Name

Physics 111 Quiz #3, January 19, 2011

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

- 1. Suppose that a uniform electric field exists along the y-axis with magnitude 12 N/C. If the potential at the origin were 26V, where would the potential be -42V?
 - a. 5.6m b. -5.6m c. 1.3m d. -1.3m $E = -\frac{\Delta V_{f,i}}{\Delta x_{f,i}} \rightarrow 12 \frac{v}{m} = -\left(\frac{-42V - 26V}{x_f - 0m}\right) \rightarrow x_f = 5.6m$
- 2. Suppose that you have the collection of point charges located on the y-axis where $q_1 = -6\mu C$ located at the origin and $q_2 = 5\mu C$ located at a distance y = 0.5m above q_1 .
 - a. What is the electric potential at the point P located on the x-axis with coordinates (0.5m, 0m)?

$$V_{P} = V_{1} + V_{2} = \frac{kq_{1}}{r_{1}} + \frac{kq_{2}}{r_{2}} = 9 \times 10^{9} \frac{Nm^{2}}{C^{2}} \left[\frac{-6 \times 10^{-6}C}{0.5m} + \frac{5 \times 10^{-6}C}{\sqrt{2 \times (0.5m)^{2}}} \right] = -4.4 \times 10^{4} V$$

b. Suppose that you want to bring in a third charge $q_3 = -1\mu C$ in along the x-axis from a location infinitely far away to the point *P* given in part a, how much work would be done on q_3 moving it from infinitely far away to point P?

$$W = q\Delta V = -1 \times 10^{-6} C \Big[0V - \left(-4.4 \times 10^4 V \right) \Big] = -0.044 J - 44 mJ$$

Physics 111 Equation Sheet

Electric Forces, Fields and Potentials

$$\vec{F} = k \frac{Q_1 Q_2}{r^2} \hat{r}$$
$$\vec{E} = \frac{\vec{F}}{q}$$
$$\vec{E}_Q = k \frac{Q}{r^2} \hat{r}$$
$$PE = k \frac{Q_1 Q_2}{r}$$
$$V(r) = k \frac{Q}{r}$$
$$E_x = -\frac{\Delta V}{\Delta x}$$
$$W_{A,B} = q \Delta V_{A,B}$$

Magnetic Forces and Fields

 $F = qvB\sin\theta$ $F = IlB\sin\theta$ $\tau = NIAB\sin\theta = \mu B\sin\theta$ $PE = -\mu B\cos\theta$ $B = \frac{\mu_0 I}{2\pi r}$

$$\varepsilon_{induced} = -N \frac{\Delta \varphi_B}{\Delta t} = -N \frac{\Delta (BACOSO}{\Delta t}$$
Constants
 $g = 9.8 \frac{m}{s^2}$
 $le = 1.6 \times 10^{-19} C$
 $k = \frac{1}{4\pi \varepsilon_o} = 9 \times 10^9 \frac{c^2}{Nm^2}$
 $\varepsilon_o = 8.85 \times 10^{-12} \frac{Nm^2}{C^2}$
 $leV = 1.6 \times 10^{-19} J$
 $\mu_o = 4\pi \times 10^{-7} \frac{Tm}{A}$
 $c = 3 \times 10^8 \frac{m}{s}$
 $h = 6.63 \times 10^{-34} Js$
 $m_e = 9.11 \times 10^{-31} kg = \frac{0.511 MeV}{c^2}$
 $m_p = 1.67 \times 10^{-27} kg = \frac{937.1MeV}{c^2}$
 $m_n = 1.69 \times 10^{-27} kg = \frac{948.3MeV}{c^2}$
 $lamu = 1.66 \times 10^{-27} kg = \frac{931.5MeV}{c^2}$
 $N_A = 6.02 \times 10^{23}$
 $Ax^2 + Bx + C = 0 \Rightarrow x = \frac{-B \pm \sqrt{B^2 - 4AC}}{2A}$

Electric Circuits

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

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

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

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

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

$$Q = CV = \left(\frac{\kappa \varepsilon_0 A}{d}\right) V = (\kappa C_0) V$$

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

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

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

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

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

$\Delta \phi_B = {}_{_{NT}} \Delta (BA \cos \theta)$ Light as a Particle & Relativity Nuclear Physics

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

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

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

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

$$p = \gamma mv$$

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

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

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

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

Geometry

Circles: $C = 2\pi r = \pi D$ $A = \pi r^2$ *Triangles*: $A = \frac{1}{2}bh$ Spheres: $A = 4\pi r^2$ $V = \frac{4}{3}\pi r^3$

Light as a Wave

$$c = f\lambda = \frac{1}{\sqrt{\varepsilon_o \mu_o}}$$

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

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

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

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

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

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

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

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

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

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

$$d \sin \theta = m\lambda \text{ or } (m + \frac{1}{2})\lambda$$

$$a \sin \phi = m'\lambda$$

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

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

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

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

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

Misc. Physics 110 Formulae

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

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

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

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

$$PE_{gravity} = mgy$$

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