Quiz # 5 Ch.#21 T131-Sec. 7-9-v1

Student ID:……… …… Student Name:………… ………. Section # ……….

Q#1: Particles A and B are electrically neutral and are separated by 5.0 µm. If 5.0 x 10^6 electrons are transferred from particle A to particle B, the magnitude of the electric force between them is: (Ans: 2.3 ×10^{-4} N)

$Q_A = -5\times10^{6}\times1.6\times10^{-19}$, $Q_B = +5\times10^{6}\times1.6\times10^{-19}$

$F = \frac{k Q_A Q_B}{d^2}$

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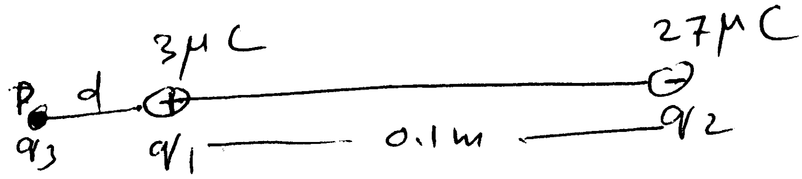
$|F| = \frac{k|Q_A||Q_B|}{d^2} = \frac{9\times10^{9}\times(5\times10^{6}\times1.6\times10^{-19})^2}{(5\times10^{-6})^2}$

$= 23.04\times10^{-5} = 2.3\times10^{-4}$ N.

Q4. Two fixed particles of charges $q_1 = +3.0 \times 10^{-6}$ C and $q_2 = -27 \times 10^{-6}$ C, are 10 cm apart. How far from q_1 should a third charge be located so that the net force on it is zero?
A) 5.0 cm



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$|F_{13}| = |F_{23}|$

$\frac{k q_1 q_3}{d^2} = \frac{k q_2 q_3}{(d+0.1)^2} \Rightarrow \frac{q_1}{d^2} = \frac{q_2}{(d+0.1)^2}$

$\frac{d+0.1}{d} = \sqrt{\frac{q_2}{q_1}} = \sqrt{\frac{27\times10^{-6}}{3\times10^{-6}}} = 3$

$\frac{d+0.1}{d} = 3 \Rightarrow 3d - d = 0.1$

$d = \frac{0.1}{2} = 0.05$ m

Quiz # 5 Ch.#21 T131-Sec. 7-9-v2

Student ID:......... ...... Student Name:............ .... Section # ....

Q#1: Two neutral metal spheres are separated by 300 m. How many electrons must be transferred from one sphere to the other so that their force of attraction has a magnitude of 10^6 N? A) 2×10^{19}

$q_1 = -q$, $q_2 = +q$, $F_{q_1 q_2} = 10^6 N$, $d = 300\,m$

$$|F| = \frac{k q^2}{d^2} \Rightarrow q = \sqrt{\frac{|F| \times d^2}{k}}$$

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$$q = \sqrt{\frac{10^6 \times (300)^2}{9 \times 10^9}} = \sqrt{10} = 3.162\ C$$

$$= \frac{3.162}{1.6 \times 10^{-19}} e = 2 \times 10^{19} e$$

Q#2: Consider the charges shown in figure 1. Find the magnitude and sign of charge Q_4 so that the net electrostatic force on charge Q_5 is zero. (Ans: + 1.8 nC)

$F_{net-x} = 0$

For $|F_{net-y}| = 0$, $\frac{k Q_4 Q_5}{(0.03)^2} = \frac{k Q_3 Q_5}{(0.05)^2}$

$$Q_4 = \frac{(0.03)^2}{(0.05)^2} \times Q_3$$

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$$= 0.36 \times Q_3$$

$Q_4 = 1.8\ nC$

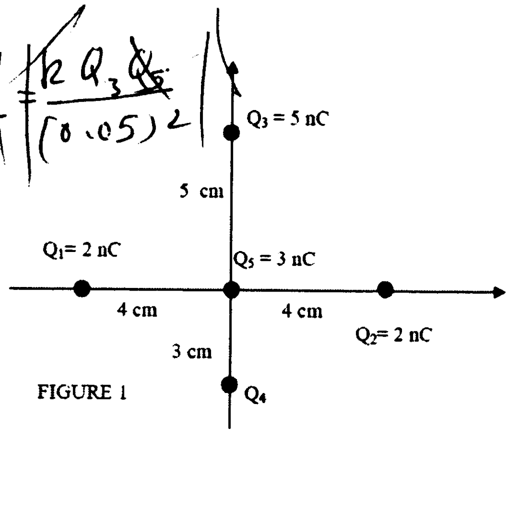


FIGURE 1

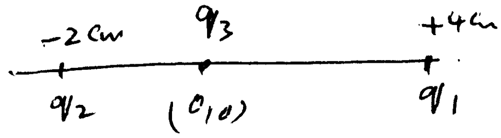
Quiz # 5 Ch.#21 T131-Sec. 7-9-v3

Student ID:.............. Student Name:..................... Section # ....

Q#1: Particle 1 with charge q_1, and particle 2 with charge q_2 are on the x axis, with particle 1 at $x = 4.0$ cm and particle 2 at $x = -2.0$ cm. Find the relationship between q_1 and q_2 so that the net force on a third particle of charge q located at the origin, be zero,

A) $q_2 = q_1 / 4$

$|F_{31}| = |F_{32}|$



$\left|\frac{k q_3 q_1}{(0.04)^2}\right| = \left|\frac{k q_3 q_2}{(0.02)^2}\right|$

$\frac{q_2}{q_1} = \frac{(0.02)^2}{(0.04)^2} = \frac{4}{16} = \frac{1}{4}$

$q_2 = \frac{q_1}{4}$

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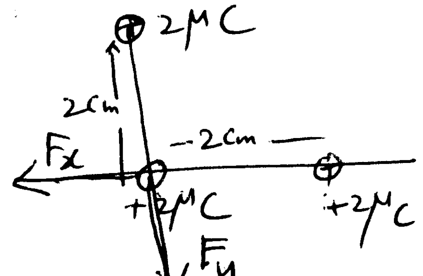
Q#2: A particle with charge 2.0 μC is placed at the origin, an identical particle, with the same charge, is placed 2.0 cm from the origin on the positive x axis, and a third identical particle, with the same charge, is placed 2.0 cm from the origin on the positive y axis. The magnitude of the force on the particle at the origin is: A) 1.3×10^2 N

F on particle at the origin



$\vec{F} = -F_x\vec{i} - F_y\vec{j}$

$= -(F_x + F_y)$

$= -kq^2\left(\frac{1}{x^2}\vec{i} + \frac{1}{y^2}\vec{j}\right)$

$= -kq^2\left(\frac{\vec{i}}{(0.02)^2} + \frac{\vec{j}}{(0.02)^2}\right) = -\frac{kq^2}{(0.02)^2}(\vec{i} + \vec{j})$

$|F| = \frac{kq^2\sqrt{2}}{(0.02)^2} = \frac{9\times10^9 \times (2\times10^{-6})^2 \times \sqrt{2}}{(0.02)^2}$

$= 130\ N = 1.3\times10^2\ N$

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Quiz # 5 Ch.#21 T131-Sec. 7-9-v4

Student ID:……… …… Student Name:……… …………. Section # ……….

Q1 Three point charges Q_1, $Q_2 = 20\ \mu C$ and $Q_3 = 50\ \mu C$ are located as shown in the figure. If the net force on Q_3 is in the direction of the negative y-axis, find the charge of Q_1.

A) −10 μC

$F_{net-x} = 0$ then

$|F_{13-x}| = |F_{23-x}|$

$\theta = \cos^{-1}(4/5) = 36.7^{0}$

$$\frac{k q_1 Q_3}{(4)^2} = \frac{k Q_2 Q_3 \cos(36.7)}{(5)^2}$$

$$|Q_1| = \frac{(4^2)}{(5^2)} k |Q_2| \times \cos(36.7)$$

$|Q_1| = 10.26\ \mu C$

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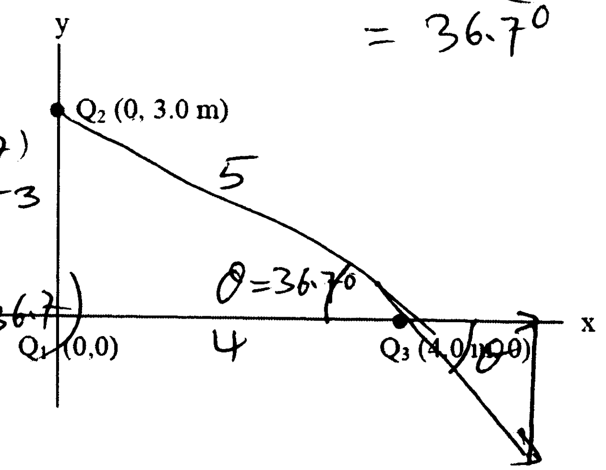

Q#2: The distance between two identical conductor spheres is 0.50 m. Initially, one sphere has a charge of -8.0 μC and the other sphere has a charge of +2.0 μC. If the spheres are connected with a very thin conducting wire, what will be the electrostatic force on each sphere? A) 0.32 N, repulsive.

charge on each sphere after touching $= \frac{-8\mu C + 2\mu C}{2}$

$q = -3\mu C$

$$|F| = \left|\frac{k q^2}{(0.5)^2}\right| = \frac{9\times10^{9} \times (3\times10^{-6})^2}{(0.5)^2}$$

$|F| = 0.324\ N$

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Quiz # 5 Ch.#21 T131-Sec. 7-9-v5

Student ID:………… Student Name:………… ………. Section # ……….

Q#1: Two identical conducting spheres A and B carry Q and 2Q charges respectively, and are separated by a distance much larger than their diameters. Initially the electrostatic force between them is F. A third identical uncharged conducting sphere C is first touched to A, then to B, and then moved away. As a result of this, the electrostatic force between A and B becomes: A) F/1.6

Force F before touching, $F = \frac{k \cdot Q \times 2Q}{d^2} = \frac{2kQ^2}{d^2}$

After touching charge in each sphere $Q_1' = \frac{Q}{2}$; $q_2' = \frac{2Q + Q/2}{2} = 1.25Q$

Force F' (after touching) between them $= \frac{k Q_1' Q_2'}{d^2} =$

6/6

$F' = k \frac{\frac{Q}{2} \times 1.25Q}{d^2} = \left(\frac{1.25}{2}\right) \frac{kQ^2}{d^2}$

$\frac{F'}{F} = \frac{\frac{1.25}{2} kQ^2/d^2}{kQ^2/d^2} = \left(\frac{1.25}{2}\right) F = 0.625F = \frac{F}{1.6}$

Q#2:. Two identical positively charged ions are separated from each other by a distance of 6.8×10^{-9} m. If the electrostatic force between them is 4.5×10^{-9} N, how many electrons are missing from each ion? A) 30

$|F| = \frac{k q^2}{d^2} \Rightarrow q = \sqrt{\frac{|F| d^2}{k}}$

4/4

$q = \sqrt{\frac{4.5\times10^{-9} \times (6.8\times10^{-9})^2}{9\times10^9}}$

$= 4.808 \times 10^{-18}$ C

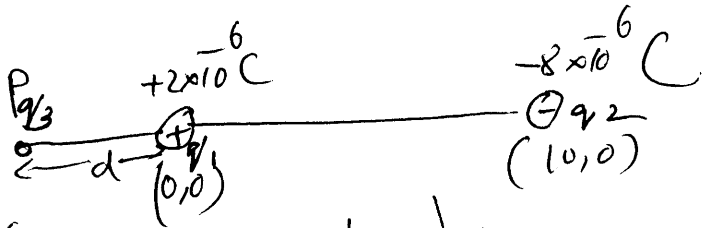
$q = \frac{4.808\times10^{-18}}{1.6\times10^{-19}} = 30$ electrons

Quiz # 5 Ch.#21 T131-Sec. 7-9-v6

Student ID:……… …… Student Name:………… ………. Section # ……….

Q#1: Two point charges $q_1 = +2.0\times10^{-6}$ C and $q_2 = -8.0\times10^{-6}$ C are located at (0.0, 0.0) cm and (10.0, 0.0) cm, respectively. Another positive point charge q_3 is to be located somewhere, on x-axis, such that the net electrostatic force on it due to q_1 and q_2 is zero. Its location will be: A) (-10.0, 0.0) cm

$|F_{+2}| = |F_{-8}|$ $|F_{13}| = |F_{23}|$, q_3



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$$\frac{2\times10^{-6}\times k}{d^2} = \frac{8\times10^{-6}\times k}{(d+0.1)^2} \Rightarrow \frac{1}{d^2} = \frac{4}{(d+0.1)^2}$$

$$\frac{1}{d} = \frac{2}{d+0.1} \Rightarrow 2d = d+0.1 \Rightarrow d = 0.1\ \text{m}$$

Q#2: Three particles are fixed as shown in Figure 1. If |q| = 2.0 μC, what is the net electrostatic force on the particle at the origin? [ˆi and ˆj are unit vectors along the +x and +y axes, respectively (Ans: (9.0×10−3 ˆi – 9.0×10−3 ˆj) N)

$$\vec F = \frac{kq^2}{4}(\vec i - \vec j)$$

$$= \frac{9\times10^{9}\times(2\times10^{-6})^2}{4}(\vec i - \vec j)$$

$$= 9\times10^{9}\times10^{-12}(\vec i - \vec j)$$

$$\vec F = 9\times10^{-3}(\vec i - \vec j)$$

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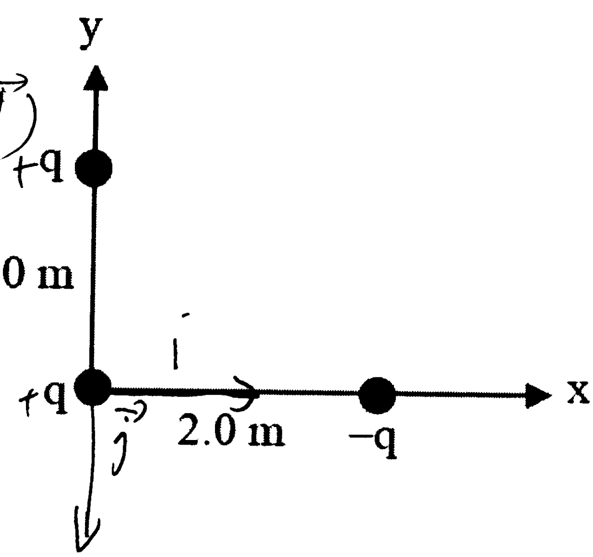
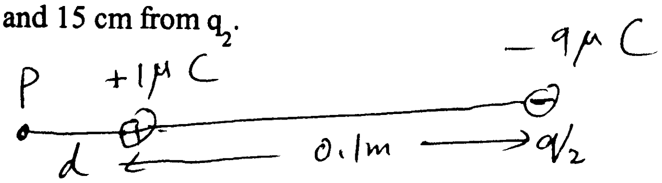


Quiz # 5 Ch.#21 T131-Sec. 7-9-v7

Student ID:......... ...... Student Name:........... .... Section # ....

Q#1: Two fixed particles, of charges q_1 = + 1.0*10**(-6) C and q_2= - 9.0*10**(-6) C, are 10 cm apart. How far from each should a third charge be located so that no net electrostatic force acts on it? (A1 5 cm from q_1 and 15 cm from q_2.



$$\frac{k \times q_1 \times q_3}{d^2} = \frac{k\, q_2 \times q_3}{(d+0.1)^2}$$

5/5

$$\frac{1\times10^{-6}}{d^2} = \frac{9\times10^{-6}}{(d+0.1)^2} \Rightarrow \frac{1}{d} = \frac{3}{d+0.1}$$

$$3d = d + 0.1 \Rightarrow 2d = 0.1 \Rightarrow d = 0.05\,m$$

$$0.05\,m,\ 0.05 + 0.1 = 0.15\,m$$

Q#2: Two small identical conducting spheres, initially uncharged are separated by a distance of 1.0 m. Find the number of electrons that must be transferred from one sphere to the other in order to produce an attractive force of 2×10^{4} N between the spheres. (Ans: 9.3×10^{15})

5/5

$$F = \frac{k\,q^2}{(d)^2} \Rightarrow q = \sqrt{\frac{F d^2}{k}} = \sqrt{\frac{2\times10^{4}\times1^2}{9\times10^{9}}}$$

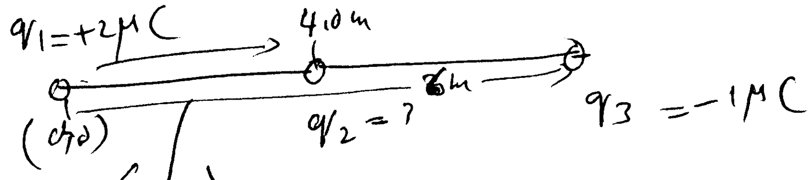
$$q = \sqrt{0.0222\times10^{-4}} = 0.149\times10^{-2}\,C$$

$$= \frac{0.149\times10^{-2}}{1.6\times10^{-19}} = 9.32\times10^{15}\,e.$$

Quiz # 5 Ch.#21 T131-Sec. 7-9-v8

Student ID:……… …… Student Name:………… ………. Section # ……….

Q#1: Consider three charges on the x-axis: $q_1 = 2.0\ \mu C$ located at $x_1 = 0.0$ m, q_2 located at $x_2 = 4.0$ m and $q_3 = -1.0\ \mu C$ located at $x_3 = 6.0$ m. What is the value of q_2 such that the force on q_3 is zero? A) $q_2 = -0.22\ \mu C$.



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$$\frac{k q_2 q_3}{(2)^2} = \frac{k q_1 q_3}{(6)^2}$$

$$q_2 = \frac{4}{36} \times q_1 = \frac{4}{36} \times 2\mu C = 0.22 \mu C$$

$$q_2 = -0.22 \mu C$$

Q2. Consider two identical conductor spheres, S_1 and S_2. Initially, sphere S_1 has a charge of -40 μC and Sphere S_2 has a charge of +20 μC. If the spheres are touched together and then separated by a distance of 0.20 m, what is the resultant force between them? (Ans: 23 N, repulsive

Charges on each sphere after touching $= \frac{+20\mu C - 40\mu C}{2} = -10\mu C$

5/5

$$F_1 = \frac{k(-10\mu C)(-10\mu C)}{(0.2)^2}$$

$$= \frac{9 \times 10^9 \times 10^2 \times 10^{-6} \times 10^{-6}}{(0.2)^2}$$

$$= 22.5\ N \simeq 23\ N$$

Quiz # 5 Ch.#21 T131-Sec. 7-9-v9

Student ID:……… …… Student Name:………… ………. Section # ……….

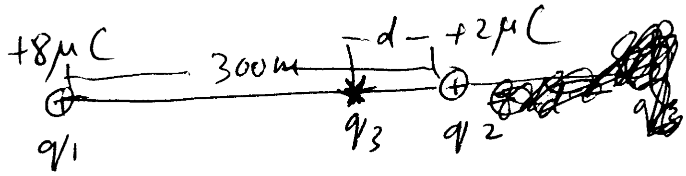
Q1 Two neutral metal sphere are separated by 0.3 km. How much electric charge must be transferred from one sphere to the other so that their electrical attraction is 10^3 N? A1 0.1 C.

$$F = \frac{kq^2}{d^2}, \quad q = \sqrt{\frac{Fd^2}{k}}$$

4/4

$$q = \sqrt{\frac{10^3 \times (300)^2}{9\times 10^9}} = \frac{1}{10}\ C$$

Q#2: Two positive charges (+8.0 C and +2.0 C) are separated by 300 m. A third charge is placed a distance r from the +8.0 C charge so that the resultant electric force on the third charge due to the other two charges is zero. The distance r is : (A1 200 m.



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$$|F_{13}| = |F_{23}|$$

$$\frac{kq_1q_3}{(300-d)^2} = \frac{kq_2q_3}{d^2} \Rightarrow \frac{\sqrt{q_1}}{300-d} = \frac{\sqrt{q_2}}{d}$$

$$\frac{2\sqrt{2}}{300-d} = \frac{\sqrt{2}}{d} \Rightarrow \frac{2}{300-d} = \frac{1}{d}$$

$$2d = 300-d$$

$$3d = 300$$

$$d = 100\ m$$

distance from q_1 = $300 - d = 300 - 100 = 200$ m

Quiz # 5 Ch.#21 T131-Sec. 7-9-v10

Student ID:......... ...... Student Name:........... .... Section # ....

Q#1 In figure 3, Q = 60 micro-C, q = 20 micro-C, a = 3.0 m, and b = 4.0 m. Calculate the total electric force on q. [i and j are the unit vectors in the positive direction of x-axis and y-axis, respectively]. (A1 0.69 i (N).

$|F_{net}| = 2 F_{qQ-x}$

$= 2 |F_{qQ}| \cos(36.9)$

$|F_{net}| = 2 \times \frac{k q Q}{(5)^2} \cos 37 = 0.69$

$\theta = \cos^{-1}\left(\frac{4}{5}\right)$

$\theta = 36.87°$

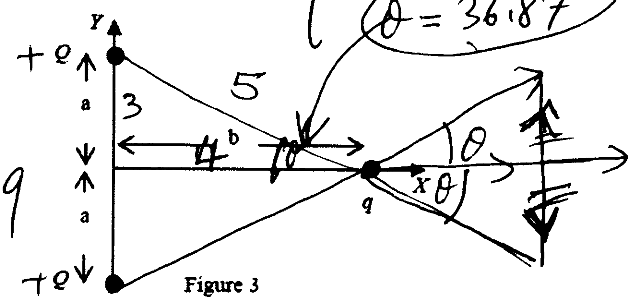

Figure 3

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$\vec{F}_{net} = |F_{net}| \vec{i}$

$\vec{F}_{net} = 0.69 \vec{i}$

Q#2: Consider two identical conductor spheres, A and B. Initially, sphere A has a charge of -80 Q and Sphere B has a charge of +20 Q. If the spheres touched and then are separated by a distance of 0.3 m, what is the resultant force between them? [Take Q = 5.7×10^{-8} C] (A1 0.3 N.

After Touching charge of each sphere

$= \frac{-80Q + 20Q}{2} = -30Q$

5/5

$|F| = \frac{k(-30Q)^2}{(0.3)^2} = \frac{9 \times 10^9 \times (-30 \times 5.7 \times 10^{-8})^2}{(0.3)^2}$

$|F| = 0.292$ N