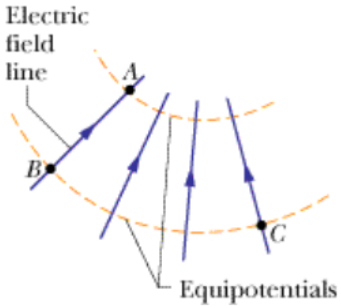
8: Electric Potential and Equipotential

Worksheet 10

1. The electric potential difference between the ground and a cloud in a particular thunderstorm is 9.3E9 V. What is the magnitude of the change in the electric potential energy of an electron that moves between the ground and the cloud?

2. Suppose that in a lightning flash the potential difference between a cloud and the ground is 1.2E9 V and the quantity of charge transferred is 28 C. (a) What is the change in energy of that transferred charge? (b) If all the energy released could be used to accelerate a 950 kg car from rest, what would be its final speed? (ANSWER: 33600000000.0; 8460.43423048847 m/s)

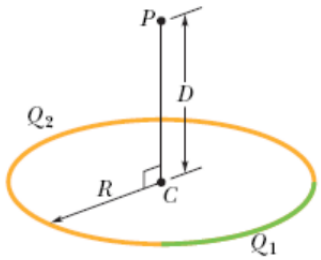
3. When an electron moves from A to B along an electric field line in the figure, the electric field does 5.10E-19 J of work on it. What are the electric potential differences (a)V_B - V_A, (b)V_C - V_A, and (c)V_C - V_B? (3.183520599251,3.183520599251, 0)



4. The electric field in a region of space has the components Ey = Ez = 0 and Ex = (3.90x N/(Cm)). Point A is on the y axis at y = 1.00 m, and point B is on the x axis at x = 2.20 m. What is the potential difference (in V) V_B - V_A?

5. As a space shuttle moves through the dilute ionized gas of Earth's ionosphere, the shuttle's potential is typically changed by -0.81 V during one revolution. Assuming the shuttle is a conducting sphere of radius 12 m, estimate the amount of charge it collects.

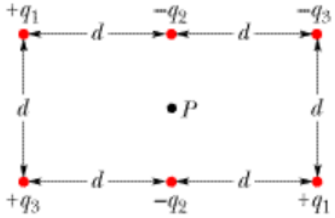
6. What are (a) the charge and (b) the charge density on the surface of a conducting sphere of radius 0.16 m whose potential is 290 V (with V = 0 at infinity)?



7. A plastic rod has been bent into a circle of radius R = 10.9 cm. It has a charge Q1 = +6.49 pC uniformly distributed along one-quarter of its circumference and a charge Q2 = -6Q1 uniformly distributed along the rest of the circumference (see the figure). With V = 0 at infinity, what is the electric potential (a) at the center C of the circle and (b) at point P, which is on the central axis of the circle at distance D = 7.43 cm from the center?

8. The magnitude E of an electric field depends on the radial distance r according to $E = A/r^4$, where A is a constant with unit volt-cubic meter. As a multiple of A, what is the magnitude of the electric potential difference between r_1 = 4.25 m and r_2 = 5.61 m?

9. Two charged, parallel, flat conducting surfaces are spaced d = 1.05 cm apart and produce a potential difference ΔV = 654 V between them. An electron is projected from one surface directly toward the second. What is the initial speed of the electron if it stops just at the second surface?



10. In the figure point P is at the center of the rectangle. With V = 0 at infinity, q_1 = 6.60 fC, q_2 = 3.02 fC, q_3 = 4.68 fC, and d = 1.78 cm, what is the net electric potential in volts at P due to the six charged particles?

11. A square metal sheet of edge length 3.00 m resides in the xy plane and carries a negative charge. An identical parallel sheet at $z = 0.15$ m carries an equal magnitude positive charge. With black lead on the bottom plate and red lead on the top plate, a voltmeter reads +5.00 V.

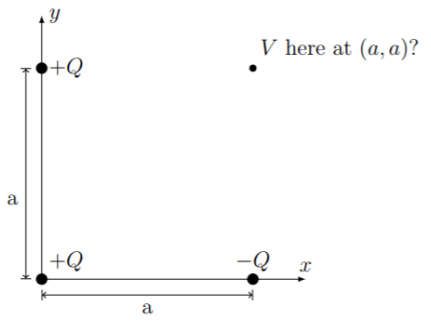
    A. Draw this setup showing electric field lines between the plates and equipotential surfaces at 1.00 V intervals.

    B. What is the magnitude of the electric field between the plates?

    C. Suppose an electron somehow pops off the bottom plate and accelerates towards the top plate. What is the speed of the electron just before it crashes into the top plate?

12. For the electric field $\vec{E} = (2.7 + 3.5x)\hat{i} + (5.62.1y)\hat{j}$ where x is in m and $\vec{E}$ is in N/C, find ΔV in moving from (0, 0) to (1.4 m, 0).

13. For V = 0 at infinity as your reference point, what would be the potential at the indicated point?



1 Answers

1. 9.3E9 eV
2. (a) 3.36E10 J (b) 8400 m/s
3. (a) 3.18 V (b) 3.18 V (c) 0
4. -9.44 V
5. -1.1E-9 C
6. (a) 5.2E-9 C (b) 1.6E-8 C/m^2
7. (a) -2.68 V (b) -2.21 V
8. 0.00245 A m^{-}2
9. 1.52E7 m/s
10. -1.38E-4 V
11. (a) drawing (b) $\vec{E}$ = -$\frac{\sigma}{epsilon_0}hatk$ (d) v= 1/33E6 m/s
12. -7.21 V
13. $\frac{kQ}{\sqrt{(2)a}}$