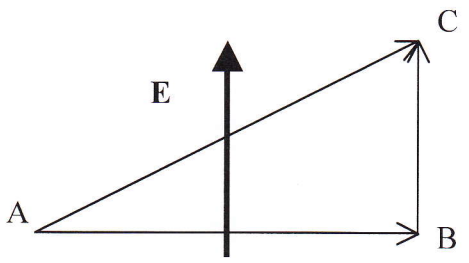
PHYS 51 Workshop - Week 3 - February 23 - March 1

These problems are based on Chapter 23

1. In a certain region of space, the electric field is 50,000 N/C in the z-direction.



In the right triangle shown above, AB = 4.0 m; BC = 3.0 m; and AC = 5.0 m. The side BC is parallel to the electric field.

a. Calculate how much work is done by the electric field as the 10 μC charge moves from A to B and then from B to C.

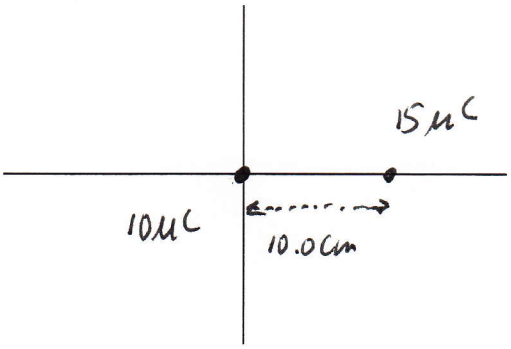
b. Calculate how much work is done by the electric field as the charge moves directly from A to C.

2. A hydrogen atom consists of an electron and a proton. The charge of the proton is 1.6×10^{-19} C, while the electron has an equal and opposite charge. The potential energy of the electron is –27.2 eV, where 1 eV = 1.6×10^{-19} J.

a. How far apart are the electron and the proton?

b. What would be the potential energy of the electron if it were twice as far from the proton?

3.

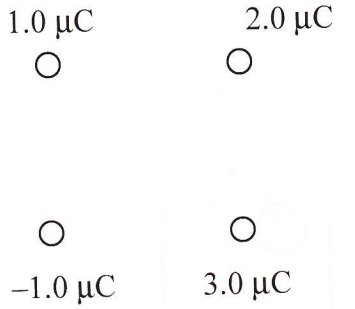


A 10 μC charge is located at the origin. A second charge of 15 μC is located 10.0 cm to the right of the origin.

a. How much does the electrical potential energy of this charge change if you move it so that it is 10.0 cm to the left of the origin? second

b. How much does the electrical potential energy of this charge change if you move it so that it is 20.0 cm below the origin?

4.



The four charges are at the corners of a square whose sides are 10.0 cm. The amount of charge of each is given.

Determine the electric potential energy of each charge.

5. a. In the previous situation, determine the potential V at the center of the square.
   b. In the previous situation, determine the potential V at a point midway between the 2.0μC and the 3.0 μC charges.
   c. How much work would be required to move a 1.0 μC charge from the center of the square to a point midway between the 2.0μC and the 3.0 μC charges?

6.

Two 10 μC charges are located at x = 10.0 cm and at x = –10.0 cm.

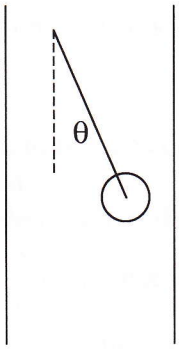
a. What is the electric potential at the origin?
b. What is the electric potential on the y-axis, where y = 10.0 cm?
c. Suppose the charge at x = 10.0 cm is –10 μC. Find the new answers to questions a&b.

7. A metal sphere has a radius of 10.0 cm. The electric potential close to the surface of of the sphere is –100,000 volts.

a. Find the amount of charge and the surface charge density σ on the surface of the sphere.

b. An electron ($q = -1.6 \times 10^{-19}$ C) is released from rest near the surface of the sphere. Find its kinetic energy, potential energy, and velocity when it has moved to a position 20.0 cm from the center of the sphere.

11.

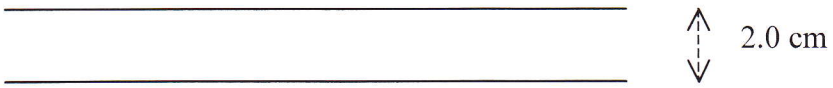


In the picture, you see two parallel vertical metal plates. A 2.0 gm ball hangs at an angle of $\theta = 30^{o}$. The ball is in equilibrium. The charge on the ball is 10.0 μC.

a. Find the magnitude and direction of the electric field between the plates.

b. Determine the surface charge density σ on one of the plates.

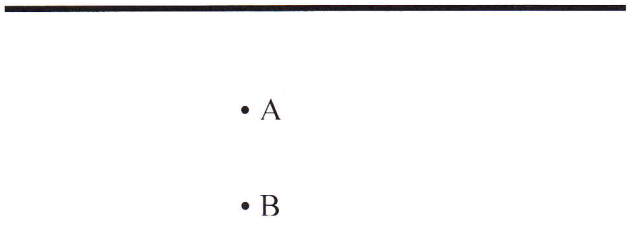
8.



Two parallel metal plates are 2.0 cm apart. The surface area of each is 0.50 m^2. The two plates have equal and opposite surface charge densities. The potential difference between the plates is 100 V; the upper plate it at the higher potential.

a. What is the electric field between the two plates? What is its direction?
b. What is the surface charge density?
c. What is the total charge on one of the plates?

9.



The line above represents an infinitely long line charge. Point A is 5.0 cm from the line charge; point B is 10.0 cm from the infinite line charge. It is observed that the potential at B is 10 volts higher than the potential at A.

a. What is the linear charge density λ ?
b. What is the magnitude and direction of the electric field at position A?

10. a. In a certain region of space, the potential is given by

$$V = E_o \frac{x}{a}$$

where a is a constant that has dimensions of distance. Find the magnitude and direction of the electric field.

b. In another region of space, the potential is given by

$V = \frac{b}{\varepsilon_o} \ln(\frac{x}{a})$ where x is a constant having units of distance.

Find the magnitude and direction of the electric field, assuming that $b > 0$. What are the dimensions of b?