Physics 200

Name: Key

23-24 Unit 9 Practice Test (Electrostatics)

Helpful Information: Prefixes: $n=10^{-9}$ $\mu = 10^{-6}$ $m = 10^{-3}$

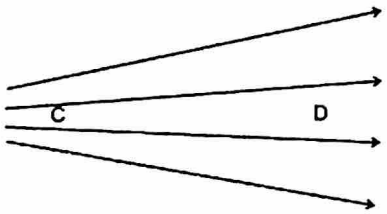
$q_{electron} = -1.6\times10^{-19}C$ $q_{proton} = 1.6\times10^{-19}C$ $k = 8.99\times10^{9}Nm^2/C^2$

I. Multiple Choice

1. Opposite charges (such as a positive and a negative) will
   A. attract each other.
   B. repel each other.
   C. both attract and repel each other.
   D. annihilate each other in a burst of energy.

2. If a positive charge is accelerated to the right by an electric field, which of the following statements must be true?
   a. The field is strong.
   b. The electric field is weak.
   c. The electric field lines point leftward.
   d. The electric field lines point rightward.

3. If a proton were to travel through the field on the right, from position C to position D, how would its motion change along the way
   a. It would speed up and then slow down.
   b. It would slow down and then speed up.
   c. The magnitude of its acceleration would increase.
   d. The magnitude of its acceleration would decrease.

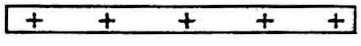


4. The gravitational force between you and the Earth is stronger than the electrostatic force between you and the Earth. Which of the following is a primary reason for this difference?

   a. The gravitational constant (G) is larger than the electrostatic constant (k).
   b. The distance between your charges and the Earth's charges is greater than the distance between your respective masses.
   c. You and the Earth are both nearly charge-neutral.
   d. Mass units (kg) have a greater magnitude than charge units (C).

5. Charge moves more easily through which of the following?
   A. a conductor
   B. an insulator
   C. Charge moves just as freely and easily in either material.

6. Two parallel plates are shown to the right. The top plate is negatively charged and the bottom plate is positively charged. In which direction does the electric field point at the position of the letter x, below the bottom plate?



X

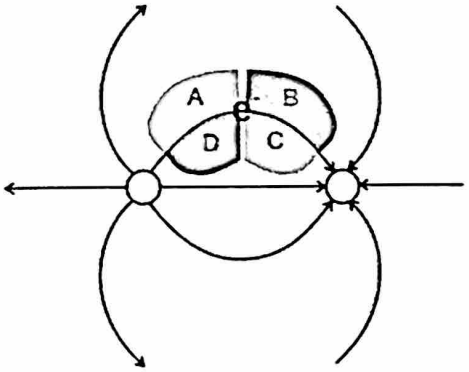
   A. Left B. Right C. Up D. Down E. The field is zero at this location

7. If the distance between two charges decreases by a factor of 3X, what happens to the size of the electric force F on each charge?
   A. 1/16 F B. 1/9 F C. 1/3 F D. 9 F E. 16 F

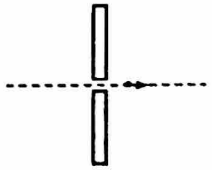
8. When a spherical metal conductor is given a net negative charge and is then placed far from any other object or electric field...
   a. Excess protons in the conductor spread themselves evenly around the outside of the conductor.
   b. Excess Electrons in the conductor spread themselves evenly around the outside of the conductor.
   c. Excess protons in the conductor shift toward the conductor's center.
   d. Excess Electrons in the conductor shift toward the conductor's center.

9. If a negatively charged balloon is brought close to a wall,
   A. electrons in the wall move away from the balloon and the balloon is then attracted to the wall.
   B. protons on the wall move away from the balloon and the balloon is then repelled by the wall.
   C. protons on the balloon move toward the wall and the balloon is then attracted to the wall.
   D. the electrons in the wall move toward the balloon and the balloon is then repelled by the wall.

10. When a metal conductor is placed in a strong, downward-pointing electric field,
   A. electrons in the conductor will move downward, and protons will move downward
   B. only electrons will move, and they will move upward.
   C. electrons in the conductor will move upward and protons will move downward
   D. only protons will move, and they will move downward.



11. An electron, initially at rest, is released from the position of the letter **e** in the diagram on the right. Into which area is it most likely to pass as it accelerates?
   A B C D None of these

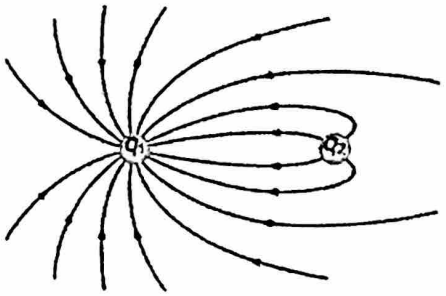


12. An electron travels from left to right through a small hole in a uniformly-charged plate. Due to the plate's electric field, the electron accelerates as it approaches the hole and then decelerates after passing through. What is the sign of the charge on the plate and what is the direction of the electric field on the right hand side of the plate?

	A	B	C	D	E
Charge on Plate	Positive	Negative	Positive	Negative	Positive
Direction of E Field	Right	Right	Left	Left	Down

13. What is the magnitude of an electric field inside a conductor that is in electrostatic equilibrium?
   a. Positive b. Negative c. Zero

14. Which of these statements is true according to the electric field diagram?
   a. q_1 is negative
   b. q_1 is positive
   c. It is impossible to determine the charge of q_1



15. Which of these statements is true according to the diagram?
   a. $|q_1| = 2|q_2|$ b. $|q_1| = 4|q_2|$
   c. $|q_2| = 2|q_1|$ d. $|q_2| = 4|q_1|$
   e. It is impossible to accurately compare the magnitudes of q1 and q2.

16. The inside of a car is a relatively safe place to be during a lightning storm. This is because...
   a. The electric field inside the conductive car body is zero.
   b. The rubber car tires are insulators, so the lightning can't flow through the car to the ground.
   c. The large mass of the car's frame dissipates the lightning's charge.
   d. The car's antenna is like a lighting rod which redirects the flow of electricity.

17. One of the most important reasons for making the conductive top of a Van de Graaf generator spherical is that, compared to other shapes, a sphere...
   a. is easy to manufacture
   b. is a very smooth shape
   c. has a lot of surface area
   d. uses less material
   e. has a surface that is equidistant from the top roller

III. Problems:

1. What is the electric force between a +20.0 μC charge and a -15μC charge that are separated by 1.5m?

$$F_E = k\frac{q_1 q_2}{r^2}$$

$$F_E = 8.99\times10^{9}\frac{N m^2}{C^2}\,\frac{(20\times10^{-6}\,C)(15\times10^{-6}\,C)}{(1.5\,m)^2}$$

$F_E = 1.2\,N$ — attractive force

2. Two identical positive charges exert a 3N force on one another when they are separated by 2m. What is the magnitude of each of these charges? $q_1 = q_2$

$$F_E = k\frac{q_1 q_2}{r^2} = 8.99\times10^{9}\frac{N m^2}{C^2}\,\frac{(q_1)^2}{(2m)^2} = 3N$$

$$q_1 = q_2 = 3.65\times10^{-5}\,C$$

3. Give the magnitude and direction of an electric field that exerts a 3.5×10^{-4} N leftward force on an electron.

$$E = \frac{F}{q}$$

$$E = \frac{3.5 \times 10^{-4} N}{1.6 \times 10^{-18} C}$$

$$E = 2.19 \times 10^{14} \frac{N}{C}, \text{ rightward}$$

4. At what distance does a 3nC charge create an electric field with a magnitude of 4N/C?

$$E = \frac{kQ}{r^2}$$

$$4 N/C = \frac{8.99 \times 10^{9} \frac{N m^2}{C^2} \left(3 \times 10^{-9} C\right)}{r^2}$$

$$r = 2.6 m$$