University of Mississippi
PHYS 212 Honors, 23 Feb 2011

Name: *KEY*

## Test 1

Instructions: Explain *briefly* all your answers; for each equation you use, state what the equation is and why it applies to the problem. Remember to include units in all of your numerical results (but not in the intermediate steps of your calculations), to use the right number of significant digits in the final results, and not to use the same symbol for different quantities in a given problem.

### Short Questions

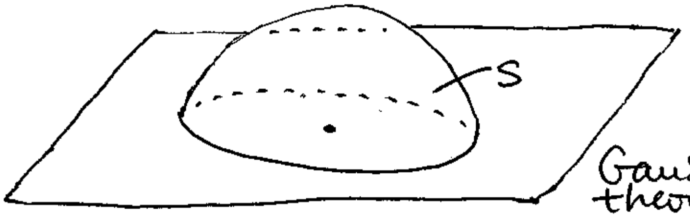
1. A plastic object like a ruler or a pen that has been rubbed with a cloth can attract small pieces of paper. How can this happen, if the paper is not charged?

The pieces of paper become polarized.

2. What would happen if you held a metal object like an aluminum or steel rod, rubbed it like the plastic object in Question 1, and tried to attract small pieces of paper with it? Explain.

Nothing – the metal is a conductor.

3. An electric charge $q = 3.0 \times 10^{-10}$ C is placed on a horizontal, nonconducting horizontal plane. What is the electric flux through a half sphere of radius 10 cm resting on the plane, centered around the charge?



$$\Phi_E = \int_S \vec{E}\cdot d\vec{A} = \frac{1}{2}\oint_{\text{sphere}} \vec{E}\cdot d\vec{A}$$

Gauss theorem

$$= \boxed{\frac{1}{2}}(q_{in}/\varepsilon_0) = \frac{3.0\times10^{-10}}{2(8.85\times10^{-12})} =$$

4. A charged particle is released from rest in an electric field. Does it start moving towards points with higher or lower electric potential? Explain.

If positive → towards lower V } always towards
If negative → towards higher V } lower $U = qV$.

5. Explain how we know that the electric potential everywhere inside a conductor is constant; specify under what assumptions we can reach this conclusion.

You guys did not study

most of you messed this up.

Assumption = the conductor is in static equilibrium

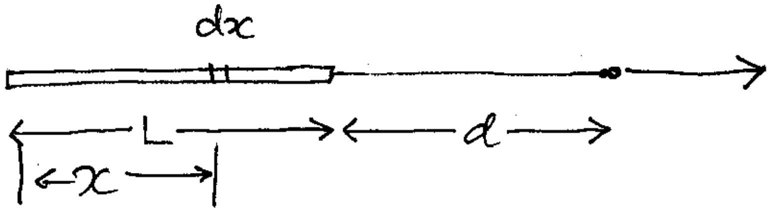
$\vec{E} = 0$ inside because otherwise charges would move & it would not be in equil.

6. Give two different reasons why dielectrics are commonly inserted between the plates of capacitors.

1. Dielectrics increase the capacitance
2. Dielectrics increase the mechanical sturdiness.

## Problems

1. An insulating thin rod of length $L = 15.0$ cm has a positive charge of $Q = 6.00$ pC uniformly distributed along it. What are the magnitude and direction of the electric field at a point on the axis of the rod, a distance $d = 15.0$ cm away from the near end of the rod? Find the answer first in terms of $L$, $Q$ and $d$, and then substitute the numerical values in it.



$$dE = k \cancel{\int} \frac{dq}{r^2} \qquad \lambda = \frac{Q}{L}$$

$$= k \frac{\lambda dx}{(L+d-x)^2}$$

$$E = \int_0^L dx \frac{k\lambda}{(L+d-x)^2} = k\lambda\left[+\frac{1}{(L+d-x)}\right]_0^L$$

$$\boxed{E = k\lambda\left(\frac{1}{d} - \frac{1}{L+d}\right)}$$

- $\vec{E}$ vs $E$

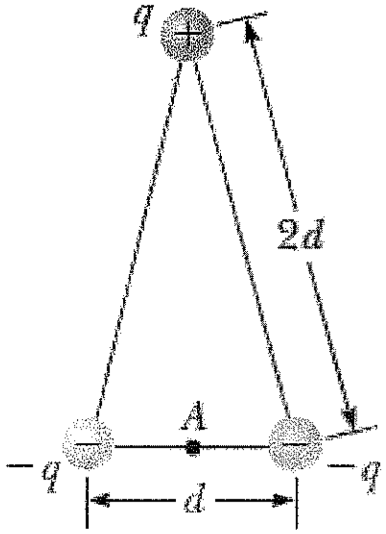
$$= (8.99\times10^{9})\left(\frac{6.00\times10^{-12}}{0.150}\right)\times$$

$$\times\left(\frac{1}{0.150} - \frac{1}{0.300}\right)$$

symbolic limits [illegible]

X X 8 =

2. The three charged particles in the figure below are at the vertices of an isosceles triangle, with base length $d = 1.80$ cm and side length $2d$; All three charges have magnitude $q = 6.40$ nC and their mass is $m = 2.30$ mg. If the positive particle is released from rest, find the speed at which it is moving as it passes point $A$, the midpoint of the base first in terms of $d$, $q$, and $m$; then substitute in the numerical values).



$$U_i = 2 \cdot k_e \frac{-q^2}{2d} = -k_e \frac{q^2}{d}$$

$$U_f = 2 \cdot k_e \frac{-q^2}{d/2} = -4 k_e \frac{q^2}{d}$$

$$\Delta U = U_f - U_i = -3 k_e \frac{q^2}{d}$$

$$\Delta U = -\Delta K = -K_f$$

$$K_f = +3 k_e \frac{q^2}{d}$$

$$\frac{1}{2} m v^2 = +3 k_e \frac{q^2}{d}$$

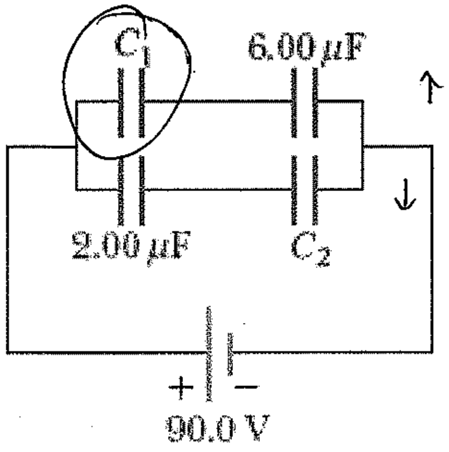
$$v = \sqrt{\frac{6 k_e q^2}{m d}}$$

$V_x$ $V_y$ $U_y$ ???

attempt F=ma 6

$$\underline{\text{everybody}} \begin{cases} V_x, V_y, \ldots \\ \text{or } a = \text{const} \\ \text{or just numbers} \end{cases}$$

3. Consider the system of capacitors shown in the figure, with $C_1 = 3.00\,\mu\text{F}$ and $C_2 = 5.00\,\mu\text{F}$. Find the potential difference across the capacitor $C_1$.



$$C = \frac{Q}{\Delta V}$$

$$C_\uparrow = \left(\frac{1}{3.00} + \frac{1}{6.00}\right)^{-1} = \left(\frac{3}{6.00}\right)^{-1} = 2.00\,\mu F$$

$$\left[\begin{array}{l} C_\downarrow = \left(\frac{1}{2.00} + \frac{1}{5.00}\right)^{-1} = \left(\frac{7.00}{10.00}\right)^{-1} = \frac{10}{7}\,\mu F \\ \qquad = 1.43\,\mu F \\ C_{eq} = C_\uparrow + C_\downarrow = 3.43\,\mu F \qquad \text{not needed} \end{array}\right]$$

$$Q_\uparrow = C_\uparrow \Delta V = \overset{2.00\times10^{-6}}{(2.00\,\mu F)}\overset{9.00\times10}{(90.0\,V)}$$
$$= 1.80\times10^{-4}\,C$$

$$\text{So } \Delta V_1 = \frac{Q_\uparrow}{C_1} = \frac{1.80\times10^{-4}}{3.00\times10^{-6}} = 60.0\,V$$

You've stopped explaining <u>why</u>!