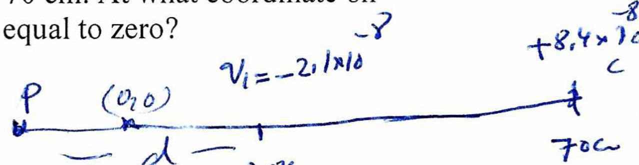
Quiz # 6 Ch.#22 T131-Sec. 7-9-v1

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

Q#1: Two particles are held fixed on an x-axis. Particle 1 of charge $q_1 = -2.1 \times 10^{-8}$ C is at x = 20 cm and particle 2 of charge $q_2 = -4.00q_1$ is at x = 70 cm. At what coordinate on the x-axis is the net electric field produced by the particles equal to zero?



$|E_p| = 0$, $|E_{q_1}| = |E_{q_2}|$

$\frac{k q_1}{d^2} = \frac{k q_2}{(0.5+d)^2}$

$\frac{2.1\times10^{-8}}{d^2} = \frac{4\times2.1\times10^{-8}}{(0.5+d)^2} \Rightarrow \frac{1}{d} = \frac{2}{0.5+d}$

$0.5+d = 2d \Rightarrow d = 0.5$

distance from origin = −30 cm

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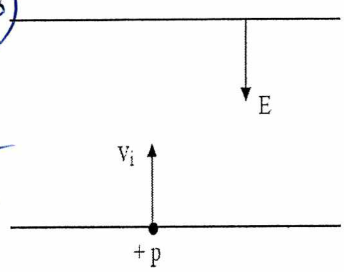
Q2. In the figure below, a uniform electric field ***E* = -18 *j*** N/C exists between two plates that are 4 cm apart. A proton is fired from the lower plate with a velocity 8×10^3 j m/s. Find the distance from that plate at which the instantaneous velocity of the proton is zero.(ignore gravity) [redacted]

$V_f^2 = V_i^2 + 2ad \Rightarrow d = -\frac{V_i^2}{2a}$ $(V_f = 0)$

$d = +\frac{V_i^2}{-2|a|} = \frac{V_i^2}{2\times\frac{qE}{m}}$

$= \frac{mV_i^2}{2qE} = \frac{1.673\times10^{-27}\times(8\times10^3)^2}{2\times1.6\times10^{-19}\times18}$

$d = 1.9\times10^{-2}$ m $= 1.9$ cm



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Q3. An electric dipole moment of magnitude $p = 3.02 \times 10^{-25}$ C.m makes an angle 64° with a uniform electric field of magnitude E = 46.0 N/C. The work required to turn the electric dipole by 90o is:

$W_E = -\Delta U = -(U_f - U_i) = -(-pE\cos\theta_f - (-pE\cos\theta_i))$

$= pE(\cos\theta_f - \cos\theta_i) = 3.02\times10^{-25}\times46(\cos(90+64) - \cos(64))$

$W_E = 3.02\times10^{-25}\times46(-1.337) = -185.73\times10^{-25}$

$W_{app} = -W_E = 185.7\times10^{-25}$ J $= 1.857\times10^{-23}$ J

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Quiz # 6 Ch.#22 T131-Sec. 7-9-v2

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

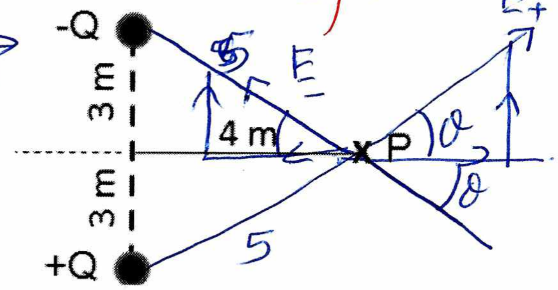
Q#1 Figure 1 shows a particle with positive charge Q and a particle with negative charge –Q , both fixed in place. What is the electric field at point P? [Take Q = 1.00 μC] A) + 432 j^ (N/C)

$\vec{E}_p = 2E_{|q|}\sin\theta = 2\frac{kQ}{5^2}\times\sin 36.7\,\vec{j}$ $\quad \theta = \tan^{-1}(3/4) = 36.7^\circ$

$= \frac{2\times9\times10^9\times10^{-6}}{5^2}\times\sin(36.7)\,\vec{j}$

$\vec{E}_p = 433\,\vec{j}$

3/3



Q#2: A proton with a speed of 4.0×10^6 m/s moves in uniform electric field of 3.8×10^3 N/C. The field is acting to decelerate the proton. How far does the proton travel before it is brought momentarily to rest? A) 22 m

$V_f^2 = V_i^2 + 2ad \Rightarrow d = \frac{-V_i^2}{2a}\ (V_f = 0)\ ;\ a = \frac{qE}{m}$

$a = \frac{qE}{m_e} = -\frac{1.6\times10^{-19}\times3.8\times10^{3}}{1.673\times10^{-27}} = -3.63\times10^{11}\ m/s^2$

$d = -\frac{V_i^2}{2a} = \frac{(4\times10^6)^2}{2\times3.63\times10^{11}} = 22.0\ m$

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Q#3: An electric dipole consists of charges -6.0×10^{-6} C and $+6.0 \times 10^{-6}$ C separated by a distance of 3.0 mm. Its dipole moment is directed along the +x-axis. This dipole is placed in an electric field of magnitude 46 N/C that makes an angle of 60° with the +x-axis. What is the magnitude of the torque exerted by the electric field on the dipole? A) 7.2×10^{-7} N.m.

$|\tau| = |p\times E| = |pE\sin\theta| = |qdE\sin\theta|$

$= 6\times10^{-6}\times3\times10^{-3}\times46\times\sin 60$

$|\tau| = 7.17\times10^{-7} = 7.2\times10^{-7}\ N.m$

3/3

Quiz # 6 Ch.#22 T131-Sec. 7-9-v3

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

Q#1: Three point charges are fixed on the y axis, as shown in Figure 1, with $q = +1.0\ \mu C$. The net electric field at point P is zero. What is the charge Q? A) − 0.43 μC

For $E_p = 0$, $|E'_{Qx}| = |2E_q \cos\theta|$

$\theta = \tan^{-1}(4/3) = 53.1^\circ$

$\left|\frac{kQ}{(3)^2}\right| = \left|\frac{2kq}{5^2} \times \cos 53\right|$

$Q = \frac{(3)^2}{(5^2)} \times 2 \times q \times \cos 53$

$|Q| = \frac{9}{25} \times 2 \times 10^{-6} \times \cos 53 = 0.433\ \mu C$

$Q = -0.433\ \mu C$

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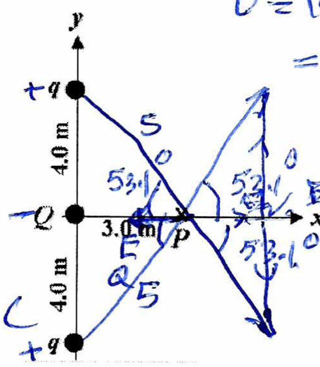

Q#2 An electron is initially moving with velocity $\mathbf{v_i} = +5.0 \times 10^6\ \hat{i}\ (m/s)$. What electric field is needed to momentarily stop the electron in a distance of 3.0 cm? A) + 2.4 kN/C

$V_f^2 = V_i^2 + 2ad$; $a = qE/m \Rightarrow E = \frac{ma}{q} = \frac{m}{q}\left(\frac{V_f^2 - V_i^2}{2d}\right)$ (where $V_f = 0$)

$E = \frac{m}{q}\left(\frac{-V_i^2}{2d}\right) = \frac{9.109 \times 10^{-31}}{-1.6 \times 10^{-19}} \frac{(5 \times 10^6)^2}{(0.03)2}$

$= 2.367 \times 10^3\ N/C = 2.4\ kN/C$

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Q#3: An electric dipole consists of a particle with a charge of $+6.0 \times 10^{-6}$ C at the origin and a particle with a charge of -6.0×10^{-6} C on the x axis at $x = 3.0 \times 10^{-3}$ m. Its dipole moment is: A) 1.8×10^{-8} C.m, in the negative x direction

$|p| = |qd| = 6 \times 10^{-6} \times 3 \times 10^{-3} = 1.8 \times 10^{-8}\ C.m$

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Quiz # 6 Ch.#22 T131-Sec. 7-9-v4

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

Q1 A point charge Q = -500 nC and two unknown point charges , q_1 and q_2 , are placed as shown in Fig. 2. The net electric field at the origin O , due to charges Q, q_1 and q_2, is equal to zero. The charges q_1 and q_2, respectively, are:

$E_{net} = 0$ Then $|E_{QY}| = |E_{q_2}|$ + $|E_{QX}| = |E_{q_1}|$

$|E_{QX}| = E_Q \cos 30 = \frac{kQ}{(2)^2}\cos 30 = 973.2\ N/C$

$|E_{QY}| = E_Q \sin 30 = \frac{kQ}{(2)^2}\sin 30 = 561.9\ N/C$

$|E_{q_1}| = \frac{kq_1}{(1.1)^2} = \frac{kQ}{(2)^2}\cos 30$

$q_1 = \frac{(1.1)^2}{(2)^2} \times Q \cos 30 = \frac{(1.1)^2 \times 500\times10^{-6} \times \cos 30}{(2)^2}$

$|q_1| = 131\ nC$

$|q_2| = \frac{(1.3)^2}{2^2} \times 500\times10^{-6} \times \sin 30 = 106\ nC$

q_1 +ve & q_2 −ve charge

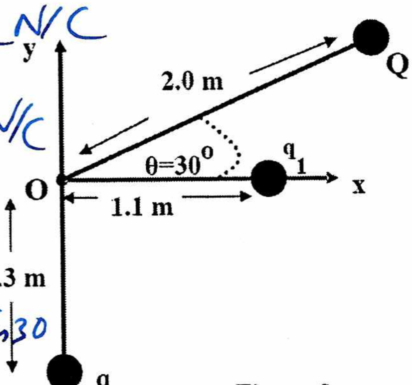


Figure 2

Q#2: A particle (m = 20 mg, q = −5.0 μC) moves in a uniform electric field **E**= (60 N/C) **i** . At t= 0, the particle has a velocity **v** = (30 m/s) **i**. Determine the velocity of the particle at t = 4.0 s.

$\vec{V}_f = V_i + at$; $a = -\frac{V_i}{t}$; $a = \frac{qE}{m} = \frac{-5\times10^{-6}\times 60}{20\times10^{-6}}\,\vec{i}$

$\vec{a} = -15\,\vec{i}\ m/s^2$

$\vec{V}_f = (30\vec{i} - (15\times4)\vec{i})\ m/s$

$= (30\vec{i} - 60\vec{i})\ m/s$

$\vec{V}_f = -30\ (m/s)\,\vec{i}$

Q#3: ; An electric dipole consists of two opposite charges, each of magnitude 2.0 nC. A uniform electric field of magnitude 300 N/C makes an angle of 25° with the dipole moment of the dipole. If the torque exerted by the field has a magnitude of 2.5×10^{-11} N.m, the distance between the two charges of the dipole is:

$\tau = p \times E$; $|\tau| = |pE\sin\theta| = |qEd\sin\theta|$

$d = \frac{|\tau|}{|qE\sin\theta|} = \frac{2.5\times10^{-11}}{1.6\times10^{-19} \times 300 \times \sin 25}$

$d = 99\times10^{-6}\ m = 99\ \mu m$

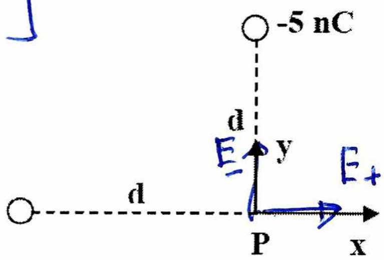
Quiz # 6 Ch.#22 T131-Sec. 7-9-v5

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

Q#1: Two charges are arranged as shown in the figure below. If d=7.2 cm, what is the resultant electric field at P? (A) 1.23×10^4 N/C making an angle of 45°with + x-axis)

$E_p = E_+ \vec{i} + E_y \vec{j}$; $E_+ = \frac{kq}{d^2}$, $E_- = -\frac{k|q|}{d^2}$

$E_p = \frac{kq}{d^2}\vec{i} - \frac{k|q|}{d^2}\vec{j} = \frac{k|q|}{d^2}[\vec{i} - \vec{j}]$



$= \frac{9\times10^{9} \times 5\times10^{-9}}{(0.072)^2}[\vec{i} - \vec{j}]$

$\vec{E_p} = 8680.6[\vec{i} + \vec{j}]$

$|E_p| = 8680.6 \times \sqrt{2}$

$= 12276.2 = 1.23\times10^{4}$ N/C

$\theta = \tan^{-1}\left(\frac{E_{py}}{E_{px}}\right) = \tan^{-1}(1)$

$\theta = 45^\circ$

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Q#2:. A proton enters a region of uniform electric field $E = 80\ \hat{j}$ (N/C) with an initial velocity $v = 20\ \hat{i}$ (km/s). What is the speed of the proton 2.0 μs after entering this region? A) 25 km/s

$V_f = V_i + at$; $a = \frac{qE}{m} = \frac{1.6\times10^{-19} \times 80\ \vec{j}}{1.673\times10^{-27}} = 7.651\times10^{9}\ \vec{j}$

$= 76.51\times10^{8}\ \vec{j} = 7.65\times10^{9}\ m/s^2\ \vec{j}$

$\vec{V_f} = 20\ km/s\ \vec{i} + 76.51\times10^{8}\times 2\times10^{-6}\ m\ \vec{j} = 20\ km/s\ \vec{i} + 15.3\ km/s\ \vec{j}$

$|V_f| = \sqrt{(20)^2 + (15.3)^2} = 25\ km/s$

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Q#3 An electric dipole of dipole moment $\mathbf{p} = (5 \times 10^{-10}$ C.m) **i** is placed in an electric field $\mathbf{E} = (2 \times 10^6$ N/C) **i** + $(2 \times 10^6$ N/C) **j**. What is magnitude of the maximum torque experienced by the dipole? A) 1.00×10^{-3} N.m

$|\tau| = |p \times E| = |5\times10^{-10}\ \vec{i} \times [2\times10^{6}\ \vec{i} + 2\times10^{6}\ \vec{j}]|$

$|\tau| = |(5\times10^{-10}\ \vec{i}) \times (2\times10^{6}\ \vec{j})| = |10\times10^{-4}(\vec{i}\times\vec{j})| = |10^{-3}\ \vec{k}|$

$\tau = 10^{-3}$ N.m

3/3

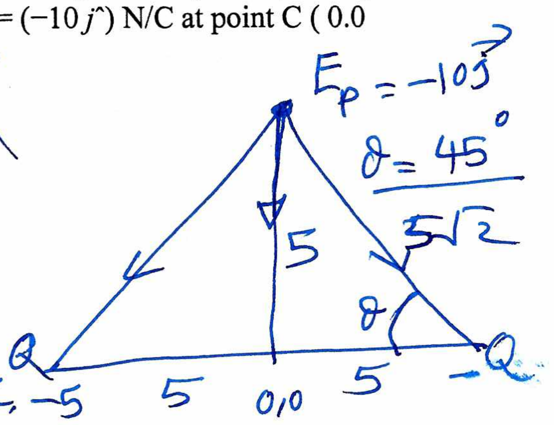
Quiz # 6 Ch.#22 T131-Sec. 7-9-v6

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

Q#1: Two identical charges each of charge Q are positioned at points A (5.0 m, 0.0 m) and B(- 5.0 m, 0.0 m) to produce a net electric field of $E = (-10\hat{j})$ N/C at point C (0.0 m, 5.0 m). Find the value of Q.

$\vec{E}_p = -10\vec{j} = -\frac{2k|Q| \sin 45}{d^2} \vec{j}$

$-10\vec{j} = \frac{2 \times 9 \times 10^9 \times Q \times \sin 45}{(5\sqrt{2})^2}$



$Q = \frac{500}{2 \times 9 \times 10^9 \times \sin 45} = 39.3\ nC$

$Q = -39.3\ nC.$

Q#2: . A charged particle with a mass of 1x10^{-4} kg is held suspended (stationary) by a downward electric field of 200 N/C. The charge on the particle is:

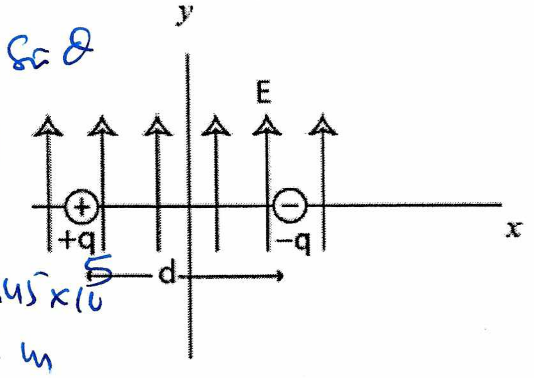
$|F_E| = |F_g| \Rightarrow |qE| = |mg| \Rightarrow |q| = \frac{|mg|}{|E|}$

$|q| = \frac{10^{-4} \times 9.8}{200} = 0.049 \times 10^{-4}\ C$

$|q| = 0.5 \times 10^{-5}\ C$

$q = -0.5 \times 10^{-5}\ C$

Q#:3 An electric dipole consists of two opposite charges, each of magnitude 5.00×10^{-19} C, separated by a distance d = 1.00×10^{-9} m. The dipole is placed in a uniform electric field of strength 2.45×10^{5} N/C. Calculate the torque exerted on the dipole when the dipole moment is perpendicular to the electric field as shown in figure 3.



$\tau = p \times E = -pE \sin\theta$

$= -pE \sin(-90)$

$\tau = pE$

$= 5 \times 10^{-19} \times 10^{-9} \times 2.45 \times 10^{5}$

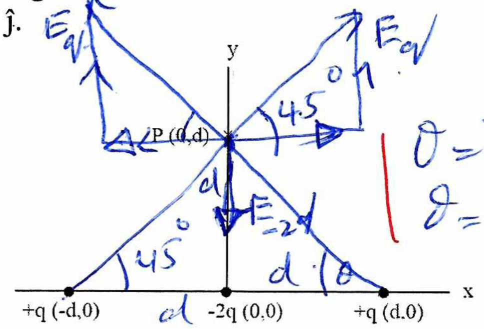
$\tau = 1.23 \times 10^{-22}$ N. m

into the page

Quiz # 6 Ch.#22 T131-Sec. 7-9-v7

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

Q#1: For the arrangement of charges shown in the figure, what is the electric field at the point P? q = 1.0 μC and d = 50 cm. A) − 47 kV/m ĵ.



$E_p = 2E_q \sin 45 - E_{-2q}$

$= 2\frac{kq}{(\sqrt{2}\times d)^2} \cdot \sin 45 - k\times\frac{2q}{d^2}$

$= \frac{2kq}{d^2}\left[\frac{\sin 45}{2} - 1\right]$

$\theta = \tan^{-1}\left(\frac{d}{d}\right)$, $\theta = 45^\circ$

$E_p = \frac{2\times 9\times 10^9 \times 10^{-6}}{(0.5)^2}\left[-0.35 - 1\right] = -46.54\times 10^3 \text{ V/m}$

$E_p = -47 \text{ kV/m}$

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Q#2: An electron is released from rest in a region of uniform electric field. The electron travels 4.0 cm in 20×10^{-9} s. What is the magnitude of the electric field? A) 1.1 kV/m.

$X = v_i t + \frac{1}{2}at^2 \Rightarrow X = \frac{1}{2}at^2 = \frac{1}{2}\times\left(\frac{qE}{m}\right)\times t^2$

$E = \frac{2Xm}{qt^2} = \frac{2\times 4\times 10^{-2}\times 9.109\times 10^{-31}}{1.6\times 10^{-19}\times(20\times 10^{-9})^2}$

$= 0.114\times 10^4 = 1.14\times 10^3 \text{ V/m} = 1.1 \text{ kV/m}$

3/3

Q#3 The dipole moment of a dipole in a 300-N/C electric field is initially perpendicular to the field, but it rotates so that it becomes in the same direction as the field. If the electric dipole moment has a magnitude of 2.0 x 10^{-9} C.m, the work done by the field is: A) +6.0 x10^{-7} J

$W = -\Delta U = -U_f + U_i$, $U = -pE\cos\theta$

$= +pE\cos\theta_f - pE\cos\theta_i = pE(\cos\theta_f - \cos\theta_i)$

$\theta_i = 90^\circ$, $\theta_f = 0$

$W = pE - 0 = pE = (q\,d)E = 2\times 10^{-9}\times 300$

$W = 6.0\times 10^{-7}$ J

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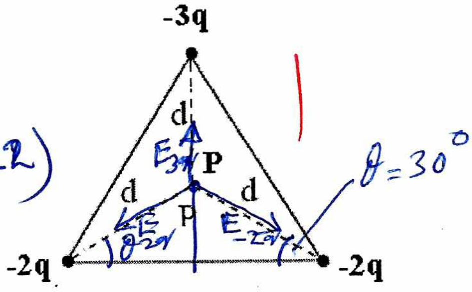
Quiz # 6 Ch.#22 T131-Sec. 7-9-v8

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

Q#1: In figure, what is the magnitude of the electric field at point P, center of the equilateral triangle? [take d = 2 m, q = 10^{-9} C]

$$E_{P\text{-}net} = |E_{-3q}| - |2E_{-2q,y}|$$
$$= \frac{k \times 3q}{d^2} - \frac{2 \times k \times 2q \sin 30}{d^2}$$
$$= \frac{kq}{d^2}(3 - 4\sin 30) = \frac{9\times10^{9}\times10^{-9}}{(2)^2}\times(3-2)$$
$$E_{P\text{-}net} = \frac{9}{4} = 2.25 \text{ N/C}$$



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Q#2: A charged oil drop with a mass of 2 × 10^{-4} kg is held suspended in equilibrium in the air by a downward electric field of 300 N/C. The charge on the drop is:

$$|F_E| = |F_g| \Rightarrow |qE| = |mg|$$
$$|q| = \frac{|mg|}{|E|} = \frac{2\times10^{-4}\times9.8}{300}$$
$$|q| = 6.5\times10^{-6} \text{ C}$$
$$q = -6.5\times10^{-6} \text{ C}$$

$F_E = qE$, mg, E

3/3

Q#3; An electric dipole consists of two opposite charges, each of magnitude 2.0 nC. A uniform electric field of magnitude 300 N/C makes an angle of 25° with the dipole moment of the dipole. If the torque exerted by the field has a magnitude of 2.5 × 10^{-11} N.m, the distance between the two charges of the dipole is: A) 99 μm

$$|\tau| = |pE\sin\theta| = |qdE\sin\theta|$$
$$d = \frac{|\tau|}{qE\sin\theta} = \frac{2.5\times10^{-11}}{2\times10^{-9}\times300\times\sin 25}$$
$$d = 0.00986\times10^{-2} = 99\times10^{-6} \text{ m}$$
$$d = 99\,\mu\text{m}$$

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Quiz # 6 Ch.#22 T131-Sec. 7-9-v9

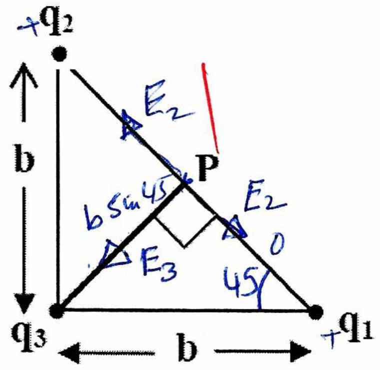
Student ID:……… …… Student Name:………… ………. Section # ……….

Q1: Three point charges q_1, q_2, and q_3 are fixed at the three corners of a right-angle triangle as shown in figure (1). Given that $q_1 = q_2 = +3.2\times10^{-19}$ C while $q_3 = -1.6\times10^{-19}$ C, and b = 5.0 cm. The magnitude of the net electric field at point P due to all the three point charges is:

$$E_p = \frac{k q_3}{(b \sin 45)^2} = \frac{9\times10^9 \times 1.6\times10^{-19}}{(0.05\times \sin 45)^2}$$

$$= 1.149\times10^{-6}\ N/C$$

3/3



Q#2: A uniform electric field has a magnitude of 2.0 × 10^4 N/C and points to the right. An electron is released from rest in this electric field. How far will the electron travel in two nanoseconds after its release?

$$|d| = v_i t + \frac{1}{2}at^2 = \frac{1}{2}at^2 = \frac{1}{2}\left(\frac{qE}{m}\right)t^2 \quad (v_i = 0)$$

$$|d| = \frac{1}{2}\left(\frac{1.6\times10^{-19}\times 2\times10^4}{9.109\times10^{-31}}\right)\times(2\times10^{-9})^2$$

$$|d| = 0.702\times10^{-2}\ m = 7\ mm$$

d 7 mm to the left

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Q# 3: An electric dipole of dipole moment **p** = (5 × 10^{-10} C.m) **i** is placed in an electric field **E** = (2 × 10^6 N/C) **i** + (2 × 10^6 N/C) **j**. What is magnitude of the maximum torque experienced by the dipole?.

$$|\tau| = |p\times E| = |5\times10^{-10}\vec{i} \times (2\times10^6\vec{i} + 2\times10^6\vec{j})|$$

$$= |(5\times10^{-10}\vec{i} \times 2\times10^6\vec{j})| = |5\times10^{-10}\times 2\times10^6 \times (\vec{i}\times\vec{j})|\ N.m$$

$$|\tau| = |10^{-3}\vec{k}| = 10^{-3}\ N.m$$

3/3

Quiz # 6 Ch.#22 T131-Sec. 7-9-v10

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

Q#1 A charge $q_1 = +3.2\times10^{-6}$ C is placed at the origin. A second charge q_2 is placed at x= 3.0 m. If a charge of 1.0×10^{-6} C experiences no force if placed at x= 4.0 m, then q_2 is: (Ans: . – 0.2x10^{-6} C.

$|E_B| = 0$

$|E_{q_2}| = |E_{q_1}| \Rightarrow \left|\frac{kq_2}{1^2}\right| = \left|\frac{kq_1}{4^2}\right|$

$|q_2| = \frac{1^2}{4^2} \times 3.2\times10^{-6} = 0.2\times10^{-6}$ C

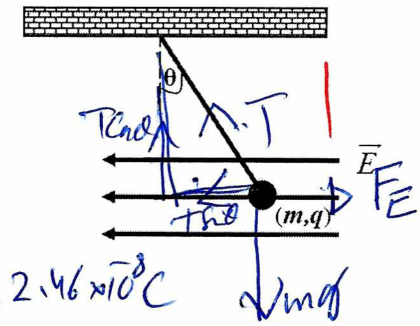
q_2 is -0.2×10^{-6} C

$q_1 = +3.2\times10^{-6}$; q_2 ; q_3 ; 0,0 — 3 — 1m — B ; 4m

3/3

Q#2: Figure (2) shows a charged ball of mass $m = 1.0$ g is suspended by a light string in the presence of a uniform electric field, $E = -3.0\times10^5\ \hat{i}$ N/C. In this field, the ball is in equilibrium at $\theta = 37^0$. The charge "q" on the ball is: A) -2.46×10^{-8} C

Figure (2)



$|T\sin\theta| = |qE|$

$|T\cos\theta| = |mg|$

$\tan\theta = \left|\frac{qE}{mg}\right| \Rightarrow q = \frac{mg\tan\theta}{E}$

$|q| = \frac{mg\tan\theta}{E} = \frac{10^{-3}\times9.8\times\tan37}{3.0\times10^5} = 2.46\times10^{-8}$ C

q is −ve i.e. -2.46×10^{-8} C

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Q#:3 The dipole moment of a dipole in a 300-N/C electric field is initially perpendicular to the field, but it rotates so that it becomes in the same direction as the field. If the electric dipole moment has a magnitude of 2.0 x 10^{-9} C.m, the work done by the field is: A) +6.0 x10^{-7} J

$W_E = -\Delta U = -U_f + U_i = -(-pE\cos\theta_f) + (-pE\cos\theta_i)$

$= pE(\cos\theta_f - \cos\theta_i)$, $\theta_f = 0^0$, $\theta_i = 90^0$

$= pE = 2\times10^{-9}\times300 = 600\times10^{-9}$ J

$W = 6\times10^{-7}$ J

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