Physics 142 - Sept. 27, 2007

Exam 1 - One week from today

Covers Material on Problems 1-3
Workshops 1-3

- Exam Timing is poor in that we are
  ~1/2 thru "Potential": Problem Set 4
  Will involve more "potential"
  problems among other things.

- Timing was better in 2005 in that
  we'd finished Prob Set 4

- Chapt 25 "Potential" Material is on exam
  and I will keep in mind that you're not yet
  done full set of chap. 25 problems.
Last time

Electric Potential

System of discrete charges

\[ V_P = \frac{kQ}{r} \]

Important

Continuous charge

\[ V_P = \int_{\text{vol}} \frac{k \, dq}{r} = \int_{\text{vol}} \frac{k \, \delta \, dV}{r} \]
Potential and the Electric field

\[ V(x,y,z) \]

\[ E(x,y,z) = -\nabla V \]

in Cartesian coords

\[ \nabla \equiv \hat{i} \frac{\partial}{\partial x} + \hat{j} \frac{\partial}{\partial y} + \hat{k} \frac{\partial}{\partial z} \]
\[ \Gamma_A = \Gamma_B \]
\[ V_A = V_B \]

All pts at fixed radius are at same potential

\[ \Rightarrow \text{Equipotential Surface} \]
d\rho = \frac{r}{r^2} \cdot d\sigma
\[ r = \sqrt{x^2 + a^2} \]

The charge is uniformly distributed on the ring.

\[ V_p = \int \frac{k d\rho}{r} = \frac{k\lambda}{\sqrt{x^2 + a^2}} \int_0^{2\pi a} d\sigma = \frac{k\lambda 2\pi a}{\sqrt{x^2 + a^2}} = \frac{kQ}{\sqrt{x^2 + a^2}} \]

\( x >> a \) \quad \rightarrow \quad \frac{kQ}{x} \quad \text{valid for large charge} \quad \checkmark

\[ \vec{E}_p = -\frac{dV_p}{dx} \hat{x} = \frac{kQx}{(x^2 + a^2)^{3/2}} \]

\[ \lim_{x \to \infty} \vec{E}_p \rightarrow \frac{12Q}{x^2} \]
What is $\vec{E}$ as in of $\nabla$?

$$\phi \vec{E} \cdot d\vec{A} = \int \vec{E} \cdot d\vec{A} + \int \vec{E} \cdot d\vec{A} + \int \vec{E} \cdot d\vec{n}$$

$$\phi \vec{E} \cdot d\vec{A} = \frac{Q_{\text{enc}}}{\varepsilon_0} \quad \rightarrow \quad 2 \vec{E} \cdot d\vec{A}$$

$$2 \vec{E} \cdot d\vec{A} = \frac{\nabla A}{\varepsilon_0}$$

$$\vec{E} \cdot d\vec{A} = \frac{\nabla A}{2\varepsilon_0}$$
\[ \mathbf{E} = 0 \quad \Rightarrow \quad \mathbf{E} = 0 \]

**Parallel Plate Capacitor**

\[
V_{\text{between Plates}} = - \int \mathbf{E} \cdot d\mathbf{s} = -1E1d = \frac{V \cdot d}{\varepsilon_0}
\]

\[ \Delta V = 1 \text{ volt} \]

\[ eV = 1 \text{ electron-Volt of energy / work to move } e \text{ from 1 plate to other} \]
\[ 1 \text{ eV} = (1.61 \text{ eV}) (1 \text{ volt}) = 1.6 \times 10^{-19} \text{ Coulomb/volt} \]
\[ = 1.6 \times 10^{-19} \text{ Joules} \]

\[ E = mc^2 \]

\[ \int_{eV}^{?} \]

\[ \text{unit of mass} = \frac{eV}{c^2} \]

\[ \downarrow \]

\[ \text{MeV/c}^2 \]
Each sphere has radius $R$ far apart.

\[ V_+ = \frac{kQ}{R} \quad V_+ \propto Q \]

\[ V_- = -\frac{kQ}{R} \quad V_- \propto Q \]

\[ V_T = V_+ - V_- = 2kQ \quad V_T \propto Q \]
define capacitance as the const. of proportionality

\[ Q = C_+ V_+ \quad Q = C_- V_- \]

\[ Q = C_{+-} V_{+-} \]
New geometry, $V_{+1}, V_{-1}, V_\tau$, all reduced

$$\mathcal{Q} = (C_{t_\tau})_{V_{\tau}}$$

Capacitance quantifies amount of charge that system can hold at given potential difference

$\mathcal{Q}$ depends only on geometry

\[ -V_1 \quad +V \]

\[ -V \quad +V \]

Large capacitance means more $\mathcal{Q}$ can be stored for same $AV$. 