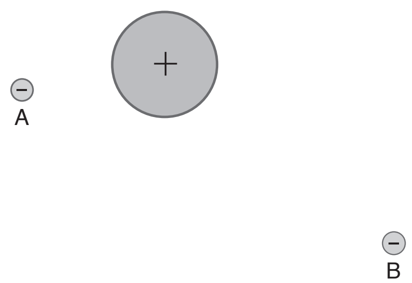
Electricity Practice Items

1. Two negative point charges, A and B, are located in the space around a uniform sphere (radius r_B) of positive charge density.



Charge A has magnitude $-Q_o$ and is located at a distance $2r_B$ from the edge of the sphere. Charge B has magnitude $-2Q_o$ and is located at a distance $5r_B$ from the edge of the sphere. What is the ratio of the magnitude of the electrostatic force exerted by the sphere upon A to the magnitude of the force it exerts upon B?

A. 25:8
B. 2:1
C. 5:4
D. 1:1

2. A storm-cloud can be thought of as one plate of a giant capacitor, with the earth being the other plate. With which of the following units would we measure the charge contained in a storm-cloud?

A. coulombs
B. farads
C. amperes
D. volts

3. A volt is a

A. joule per coulomb
B. ampere · ohm
C. electron volt per electron
D. all of the above

4. A negatively charged rubber rod, without touching, is brought in close proximity to an electrically neutral metallic sphere. The sphere has a copper wire running from its base into a large copper plate buried in moist soil. The wire is cut and the rubber rod is removed from the proximity of the sphere. Which of following describes the present condition of the sphere?

I. The surface of the sphere is negatively charged.
II. The surface of the sphere is positively charged.
III. The potential difference between the ground and the sphere is positive.

A. I
B. II
C. I and III
D. II and III

5. Which of the following would serve as a poor conductor?

A. molten sodium chloride
B. metallic silver
C. fused quartz (SiO_2)
D. all are good conductors

6. What is the electric field intensity at a point 30 millimeters from a charge of 1×10^{-5} C?
(Coulomb constant $k = 9 \times 10^{9}$ N m^2 C^{-1})

- **A.** 1.0 N/C
- **B.** 1.0×10^{6} N/C
- **C.** 3.0×10^{6} N/C
- **D.** 1.0×10^{8} N/C

7. After passing through the aperture of the electron gun, a cathode ray travels parallel to an electric field moving from a zone of high potential towards an area of lower potential. As the electrons move from the higher potential towards the lower potential area

- **A.** they slow down.
- **B.** their potential energy decreases.
- **C.** the path of the cathode ray curves.
- **D.** they maintain a constant velocity.

8. The molar heat capacity of helium is very close to that of an ideal gas (3/2 R). One mole of protons contains a magnitude of charge equal to 96,500 C (1 faraday). Approximately how much will the temperature rise in one mole of alpha particles (He^{2+}) moving in a vacuum in through a 1 mV decrease in potential?

- **A.** -8 K
- **B.** 8 K
- **C.** 15 K
- **D.** 31 K

9. Two point charges, one with a charge of +90.0μC and the other with a charge of −10.0μC are placed 10 mm apart. At what point along the axis between them is the electric field zero?

- **A.** 1.0mm from the +90.0μC charge
- **B.** 2.5mm from the +90.0μC charge
- **C.** 2.5mm from the −90.0μC charge
- **D.** at no point on the axis between them

10. Introducing a dielectric substance between two parallel charged plates

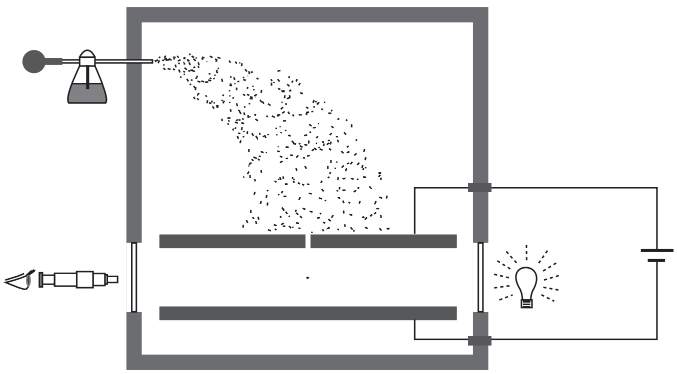
- **A.** weakens the electric field between the plates.
- **B.** increases the potential difference between the plates.
- **C.** creates a uniform electric field in the space between the plates.
- **D.** decreases the capacitance of the plates.

11. Which of the following occurs with an increase in electrostatic potential energy?

- **A.** A gaseous sodium ion captures an electron.
- **B.** Negative charges introduced at a point on a neutral metal sphere spread over its surface area with uniform distribution.
- **C.** One glucose molecule reacts with six molecules of oxygen to form six molecules of carbon dioxide and six molecules of water.
- **D.** A globular polypeptide unfolds from its native configuration in high temperature conditions.

Passage (Questions 11-16)

In 1909, the U.S. physicist Robert Millikan (1868-1953) performed a series of experiments, in which, by observing the behavior of electrically charged oil droplets within a uniform electric field, he was able to determine the charge on an electron. The apparatus utilized by Millikan in these experiments is illustrated by the schematic below. A spray bottle produces a fine mist of oil droplets. Some of these pass through an aperture into a viewing chamber, where they may be observed.



To determine the mass of a particular droplet, the experimenter observes the rate at which it falls in the earth's gravitational field. The drop reaches a terminal velocity, which depends on the mass of the droplet, the oil density and the viscosity of the air.

Some of the oil droplets possess an electric charge, acquired when they attach themselves to ions produced by the irradiation of the surrounding air with X-rays. When such a droplet passes into the viewing chamber, the electric field of the two charged plates produces a force on the droplet opposite in direction to that of the earth's gravitational field. If one adjusts the voltage on the plates, the electrical force on the droplet can be made to balance the gravitational force exactly, and the droplet will remain suspended.

In this manner, the experimenter determines the magnitude of the electric field necessary to produce a force on the droplet equal in magnitude to the opposing force of gravity. The charge on the droplet may then be determined. Millikan obtained values such as the following for the magnitude of the charge on certain droplets:

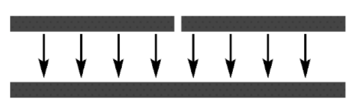
$$q_1 = -1.6 \times 10^{-19}\ \text{C}$$
$$q_2 = -6.4 \times 10^{-19}\ \text{C}$$
$$q_3 = -8.0 \times 10^{-19}\ \text{C}$$

12. If the electrical field strength is of slightly lower magnitude than necessary to oppose the action of the earth's gravitational field, the oil droplet slowly descends. As it does so

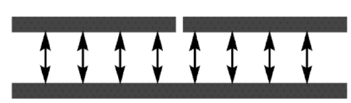
A. both its electrostatic potential energy and gravitational potential energy decrease.
B. its electrostatic potential energy decreases while its gravitational potential energy increases.
C. its electrostatic potential energy increases while its gravitational potential energy decreases.
D. both its electrostatic potential energy and gravitational potential energy increase.

13. Which of the following is the most proper representation of the electric field between the charged plates?

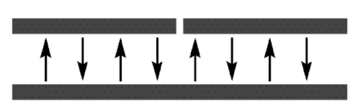
A.



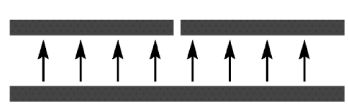
B.



C.



D.



14. If the charged plates in the Millikan apparatus, separated by a distance of two centimeters, have a potential difference of 1200 volts, what is the magnitude of the electric field between the plates away from the edges of the plates?

A. 2,400 N/C
B. 60,000 N/C
C. 240,000 N/C
D. 480,000 N/C

15. Which of the following statements are true with regard to the drag force of the air upon the droplet at terminal velocity and the electrical force upon the droplet at the later time it is suspended within the viewing chamber?

I. The two forces have equal magnitude.
II. Both forces are conservative.
III. Neither force performs work.

A. I only
B. I and III
C. II and III
D. I, II, and III

16. The charges on the oil droplets possess magnitudes commonly divisible by 1.6×10^{-19} C. The fact that electric charge cannot be more finely divided is a consequence of

A. the conservation of electric charge.
B. Coulomb's law.
C. the quantum nature of electric charge.
D. the photoelectric effect.

17. Using q as the charge on a certain droplet, m as its mass, d as the distance between the charged plates, and g as the acceleration due to gravity, express the correct voltage to apply across the plates in order to suspend the droplet in the viewing chamber?

A. $\frac{mgd}{q}$

B. $\frac{mgq}{d}$

C. $\frac{mgq}{d^2}$

D. $\frac{mgd^2}{q}$