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PHYS-2B, section 34945, Spring 2020

INSTRUCTOR
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Fresno

Resistance and More Potential (Homework)

Current Score

QUESTION	1	2	3	4	5	6	7	8	9	10	11	12
POINTS	3/3	8/8	3/3	4/4	5/5	4/4	2/2	2/2	1/5	1/1	2/2	2/2

TOTAL SCORE

37/41	90.2%

Due Date Past Due

WED, FEB 19, 2020
11:59 PM PST

Request Extension

Assignment Submission & Scoring

Assignment Submission

For this assignment, you submit answers by question parts. The number of submissions remaining for each question part only changes if you submit or change the answer.

Assignment Scoring

Your last submission is used for your score.

The due date for this assignment has passed.

Your work can be viewed below, but no changes can be made.

Important! Before you view the answer key, decide whether or not you plan to request an extension. Your Instructor may not grant you an extension if you have viewed the answer key. Automatic extensions are not granted if you have viewed the answer key.

Request Extension

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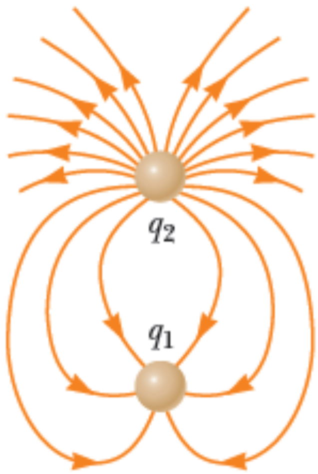
1. 3/3 points | Previous Answers | **SERCP11 15.5.OP.034.**

My Notes | Ask Your Teacher

In the figure below, the electric field lines for two charged particles are shown. The lower particle has charge q_1, while the upper particle has charge q_2.



(a) Which charge is larger in magnitude?

- q_1
- q_2
- The charges are equal in magnitude.

(b) What is the sign of q_1?

- positive
- negative
- The magnitude is zero.

(c) What is the sign of q_2?

- positive
- negative
- The magnitude is zero.

Solution or Explanation

(a) Note that q_2 has more field lines connected to it than does q_1. The larger the density of field lines connected to a charge, the larger the magnitude of charge. Therefore, q_2 is larger in magnitude than q_1.

(b) Electric field lines point away from positive charges and toward negative charges. Therefore, q_1 is negative.

(c) For the same reason as above, q_2 is positive.

Need Help? Read It

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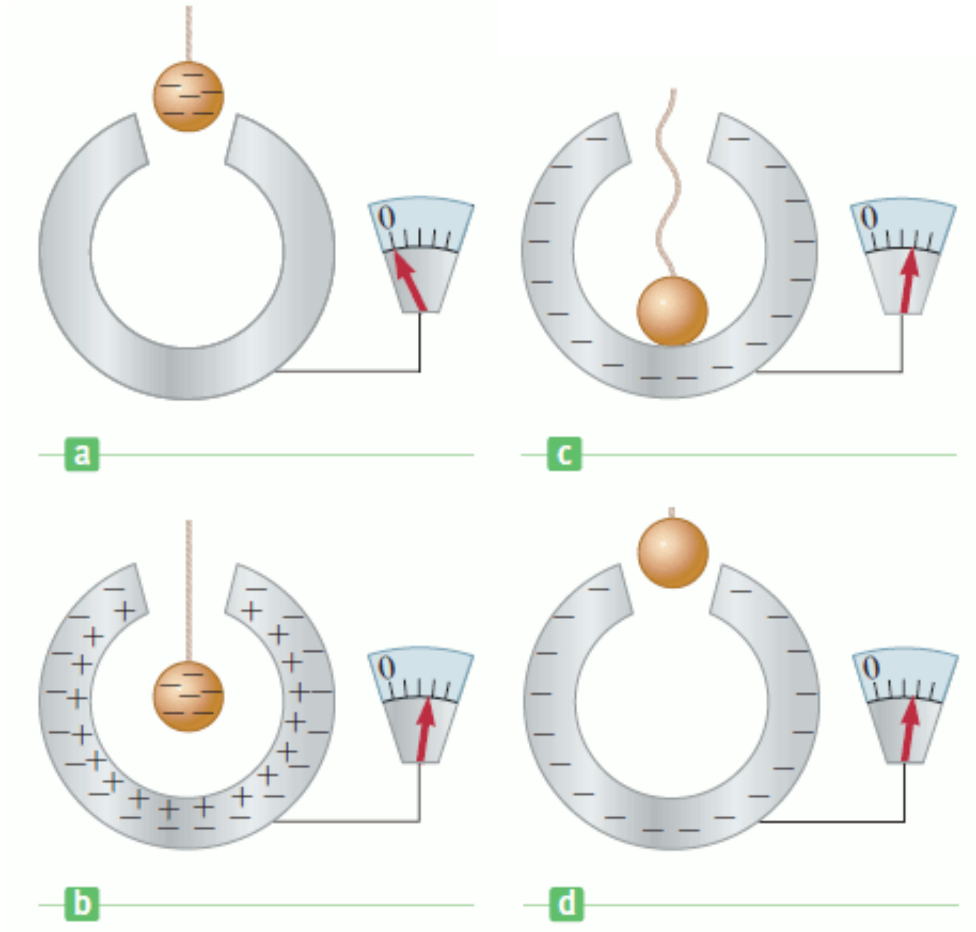
2. 8/8 points Previous Answers **SERCP11 15.5.P.039.**

My Notes Ask Your Teacher

Refer to the figure below. The charge lowered into the center of the hollow conductor has a magnitude of 4.6 μC. Find the magnitude and sign of the charge on the inside and outside of the hollow conductor when the charge is as shown in the following images.



(a) Figure (a)

Inside: 0 ✓ 0 μC

Outside: 0 ✓ 0 μC

(b) Figure (b)

Inside: 4.6 ✓ 4.6 μC

Outside: -4.6 ✓ -4.6 μC

(c) Figure (c)

Inside: 0 ✓ 0 μC

Outside: -4.6 ✓ -4.6 μC

(d) Figure (d)

Inside: 0 ✓ 0 μC

Outside: -4.6 ✔ -4.6 μC

Solution or Explanation

(a) Zero net charge on each surface of the sphere.

(b) The negative charge lowered into the sphere repels −4.6 μC on the outside surface, and leaves +4.6 μC on the inside surface of the sphere.

(c) The negative charge lowered inside the sphere neutralizes the inner surface, leaving zero charge on the inside. This leaves −4.6 μC on the outside surface of the sphere.

(d) When the object is removed, the sphere is left with −4.6 μC on the outside surface and zero charge on the inside.

Need Help? Read It

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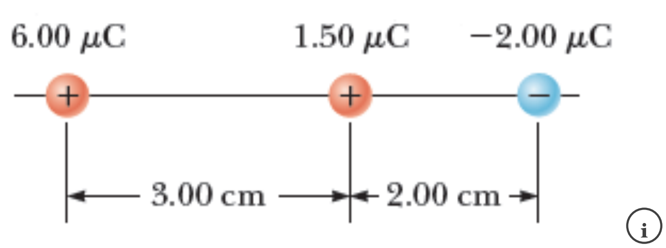
3. 3/3 points Previous Answers **SERCP11 15.3.P.018.**

My Notes Ask Your Teacher

(a) Determine the electric field strength at a point 1.00 cm to the left of the middle charge shown in the figure below. (Enter the magnitude of the electric field only.)



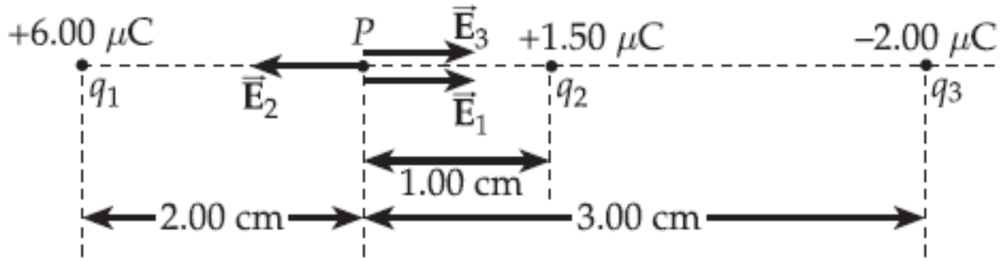
2e7 ✔ 2.00e+07 N/C

(b) If a charge of −4.70 μC is placed at this point, what are the magnitude and direction of the force on it?

magnitude 94 ✔ 93.9 N

direction toward the left ✔ toward the left

Solution or Explanation



(a) Taking to the right as positive, the resultant electric field at point *P* is given by

$$\begin{aligned} E_R &= E_1 + E_3 - E_2 \\ &= \frac{k_e|q_1|}{r_1{}^2} + \frac{k_e|q_3|}{r_3{}^2} - \frac{k_e|q_2|}{r_2{}^2} \\ &= \left(8.99 \times 10^9\ \mathrm{N \cdot m^2/C^2}\right)\left[\frac{6.00 \times 10^{-6}\ \mathrm{C}}{(0.0200\ \mathrm{m})^2} + \frac{2.00 \times 10^{-6}\ \mathrm{C}}{(0.0300\ \mathrm{m})^2} - \frac{1.50 \times 10^{-6}\ \mathrm{C}}{(0.0100\ \mathrm{m})^2}\right] \end{aligned}$$

This gives $E_R = 2.00 \times 10^7$ N/C to the right
or $\vec{\mathbf{E}}_R = +2.00 \times 10^7$ N/C .

(b) $\vec{\mathbf{F}} = q\vec{\mathbf{E}}_R = (-4.70 \times 10^{-6}\ \mathrm{C})(2.00 \times 10^7\ \mathrm{N/C}) = 93.9$ N to the left
or $\vec{\mathbf{F}} = -93.9$ N.

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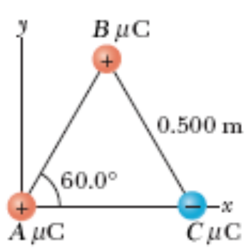
4. 4/4 points Previous Answers **SERCP11 15.3.P.024.**

My Notes Ask Your Teacher



(a) Three point charges, *A* = 1.80 μC, *B* = 6.70 μC, and *C* = −3.95 μC, are located at the corners of an equilateral triangle as in the figure above. Find the magnitude and direction of the electric field at the position of the 1.80 μC charge.

magnitude 2.10e5 ✔ 2.10e+05 N/C

direction 84.1 ✔ 84.1 ° below the $+x$-axis

(b) How would the electric field at that point be affected if the charge there were doubled?

- ○ The magnitude of the field would be halved.
- ● The field would be unchanged.
- ○ The magnitude of the field would double.
- ○ The magnitude of the field would quadruple.

✔

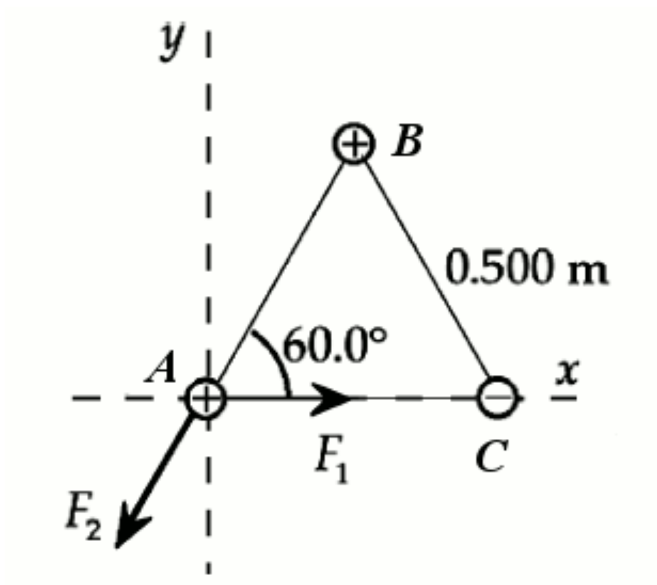
Would the magnitude of the electric force be affected?

- ● Yes
- ○ No

✔

Solution or Explanation

(a) Please see the sketch below.



$$F_1 = \frac{(8.99 \times 10^9\ \mathrm{N \cdot m^2/C^2})(1.80 \times 10^{-6}\ \mathrm{C})(3.95 \times 10^{-6}\ \mathrm{C})}{(0.500\ \mathrm{m})^2}$$

or

$F_1 = 0.256$ N

$$F_2 = \frac{(8.99 \times 10^9\ \mathrm{N \cdot m^2/C^2})(1.80 \times 10^{-6}\ \mathrm{C})(6.70 \times 10^{-6}\ \mathrm{C})}{(0.500\ \mathrm{m})^2}$$

or

$F_2 = 0.434$ N

The components of the resultant force acting on the 1.80 μC charge are:

$$F_x = F_1 - F_2 \cos(60.0°) = 0.256\ \mathrm{N} - (0.434\ \mathrm{N}) \cos(60.0°) = 0.0388\ \mathrm{N}$$

and

$$F_y = -F_2 \sin(60.0°) = -(0.434\ \mathrm{N}) \sin(60.0°) = -0.376\ \mathrm{N}$$

The magnitude and direction of this resultant force are

$$F = \sqrt{F_x{}^2 + F_y{}^2} = \sqrt{(0.0388\ \mathrm{N})^2 + (-0.376\ \mathrm{N})^2} = 0.378\ \mathrm{N}$$

$$\text{at } \theta = \tan^{-1}\left(\frac{F_y}{F_x}\right) = \tan^{-1}\left(\frac{-0.376\ \mathrm{N}}{0.0388\ \mathrm{N}}\right) = -84.1°$$

or 84.1° below the $+x$-axis.

Since the electric field at a location is defined as the force per unit charge experienced by a test charge placed in that location, the electric field at the origin in the charge configuration is

$$\vec{\mathbf{E}} = \frac{\vec{\mathbf{F}}}{q_0} = \frac{0.378\ \mathrm{N}}{1.80 \times 10^{-6}\ \mathrm{C}} \text{ at } -84.1° = 2.10 \times 10^5\ \mathrm{N/C} \text{ at } 84.1° \text{ below the } +x\text{-axis}$$

(b) The electric force experienced by the charge at the origin is directly proportional to the magnitude of that charge. Thus, doubling the magnitude of this charge would double the magnitude of the electric force. However, the electric field is the force per unit charge and the field would be unchanged if the charge was doubled. This is easily seen in the calculation of part (a) above. Doubling the magnitude of the charge at the origin would double both the numerator and the denominator of the ratio $\vec{\mathbf{F}}/q_0$, but the value of the ratio (i.e., the electric field) would be unchanged.

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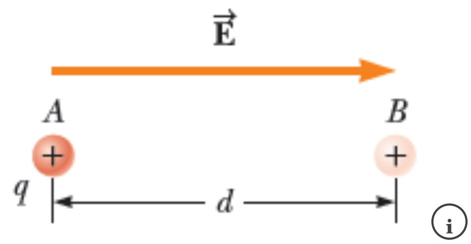
5. 5/5 points Previous Answers **SERCP11 16.1.OP.006.**

My Notes Ask Your Teacher

The figure below shows a small, charged sphere, with a charge of q = +44.0 nC, that moves a distance of d = 0.189 m from point A to point B in the presence of a uniform electric field $\vec{\mathbf{E}}$ of magnitude 260 N/C, pointing right.



(a) What is the magnitude (in N) and direction of the electric force on the sphere?

magnitude 1.14e-5 1.14e-05 N

direction toward the right toward the right

(b) What is the work (in J) done on the sphere by the electric force as it moves from A to B?

2.15e-6 2.16e-06 J

(c) What is the change of the electric potential energy (in J) as the sphere moves from A to B? (The system consists of the sphere and all its surroundings.)

$PE_B - PE_A$ = -2.15e-6 -2.16e-06 J

(d) What is the potential difference (in V) between A and B?

$V_B - V_A$ = -48.9 -49.1 V

Solution or Explanation

Note: We are displaying rounded intermediate values for practical purposes. However, the calculations are made using the unrounded values.

(a) The electric force is given by $\vec{\mathbf{F}} = q\vec{\mathbf{E}}$. The magnitude is

$$F = |q|E = (44.0 \times 10^{-9}\ \text{C})(260\ \text{N/C}) = 1.14 \times 10^{-5}\ \text{N}.$$

Because the charge is positive, the force is in the same direction as the electric field, or to the right.

(b) The work is given by $W = Fd\cos(\theta)$, where θ is the angle between the force F and displacement d. In this case both are in the same direction, so $\theta = 0$ and $\cos(\theta) = 1$. So,

$$W = Fd = (1.14 \times 10^{-5}\ \text{N})(0.189\ \text{m}) = 2.16 \times 10^{-6}\ \text{J}.$$

(c) The change in electric potential energy of the system is defined to be the negative of the work done by the electric force, or,

$$PE_B - PE_A = -W = -2.16 \times 10^{-6}\ \text{J}.$$

The negative sign is consistent with the fact that the electric field tends to accelerate the charge over the given displacement—its kinetic energy increases, so its potential energy must decrease.

(d) The change in electric potential is related to the change in potential energy by

$$\Delta V = \frac{\Delta PE}{q}, \text{ or}$$

$$V_B - V_A = \frac{PE_B - PE_A}{q}.$$

So, $V_B - V_A = \dfrac{-2.16 \times 10^{-6}\ \text{J}}{44.0 \times 10^{-9}\ \text{C}} = -49.1\ \text{V}.$

The negative sign is consistent with the fact that the electric field and the path from A to B are in the same direction.

Need Help? Read It

6. 4/4 points Previous Answers **SERCP11 16.1.P.001.**

My Notes Ask Your Teacher

A uniform electric field of magnitude 369 N/C pointing in the positive x-direction acts on an electron, which is initially at rest. The electron has moved 3.50 cm.

(a) What is the work done by the field on the electron?

2.07e-18 ✓ 2.07e-18 J

(b) What is the change in potential energy associated with the electron?

-2.07e-18 ✓ -2.07e-18 J

(c) What is the velocity of the electron?

magnitude 2.13e6 ✓ 2.13e+06 m/s

direction -x ✓ -x

Solution or Explanation

(a) Because the electron has a negative charge, it experiences a force in the direction opposite to the field and, when released from rest, will move in the negative x-direction. The work done on the electron by the field is

$$W = F_x(\Delta x) = (qE_x)\Delta x = (-1.60 \times 10^{-19}\text{ C})(369\text{ N/C})(-3.50 \times 10^{-2}\text{ m})$$
$$= 2.07 \times 10^{-18}\text{ J}$$

(b) The change in the electric potential energy is the negative of the work done on the particle by the field. Thus,

$$\Delta PE = -W = -2.07 \times 10^{-18}\text{ J}$$

(c) Since the Coulomb force is a conservative force, conservation of energy gives

$$\Delta KE + \Delta PE = 0,$$

or

$$KE_f = \frac{1}{2}m_e v_f^2 = KE_i - \Delta PE = 0 - \Delta PE,$$

and

$$v_f = \sqrt{\frac{-2(\Delta PE)}{m_e}} = \sqrt{\frac{-2(-2.07 \times 10^{-18}\text{ J})}{9.11 \times 10^{-31}\text{ kg}}} = 2.13 \times 10^6\text{ m/s in the } -x\text{-direction}$$

Need Help? Read It

7. 2/2 points Previous Answers **SERCP11 16.1.P.009.**

My Notes Ask Your Teacher

An ionized oxygen molecule (O_2^{+}) at point A has charge +*e* and moves at 1.32×10^{3} m/s in the positive *x*-direction. A constant electric force in the negative *x*-direction slows the molecule to a stop at point B, a distance of 0.931 mm past A on the *x*-axis. Calculate the *x*-component of the electric field and the potential difference between points A and B. (The mass of an oxygen molecule is 5.31×10^{-26} kg and the fundamental charge is $e = 1.60 \times 10^{-19}$ C.)

HINT

(a) the *x*-component of the electric field (in V/m)

-311 ✓ -311 The SI unit for electric field is newtons per coulomb (N/C), which is equivalent to volts per meter (V/m). V/m

(b) the potential difference between points A and B (in V)

0.2895 ✓ 0.289 V

Solution or Explanation

Note: We are displaying rounded intermediate values for practical purposes. However, the calculations are made using the unrounded values.

(a) Apply conservation of energy, using the facts that $\Delta PE = -qE_x\Delta x$ (where $q = +e$ for the oxygen ion) and $KE_f = 0$.

$$\Delta KE + \Delta PE = 0$$
$$(KE_f - KE_i) + \Delta PE = 0$$
$$\left(0 - \frac{1}{2}(m_{O_2{}^+})v_0{}^2\right) + (-eE_x\Delta x) = 0$$

Solve for E_x and substitute values to find the following.

$$E_x = -\frac{\frac{1}{2}(m_{O_2{}^+})v_0{}^2}{e\Delta x}$$
$$= -\frac{\frac{1}{2}(5.31 \times 10^{-26}\text{ kg})(1.32 \times 10^3\text{ m/s})^2}{(1.60 \times 10^{-19}\text{ C})(0.931 \times 10^{-3}\text{ m})}$$
$$= -311\text{ V/m}$$

(b) The potential difference between points A and B is the following.

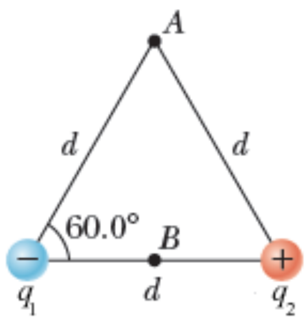
$$\Delta V = -E_x\Delta x = -(-311\text{ V/m})(0.931 \times 10^{-3}\text{ m})$$
$$= 0.289\text{ V}$$

Need Help? Read It Watch It

8. 2/2 points Previous Answers **SERCP11 16.2.OP.012.**

My Notes Ask Your Teacher

The figure below shows two small, charged spheres separated by a distance of d = 2.50 cm. The charges are q_1 = −20.0 nC and q_2 = 30.0 nC. Point B is at the midpoint between the two charges, and point A is at the peak of an equilateral triangle, with each side of length d, as shown. (Assume the zero of electric potential is at infinity.)



(a) What is the electric potential (in kV) at point A?

3.6 ✔ 3.6 kV

(b) What is the electric potential (in kV) at point B?

7.2 ✔ 7.19 kV

Solution or Explanation

Note: We are displaying rounded intermediate values for practical purposes. However, the calculations are made using the unrounded values.

(a) The electric potential at a point in space, due to a charged particle, is given by

$$V = \frac{k_e q}{r}$$

where q is the charge and r is the distance from the charge to the point. The total potential is the sum of the potential due to each charge. Therefore, at point A,

$$V_A = \frac{k_e q_1}{r_1} + \frac{k_e q_2}{r_2}$$

Note the distance from A to each charge is the same, so $r_1 = r_2 = d$. Therefore,

$$V_A = \frac{k_e q_1}{d} + \frac{k_e q_2}{d} = \frac{k_e}{d}(q_1 + q_2).$$

Substituting values gives

$$V_A = \frac{8.99 \times 10^9 \text{ N} \cdot \text{m}^2/\text{C}^2}{0.0250 \text{ m}}(-20.0 \times 10^{-9} \text{ C} + 30.0 \times 10^{-9} \text{ C}) = 3{,}600 \text{ V, or}$$

$$V_A = 3.60 \text{ kV.}$$

(b) The potential at B is found in the same way. Note the distance from B to each charge is now $\frac{d}{2}$.

$$V_B = \frac{k_e q_1}{\left(\frac{d}{2}\right)} + \frac{k_e q_2}{\left(\frac{d}{2}\right)} = \frac{2k_e}{d}(q_1 + q_2)$$

Note this turns out to be 2 times the potential V_A, so,

$$V_B = 2V_A = 2(3.60 \text{ kV}) = 7.19 \text{ kV}.$$

Need Help? Read It

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9. 1/5 points Previous Answers **SERCP11 16.2.P.019.**

My Notes Ask Your Teacher

A proton is located at the origin, and a second proton is located on the x-axis at x_1 = 6.66 fm (1 fm = 10^{-15} m).

(a) Calculate the electric potential energy associated with this configuration.
3.46e-14 ✓ 3.46e-14 J

(b) An alpha particle (charge = $2e$, mass = 6.64×10^{-27} kg) is now placed at (x_2, y_2) = (3.33, 3.33) fm. Calculate the electric potential energy associated with this configuration.
1.22e-13 ✗ 2.30e-13
Your response differs from the correct answer by more than 10%. Double check your calculations. J

(c) Starting with the three particle system, find the change in electric potential energy if the alpha particle is allowed to escape to infinity while the two protons remain fixed in place. (Throughout, neglect any radiation effects.)
(No Response) -1.95e-13 J

(d) Use conservation of energy to calculate the speed of the alpha particle at infinity.
(No Response) 7.67e+06 m/s

(e) If the two protons are released from rest and the alpha particle remains fixed, calculate the speed of the protons at infinity.

(No Response) 1.17e+07 m/s

Solution or Explanation

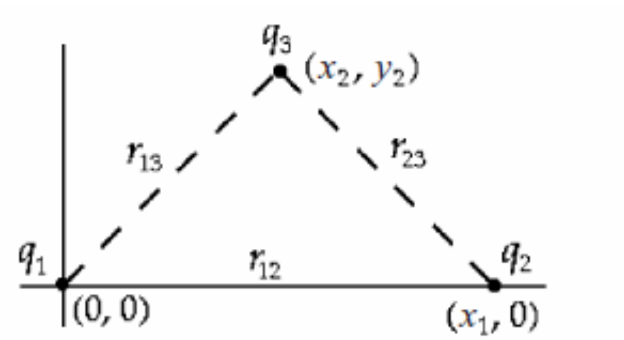
Note: We are displaying rounded intermediate values for practical purposes. However, the calculations are made using the unrounded values.

(a) When the charge configuration consists of only the two protons (q_1 and q_2 in the figure below), the potential energy of the configuration is

$$PE_a = \frac{k_e q_1 q_2}{r_{12}} = \frac{(8.99 \times 10^9 \text{ N} \cdot \text{m}^2/\text{C}^2)(1.60 \times 10^{-19} \text{ C})^2}{6.66 \times 10^{-15} \text{ m}}$$

or

$$PE_a = 3.46 \times 10^{-14} \text{ J}$$



(b) When the alpha particle (q_3 in the figure above) is added to the configuration, there are three distinct pairs of particles, each of which possesses potential energy. The total potential energy of the configuration is now

$$PE_b = \frac{k_e q_1 q_2}{r_{12}} + \frac{k_e q_1 q_3}{r_{13}} + \frac{k_e q_2 q_3}{r_{23}} = PE_a + 2\left(\frac{k_e(2e^2)}{r_{13}}\right)$$

where use has been made of the facts that $q_1 q_3 = q_2 q_3 = e(2e) = 2e^2$ and

$$r_{13} = r_{23} = \sqrt{(3.33 \text{ fm})^2 + (3.33 \text{ fm})^2} = \sqrt{22.2} \text{ fm} = \sqrt{22.2} \times 10^{-15} \text{ m}.$$

Also, note that the first term in this computation is just the potential energy computed in part (a). Thus,

$$PE_b = PE_a + \frac{4k_e e^2}{r_{13}}$$

$$= 3.46 \times 10^{-14} \text{ J} + \frac{4(8.99 \times 10^9 \text{ N} \cdot \text{m}^2/\text{C}^2)(1.60 \times 10^{-19} \text{ C})^2}{\sqrt{22.2} \times 10^{-15} \text{ m}} = 2.30 \times 10^{-13} \text{ J}$$

(c) If we start with the three-particle system of part (b) and allow the alpha particle to escape to infinity [thereby returning us to the two-particle system of part (a)], the change in electric potential energy will be

$$\Delta PE = PE_a - PE_b = 3.46 \times 10^{-14}\text{ J} - 2.30 \times 10^{-13}\text{ J} = -1.95 \times 10^{-13}\text{ J}$$

(d) Conservation of energy, $\Delta KE + \Delta PE = 0$, gives the speed of the alpha particle at infinity in the situation of part (c) as

$$\frac{1}{2}m_\alpha {v_\alpha}^2 - 0 = -\Delta PE,$$

or

$$v_\alpha = \sqrt{\frac{-2(\Delta PE)}{m_\alpha}} = \sqrt{\frac{-2(-1.95 \times 10^{-13}\text{ J})}{6.64 \times 10^{-27}\text{ kg}}} = 7.67 \times 10^{6}\text{ m/s}$$

(e) When, starting with the three-particle system, the two protons are both allowed to escape to infinity, there will be no remaining pairs of particles and hence no remaining potential energy. Thus, $\Delta PE = 0 - PE_b = -PE_b$. and conservation of energy gives the change in kinetic energy as $\Delta KE = -\Delta PE = +PE_b$. Since the protons are identical particles, this increase in kinetic energy is split equally between them giving

$$KE_{\text{proton}} = \frac{1}{2}m_p {v_p}^2 = \frac{1}{2}(PE_b),$$

or

$$v_p = \sqrt{\frac{PE_b}{m_p}} = \sqrt{\frac{2.30 \times 10^{-13}\text{ J}}{1.67 \times 10^{-27}\text{ kg}}} = 1.17 \times 10^{7}\text{ m/s}$$

Need Help? Read It

10. 1/1 points Previous Answers **SERCP11 17.4.OP.010.**

My Notes Ask Your Teacher

The potential difference across a resistor in a particular electric circuit is 300 V. The current through the resistor is 15.0 A. What is its resistance (in Ω)?

20 ✔ 20 Ω

Solution or Explanation

From Ohm's law,

$$R = \frac{\Delta V}{I} = \frac{300\text{ V}}{15.0\text{ A}} = 20.0\ \Omega.$$

Need Help? Read It

11. 2/2 points Previous Answers **SERCP11 17.4.OP.014.**

My Notes Ask Your Teacher

A gold wire with a circular cross-section has a mass of 1.20 g and a resistance of 0.710 Ω. At 20°C, the resistivity of gold is 2.44×10^{-8} Ω · m and its density is 19,300 kg/m^3.

How long (in m) is the wire?

1.35 ✔ 1.35 m

What is the diameter (in mm) of the wire?

.242 ✔ 0.243 mm

Solution or Explanation

Note: We are displaying rounded intermediate values for practical purposes. However, the calculations are made using the unrounded values.

(a) Let's call the mass m = 1.20 g, the resistance R = 0.710 Ω, the resistivity ρ = 2.44×10^{-8} Ω · m, and the density D = 19,300 kg/m^3. We'll call the unknown length of the wire L and cross-sectional area A.

Let's start with the relationship between resistance, resistivity, area, and length.

$$R = \frac{\rho L}{A} \qquad (1)$$

This equation has two unknowns, L and A. We need to find another equation with these two unknowns to be able to solve for them. From the relationship between mass, density, and volume, we have the following.

$$D = \frac{m}{V} \qquad (2)$$

The volume V of a cylinder is the end-cap area A times the length L.

$$V = AL$$

Substituting this into equation (2) gives the following.

$$D = \frac{m}{AL}$$

Solving this equation for A gives the following.

$$A = \frac{m}{LD} \qquad (3)$$

Substituting equation (3) into equation (1) gives the following.

$$R = \frac{\rho L}{\left(\frac{m}{LD}\right)} = \frac{\rho L^2 D}{m} \qquad (4)$$

Solving this equation for the length L gives the following.

$$L = \sqrt{\frac{mR}{\rho D}}$$

Substituting values into this equation (being careful to convert units) gives the following.

$$L = \sqrt{\frac{(1.20 \times 10^{-3}\ \text{kg})(0.710\ \Omega)}{(2.44 \times 10^{-8}\ \Omega \cdot \text{m})(19{,}300\ \text{kg/m}^3)}} = 1.35\ \text{m}$$

(b) From equation (3), the cross-sectional area is as follows.

$$A = \frac{m}{LD}$$

The cross-sectional area of a circle, in terms of its diameter d, is as follows.

$$A = \frac{\pi d^2}{4}$$

Substituting this into equation (3) gives the following.

$$\frac{\pi d^2}{4} = \frac{m}{LD}$$

Solving this for d gives the following.

$$d = \sqrt{\frac{4m}{\pi LD}} = 2\sqrt{\frac{m}{\pi LD}}$$

Substituting values, including the value of L found in part (a), gives the following.

$$d = 2\sqrt{\frac{1.20 \times 10^{-3}\text{ kg}}{\pi(1.35\text{ m})(19{,}300\text{ kg/m}^3)}} = 2.43 \times 10^{-4}\text{ m}$$

In units of mm, this is as follows.

$$d = 0.243\text{ mm}$$

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12. 2/2 points Previous Answers **SERCP11 17.4.OP.017.**

My Notes Ask Your Teacher

A long wire with a radius of 0.400 cm carries a current. The potential difference across a 2.80 m long section of this wire is 14.0 V, and the wire carries a current of 0.390 A.

(a) What is the resistance (in Ω) of the 2.80 m long section of wire?

35.9 ✔ 35.9 Ω

(b) What is the resistivity (in Ω · m) of the wire?

6.44e-4 ✔ 0.000644 Ω · m

Solution or Explanation

Note: We are displaying rounded intermediate values for practical purposes. However, the calculations are made using the unrounded values.

(a) Resistance R is related to potential difference ΔV and current I by Ohm's law.

$$R = \frac{\Delta V}{I} = \frac{14.0\ \text{V}}{0.390\ \text{A}} = 35.9\ \Omega$$

(b) Resistance R is related to resistivity ρ, length L, and cross-sectional area A by

$$R = \rho\frac{L}{A}.$$

Solving for ρ gives

$$\rho = \frac{RA}{L}$$

The area of a circle is πr^2, where r is the radius, so

$$\rho = \frac{R\pi r^2}{L} = \frac{(35.9\ \Omega)(\pi)(0.400 \times 10^{-2}\ \text{m})^2}{2.80\ \text{m}} = 6.44 \times 10^{-4}\ \Omega \cdot \text{m}.$$

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