Quiz #8 Ch.#24 T122 Phys101.28-30-v1

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

Q#1: The electric potential (in volts) in a certain region of space is given by $V = 3xy$. What is the magnitude of the electric field (in units of V/m) at the point (1.0 m, 1.0 m)?

A) 4.2

$E_x = -\frac{\partial V}{\partial x} = -3y \; ; \; E_y = -3x$

$E_x(x=1.0, y=1.0) = -3 \; ; \; E_y(x=1.0, y=1.0) = -3$

$|E| = \sqrt{E_x^2 + E_y^2} = \sqrt{(-3)^2 + (-3)^2} = \sqrt{18} = 4.2 \text{ V/m}$

Q#2: In figure 2, four ~~equal~~ charges q= - 1.0 μC are fixed at the corners of a square whose sides are of length d= 2.0 cm. The work done by an external agent to bring a fifth charge, Q = +5.0μC , from infinity to the center of the square is: (A1 - 2.8*k*q*Q/d.)

$U = W_{app} = QV_P$

$V_P = k\left[\frac{2\times q}{d/\sqrt{2}} + \frac{2\times -2q}{d/\sqrt{2}}\right]$

$= \frac{\sqrt{2}k}{d}\left[2q - 4q\right] = \frac{\sqrt{2}k}{d}\left[-2q\right]$

$= \frac{-2\sqrt{2}kq}{d} = \frac{-2.828\times 9\times 10^{9}\times(-1\times 10^{-6})}{(0.02)}$

$V_P = 1272.8\times 10^{3}$ V

$W_{app} = QV_P = 5\times 10^{-6}\times 1272.8\times 10^{3} = 6.36\times 10^{-3}$ J

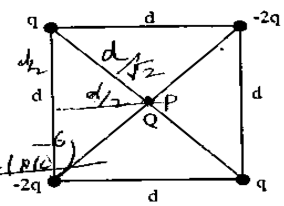


FIGURE 2

Q#3: A particle m = 8.0×10^{-9} kg, q = $+6.0\times10^{-9}$ C has a speed of 80 m/s at point A and moves to point B where the potential is 2.0×10^{3} V greater than at point A. What is the particle's kinetic energy at point B? (Assume that only electric forces act on the particle during its motion.) (A1 14*10**(-6) J.)

$\Delta K = W_E = -\Delta U = -q\Delta V$

$\Delta K = K_f - K_i = -q\Delta V$

$K_f = K_i - q\Delta V = \frac{1}{2}\times m\times v^2 - 6\times 10^{-9}\times 2\times 10^{3}$

$= \frac{1}{2}\times 8\times 10^{-9}\times(80)^2 - 6\times 10^{-9}\times 2\times 10^{3}$

$= 25.6\times 10^{-6} - 12.0\times 10^{-6}$

$= 13.6\times 10^{-6} \approx 14\times 10^{-6}$ J

Quiz #8 Ch.#24 T122 Phys101.28-30-v2

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

Q#1: The electric potential in a certain region is given by $V = 4xz - 5y + 3z^2$, where x, y, and z are in meters, and V is in volts. Find the magnitude of the electric field at the point (+2 m, −1 m, +3 m). (Ans: 29 V/m)

$V = 4xz - 5y + 3z^2$; $E_x = -\frac{\partial V}{\partial x} = -4z = -4\times 3 = -12$

$E_y = -\frac{\partial V}{\partial y} = -5$; $E_z = -4x - 6z = -(4\times 2) - (6\times 3) = -26$

$|E| = \sqrt{E_x^2 + E_y^2 + E_z^2} = \sqrt{(-12)^2 + (-5)^2 + (-26)^2} = 29.1\ V/m$

Q#2: In figure (7), what is the net potential at point P due to the four point charges if V = 0 at infinity ? [take d = 2 cm, q = 1.0 micro-C]. (A1 9.0*10**5 V.)

$V_P = k\left[\frac{-2q}{d} + \frac{3q}{d} + \frac{-2q}{d} + \frac{3q}{d}\right]$

$= \frac{2k}{q}\left[-2q + 3q\right] = \frac{2kq}{d}$

$= \frac{2\times 9\times 10^9 \times 1\times 10^{-6}}{0.02} = 900\times 10^3\ V$

$V_P = 9\times 10^5\ V$

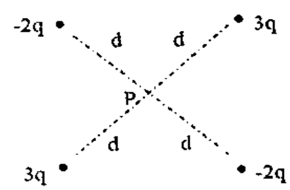


Figure (7)

Q#3 Two protons, P, are fixed 6.0 m apart, as shown in figure 7. An electron, e, is released from point A. Find its speed at point O, midway between the protons. (Ans: 11.6 m/s.)

$\Delta K = K_f - K_i = -\Delta U = -q_e \Delta V_{OA}$

$K_f = -q_e(V_O - V_A)$ $(K_i = 0)$

$K_f = \frac{1}{2} m_e v_e^2 = -q_e(V_O - V_A)$

$v_e = \sqrt{\frac{-2q_e}{m_e}(V_O - V_A)}$

$V_A = \frac{2kq_p}{5}$; $V_O = \frac{2kq_p}{3}$

$V_O - V_A = 2kq_p\left(\frac{1}{3} - \frac{1}{5}\right) = 2\times k\times q_p\times\frac{2}{15}$

$= 2\times 9\times 10^9 \times 1.6\times 10^{-19} \times \frac{2}{15} = 1.92\times 10^{-19}\ V$

$v_e = \sqrt{\frac{-2\times(-1.6\times 10^{-19})\times 1.92\times 10^{-19}\times 2}{9.11\times 10^{-31}}} = 11.6\ m/s$

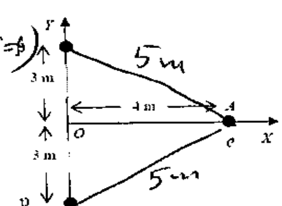


Figure 7

Quiz #8 Ch.#24 T122 Phys101.28-30-v3

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

Q#1: A particle of charge 2 ×10-3 C is placed in an xy plane where the electric potential depends on x and y as shown in Figure 5. The potential does not depend on z. What is the electric force (in N) on the particle? (Ans: +5^i-2^j)

$\vec{F} = q\vec{E} = 2\times10^{-3}\times\vec{E}$

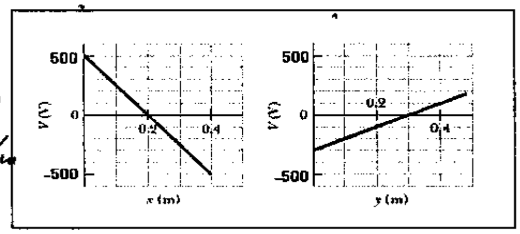
$\vec{E} = E_x\vec{i} + E_y\vec{j}$

$E_x = -\frac{\partial V}{\partial x} = -\frac{-500}{0.2} = 2500\,V/m$

$E_y = -\frac{\partial V}{\partial y} = -\frac{300}{0.3} = -1000\,V/m$

$E = 2500\vec{i} - 1000\vec{j}$

$F = 2\times10^{-3}(2500\vec{i} - 1000\vec{j}) = 5\vec{i} - 2\vec{j}$

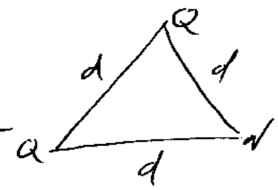


Q#2: Three point charges are initially infinitely far apart. Two of the point charges are identical and have charge Q = -2.0 μC. If zero net work is required to assemble the three charges at the corners of an equilateral triangle of side d= 14.0 cm, then the value of the third charge is (A1 - Q/2.)

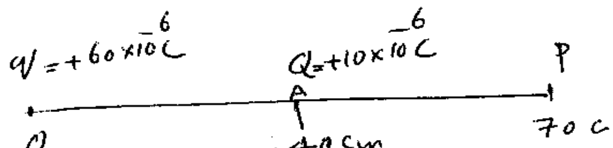
$W_{app} = U_f = k\left[\frac{Q^2}{d} + \frac{qQ}{d} + \frac{qQ}{d}\right] = 0$

$= \frac{k}{d}\left[Q^2 + 2qQ\right] = 0 \Rightarrow 2q\cancel{Q} = -Q\cancel{Q}$

$q = -\frac{Q}{2} = -\left(\frac{-2.0\mu C}{2}\right) = +1\mu C$



Q#3: A +60 × 10^{-6} C charge is held fixed at the origin. If a +10 × 10^{-6} C charge is released from rest at a point x = 40 cm, what is its kinetic energy the instant it passes the point x = 70 cm? (Ans: 5.8 J)



$\Delta K = K_f - K_i = -Q\Delta V = -Q(V_P - V_A)$

$K_f = -Q\left[\frac{kq}{0.7} - \frac{kq}{0.4}\right] = -kqQ\left[\frac{1}{0.7} - \frac{1}{0.4}\right] = -kqQ\times\left(\frac{-0.3}{0.28}\right)$

$= \frac{0.3}{0.28}\times kqQ =$ 3

$K_f = \frac{0.3}{0.28}\times 9\times10^{9}\times 60\times10^{-6}\times 10\times10^{-6} = 5.786\,J$

Quiz #8 Ch.#24 T122 Phys101.28-30-v4

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

Q#1: The electric potential in a certain region is described by V(x,y, z) = 2xy- 4x2 + 6 y. Find the magnitude of the net electric field at x = -1 and y = 1? (Ans: 11 N/C)

$V = 2xy - 4x^2 + 6y$

$E_x = -\frac{\partial V}{\partial x} = -2y + 8x \; ; \; E_y = -\frac{\partial V}{\partial y} = -2x - 6$

$E_x(x=-1, y=+1) = -2 - 8 = -10 \, V/m \; ; \; E_y = 2 - 6 = -4$

$E = \sqrt{E_x^2 + E_y^2} = \sqrt{(-10)^2 + (-4)^2} = 10.8 \, N/C \simeq 11 \, N/C$

Q#2: In figure 9, two equal positive charges, each of magnitude 5.0*10**(-5) C, are fixed at point A and B separated by a distance of 6 m. An equal and opposite charge moves towards them along the line CO. At point C, 4.0 m from O, the kinetic energy of the moving charge is 4.0 J. What is the kinetic energy of this charge when it passes point O? (A1 10.0 J)

$\Delta K = -Q_- \Delta V = -Q_-(V_O - V_C)$

$K_f - K_i = -Q_-\left(\frac{2k Q_+}{3} - \frac{2k Q_+}{5}\right)$

$K_f = K_i - 2k Q_- Q_+ \left(\frac{1}{3} - \frac{1}{5}\right)$

$= K_i - 2k Q_- Q_+ \left(+\frac{2}{15}\right)$

$= K_i + 2k |Q_-| |Q_+| \times \left(\frac{2}{15}\right)$

$= K_i + 2 \times 9 \times 10^9 \times 5 \times 5 \times 10^{-10} \times \frac{2}{15} = 4 + 6 = 10 \, J$

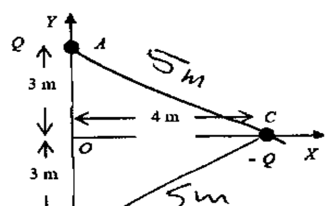


Figure 9

Q#3: What is the external work required to bring four 3.0×10^{-9} C positive point charges from infinity and place them at the corner of a square of side 0.12 m (Ans: +3.7 μJ)

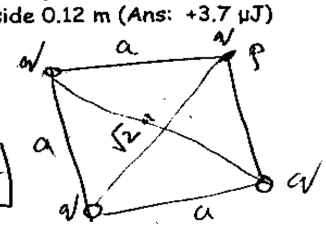
$W_{app} = \Delta U = U_f - U_i = U_f$

$= k\left[\frac{q^2}{a} + \frac{q^2}{a} + \frac{q^2}{a} + \frac{q^2}{a} + \frac{q^2}{\sqrt{2}a} + \frac{q^2}{\sqrt{2}a}\right]$

$= \frac{kq^2}{a}\left[4 + \frac{2}{\sqrt{2}}\right] = \frac{kq^2}{a} \times 5.414$

$= 5.414 \times \frac{k \times q^2}{a} = \frac{5.414 \times 9 \times 10^9 \times (3 \times 10^{-9})^2}{0.12}$

$= 3.654 \times 10^{-6} \, J$



Quiz #8 Ch.#24 T122 Phys101.28-30-v5

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

Q#1: In a certain region of the xy plane, the electric potential is given by $V(x,y) = 2xy - 3x^2 + 5y$, where At which point is the electric field equal to zero? (Ans: (-2.5, -7.5))

$$V = 2xy - 3x^2 + 5y, \quad E_x = -\frac{\partial V}{\partial x}; \quad E_y = -\frac{\partial V}{\partial y}$$

$$E_x = -2y + 6x; \quad E_y = -2x - 5$$

$$E_y = 0 = -2x - 5 \Rightarrow 2x = -5, \quad x = -\frac{5}{2} = -2.5$$

$$E_x = 0 = -2y + 6x = -2y + 6\times(-2.5) = -2y - 15$$

$$-2y - 15 = 0 \Rightarrow 2y = -15, \quad y = -7.5$$

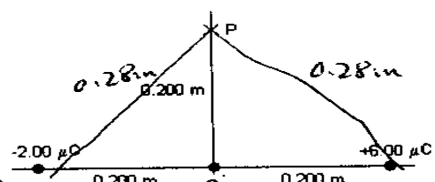
Q#2 An electron is projected with an initial kinetic energy ~~of 3.6 × 10^-24^~~ J toward a fixed proton. If the electron is initially infinitely far from the proton, at what distance from the proton is its speed equal to twice its initial speed? (A) 21 µm)

$$v_f = 2v_i \Rightarrow K_f = 4K_i, \quad K_i = 3.6\times10^{-24}\ J$$

$$\Delta K = 4K_i - K_i = 3K_i = \Delta U = U_f = \frac{k q_e q_p}{d}$$

$$d = \frac{k q_e q_p}{3K_i} = \frac{9\times10^9 \times (1.6\times10^{-19})^2}{3\times3.6\times10^{-24}} = 2.13\times10^{-5} = 21.3\times10^{-6}\ m$$

Q#3: Three point charges −2.00 µC, Q, and +6.00 µC are fixed along the x-axis as shown in Figure 3. If the net electric potential at point P due to these charges is Zero, the charge Q is: (Ans: −2.83 µC)



$$V_P = k\left[\frac{-2\times10^{-6}}{0.28} + \frac{6\times10^{-6}}{0.28} + \frac{Q}{0.2}\right] = 0$$

$$\frac{Q}{0.2} = -\left[\frac{-2\times10^{-6}}{0.28} + \frac{6\times10^{-6}}{0.28}\right] = \frac{2\times10^{-6}}{0.28} - \frac{6\times10^{-6}}{0.28} = -\frac{4\times10^{-6}}{0.28}$$

$$Q = \frac{-4\times10^{-6}}{1.4} = \frac{-4\times10^{-6}}{1.4} = -2.86\ \mu C$$

Quiz #8 Ch.#24 T122 Phys101.28-30-v6

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

Q#1. The electric potential at point in an XY plane is given by $V = 3X^2 - 4Y^2$. What are the magnitude and direction of the electric field at a point (4m, 2m) ? (Ans: E = 29 N/C and 146 counterclockwise from + x-axix.)

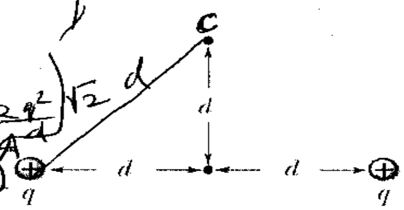
$V = 3x^2 - 4y^2$; $E_x = -\frac{\partial V}{\partial x} = -6x = -24$

$E_y = +8y = 16\ N/C$

$|E| = \sqrt{(-24)^2 + (16)^2} = 28.8\ N/C$

$\theta = \tan^{-1}\left(\frac{16}{-24}\right) = -33.7^\circ = 146.3^\circ$

Q#2 Two charges $q = +2.0\ \mu C$ are fixed a distance $2d = 2.0$ cm apart (see Figure 5). With V = 0 at infinity, how much work needs to be done by an external agent to move one of the charges to point C? (Ans: + 0.75 J)



$W_{app} = q\,\Delta V = q(V_C - V_A)$

$= kq^2\left(\frac{1}{\sqrt{2}d} - \frac{1}{2d}\right)$

$= \frac{kq^2}{\sqrt{2}d}\left(1 - \frac{1}{\sqrt{2}}\right) = \frac{0.29\,kq^2}{\sqrt{2}\,d}$

$= \frac{0.29 \times kq^2}{\sqrt{2}\ d} = \frac{0.29 \times 9\times10^9 (2\times10^{-6})^2}{\sqrt{2} \times 0.01}$

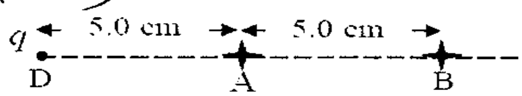
$W_{app} =$ ~~[struck out]~~ $\Rightarrow W_{app} = 2 \times 369 \times 10^{-3} = 0.74\,J$

Q#3: A particle having a charge of $q = 8.0\times10^{-9}$ C is fixed at point D. Another particle of mass 10 g and charge of 5.0×10^{-9}C starts from rest at point A and moves in a straight line to the right, as shown in figure (4). The speed of the particle when it reaches point B is: [Assume V = 0 at infinity.] (Ans: 0.08 m/s)

$\Delta K = K_f - K_i = -kq_1q_2\left(\frac{1}{0.1} - \frac{1}{0.05}\right)$

$K_i = 0$

$K_f = -kq_1q_2 \times \left(-\frac{1}{0.1}\right)$



$\frac{1}{2}mv_f^2 = \frac{kq_1q_2}{0.1}$

$v_f = \sqrt{\frac{2kq_1q_2}{m \times 0.1}} = \sqrt{\frac{2 \times 9\times10^9 \times 8\times10^{-9} \times 5\times10^{-9}}{0.01 \times 0.1}}$

$= 0.0268\ m/s$

$= 0.027\ m/s = 2.7\ cm/s$