XF.5a **1150**

PHYS-1150(5) (Kaldon-40527) **Name** _____
WMU - Fall 2006
Final Exam - 200,000 points

☐ You MUST Go Through Check-Out When Done

Rev. 12/11/06 Mo.6

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
Short Answers Should Be Short! – Feel Free to Ask Any Questions

FINAL EXAM [FORM - A]

PHYS-1150 (KALDON-5)

FALL 2006

WMU

$k = 8.988 \times 10^{9}\ N \cdot m^2 / C^2$

$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2 / N \cdot m^2$

$c = 2.998 \times 10^{8}\ m/s$

$e = 1.602 \times 10^{-19}\ C$

$\mu_0 = 4\pi \times 10^{-7}\ T \cdot m / A$

$h = 6.636 \times 10^{-34}\ J \cdot s$

We've come a long way since September and covered a lot of Physics. Your journey is almost over. Complete this course with a decent grade and you may not have to ever again take a semester of Physics. All you have to do is make it through this Final Exam. So sit back, have a cookie and enjoy this last moment of calm.

Relax…

Consider the Poor Nitrogen Ion… (50,000 points)

1.) A positively charged nitrogen ion ($q = +e$; $m = 14 \times 1.67 \times 10^{-27}$ *kg*) starts at rest and is driven to a final speed *v* by an accelerating potential $\Delta V = 6{,}000{,}000$ *volts*. (a) What is the final kinetic energy of the ion?

(b) If the ion travels 15.0 meters during its acceleration, find the magnitude of the constant electric field *E* that accelerates the ion. *This does not require the answer to (a).*

(c) Suppose that 1.123×10^{15} ions are produced every minute. Express the beam current in Amperes.

(d) This ion is moving in the *+x* direction when a magnetic field $\vec{B} = 5.00T\,\hat{j}$ is turned on. What is the magnitude and direction of the magnetic force on the ion at the instant the field is turned on?

(e) What is the period of the resulting circular motion?

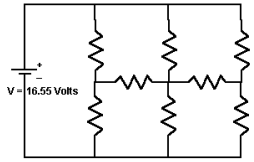
A Physics Christmas Present… (Batteries Not Included) (50,000 points)

2.) You are given a resistor R = 100.Ω, a capacitor C = 1000. μF and an inductor L = 0.100 H. The capacitor has parallel plates of sides *a* and a gap *d = 1.00 mm*. Find *a*.

(b) The inductor is a solenoid of 1000. turns and a diameter *D = 6.00 mm*. Find the length *l* of the inductor.

(c) All three of these devices are plugged into a series RLC circuit and run on 50.0 Hz A.C. Find the impedance *Z* of this circuit.

(d) A brand fresh battery has a potential difference *V = 1.50 volts* with a 100. Ω resistor attached in a simple circuit. Some time later, the voltage has dropped to 1.37 volts. Find the internal resistance *r* of the weakened battery.



(e) This little festive arrangement has eight identical resistors, each *R = 100. Ω*, as shown. This is another circuit that technically requires Kirchhoff's Laws to solve, but because the resistors are identical, you can easily find the equivalent resistance, R_{eq} , of this circuit. What is R_{eq} ? *Sketch the intermediate circuits and circle the resistors you combining, indicating if they are in series or parallel, if you want full credit for this problem.*

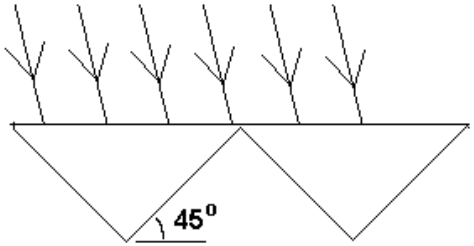
A Little Light Motif – And Yes, Dr. Phil Knows How to Spell *leitmotif* (50,000 points)

3.) Heinrich Hertz's original apparatus for generating and detecting electromagnetic radio waves has very small values of *L* and *C*. (a) Suppose Hertz found waves of $f = 111\ MHz$. What is the wavelength, λ, of this EM wave?

(b) Hertz's apparatus created EM waves when a spark jumps the gap between two spherical conductors along the *x-axis*. Therefore $E_{max} = 3.00 \times 10^6\ V/m$. What is B_{max} to this E_{max}?

(c) At a gas station you happen to look straight down at a puddle of water ($n = 1.33$) that has a thin layer of gasoline ($n = 1.50$) on top. Although white sunlight is shining down on the puddle, the reflection seems to be mostly red light ($\lambda = 640.\ nm = 640. \times 10^{-9}\ m$) with absolutely no blue light ($\lambda = 512\ nm$). What is the minimum thickness of the gasoline layer?

(d) Light rays come in at an unspecified angle as shown, to a piece of glass made up of triangular cross-section prisms. Pick any one of the incoming rays which will have Total Internal Reflection from the glass-to-air interface on the bottom of the glass and show what happens to it until it comes out of the glass. There are no numbers to calculate in this problem, but of course the index of refraction of the glass *is* higher than the index of refraction of air ($n = 1.00$). *Show all relevant lines in your sketches.*



(e) Find the critical angle θ_c for glass with an $n = 1.57$ in air.

Ah, Christmas With Friends And Relatives – Until The Evil Aliens Show Up! (50,000 points)

4.) (a) The Evil Dragot Empire sends an invasion fleet towards Earth from Alpha Centauri, 4.20 LY (light years) away. They send a radio signal from Alpha Centauri, letting us know "They are coming." How long does it take this signal to get to Earth? *You may answer (a) through (d) in units of years and LY.*

(b) The invasion fleet travels at 99.0% the speed of light (0.990 c). How long does it take for the invasion fleet to get to Earth, from our point of view on Earth? *Though you don't have to calculate it, the difference between (b) and (a) is "how much advance notice the poor Human race has before the invasion."*

(c) How far a distance does the Grand Evil Dragot Admiral traveling aboard the Imperial Flagship think Earth is?

(d) How long does the invasion fleet say it takes to get to Earth?

(e) Hmm… need one more problem. Oh what does it matter? The evil aliens are coming! So let's look at two wires, each 1.00 meters long, each carrying a current of 1.00 A. They are separated by a distance $d = 0.0500\ m = 5.00\ cm$. Find the magnetic force vector, $\vec{F}_B$, of wire 1 on wire 2.