PHYS-115(x) (Kaldon-xxxxx)
WMU - Winter 2001
Exam 2 - 100,000 points

Sample Exam

Name ______________________________

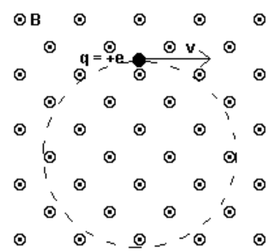
Book Title ______________________________

Section: **3a** A to F **3b** G to M **3c** N to S **3d** T to Z 01/23/2001•Rev.5

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
BOLDFACE Variables Are Vectors - Feel Free to Ask Any Questions

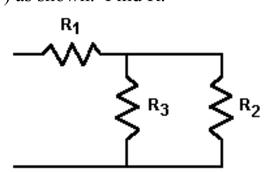
"There I Was, Officer, Minding My Own Business, When All Of A Sudden…" (50,000 pts.)

1.) A proton ($q = +e$, $m_p = 1.67\times10^{-27}\ kg$) is moving along with velocity $\vec{v} = 1.38\times10^{6}\ m/s\ \hat{i}$, when a magnetic field, B, is suddenly turned on in the $+z$-direction as shown. The radius of the circular orbit is 2.00 meters. (a) What is the magnitude of the magnetic field B ?

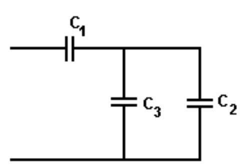


(b) If an electric field vector, $\vec{E}$, is turned on after one circle such that the proton's velocity vector $\vec{v} = 1.38\times10^{6}\ m/s\ \hat{i}$ never turns, find the electric field vector, $\vec{E}$.

(c) A 157 Ω resistor is made of three identical resistors ($R = R_1 = R_2 = R_3$) as shown. Find R.



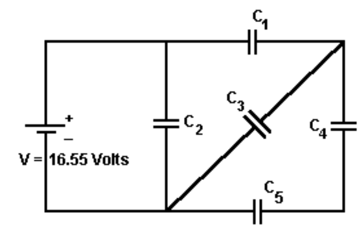
(d) A 157 μF capacitor is made of three identical capacitors ($C = C_1 = C_2 = C_3$) as shown. Find C.



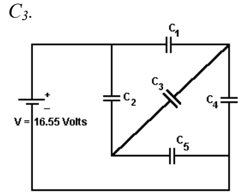
(e) At $t = 3\tau$, a series RC circuit's current drops to about 5% of its initial value, I_0 . If $R = 157\ \Omega$ and $C = 157\ \mu F$, what time is this?

This Physics is Past Your Capacity to Resist (50,000 pts.)

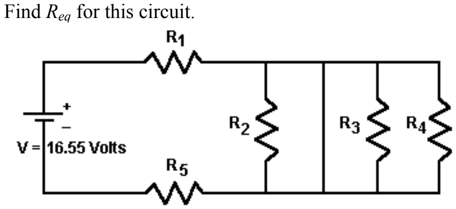
2.) (a) The following circuit can be reduced to a single equivalent capacitor by network reduction. At each step in the reduction, circle the capacitors you are going to reduce, mark them as SERIES or PARALLEL, then draw the next equivalent circuit down to (and including) the final circuit. DO NOT WRITE DOWN OR TRY TO SOLVE THE EQUATIONS THAT GO WITH EACH CIRCUIT.



(b) The following circuit cannot be reduced by network reduction to a single equivalent capacitance. However, if $C_1 = C_2 = C_4 = C_5 = 100.$ pF, you can easily find the charges $\pm Q_3$ on the plates of C_3. Find Q_3 and BRIEFLY explain your reasoning. *Hint: You might want to consider what is the voltage difference V_3 across the capacitor C_3.*



(c) The following diagram is correct "as Dr. Phil intended it", even if it looks funny. All the resistors are 111 Ω. Find R_{eq} for this circuit.



(d) An RC circuit has $R = 105\ k\Omega$ and $C = 151\ \mu F$. Find the time t when the fully charged capacitor will discharge to 85.0%, $q(t) = 0.850\ Q_0$.

(e) A charge $q = -1.03\times10^{-6}\ C$ is moving at $v_x = +3.37\ m/s$; $v_y = v_z = 0$ when it experiences a magnetic field $B_x = 2.00\ T$; $B_y = 2.00\ T$; $B_z = 0$. Find the magnetic force vector $\vec{F}_B$ acting on the charge q.

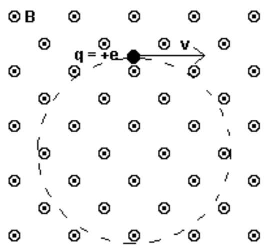
No Moving Electric Charges in Miami After Hurricane Wilma… (50,000 points)

3.) A parallel plate capacitor consists of two metal plates, each *5.00 cm* wide by *10.0 cm* long, with a gap $d = 2.00\ mm$. The space between the plates is filled with silicone oil (dielectric constant $\kappa = 2.50$ and dielectric strength $15.0 \times 10^6\ V/m$). (a) Show whether you can safely charge this capacitor with ΔV = 25,000 volts.

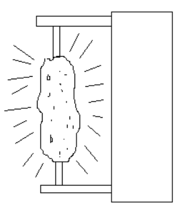
(b) Consider four identical 625 Ω resistors and a 16.55 volt battery. Find the maximum and the minimum equivalent resistance you can make with these resistors. Be sure to draw the two circuit diagrams for full credit.

(c) A brand fresh 6.00 volt battery acts like a perfect battery at time $t = 0$ and delivers a current of 1.63 A. At some later time, as the real battery weakens, the current drops to 1.51 A. Find the power dissipated by the internal resistance inside the real battery when I = 1.51 A.

(d) A proton ($q = +e$, $m_p = 1.67 \times 10^{-27}\ kg$) is moving along with velocity $\vec{v} = 1.38\ m/s\ \hat{i}$, when a magnetic field, $B = 1.439 \times 10^{-4}\ T$, is suddenly turned on in the $+z$-direction as shown. Find the radius r of the circular path the proton makes.



(e) Pages 157-158 of Penn & Teller's How to Play With Your Food talks about "The Incredibly Dangerous Glowing Pickle Machine." † Here an ordinary dill pickle is skewered at the ends with two metal prongs, which are then hooked up to 110. volts of potential difference. If the current flowing through the green glowing pickle is 5.00 A, and the pickle is roughly 2.00 cm × 2.00 cm × 10.0 cm long, calculate the resistivity ρ of the pickle.



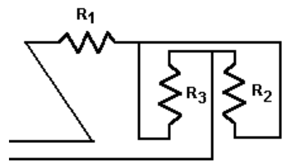
† Does Dr. Phil really have to tell you DO NOT TRY THIS AT HOME? Okay, I will. DO NOT TRY THIS AT HOME!

Don't Panic. Just Follow the Wires and Make the Connections (50,000 points)

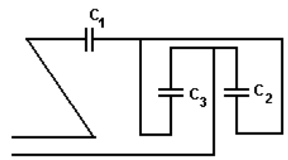
4.) (a) You are given two square metal plates with sides $a = 5.00\ cm$. Design an air filled capacitor, such that when hooked up to a 9.00 volt battery and fully charged, it will spark across the gap and discharge. What is the capacitance C of this badly designed capacitor? *Do not say that the answer is zero… (grin).*

(b) A brand fresh 6.00 volt battery acts like a perfect battery at time $t = 0$ and delivers a current of 1.63 A. At some later time, as the real battery weakens, the current drops to 1.51 A. Find the internal resistance r of the weak battery.

(c) A 311 Ω resistor is made of three identical resistors ($R = R_1 = R_2 = R_3$) as shown. Find R.



(d) A 311 pF capacitor is made of three identical capacitors ($C = C_1 = C_2 = C_3$) as shown. Find C.



(e) A particular circuit generates 125 W of Joule heating when hooked up to a perfect battery which has a potential difference of 6.00 volts. If the perfect battery is replaced with another perfect battery of half the voltage, find the power dissipated by Joule heating in this new circuit.