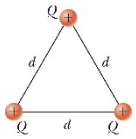
University Physics II

Homework Set 4

1. *a*. Calculate the speed of a proton that is accelerated from rest through an electric potential difference of 120 V.

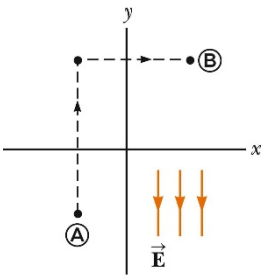
   b. Calculate the speed of an electron that is accelerated through the same electric potential difference.

2. What is the build energy needed to assemble an atomic nucleus containing three protons only if we model it as an equilateral triangle of side 2.00 x 10^{-15} m with a proton at each vertex? Assume the protons start infinitely far away.



3. Certain sharks can detect an electric field as weak as 1.0 μV/m. To grasp how weak this field is, if you wanted to produce it between two parallel metal plates by connecting an ordinary 1.5-V AA battery, how far apart would the plates have to be?

4. A uniform electric field of magnitude 325 V/m is directed in the negative y direction as shown in the figure at right. The coordinates of point A are (– 0.200, – 0.300) m and those of point B are (0.400, 0.500) m. Calculate the electric potential difference $\Delta V = V_B - V_A$ using the dashed-line path.

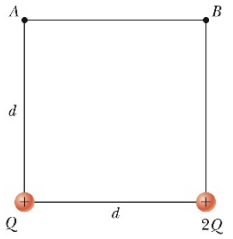


5. A proton gun fires a proton from midway between two plates, A and B, which are separated by a distance of 10.0 cm. Plate A is kept at a zero potential, while plate B is held at a potential of 400 V. The proton initially moves at a speed of 150.0 km/s toward plate B.
   a. How far does the proton travel from its starting location (*in cm*)?
   b. Will the proton reach plate B?
   c. If not, how close will it get (*in cm*)?

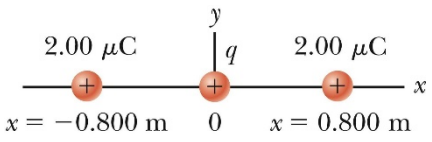
6. *a*. Calculate electric potential 0.250 cm from an electron.
   b. Find the magnitude of the electric potential difference (|ΔV|) between two points that are 0.250 cm and 0.750 cm from the electron.
   c. How much would the previous answers change if the electron were replaced with a proton?

7. Two point charges are on the y axis. A 4.50 μC charge is located at y = 1.25 cm, and a –2.24 μC charge is located at y = –1.80 cm. Find the total electric potential at:
   a. The origin
   b. A point whose coordinates are (1.50, 0) cm.

8. The two charges in the figure at right are separated by a distance of 2.00 cm, and Q = +5.00 nC. Find:
   a. The electric potential at A
   b. The electric potential at B
   c. The electric potential difference (ΔV) between B and A

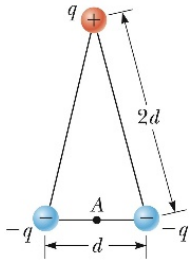


9. Given two particles with 2.00 μC charges as shown in the figure at right and a particle with charge $q = 1.28\ x\ 10^{-18}$ C at the origin:



   a. What is the net force exerted by the two 2.00 μC charges on charge q?
   b. What is the electric field at the origin due to the two 2.00 μC charges?
   c. What is the electric potential at the origin due to the two 2.00 μC charges?

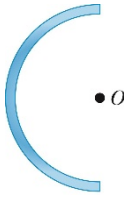
10. The three charged particles in the figure at right are at the vertices of an isosceles triangle (*where* $d = 2.00$ *cm*). Taking $q = 7.00$ μC, calculate the electric potential at point A (*the mid-point of the base*).



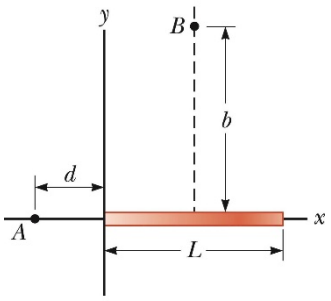
11. The potential in a region between $x = 0$ and $x = 6.00$ *m* is $V = a + bx$, where $a = 10.0$ V and $b = -7.00$ V/*m*. Determine:
   a. The potential at $x = 0$ *m*, 3.00 *m* and 6.00 *m*
   b. The magnitude and direction of the electric field at $x = 0$ *m*, 3.00 *m* and 6.00 *m*

12. Over a certain region of space, the electric potential is $V = 5x - 3x^2y + 2yz^2$. Find:
   a. The expressions for the x, y, and z components of the electric field over this region.
   b. What is the magnitude of the electric field at point P located at (1.00, 0 , –2.00) *m*?

13. A uniformly charged insulating rod of length 14.0 *cm* is bent into the shape of a semicircle as shown in the figure at right. The rod has a total charge of –7.50 μC. Find the electric potential at O, the center of the semicircle.



14. **A rod of length L lies along the x axis with its left end at the origin as shown in the figure at right. It has a non-uniform charge density $\lambda = \alpha x$, where α is a positive constant.
   a. What are the units of α?
   b. Calculate the expression for the electric potential at A.

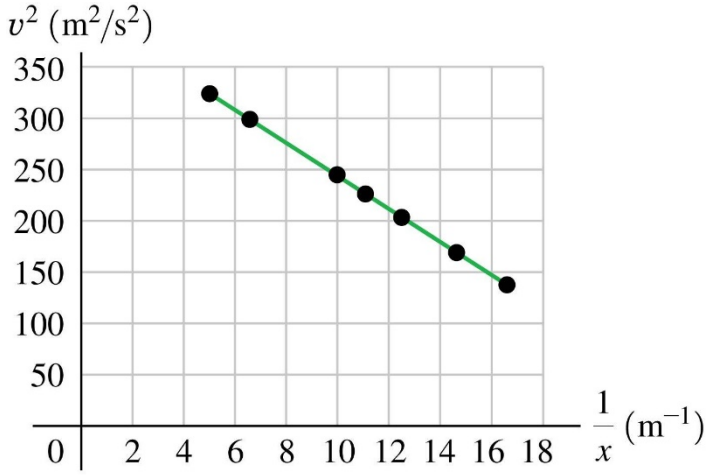


15. A spherical conductor has a radius of 14.0 *cm* and a charge of 26.0 μC. Calculate the magnitude of the electric field (E) **and** the electric potential (V) at:
   a. $r = 10.0$ *cm*
   b. $r = 14.0$ *cm*
   c. $r = 20.0$ *cm*

   Hint: To determine the type of sphere you are working with, ask yourself "Where is the charge is located?"

16. A small, stationary sphere carries a net charge Q. To measure Q, you perform the following experiment:

From a large distance (*where you can assume the initial electric potential is zero*), you fire a small particle with mass $m = 4.00 \times 10^{-4}\ kg$ and charge $q = 5.00 \times 10^{-8}$ C directly at the center of the sphere. The apparatus you are using measures the particles speed v as a function of the distance x from the sphere. The stationary sphere's mass is much greater than the mass of the projectile, so you assume that the sphere remains at rest during the collision. All the measured values of x are much larger than the radius of either object, so you treat both objects as point particles. You plot your data on a graph of v^2 versus $1/x$ as shown below. The straight line $v^2 = -(15.75 m^3/s^2)(1/x) + 400\ m^2/s^2$ gives a good fit to the data points.



a. Explain why the graph is a straight line.
Hint: Use Conservation of Energy

b. What is the initial speed v_o of the particle when it is very far from the sphere?

c. What is Q?

d. How close does the particle get to the sphere under the assumed conditions of the experiment?