Physics 122 – Class #11
Date: 9/23/14

Questions?
Announcements/reminders

MP HW04 and written HW04 are due Today!

Exam on Thursday 25\textsuperscript{th}. Did you go through the homeworks? Examples? Conceptual questions? Qizzes? Practice test? If you need help with any of the problems you are working on, ask for help! Come talk to me, or go to any of the help sessions. Wednesday 3-5 pm Brandon (TA) will be at WORKMAN 110, available to you...

Always check the class website to make sure of assignments and due dates.

(http://www.physics.nmt.edu/~saska/phys122.html)
Physics 122 – Class #11

Last class: Charges and electric force..

Today: Charges, electric force, electric field ...
REMEMBER:

Charge is property of matter.

Electrons and protons have same magnitude of charge, but of opposite sign. By convention, electrons have “-” and protons have “+” charge.

\[ e = 1.60 \times 10^{-19} \text{ C} \]

1 electron has \(-e\) charge

1 proton has \(+e\) charge

There are two types of charge. Opposite charges attract, same charges repel.

The total charge on an object is a multiple of \(e\) (Charge is quantized).

\[ Q = (N_p - N_e) e \]

Electrically neutral objects have equal number of “+” and “-” charges.

\[ N_p = N_e \]

Charge gets transferred from one object to another via contact.
Electric force is a long range force. No contact needed for a charged object to “feel” the force from another charged object.

Neutral objects get attracted by charged objects as a result of polarization force (due to separation of charge).

Electric diapole.

Separation of charge occurs within the atoms.

Charge is conserved!
Conductors: electron sea. The charge in conductors can move freely. They always move in a way to find a state of ELECTROSTATIC EQUILIBRIUM - No net motion of charge. The electric field inside the conductor is zero everywhere. In an isolated conductor, the excess charge resides on the surface of the conductor.

Conductors in contact “share” the excess charge.

Insulators: get charged, but charge is not moving!
Coulomb's Law (force between two point charges):

\[
\overrightarrow{F}_{1\text{on }2} = \overrightarrow{F}_{2\text{on }1} = \left( K \frac{q_1 q_2}{r^2} \right)
\]

\[
\overrightarrow{F}_{1\text{on }2} = \left( \begin{array}{c} \hat{\imath} \\ \hat{j} \end{array} \right) \hat{\imath}
\]

\[
\overrightarrow{F}_{2\text{on }1} = \left( \begin{array}{c} \hat{j} \\ \hat{\imath} \end{array} \right) (-\hat{\imath})
\]
Superimposition of forces:

\[ \vec{F}_{\text{net}} = \vec{F}_{1 \text{ on } a} + \vec{F}_{2 \text{ on } a} + \vec{F}_{3 \text{ on } a} \]
Conceptual questions (at the end of the chapter)

7. A negatively charged electroscope has separated leaves.
   a) How will the leaves react if you bring a negatively charged rod next to the top of the electroscope?
   b) How will the leaves react if you bring a positively charged rod next to the top of the electroscope?
8. The two oppositely charged metal spheres have equal quantities of charge. They are brought to a contact with a neutral metal rod. What is the final charge state of each sphere and the rod? Use both charge diagrams and words to explain.

Result: Neutral spheres
9. Metal sphere A has 4 units of negative charge and metal sphere B has 2 units of positive charge. The two spheres are brought to contact. What is the final charge state of each sphere? Explain.
Conceptual questions (at the end of the chapter)

10. Metal spheres A and B are initially neutral and touching. A positively charged rod is brought near A, but not touching. Is A now positive, negative, or neutral? Use both charge diagrams and words to explain.
Problem 25.39 (at the end of the chapter)

What is the force on the 1.0 nC charge in the middle, due to the other charges? Give your answer in component form.

\[ 2_1 = 2_4 = -2.0 \text{nC} \]
\[ 2_2 = 2_3 = 2.0 \text{nC} \]
\[ 2_5 = 1.0 \text{nC} \]
\[ a = 1.0 \text{ cm} \]
\[ F_{1\text{on5}} = F_{2\text{on5}} = F_{3\text{on5}} = F_{4\text{on5}} = K \frac{125 \times 2.0 \text{mC}}{d^2} \]

\[ d^2 = \left(\frac{a}{2}\right)^2 + \left(\frac{a}{2}\right)^2 = 2 \frac{a^2}{4} = \frac{a^2}{2} \]

\[ F_y = 0 \]

\[ F_x = 4 \left( K \frac{125 \times 2.0 \text{mC}}{d^2} \cos 45^\circ \right) (-i) \]
Problem 21.59

\[
\begin{align*}
\Delta \phi &= m (2\pi) \text{ rad} \\
&= \frac{2\pi}{\lambda} \Delta x + \Delta \phi_0 \\
\Rightarrow \\
\Delta x &= m \cdot \lambda \\
\Rightarrow \lambda &= 0.40 \text{ cm}
\end{align*}
\]
\[ f = \frac{V}{\lambda} = \frac{340 \text{ m/s}}{0.40 \text{ cm}} = \]

\[ \Delta \phi = \frac{2\pi}{\lambda} + \Delta \phi_0 = m \cdot (2\pi) \]

\[ \Delta \phi_0 = m \cdot (2\pi) - \frac{2\pi}{\lambda} \]
\[ \Delta r_p = d \sin \Theta_r \]

\[ \Theta_{\text{new}} = \Theta_r + \Theta \]

\[ \tan \Theta_{\text{new}} (\Theta_r + \Theta) = \frac{y_1}{L} \]

\[ \Theta_m = m \frac{\Delta x}{L} \]

\[ \Theta = 0 \]
Example 25.8 (from the text)

A -1.0 nC charged particle is located at the origin. Points 1, 2, and 3 have (x, y) coordinates (1 cm, 0 cm), (0 cm, 1 cm), and (1 cm, 1 cm), respectively. Determine the electric field at these points, then show the vectors on an electric field diagram.
Example 25.8 (from the text) ... continues
Example 25.8 (from the text) … continues