**PHYS-207(5) (Kaldon-19884)** **Name** _____

**WMU-Fall 2001** **Book Title** _____

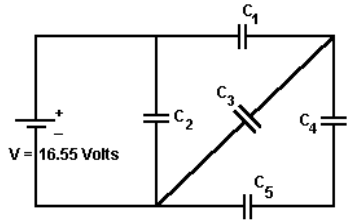
**Exam 2 - 100,000 points + 20,000 ☆ points** **Section:** **5a** A to D **5b** E to I **5c** J to M **5d** N to S **5e** T to Z

10/15/2001.Rev6.1rev02/25/03

**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

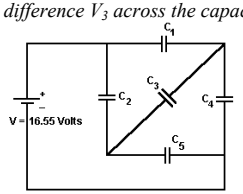
**This Physics is Past Your Capacity to Resist (50,000 pts.)**

1.) (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.

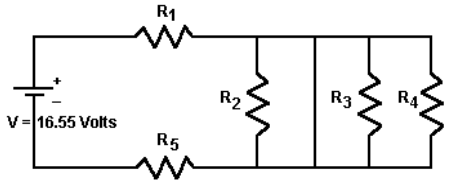





(b) The following circuit cannot be reduced by network reduction to a single equivalent capacitance. However, if $C_1 = C_2 = C_4 = C_5 = 100.$ pF, you can easily find the charges $\pm Q_3$ on the plates of $C_3$. Find $Q_3$ and BRIEFLY explain your reasoning. *Hint: You might want to consider what is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

**Staring at Star Problems (50,000 points)**

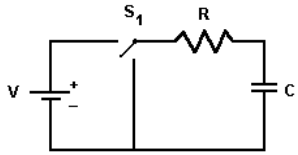
2.) ☆(a) An electron is injected into the middle of a parallel plate capacitor, with a potential difference of $\Delta V = 4.00$ *volts* and a gap distance $d = 1.00$ *mm* $= 0.00100$ *m*. The electron is moving at $v_{0x} = 1.00$ *m/s* and is drawn to the top plate. Find the Work done by the Electric Force $F_E$ to move the electron in the *y*-direction, $W = \int_a^b \vec{F}_E \cdot d\vec{s}$ , from the center of the gap to the top plate.


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

☆(b) A rectangular resistor, with a cross-sectional area $A = (0.0100m)^2 = 0.000100\ m^2$ and a length $L = 0.0700\ m$, has an unusual resistivity that varies with its length, $\rho(x) = (10.0\ \Omega)\ x$. Find the resistance of this resistor from $x = 0$ to $x = L$.



☆(c) 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 charging capacitor, write a Kirchhoff's Law voltage loop equation. Remember that the definition of current is $I = dq/dt$. Show that $q(t) = Q_0(1 - e^{-t/RC})$ .




(d) A proton, $m_p = 1.67 \times 10^{-27}$ *kg*, traveling with a speed $v = 1135$ *m/s* is trapped in the *x*-*y* plane by the centripetal force caused by a magnetic field $\vec{B} = 0.0405T\,\hat{k}$ . Find the radius *r* of the circular orbit the proton is in.

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

☆(e) For the proton in (d), find the Work done by the magnetic field $F_B$ over the course of one full orbit, $W = \int_a^b \vec{F}_B \cdot d\vec{s}$ . The distance traveled will be $C = 2\pi r$. *If you did not get a radius in (d), use r = 1.00 mm.*