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Physics 212, Spring 2009

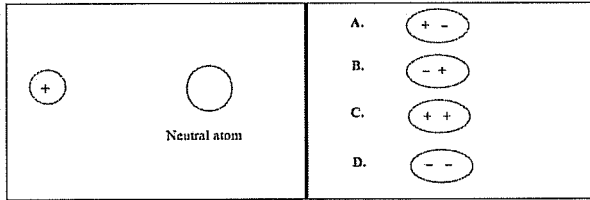
Quiz 3, Form: **A**

Name: Key
Date: _____

Magnitude of the charge of an electron or proton: $e = 1.6 \times 10^{-19}$ C.

Section 1. Multiple Choice

1. A positively charged ion is near a neutral atom. Which diagram shows the polarization of the neutral atom?



- (a) A.
(b) B.
 (c) C.
 (d) D.
 (e) None of the above because the neutral atom will not be polarized.

2. The ion and the neutral atom in the previous question will

- (a) not attract or repel since the atom is neutral.
 (b) attract if close and repel if far away.
 (c) repel if close and attract if far away.
(d) attract.
 (e) repel.

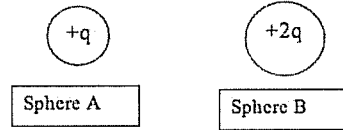
3. In what type of material are all electrons bound to atoms and can only move within an atom?

- (a) conductor
(b) insulator
 (c) both a conductor and an insulator
 (d) neither a conductor nor an insulator

4. In what type of material can mobile electrons move freely throughout the material?

- (a)** conductor
 (b) insulator
 (c) both a conductor and an insulator
 (d) neither a conductor nor an insulator

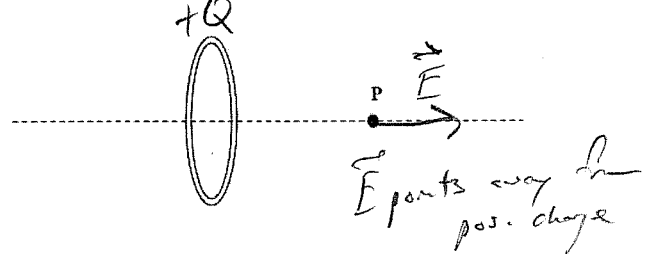
5. Two metal spheres are charged. Sphere A has a charge $+q$, and Sphere B has a charge $+2q$, which is twice the charge as sphere A.



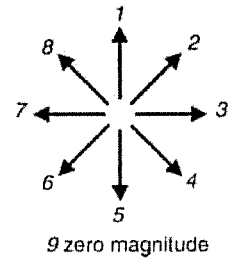
On which sphere is the electrostatic force the greatest, in magnitude?

- (a) Sphere A
 (b) Sphere B
(c) Neither, because the magnitude of the force on each sphere is the same.

6. A ring has a uniform, positive charge.

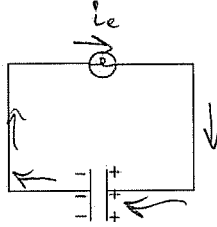


What is the direction of the electric field at point P, along the axis of the ring?

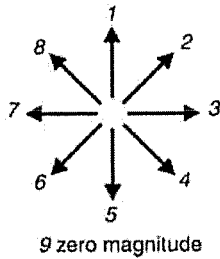


- (a) 5
 (b) 1
 (c) 7
 (d) 2
(e) 3

7. A fully charged capacitor is connected to a light bulb. At $t = 0$, the last wire is connected and electrons flow through the wires and bulb. The charged plates of the capacitor at $t = 0$ are shown below.



In what direction will electrons flow through the bulb just after $t = 0$ when the circuit is completed?



- (a) 9
 (b) 7
 (c) 5
 (d) 3
 (e) 1

8. Suppose that you repeat the experiment in the previous question, starting with a fully charged capacitor exactly as before. However, this time you use a bulb that has a larger resistance. The time elapsed for the capacitor to fully discharge with the higher resistance bulb will be

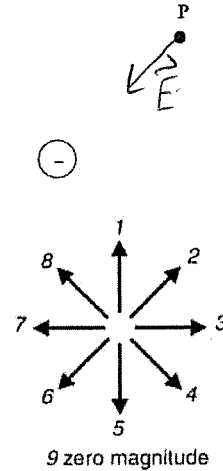
- (a) the same as with the lower resistance bulb.
 (b) less than with the lower resistance bulb.
 (c) greater than with the lower resistance bulb.

9. A chloride ion has 17 protons and 18 electrons. What is the net charge of the ion in units of coulombs?

- (a) +1 C
 (b) -1 C
 (c) zero; because it is neutral
 (d) $+1.6 \times 10^{-19}$ C
 (e) -1.6×10^{-19} C

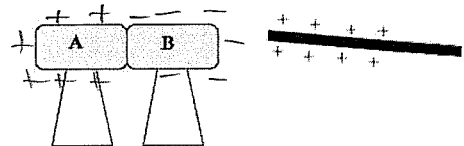
1 excess electron
 $1 \text{ electron} = -1.6 \times 10^{-19} \text{ C}$

10. What is the electric field at point P which is at a distance r from a negatively charged particle, as shown below.



- (a) 2
 (b) 8
 (c) 6
 (d) 4
 (e) 3

11. Two neutral aluminum cans are attached to styrofoam cups which are used as insulating stands. They are touching each other when a positively charged glass rod is brought near to can B (but does not touch can B). Can A is then separated from can B, and the rod is removed. Can B will be



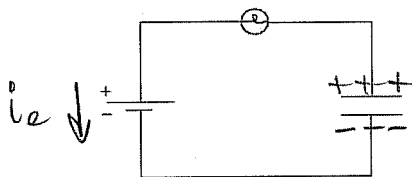
- (a) positively charged.
 (b) negatively charged.
 (c) neutral.

12. The force on a negatively charged particle due to an electric field is

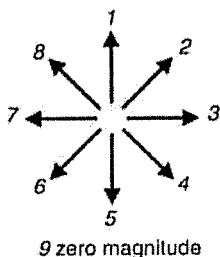
- (a) opposite the electric field.
- (b) in the same direction as the electric field.
- (c) neither, because it depends on the strength of the electric field.
- (d) none of the above because electric fields don't exert forces on charged particles.

$F = qE$

13. Questions 13–15 pertain to the following situation. The circuit schematic for a charging capacitor is shown below. Suppose that at $t = 0$, there is no excess charge on the capacitor plates and you connect the last wire to complete the circuit and charge the capacitor.



In what direction will electrons flow through the battery just after $t = 0$ when the circuit is completed?



- (a) 3
- (b) 9
- (c) 1
- (d) 7
- (e) 5

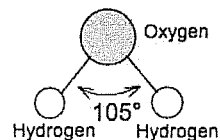
14. After a long very long time, what is the direction of the electron current through the battery?

- (a) 5
- (b) 1
- (c) 3
- (d) 9
- (e) 7

15. Which capacitor plate will become negatively charged?

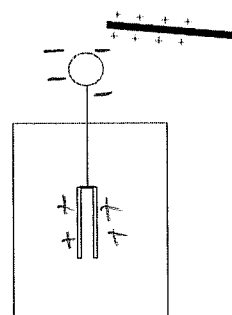
- (a) the top plate, as shown in the diagram
- (b) the bottom plate, as shown in the diagram
- (c) neither, because each capacitor plate will remain neutral

16. A water molecule is a polar molecule. Which "side" of the molecule is positively charged?



- (a) hydrogen "side"
- (b) oxygen "side"

17. A glass rod is rubbed with silk. Electrons are transferred from the rod to the silk, making the rod positively charged. If you bring the positively charged rod near a neutral electroscope (but do not touch the electroscope), as shown below, the leaves of the electroscope will become _____ and the top of the electroscope will become _____.



- (a) more negatively charged; less negatively charged
- (b) more positively charged; less positively charged
- (c) negatively charged; positively charged
- (d) positively charged; negatively charged
- (e) None of the above, because the electroscope will be neutral all over.

18. In the previous question, when the rod is brought near to the neutral electroscope, the leaves of the electroscope will

- (a) continue to hang straight downward in equilibrium, neither attracting nor repelling.
- (b) attract and stick together.
- (c) repel and spread out.

19. Suppose that you touch the rod to the electroscope, and electrons leave the electroscope and are transferred to the rod. You then take the rod far away from the electroscope so that it does not affect the electroscope. The electroscope will be

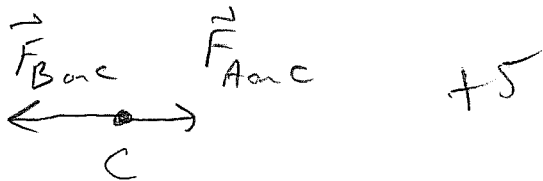
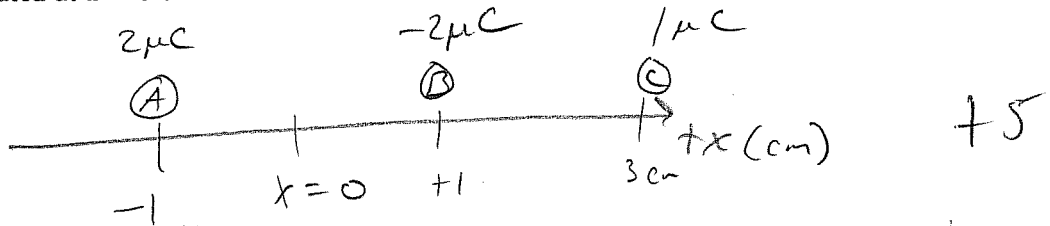
- (a) positively charged.
- (b) negatively charged.
- (c) neutral.

20. Suppose that you use video analysis to measure the electrostatic force on a charged sphere, and you plot this force as a function of distance r from another identically charged sphere. You find that the curve fit is of the form $F = \frac{A}{r^2}$. What is the constant A ?

- (a) $(9 \times 10^9 \text{ Nm}^2/\text{C}^2)/q^2$
- (b) $(9 \times 10^9 \text{ Nm}^2/\text{C}^2)/q$
- (c) $(9 \times 10^9 \text{ Nm}^2/\text{C}^2)$
- (d) $(9 \times 10^9 \text{ Nm}^2/\text{C}^2)q$
- (e) $(9 \times 10^9 \text{ Nm}^2/\text{C}^2)q^2$

Section 2. Problem Solving

21. A dipole consists of a positive charge of $2 \mu\text{C}$ located at $x = -1 \text{ cm}$ and a negative charge of $-2 \mu\text{C}$ located at $x = +1 \text{ cm}$. What is the net electrostatic force on a positively charged sphere of charge $1 \mu\text{C}$ located at $x = 3 \text{ cm}$?



$$|\vec{F}|_{B \text{ on } C} = \frac{(9 \times 10^9) (2 \times 10^{-6} \text{ C}) (1 \times 10^{-6} \text{ C})}{(0.02)^2} = 45 \text{ N} \quad +5$$

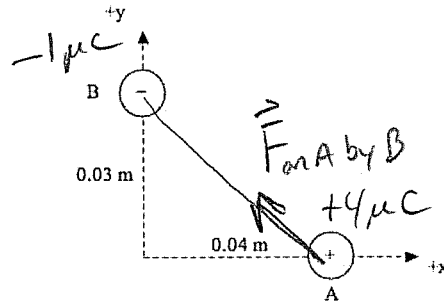
$$|\vec{F}|_{A \text{ on } C} = \frac{(9 \times 10^9) (2 \times 10^{-6} \text{ C}) (1 \times 10^{-6} \text{ C})}{(0.04)^2} = 11.25 \text{ N}$$

$$\begin{aligned} F_{\text{net } x} &= F_{A \text{ on } C_x} - F_{B \text{ on } C_x} \\ &= 11.25 \text{ N} - 45 \text{ N} \quad +5 \\ &= -33.75 \text{ N} \end{aligned}$$

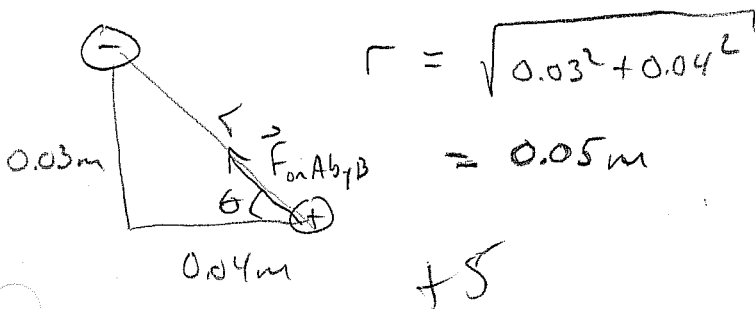
$F_{\text{Net } x} \approx -34 \text{ N}$

+5

22. A negatively charged sphere of charge $1 \mu\text{C}$ is 0.03 m from the origin and a positively charged sphere of charge $4 \mu\text{C}$ is 0.04 m from the origin, as shown below.



- (a) Sketch the electrostatic force on sphere A. *Note: it's an attractive force*
 (b) What are the x-component and y-component of the electrostatic force on sphere A by sphere B? +5



$$r = \sqrt{0.03^2 + 0.04^2}$$

$$= 0.05 \text{ m}$$

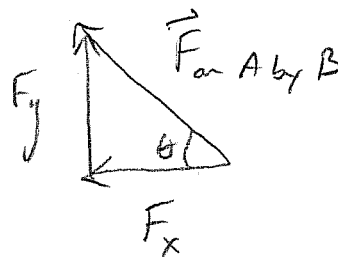
$$|\vec{F}|_{\text{on A by B}} = \frac{(9 \times 10^9)(1 \times 10^{-6})(4 \times 10^{-6})}{(0.05)^2}$$

$$= 14.4 \text{ N} \quad +5$$

get θ from the triangle

$$\tan \theta = \frac{0.03}{0.04} = 0.75$$

$$\theta = \tan^{-1}(0.75) = 36.9^\circ \quad +5$$



$$F_x = 14.4 \text{ N} \cos(36.9^\circ) = -11.5 \text{ N}$$

$$F_y = 14.4 \text{ N} \sin(36.9^\circ) = 8.65 \text{ N}$$

+5