Phys132 - Fund. Phys. 2 Name: Solutions

Homework 4 Due Thu, Jan 25, 2007

Reading Assignment: Please read Chapter 18 Section 18.11 **and** Chapter 19, sections 19.1 thru 19.3.

Instructions: Answer all of the questions below. Circle the letter of your answer for the multiple-choice problems. Show your work or reasoning for **all numerical problems**.

1. What is the magnitude of the electric field due to a 4.0×10^{-9} C charge at a point 0.020 m away?

   (a) 1.8×10^{3} N/C
   (b) 9.0×10^{4} N/C
   (c) 1.0×10^{5} N/C
   (d) 3.6×10^{6} N/C
   (e) 7.2×10^{7} N/C

$$E = k\frac{|q|}{r^2} = \left(8.99 \times 10^{9} \frac{N m^2}{C}\right)\frac{(4.0 \times 10^{-9} C)}{(0.020\ m)^2}$$

$$= 8.99 \times 10^{4}\ N/C$$

2. The electric field inside a parallel plate capacitor...

   (a) ...is strongest near the plates and points away from the positive plate.
   (b) ...is strongest near the plates and points toward the positive plate.
   (c) ...is strongest in the middle and points toward the positive plate.
   (d) ...is strongest in the middle and points away from the positive plate.
   (e) ...is uniform between the plates and points toward the positive plate.
   (f) ...is uniform between the plates and points away from the positive plate.

3. What is the magnitude of electric field inside a parallel plate capacitor if the charge on each plate is $q = \pm 6.0 \times 10^{-9}$ C and the area of each plate is $A = 52\,\mathrm{m}^2$?

   Answer: 13 N/C

$$E = \frac{q}{\varepsilon_0 A} = \frac{(6.0 \times 10^{-9} C)}{\left(8.85 \times 10^{-12} \frac{C^2}{N m^2}\right)(52\ m^2)}$$

$$= 13.04\ N/C$$

4. An electric field of 260 000 N/C points due west at a certain spot. What are the magnitude and direction of the force that acts on a charge of (a) $q_1 = -7.0\,\mu$C and (b) $q_2 = 3\,\mu$C at this spot?

Answers: (a) 1.8 N to the East (b) 0.78 N to the West

$F = |q|E$

(a) $F_1 = |q_1|E = (7.0\times10^{-6}\,C)(2.6\times10^{5}\,N/C) = 1.82\,N$
To the east because q_1 is negative

(b) $F_2 = |q_2|E = (3.0\times10^{-6}\,C)(2.6\times10^{5}\,N/C) = 0.78\,N$
To the west because q_1 is positive

5. A charged ***conducting*** sphere with a radius of $R = 5 \times 10^{-3}$ m has a total charge of 150 μC. This charge is where? Explain.

(a) ...spread throughout the volume inside the sphere.

(b) ...concentrated in the center of the sphere.

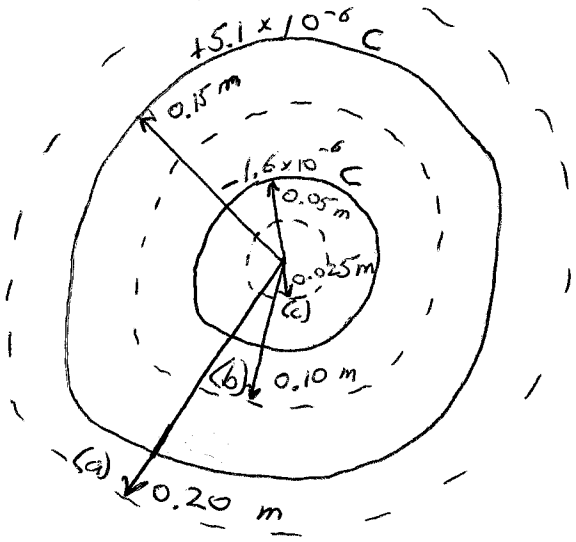
(c) ...spread on the surface of the sphere.

6. (Refer to Concept Simulation 18.3 on www.wiley.com/college/cutnell for a perspective that is useful in solving this problem.) Two spherical shells have a common center. A -1.6×10^{-6} C charge is spread uniformly over the inner shell, which has a radius of 0.050 m. A $+5.1 \times 10^{-6}$ C charge is spread uniformly over the outer shell, which has a radius of 0.15 m. Find the magnitude and direction of the electric field at a distance (measured from the common center) of (a) 0.20 m, (b) 0.10 m, and (c) 0.025 m.

Answers: (a) 7.9×10^5 N/C outward (b) -1.4×10^6 N/C (neg. means inward)

(c) 0 N/C

Key: Shells ——— Gaussian Spheres - - -



(a) $EA = \frac{q_{enc}}{\varepsilon_0}$

$q_{enc} = -1.6\times10^{-6}\,C + 5.1\times10^{-6}\,C$
$= 3.5\times10^{-6}\,C$

$A = 4\pi R^2 = 4\pi(0.2\,m)^2 = 0.50\,m^2$

$E = \frac{3.5\times10^{-6}\,C}{\left(8.85\times10^{-12}\,\frac{C^2}{N\,m^2}\right)(0.50\,m^2)}$

$= 7.9 \times 10^5\,N/C$

(continued)

6) (b)

$q_{enc} = -1.6 \times 10^{-6}$ C (only the inner shell is inside)

$A = 4\pi R^2 = 4\pi (0.1\ m)^2$

$= 0.126\ m^2$

$$EA = \frac{q_{enc}}{\varepsilon_0} \rightarrow E = \frac{-1.6 \times 10^{-6}\ C}{(8.85 \times 10^{-12}\ \frac{C^2}{N \cdot m^2})(0.126\ m^2)}$$

$$= -1.4 \times 10^6\ N/C$$

(c) No charge is enclosed, so $q_{enc} = 0$

and therefore $E = 0$.