Name

Physics 111 Quiz #3, January 31, 2014

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.

A circuit is shown below where all the resistors are $R = 75\Omega$ and they are connected to a V = 12V battery.



Resistors R_{12345} and R_6 are in series and this is the equivalent resistance of the circuit. Thus we have $R_{eq} = R_{123456} = R_{12345} + R_6 = 90\Omega + 75\Omega = 165\Omega$.

b. What is the total current produced by the battery?

$$I_{total} = \frac{V}{R_{eq}} = \frac{12V}{165\Omega} = 0.073A = 73mA$$

c. What is the potential drop across R_6 ?

 $V_6 = I_{total} R_6 = 0.073 A \times 75 \Omega = 5.45 V$

d. What is the current between resistors R_2 and R_3 ?

The potential difference across the combination of resistors R_1 , R_2 , and R_3 is given by $V_{123} = V_B - V_6 = 12V - 5.45V = 6.55V$. The current between resistors R_2 and R_3 is given by $I_{123} = \frac{V_{123}}{R_{123}} = \frac{6.55V}{225\Omega} = 0.029A = 29mA$.

e. What is the power dissipated as heat across R_5 ?

The power dissipated across resistor R_5 is given by

 $P_5 = I_{45}^2 R_5 = (0.044A)^2 \times 75\Omega = 0.145W = 145mW$, where $I_{45} = I_{total} - I_{123} = 73mA - 29mA = 44mA = 0.044A$.

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

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

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

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

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

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

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

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

$$Q = CV = \left(\frac{\kappa \varepsilon_{0} A}{d}\right)V = (\kappa C_{0})V$$

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

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

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

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

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

 $\Delta(BA\cos\theta)$ 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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Misc. Physics 110 Formulae

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

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

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

$$W = \Delta KE = \frac{1}{2}m(v_{f}^{2} - v_{i}^{2}) = -\Delta PE$$

$$PE_{gravity} = mgy$$

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

$$x_{f} = x_{i} + v_{ix}t + \frac{1}{2}a_{x}t^{2}$$

$$v_{fx} = v_{ix} + a_{x}t$$

$$v_{fx}^{2} = v_{ix}^{2} + 2a_{x}\Delta x$$