets of spheres ~ simultaneously MOST OF REST

E_B $\qquad$ E_b

$\dfrac{kQ_B}{R_B^2}$ $\qquad$ $\dfrac{kQ_b}{R_b^2}$

$\dfrac{kQ_B}{R_B}\ \dfrac{1}{R_B}$ $\qquad$ $\dfrac{kQ_b}{R_b}\ \dfrac{1}{R_b}$