Physics 114, February 2, 2010

- Exam 1 - Feb 11, 2010
  Hoyt
  Normal lecture time
- Will cover [Material thru end of Gauss' law example today
  Workshops 1+2
  Prob sets 1-3
  Chapters 21, 22]
- Life goes on as normal in workshop and lectures (except on Feb. 11)

- P.S. 4 due Thurs. Feb 18
  Delayed due to exam
  Big Prob set
  Best if work on it along the way.

- Exam 1

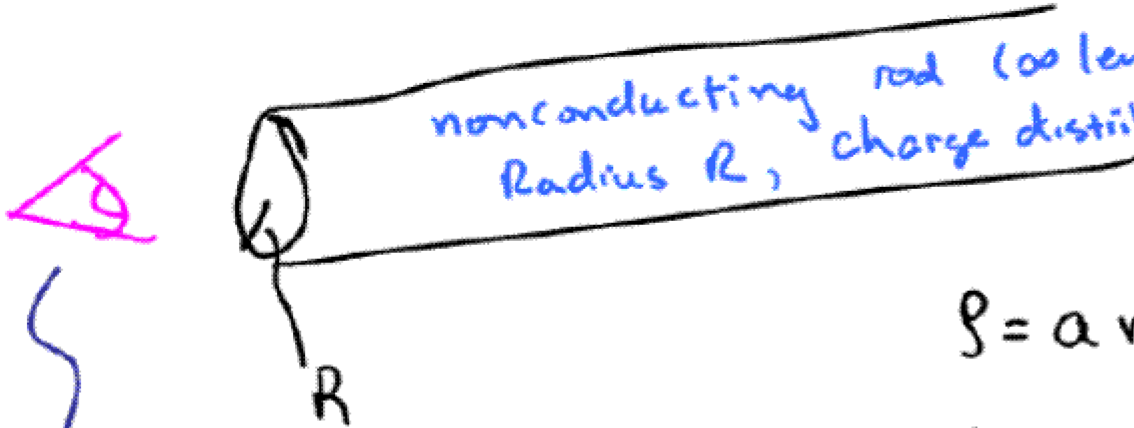
  Pen
  show work if you want credit ...

  Scientific calculator

  One Side of 8.5x11 inch sheet
  formulas + examples
  Not Topologically enhanced

  See old exams to get a sense of what you will see

Last little Gauss' law example

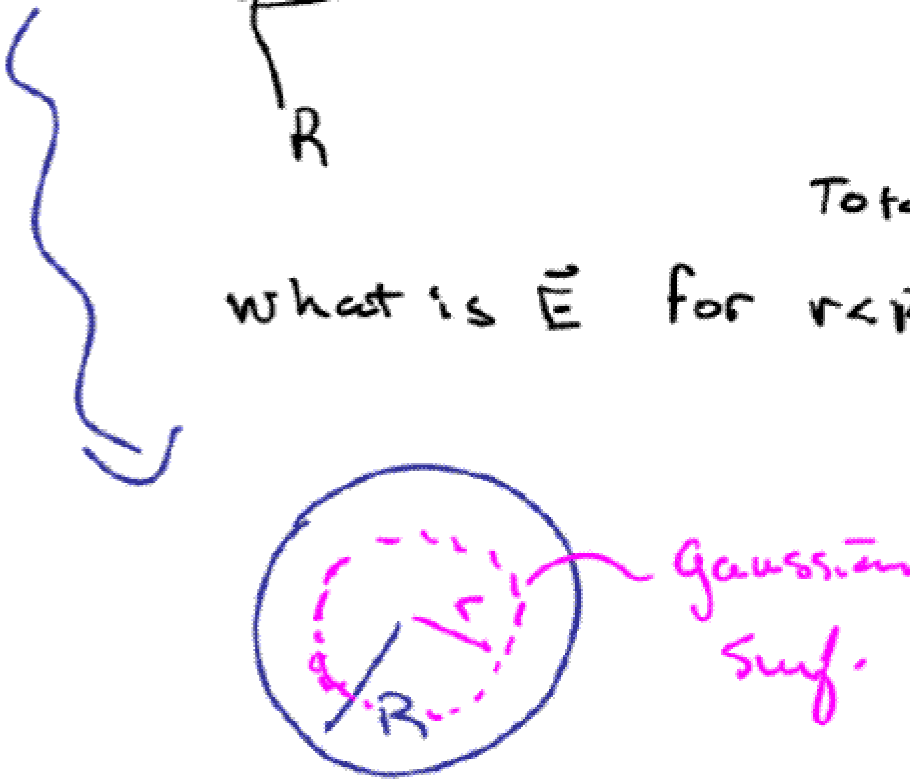


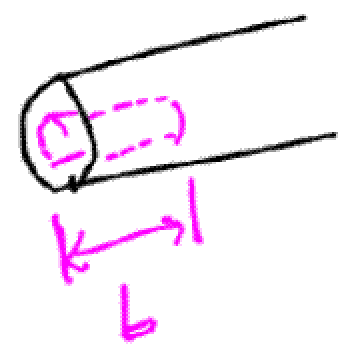
noncondicting rod (∞ length)
Radius R, charge distributed as $\rho = ar$
for $r<R$

$\rho = ar \qquad r<R$

Total chg/length of $+\lambda$

what is $\vec{E}$ for $r<R$





$$\oint \vec{E}\cdot\vec{dA} = \frac{Q_{encl}}{\epsilon_0}$$

$$\int_{\text{endcap 1}} \vec{E}\cdot d\vec{A} + \int_{\text{endcap2}} \vec{E}\cdot d\vec{A} + \int_{\text{pipe}} \vec{E}\cdot d\vec{A} = \frac{Q_{enc}}{\epsilon_0}$$

$\vec{E}\cdot d\vec{A} = 0$

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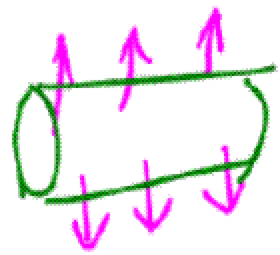


Recall $\vec{A}\cdot\vec{B} = |\vec{A}||\vec{B}|\cos\theta$

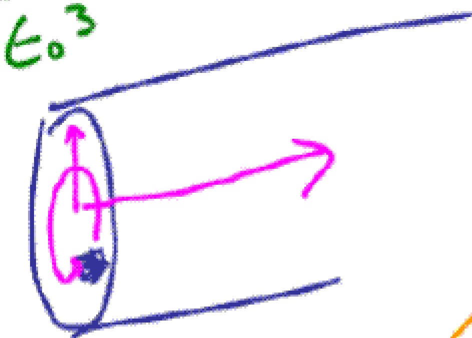
$$|\vec{E}|\int_{\substack{\text{pipe}\\ \text{surf}}} dA = |\vec{E}|\, 2\pi r L = \frac{Q_{encl}}{\epsilon_0}$$

over volume of Gaussian surface

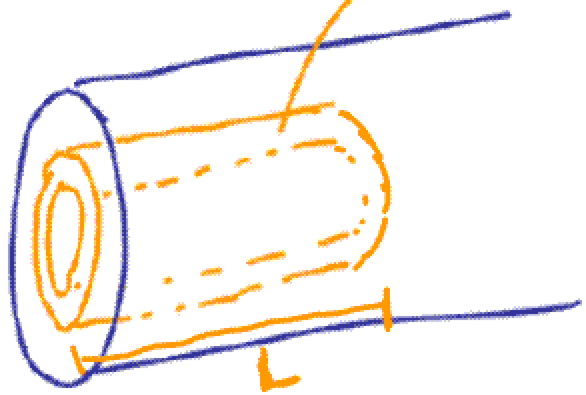
$$|\vec{E}|\, 2\pi r l = \frac{\int \rho\, dv}{\epsilon_0} = \frac{\int \rho \overbrace{[2\pi r L\, dr]}^{dv}}{\epsilon_0} = \frac{2\pi L}{\epsilon_0}\int_0^r a r^2\, dr$$

$|\vec{E}| = \frac{a r^2}{\epsilon_0 3}$ out radially

$$|\vec{E}| 2\pi r L = \frac{2\pi L a}{\epsilon_0} \frac{r^3}{3}$$



$$dv = 2\pi r L \, dr$$

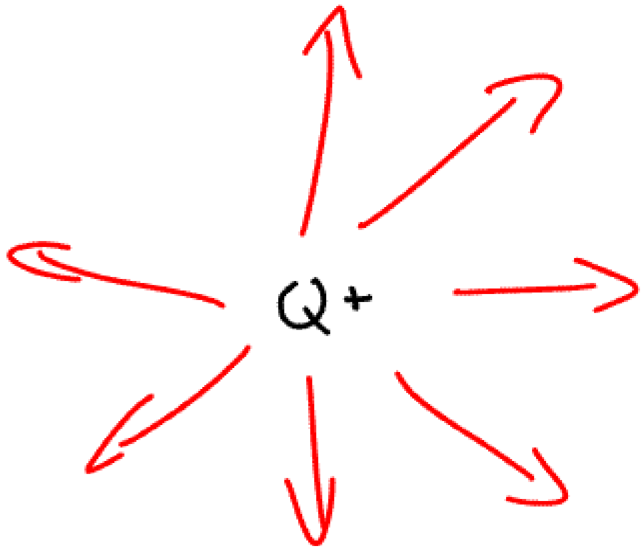


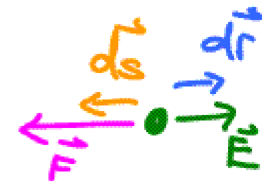
$$|\vec{E}| = \frac{a r^2}{\epsilon_0 3}$$

$$\vec{E} = \frac{a r^2}{\epsilon_0 3} \, \widehat{\text{radial}} \quad \text{for } r < R$$

$\boxed{\text{End of material for Exam 1}}$

Energy and Potential in electrostatics





How much work does it take me to move q from pt. A to pt. B

$$\int_A^B \vec{F}\cdot\vec{ds} = -\int_{r_A}^{r_B} \vec{F}\cdot\vec{dr} = \int_{r_A}^{r_B} q\vec{E}\cdot\vec{dr} = \int_{r_A}^{r_B} qE\,dr$$

Switch to integral over $\vec{r}$
$\vec{dr} = -\vec{ds}$

$\vec{F} = -q\vec{E}$

$$= -\int_{r_A}^{r_B} q\frac{kQ}{r^2}\,dr = -qQk\int_{r_A}^{r_B}\frac{1}{r^2}\,dr = \left.\frac{qQk}{r}\right]_{r_A}^{r_B}$$

$$W_{A\to B} = \frac{qQk}{r_B} - \frac{qQk}{r_A}$$ → quantity is positive
should be since
I am putting work
into the system

$$\frac{W}{q} = kQ\left[\frac{1}{r_B} - \frac{1}{r_A}\right] \equiv$$ Potential
Difference
bet
A + B

$$\Delta V = V_B - V_A = V_{AB} \equiv \text{Potential Difference}$$

1 Volt = 1 Joule / Coulomb

Man of the Hour

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

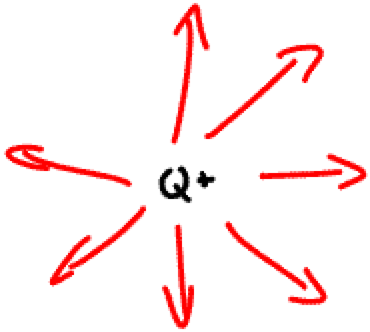
1 Volt = 1 Joule/Coulomb

Count Alessandro Giuseppe Antonio Anastasio Volta

Como, Lombardy, Italy

1745 – 1827

Invented the Voltaic pile forerunner of the modern battery



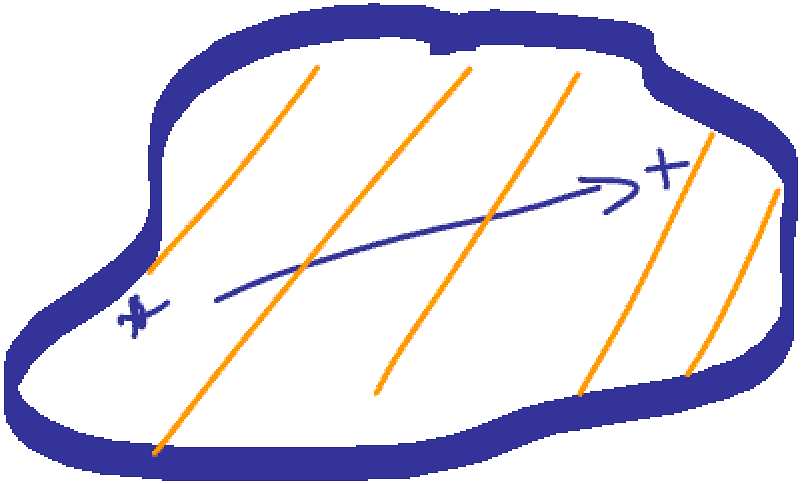
$$V_{AB} = kQ\left[\frac{1}{r_B} - \frac{1}{r_A}\right]$$

(Absolute)
Define the potential to be zero at $r \to \infty$

$r_A \to \infty$

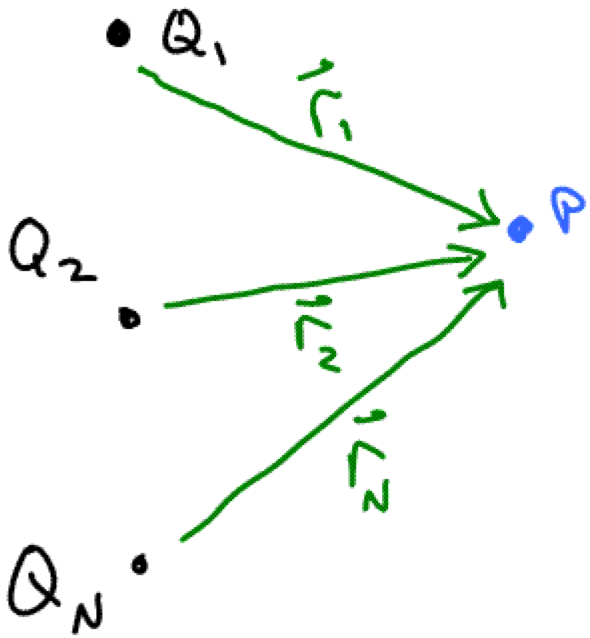
$$\boxed{V(r) = \frac{kQ}{r}}$$

Potential of a Point charge



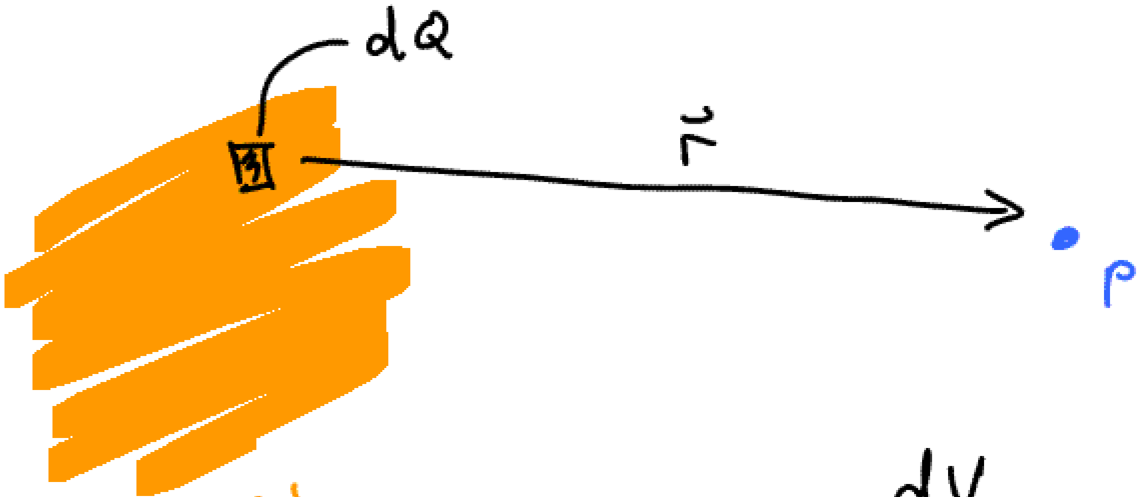
Conductor is at an "equipotential"

equipotential surface



$$\boxed{V_P = \sum_{i=1}^{N} V_i = \sum_{i=1}^{N} \frac{kQ_i}{r_i}}$$

Potential for a system of discrete charges



Charge Distribution

$$dV_{P\,\text{due to } dQ} = \frac{k\,dQ}{r}$$

Potential at P due to charge distribution

$$\boxed{V_P = \int_{vol} \frac{k\,dQ}{r}}$$

r is Not squared
Not a vector

easy relative to $\vec{E}$ calcs

$$V = \frac{W}{q} \qquad dV = \frac{dW}{q} = \frac{-\vec{F} \cdot \vec{ds}}{q} = -\vec{E} \cdot \vec{ds}$$

$$dV = -E_s \, ds$$

$$E_s = -\frac{dV}{ds}$$

$V(x,y,z)$

$\vec{A} = A_x\hat{i} + A_y\hat{j} + A_z\hat{k}$

$$E_x = -\frac{\partial V}{\partial x}$$

$$E_y = -\frac{\partial V}{\partial y}$$

$$E_z = -\frac{\partial V}{\partial z}$$

Not For This Course

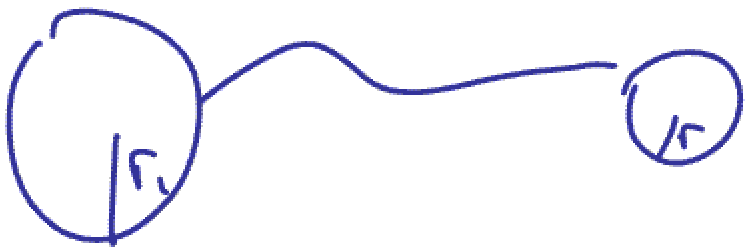
Just so you've seen it once

$$\vec{E} = -\frac{\partial V}{\partial x}\hat{i} - \frac{\partial V}{\partial y}\hat{j} - \frac{\partial V}{\partial z}\hat{k}$$

vector operator

$$\vec{\nabla} = \text{DEL} = \frac{\partial}{\partial x}\hat{i} + \frac{\partial}{\partial y}\hat{j} + \frac{\partial}{\partial z}\hat{k}$$

$$\vec{E} = -\vec{\nabla} V = -\text{grad}(V)$$



$$Q = q_1 + q_2$$

$$\frac{k q_1}{r_1} = \frac{k q_2}{r_2}$$

$$\frac{q_1}{q_2} = \frac{r_1}{r_2}$$