QUIZ9- CHAPTER 24
DATE: 02/04/20

Name: Key Id#: Sect.#: 28 Serial#:

1. The electric potential at points in the xy–plane is given by $V = x^3 - 2xy^2$ Volts, where x and y are in meters. Calculate the magnitude of the electric field at the point with the coordinates x = 2 m and y = 3 m.

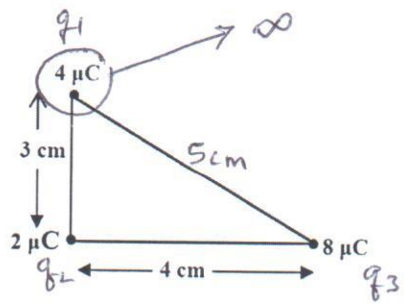
$$E_x = -\frac{\partial V}{\partial x} = -(3x^2 - 2y^2) = -3x^2 + 2y^2$$

$$E_y = -\frac{\partial V}{\partial y} = -(-4xy) = 4xy$$

$$\left.\begin{matrix} x = 2m \\ y = 3m \end{matrix}\right\} \quad E_x = +6 \quad E_y = +24 \quad \vec{E} = +6\hat{i} + 24\hat{j}$$

$$\boxed{|\vec{E}| = 24.7 \ \frac{N}{C}}$$

2. The figure shows three charges located at the corners of a triangle.
   (a) How much work would be needed to remove the 4 μC charge to infinity? [Assume V = 0 at infinity.]



$$W_{app} = \Delta U = U_f - U_i$$

$$U_f = \frac{k q_2 q_3}{r_{23}} = \frac{9\times10^9 \times 2\times10^{-6} \times 8\times10^{-6}}{0.04} = 3.6\,J$$

$$U_i = \frac{k q_1 q_2}{r_{12}} + \frac{k q_2 q_3}{r_{23}} + \frac{k q_1 q_3}{r_{13}} = 2.4 + 3.6 + 5.76 = 11.76\,J$$

$$W_{app} = 3.6 - 11.76 = \boxed{-8.16\,J}$$

(b) Does an external agent or the electric field do the work? Why?

Since applied work is negative it means the electric force does the work.

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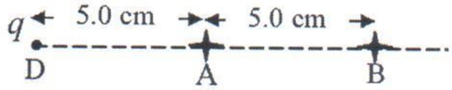
Name: Key Id#: Sect.#: 29 Serial#:

1. A particle having a charge $q = 8 \times 10^{-8}$ C of is fixed at point D. Another particle of mass 10 g and charge of $Q = 5.0 \times 10^{-9}$ C starts from rest at point A and moves in a straight line to the right. What is the speed of the particle of charge Q when it reaches point B shown in the figure [Assume V = 0 at infinity.]



$$\Delta K + \Delta U = 0$$

$$\left(\tfrac{1}{2} m v_f^2 - 0\right) + Q(V_B - V_A) = 0$$

$$\tfrac{1}{2} m v_f^2 = -Q(V_B - V_A) = -Q\left(\frac{kq}{r_B} - \frac{kq}{r_A}\right)$$

$$v_f = \sqrt{-\frac{2Q}{m}\left(\frac{kq}{r_B} - \frac{kq}{r_A}\right)} = \sqrt{-\frac{2\times5\times10^{-9}}{10\times10^{-3}}\left(\frac{9\times10^{9}\times8\times10^{-8}}{0.1} - \frac{9\times10^{9}\times8\times10^{-8}}{0.05}\right)}$$

$$\boxed{v_f = 0.085\,\text{m/s}}$$

2. In the figure below, two conducting spheres, one having twice the diameter of the other, are separated by a distance large compared to their diameters. Initially, the smaller sphere (1) has charge q1 = 20 μC and the larger sphere (2) has a charge q2 = – 10 μC. Calculate the charge on each sphere when they are connected by a long thin conducting wire.

When they are connected by a wire the two spheres have the same potential

$$V_1 = V_2 \Rightarrow \frac{k q_1'}{R_1} = \frac{k q_2'}{2R_1}$$

$$q_2' = 2q_1'$$

also $q_2' + q_1' = q_2 + q_1 = -10 + 20 = 10\,\mu C$

$$3q_1' = 10\,\mu C \Rightarrow \boxed{q_1' = 3.3\,\mu C}$$

$$\boxed{q_2' = 6.6\,\mu C}$$

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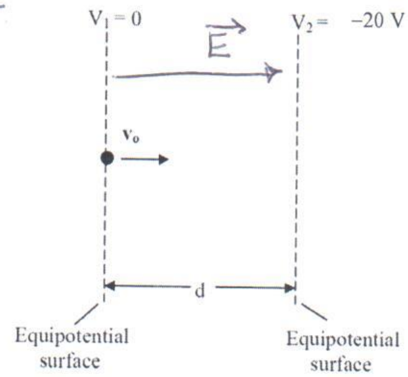
1. The figure shows a particle (proton or electron) moving between two equipotential surfaces $V_1 = 0$ and $V_2 = -20$ V which are separated by a distance d = 2.0 cm. The speed of the particle at surface V_1 is $v_0 = 30$ km/s and increasing.

(a) Is the particle an electron or a proton? Why?

The particle is a proton because it is moving ~~against~~ with $\vec{E}$



(b) What is the speed of the particle when it reaches the equipotential surface at V_2?

$$\Delta K + \Delta U = 0$$

$$\left(\frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2\right) + q(V_f - V_i) = 0$$

$$\frac{1}{2}mv_f^2 = \frac{1}{2}mv_i^2 - q(V_f - V_i)$$

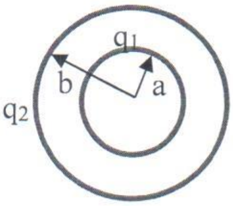
$$v_f = \sqrt{v_i^2 - \frac{2q}{m}(V_f - V_i)}$$

$$= \sqrt{(30{,}000)^2 - \frac{2(1.6\times10^{-19})\times(-20-0)}{1.67\times10^{-27}}} = 68791 \text{ m/s}$$

$$\boxed{v_f = 69 \text{ km/s}}$$

2. Two concentric spherical shells carrying charges $q_1 = -10$ nC and $q_2 = +20$ nC and radii a = 5.0 cm and b = 12 cm. Calculate the electric potential at r = 20 cm from the center.

$$V = \frac{kq_1}{r} + \frac{kq_2}{r}$$ both shells are like points charges



$$V = \frac{k}{r}(q_1 + q_2) = \frac{9\times10^9}{0.2}(-10\times10^{-9} + 20\times10^{-9})$$

$$\boxed{V = 450 V}$$

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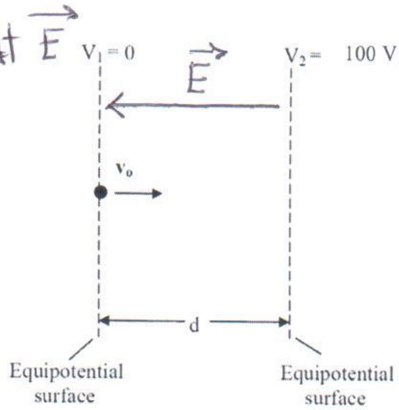
Name: Key Id#: Sect.#: 30 Serial#:

1. The figure shows a particle (proton or electron) moving between two equipotential surfaces $V_1 = 0$ and $V_2 = 100$ V which are separated by a distance d = 2.0 cm. The speed of the particle at surface V_1 is $v_0 = 30$ km/s and increasing.

(a) Is the particle an electron or a proton? Why?

The particle is an electron because it is moving against $\vec{E}$



(b) What is the speed of the particle when it reaches the equipotential surface at V_2?

$$\Delta K + \Delta U = 0$$

$$\left(\frac{1}{2} m v_f^2 - \frac{1}{2} m v_i^2\right) + q(V_f - V_i) = 0$$

$$v_f = \sqrt{v_i^2 - \frac{2q}{m}(V_f - V_i)}$$

$$= \sqrt{(30{,}000)^2 - \frac{2(-1.6\times10^{-19})(100-0)}{9.1\times10^{-31}}} = 5.930070 \text{ m/s}$$

$$\boxed{v_f = 5.9 \times 10^6 \text{ m/s}}$$

2. Two concentric spherical shells carrying charges $q_1 = -10$ nC and $q_2 = +20$ nC and radii a = 5.0 cm and b = 12 cm. Calculate the electric potential at r = 20 cm from the center.