Physics 142 - September 21, 2010

- General issues?
  - prob sets?
  - workshops?

- Tuesday office hour
  → Tues at 4pm

- Unresolved questions/confusion on recent material?
Gauss' Law \[ \int \vec{E} \cdot d\vec{A} = \frac{Q_{enc}}{\varepsilon_0} \]

Always True ... most useful under certain conditions of symmetry.

Curvilinear coordinates

Volume element \[ dV = r \sin \theta \, dr \, d\theta \, d\phi \]
I'll limit us to problems in 1 variable. Usually that means radial dependence. Effectively integrates out angular dependence.

Sphere: \( dv = 4\pi r^2 dr \)

Shell: \( dv = r d\phi dz dr \)

Cylinder: \( dv = 2\pi r dz dr \)
nonconducting core radius $R_A$
has $+\lambda$
distributed
\[ S(r) = ar \quad r < R_A \]

Find $\vec{E}$ in all space

$r < R_A$
\[ E \text{ radially outward by symmetry} \]
\[ \int E \cdot dA = \frac{Q_{\text{enc}}}{E_0} \]

\[ E \perp dA \]

\[ \int g \, dv = \int_0^L a \pi r^2 L \, dr \]

\[ A = 2 \pi r L \]

\[ Q_{\text{enc}} = a_2 \pi c r^3 \]

\[ \frac{Q_{\text{enc}}}{3} \]
\[ \frac{1}{2} \vec{E} \cdot 2\pi r L = \frac{a}{2\pi L} r^3 \frac{1}{3 \varepsilon_0} \]

\[ \vec{E} = \frac{a}{3 \varepsilon_0} r^2 \text{ radially out } r < R_A \]

\[ R_A < r < R_B \]

\[ \oint \vec{E} \cdot d\vec{A} = \frac{Q_{enc}}{\varepsilon_0} \]

\[ (\vec{E} \cdot 2\pi r L = \frac{1}{4 \pi \varepsilon_0} \frac{R_A^3}{3} ) \]
\[ R_A < r < R_B \]

\[ \mathbf{E} = \frac{a}{\varepsilon_0} \frac{R_A^3}{r} \quad \text{(radially outward)} \]

\[ \begin{array}{l}
  \text{radially outward} \\
  \text{because region inside conductor}
\end{array} \]

\[ R_B < r < R_c \]

\[ \mathbf{E} = \frac{a}{36} r^2 \]

\[ \mathbf{E} = 0 \]
Ans. is
same as in 2nd region \((R_A < r < R_B)\)
because symmetry \(\text{And}\) \(Q_{encl}\)
are the same

\[ r > R_c \]

\[ \bar{E} = \frac{\alpha R_A^3}{\varepsilon_0 3 r} \] radially outward
Recall how useful energy considerations are for mechanics.

\[ W = \int_{A}^{B} \vec{F} \cdot d\vec{s} = \int_{A}^{B} F ds = \int_{A}^{B} q_0 E ds = - \int_{R_A}^{R_B} q_0 E dr \]
\[ W = \int_{R_A}^{R_B} \frac{kQ}{r^2} \, dr = -q_0 k Q \left[ \frac{-1}{r} \right]_{R_A}^{R_B} \]

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

\text{Net \, \text{+} \, quantity}

\[ W = \frac{q_0}{2} \] Potential difference \, \text{work change} \, \Delta V = \frac{\Delta U}{q_0} \]

\[ \Delta V = V_B - V_A \equiv V_{AB} \]

\text{Unit} = \frac{\text{Joules}}{\text{Coulomb}} \equiv \text{Volt}