

Name _____

Physics 111 Quiz #1, September 18, 2015

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.

Suppose that you have four charges that are located at the corners of a square with sides of length $l = 10\text{cm}$. The charges and their locations are given in the table below, where each charge has the same magnitude $|q| = 1\mu\text{C}$.

Location	Charge
$A = (0,0)$	$-q$
$B = (0,a)$	$+q$
$C = (a,a)$	$-q$
$D = (a,0)$	$+q$

1. What is the electric field at a point P with coordinates $(0, \frac{a}{2})$?
Label the points A , B , C , & D for easier reference.

$$E_{\text{net},x} = +E_B \cos\theta - E_C \cos\theta = 0$$

$$E_{\text{net},y} = -E_A + E_D \sin\theta + E_C \sin\theta - E_B$$

$$= -\frac{kq}{\left(\frac{a}{2}\right)^2} + \frac{kq}{\frac{5a^2}{4}} \left(\frac{\frac{a}{2}}{\sqrt{\frac{5}{4}}a} \right) + \frac{kq}{\frac{5a^2}{4}} \left(\frac{\frac{a}{2}}{\sqrt{\frac{5}{4}}a} \right) - \frac{kq}{\left(\frac{a}{2}\right)^2}$$

$$= -7.3 \frac{kq}{a^2} = -7.3 \times \frac{9 \times 10^9 \frac{\text{Nm}^2}{\text{C}^2}}{(0.1\text{m})^2} \times 1 \times 10^{-6} \text{C} = -6.6 \times 10^6 \frac{\text{N}}{\text{C}}$$

Therefore the net electric field has a magnitude $6.6 \times 10^6 \frac{\text{N}}{\text{C}}$ and points along the negative y-axis.

2. If a $\frac{1}{2}\mu C$ charge were placed at point P and released from rest, the initial motion of the $\frac{1}{2}\mu C$ charge would most likely be
- a. to move toward the point $(0,a)$.
 - ☒ b. to move toward the point $(0,0)$.
 - c. to move toward the point $(a,0)$.
 - d. to move toward the point (a,a) .
 - e. to remain at rest.

3. What is the electric potential at point?

$$V_p = V_A + V_B + V_C + V_D = \frac{kq}{\frac{a}{2}} - \frac{kq}{\frac{a}{2}} + \frac{kq}{\frac{\sqrt{2}a}{2}} - \frac{kq}{\frac{\sqrt{2}a}{2}} = 0$$

Physics 111 Equation Sheet

Electric Forces, Fields and Potentials

$$\vec{F} = k \frac{Q_1 Q_2}{r^2} \hat{r}$$

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

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

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

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

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

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

Magnetic Forces and Fields

$$F = qvB \sin \theta$$

$$F = IlB \sin \theta$$

$$\tau = NIAB \sin \theta = \mu B \sin \theta$$

$$PE = -\mu B \cos \theta$$

$$B = \frac{\mu_0 I}{2\pi r}$$

$$\mathcal{E}_{induced} = -N \frac{\Delta \phi_B}{\Delta t} = -N \frac{\Delta(BA \cos \theta)}{\Delta t}$$

Constants

$$g = 9.8 \frac{m}{s^2}$$

$$1e = 1.6 \times 10^{-19} C$$

$$k = \frac{1}{4\pi\epsilon_0} = 9 \times 10^9 \frac{C^2}{Nm^2}$$

$$\epsilon_0 = 8.85 \times 10^{-12} \frac{Nm^2}{C^2}$$

$$1eV = 1.6 \times 10^{-19} J$$

$$\mu_0 = 4\pi \times 10^{-7} \frac{Tm}{A}$$

$$c = 3 \times 10^8 \frac{m}{s}$$

$$h = 6.63 \times 10^{-34} Js$$

$$m_e = 9.11 \times 10^{-31} kg = \frac{0.511 MeV}{c^2}$$

$$m_p = 1.67 \times 10^{-27} kg = \frac{937.1 MeV}{c^2}$$

$$m_n = 1.69 \times 10^{-27} kg = \frac{948.3 MeV}{c^2}$$

$$1amu = 1.66 \times 10^{-27} kg = \frac{931.5 MeV}{c^2}$$

$$N_A = 6.02 \times 10^{23}$$

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

Electric Circuits

$$I = \frac{\Delta Q}{\Delta t}$$

$$V = IR = I \left(\frac{\rho L}{A} \right)$$

$$R_{series} = \sum_{i=1}^N R_i$$

$$\frac{1}{R_{parallel}} = \sum_{i=1}^N \frac{1}{R_i}$$

$$P = IV = I^2 R = \frac{V^2}{R}$$

$$Q = CV = \left(\frac{\kappa \epsilon_0 A}{d} \right) V = (\kappa C_0) V$$

$$PE = \frac{1}{2} QV = \frac{1}{2} CV^2 = \frac{Q^2}{2C}$$

$$Q_{charge}(t) = Q_{max} \left(1 - e^{-\frac{t}{RC}} \right)$$

$$Q_{discharge}(t) = Q_{max} e^{-\frac{t}{RC}}$$

$$C_{parallel} = \sum_{i=1}^N C_i$$

$$\frac{1}{C_{series}} = \sum_{i=1}^N \frac{1}{C_i}$$

Light as a Particle & Relativity

$$E = hf = \frac{hc}{\lambda} = pc$$

$$KE_{max} = hf - \phi = eV_{stop}$$

$$\Delta \lambda = \frac{h}{m_e c} (1 - \cos \phi)$$

$$\gamma = \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}}$$

$$p = \gamma mv$$

$$E_{total} = KE + E_{rest} = \gamma mc^2$$

$$E_{total}^2 = p^2 c^2 + m^2 c^4$$

$$E_{rest} = mc^2$$

$$KE = (\gamma - 1)mc^2$$

Geometry

$$\text{Circles: } C = 2\pi r = \pi D \quad A = \pi r^2$$

$$\text{Triangles: } A = \frac{1}{2} bh$$

$$\text{Spheres: } A = 4\pi r^2 \quad V = \frac{4}{3} \pi r^3$$

Light as a Wave

$$c = f\lambda = \frac{1}{\sqrt{\epsilon_0 \mu_0}}$$

$$S(t) = \frac{\text{energy}}{\text{time} \times \text{area}} = c\epsilon_0 E^2(t) = c \frac{B^2(t)}{\mu_0}$$

$$I = S_{avg} = \frac{1}{2} c\epsilon_0 E_{max}^2 = c \frac{B_{max}^2}{2\mu_0}$$

$$P = \frac{S}{c} = \frac{\text{Force}}{\text{Area}}$$

$$S = S_o \cos^2 \theta$$

$$v = \frac{1}{\sqrt{\epsilon \mu}} = \frac{c}{n}$$

$$\theta_{inc} = \theta_{refl}$$

$$n_1 \sin \theta_1 = n_2 \sin \theta_2$$

$$\frac{1}{f} = \frac{1}{d_o} + \frac{1}{d_i}$$

$$M = \frac{h_i}{h_o} = -\frac{d_i}{d_o}$$

$$M_{total} = \prod_{i=1}^N M_i$$

$$S_{out} = S_{in} e^{-\sum_i \mu_i x_i}$$

$$HU = \frac{\mu_w - \mu_m}{\mu_w}$$

Nuclear Physics

$$E_{binding} = (Zm_p + Nm_n - m_{rest})c^2$$

$$\frac{\Delta N}{\Delta t} = -\lambda N_o \rightarrow N(t) = N_o e^{-\lambda t}$$

$$A(t) = A_o e^{-\lambda t}$$

$$m(t) = m_o e^{-\lambda t}$$

$$t_{\frac{1}{2}} = \frac{\ln 2}{\lambda}$$

Misc. Physics 110 Formulae

$$\vec{F} = \frac{\Delta \vec{p}}{\Delta t} = \frac{\Delta(mv)}{\Delta t} = m\vec{a}$$

$$\vec{F} = -k\vec{y}$$

$$\vec{F}_C = m \frac{v^2}{R} \hat{r}$$

$$W = \Delta KE = \frac{1}{2} m (v_f^2 - v_i^2) = -\Delta PE$$

$$PE_{gravity} = mgy$$

$$PE_{spring} = \frac{1}{2} ky^2$$

$$|\vec{A}| = \sqrt{A_x^2 + A_y^2}$$

$$\phi = \tan^{-1} \left(\frac{A_y}{A_x} \right)$$

$$\vec{a} \cdot \vec{a} = a^2$$

