Name____

Physics 121 Quiz #1, January 8, 2016

Please show all work, thoughts and/or reasoning in order to receive partial credit. The quiz is worth 10 points total.

I affirm that I have carried out my academic endeavors with full academic honesty.

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Suppose that you have two point charges where charge $q_1 = 1nC$ is located at $\langle 0.5,-0.1,-0.5\rangle m$ and another charge $q_2 = -9nC$ is located at $\langle -0.6,-0.7,-0.2\rangle m$.

1. What is the electric force on q_1 due to q_2?

$$\hat{r} = \frac{\vec{r}_o - \vec{r}_s}{\left|\vec{r}_o - \vec{r}_s\right|} = \frac{\langle 0.5,-0.1,-0.5\rangle m - \langle -0.6,-0.7,-0.2\rangle m}{\sqrt{(0.5+0.6)^2 + (-0.1+0.7)^2 + (-0.5+0.3)^2}\, m}$$

$$= \frac{\langle 1.1,0.6,-0.3\rangle}{1.288} = \langle 0.854,0.466,-0.233\rangle$$

$$\vec{F}_{1,2} = k\frac{q_1 q_2}{r_{1,2}^2}\hat{r} = 9\times 10^9 \tfrac{Nm^2}{C^2}\left[\frac{1\times 10^{-9} C \times \left(-9\times 10^{-9} C\right)}{(1.28m)^2}\right]\langle 0.854,0.466,-0.233\rangle$$

$$\vec{F}_{1,2} = \langle -4.17,-2.27,1.14\rangle \times 10^{-8} N$$

2. What is the electric field at charge q_1's location due to charge q_2?

The electric field is given by:

$$\vec{E} = \frac{\vec{F}_{1,2}}{q_1} = \frac{\langle -4.17,-2.27,1.14\rangle \times 10^{-8} N}{1\times 10^{-9} C} = \langle -41.7,-22.7,11.4\rangle \frac{N}{C}$$

3. If the charge q_1 were released from rest at its initial location, the direction of q_1's acceleration would most likely be
   a. directly toward the charge q_2.
   b. directly away from the charge q_2.
   c. not defined since the magnitude of q_1's acceleration is zero and thus charge q_1 would remain at rest.
   d. unable to be determined since the mass of q_1 is unknown.

Physics 121 Equation Sheet

Electric Forces, Fields and Potentials

$$\vec{F} = k\frac{Q_1 Q_2}{r^2}\hat{r}; \quad \hat{r} = \frac{\vec{r}_o - \vec{r}_s}{|\vec{r}_o - \vec{r}|}$$

$$\vec{E} = \frac{\vec{F}}{q}$$

$$\vec{E}_Q = k\frac{Q}{r^2}\hat{r}$$

$$PE = k\frac{Q_1 Q_2}{r}$$

$$V(r) = k\frac{Q}{r}$$

$$E_x = -\frac{\Delta V}{\Delta x}$$

$$W = -q\Delta V_{f,i}$$

Constants

$$g = 9.8\,\tfrac{m}{s^2}$$

$$1e = 1.6\times10^{-19}C$$

$$k = \frac{1}{4\pi\varepsilon_o} = 9\times10^{9}\,\tfrac{C^2}{Nm^2}$$

$$\varepsilon_o = 8.85\times10^{-12}\,\tfrac{Nm^2}{C^2}$$

$$1eV = 1.6\times10^{-19}J$$

$$\mu_o = 4\pi\times10^{-7}\,\tfrac{Tm}{A}$$

$$c = 3\times10^{8}\,\tfrac{m}{s}$$

$$h = 6.63\times10^{-34}Js$$

$$m_e = 9.11\times10^{-31}kg = \frac{0.511MeV}{c^2}$$

$$m_p = 1.67\times10^{-27}kg = \frac{937.1MeV}{c^2}$$

$$m_n = 1.69\times10^{-27}kg = \frac{948.3MeV}{c^2}$$

$$1amu = 1.66\times10^{-27}kg = \frac{931.5MeV}{c^2}$$

$$N_A = 6.02\times10^{23}$$

$$Ax^2 + Bx + C = 0 \rightarrow x = \frac{-B\pm\sqrt{B^2-4AC}}{2A}$$