

PHYS 122 A,B Spring 2012
MIDTERM 1
April 12th 2012

NAME _____
Last First
Student # _____

PART I Multiple Choice – Each question is worth 5 points – total 55 points

1. A positively charged rod is brought near one side of an (initially) neutral metal ball, the other side of which is connected to ground. The ground connection is then removed after which the rod is taken far away. Which one of the following statements is true?

- (a) Electrons were transferred from ball to ground and the ball is now positively charged.
- (b) Electrons were transferred from ground to ball and the ball is now positively charged.
- (c) Electrons were transferred from ball to ground and the ball is now negatively charged.
- (d) Electrons were transferred from ground to ball and the ball is now negatively charged.
- (e) None of the above

Questions 2 and 3 are connected

2. Point charges q_1 and q_2 are located on the x-axis at positions x_1 and x_2 respectively. Charge q_3 is then positioned on the x-axis at x_3 such that *each* charge feels no net electric force. If $x_1 = 1.00$ m, $x_2 = 2.00$ m, $q_1 = 1.00$ nC, $q_2 = 2.00$ nC, then the value of x_3 is

- (a) 0.75 meters
- (b) 1.28
- (c) 1.41
- (d) 1.78
- (e) 2.33

3. (See question 2). The value of q_3 is

- (a) -2.06 nC
- (b) -1.51
- (c) -1.08
- (d) -0.72
- (e) -0.34

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4. Three identical charges are placed equidistant from each other on the x-y plane. If the total electric force on one of the charges is \hat{j} N, what are the forces on the other two?

- (a) 0 and 0
- (b) $\hat{i} + \hat{j}$ and $\hat{i} - \hat{j}$
- (c) $(\sqrt{3}/2)\hat{i} - \hat{j}/2$ and $(-\sqrt{3}/2)\hat{i} - \hat{j}/2$
- (d) $\hat{i}/\sqrt{2} - \hat{j}/\sqrt{2}$ and $-\hat{i}/\sqrt{2} - \hat{j}/\sqrt{2}$
- (e) $\hat{i} - \hat{j}/2$ and $-\hat{i} - \hat{j}/2$

5. Two spherical metallic shells with total charges q and $2q$ are both centered at $(x, y, z) = (0, 0, 0)$, and have radii 1m and 2m respectively. If the electric field at $(0, 0, 3\text{m})$ is measured to be 3 N/C in the +z-direction, the value of q must be

- (a) 1 nano-Coulomb
- (b) 2
- (c) 3
- (d) 4
- (e) 5

6. When the electric field magnitude in dry air exceeds 3×10^6 N/C, the air ionizes and an electric discharge can occur. A $100\mu\text{C}$ charge is placed on a uniform conducting sphere in air. How small can the radius of this sphere be, before an electric discharge may occur?

- (a) .75 meters
- (b) .55
- (c) .97
- (d) .12
- (e) .37

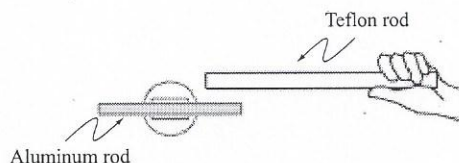
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Two infinite non-conducting uniformly charged planes lie parallel to each other and parallel to the yz plane. One is at $x_1=+2$ m and has a surface charge density of $\sigma_1=+7.0$ $\mu\text{C}/\text{m}^2$. The other is at $x_2=-2$ m and has a surface charge density of $\sigma_2=-2.0$ $\mu\text{C}/\text{m}^2$. Find the electric fields in the following three regions:

7. $x > 2.00$ m
- A. 0.00
 - B. $+2.82 \times 10^5 \frac{\text{N}}{\text{C}} \hat{i}$
 - C. -2.82×10^5
 - D. $+5.08 \times 10^5$
 - E. -5.08×10^5
8. $-2.00 < x < +2.00$ m
- A. 0.00
 - B. $+2.82 \times 10^5 \frac{\text{N}}{\text{C}} \hat{i}$
 - C. -2.82×10^5
 - D. $+5.08 \times 10^5$
 - E. -5.08×10^5
9. $x < -2.00$ m
- A. 0.00
 - B. $+2.82 \times 10^5 \frac{\text{N}}{\text{C}} \hat{i}$
 - C. -2.82×10^5
 - D. $+5.08 \times 10^5$
 - E. -5.08×10^5

10. An aluminum rod is placed by hand on an insulating pivot as used in the lab. No other objects are nearby. Then, a Teflon rod is rubbed with a wool cloth and is brought near to the side of the aluminum rod as shown below.



Which statement is most correct?

- (a) The aluminum rod will experience an attractive force toward the Teflon rod since it becomes polarized, causing the aluminum rod to rotate counter clockwise.
 - (b) The aluminum rod experiences no force since it was discharged when it was placed on the pivot.
 - (c) The aluminum rod experiences an attractive force toward the Teflon rod since it was charged positively when it was placed on the pivot. The aluminum rod will therefore rotate counter clockwise.
 - (d) The aluminum rod experiences a repulsive force away from the Teflon rod since it was charged negatively when it was placed on the pivot. The aluminum rod will therefore rotate clockwise.
 - (e) The aluminum rod will experience a repulsive force away from the Teflon rod since it becomes polarized, causing the aluminum rod to rotate clockwise.
11. While the charged Teflon rod is held near the aluminum rod, the left end of the aluminum rod is briefly touched by a hand. The aluminum rod and the Teflon rod do not touch in the process. Then the Teflon rod is replaced by an acrylic rod that has been rubbed by a wool cloth.

Which statement is most correct?

- (a) The aluminum rod will experience an attractive force toward the acrylic rod since it is now net negatively charged, causing the aluminum rod to rotate counter clockwise.
- (b) The aluminum rod will experience a repulsive force away from the acrylic rod since it is now net negatively charged, causing the aluminum rod to rotate clockwise.
- (c) The aluminum rod will experience a repulsive force away from the acrylic rod since it is now net positively charged, causing the aluminum rod to rotate clockwise.
- (d) The aluminum rod will experience an attractive force toward the acrylic rod since it is now net positively charged, causing the aluminum rod to rotate counter clockwise.
- (e) The aluminum rod experiences no force since it was grounded when touching it with the finger.

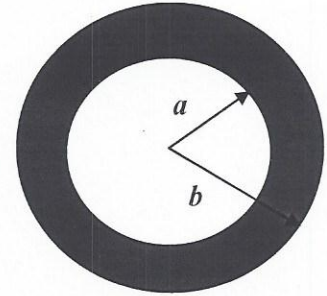
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PART II Long handwritten lecture question - **total 25 points**

A hollow spherical non-conducting shell of inner radius a and outer radius b carries charge density $\rho = C/r^2$ in the region $a \leq r \leq b$. Find the electric field in three regions:
[SHOW YOUR WORK!]

(i) (5 points) $r < a$



(ii) (10 points) $a < r < b$

(iii) (10 points) $r > b$