PHYS-2070 (9) (Kaldon-41285) **Name ____**
WMU - Fall 2005
Final Exam - 200,000 points + 40,000 ☆ points ☐ **You Must Go Through "Check-Out" With Dr. Phil**

12/04/2005•Rev.A7a

State Any Assumptions You Need To Make – Show All Work – Circle Any Final Answers
Use Your Time Wisely – Work on What You Can – Be Sure to Write Down Equations
Feel Free to Ask Any Questions ☐☆2a ☐☆2b ☐☆2c ☐☆2e

Shoving Protons From One End of the Box to the Other (50,000 points)

1.) A proton ($m = 1.67 \times 10^{-27}\ kg$) starts at rest and is driven to a final speed $v = 1250\ m/s$ by an accelerating potential ΔV. (a) Find ΔV.

(b) The proton is moving at its final speed $v = 1250\ m/s$ in the $+x$ direction when a magnetic field $\vec{B} = -0.0250T\,\hat{k}$ is turned on. What is the magnitude and direction of the magnetic force on the proton at the instant the field is turned on?

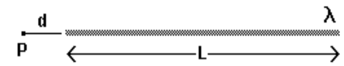
(c) The accelerating potential is created by a parallel plate capacitor. If the gap $d = 1.00\ cm$, find the electric field E and determine whether it's "legal" in air. *If you didn't get an answer to (a), use ΔV = 33,000 volts*

(d) The capacitor has a capacitance of 883 μF. If the plates are square with sides of length a, find a.

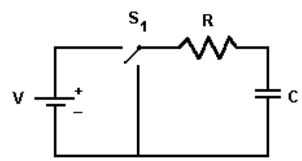
(e) 165 of these capacitors are strung together in a long chain, negative plate of one connected to the positive plate of the next. What is the equivalent capacitance of this arrangement?

Star Points (50,000 points)

2.) ☆(a) Use direct integration to find the magnitude of E at a point P a distance d from a finite line of charge, $L = 1.00\ m$ and $\lambda = 1.00 \times 10^{-4}\ C/m$, where $d = 0.100\ m$.



☆(b) Consider an RC circuit as shown. Flip the switch S_1 to the left and the capacitor charges. Once charged with a charge $\pm Q_0$, if the switch S_1 is turned down, then the capacitor discharges. For the discharging capacitor, write a Kirchhoff's Law voltage loop equation. Remember that the definition of current is $I = dq/dt$. Show that $Q(t) = Q_0\, e^{-t/RC}$.



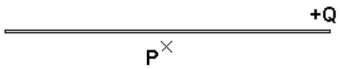
☆(c) Find the magnetic flux, Φ_B, in a circular area of radius a in the xy plane, where the magnetic field is $\vec{B} = b\,r\,\hat{k}$, where b is just some constant.

(d) On Friday we discussed where the dividing line between classical and relativistic physics lies. For "ordinary" everyday problems, one might consider a 10% change in perceived time or distance as relevant, $\gamma = 1.10$ which translates to $\beta = 0.4167$ or $v \approx 0.4167c$. But a scientist wants to make more careful measurements. Find the β which corresponds to 1.00% changes.

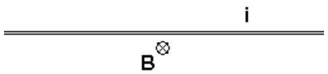
☆(e) Show if $B = [\, A_1 t^2 + B_2 \cos(kx - \omega t)\,]$ is a solution to the wave equation for B, $\dfrac{\partial^2 B}{\partial t^2} = c^2 \dfrac{\partial^2 B}{\partial x^2}$.

Electricity! Magnetism! Together! Hurray! (50,000 points)

3.) (a) A 1.00 meter long thin rod carries a total charge $Q = 0.0378\ C$. Use Gauss' Law to find the strength of the electric field 1.00 cm below the center of the rod.



(b) A wire carries a current of i and creates a magnetic field $\vec{B} = -3.48\times10^{-4}\,T\,\hat{k}$ as shown, a distance 1.00 cm below the wire. Find the magnitude of i and the direction of the current.



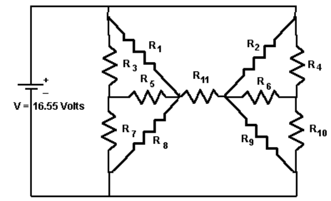
(c) You wish to create a microwave oven, but first you need to make a source of microwaves. If the wavelength of the microwave is $\lambda = 1.00\ cm$, find the frequency f and the angular frequency ω.

(d) If the LC oscillator of this microwave generating circuit has a capacitance $C = 1.00\ pF$, then find the inductance L.

(e) The inductor is an air-filled solenoid consisting of N turns of radius R over a length L. A cylindrical Gaussian surface encases the inductor. Find the total magnetic flux passing through the Gaussian surface.

A Battery of Resistance Problems (50,000 points)

4.) Eleven identical resistors, each 100.Ω, are arranged by a madman as shown. Technically it cannot be reduced by network reduction and requires Kirchhoff's Laws to solve. (a) Redraw this circuit, eliminating any resistors which might not actually do anything.



(b) Find the equivalent resistance of your new circuit.

(c) A 6.00 volt battery has an emf of $\mathcal{E}$ = 6.00 volts and delivers a current of 0.366 A when fresh. Find the resistance R of the load attached to the battery.

(d) A couple of hours later, the current has dropped to 0.266 A. Find the internal resistance r of the used battery.

(e) Find the total power P being generated by the used battery.

Worksheet – turn in with exam if you use it.