

X2.5a

PHYS-1150(5) (Kaldon-40527)
 WMU - Fall 2006
 Exam 2A - 100,000 points

Name _____ **S O L U T I O N** _____

Book Title _____

1150

Rev. 10/23/06 Mo.4

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

EXAM 2 [FORM - A]**PHYS-1150 (KALDON-5)****FALL 2006****WMU**

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

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

$$\epsilon_0 = 8.85 \times 10^{-12} \text{ C}^2 / \text{N} \cdot \text{m}^2$$

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

Mmm... Yummy Physics Constants**Goes Good With Cookies...***I love this job!***"R" Is Just The 18th Letter Of The Alphabet... Except In Physics! (50,000 points)**

1.) Consider a 625Ω resistor made from a cylinder with a length of 2.50 cm and a diameter of 1.00 cm. (a) What would be the resistivity ρ of this resistor's material?



$$A = \pi r^2 = \pi (0.00500\text{m})^2 = 0.00007854\text{m}^2 = 7.854 \times 10^{-5} \text{m}^2$$

$$R = \rho \frac{L}{A}$$

$$\rho = \frac{RA}{L} = \frac{(625\Omega)(7.854 \times 10^{-5} \text{m}^2)}{(0.0250\text{m})} = 1.964\Omega \cdot \text{m}$$

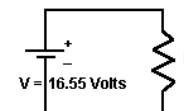
(b) Hook this resistor up to a 16.55 volt battery. Find the voltage drop, the current and power lost of this resistor.

$$V = 16.55\text{volts}$$

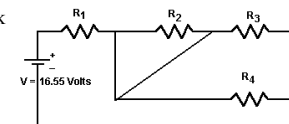
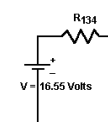
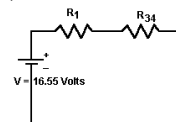
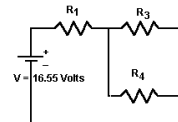
$$V = IR$$

$$I = \frac{V}{R} = \frac{16.55\text{volts}}{625\Omega} = 0.02648\text{A}$$

$$P = IV = (0.02648\text{A})(16.55\text{volts}) = 0.4382\text{W}$$



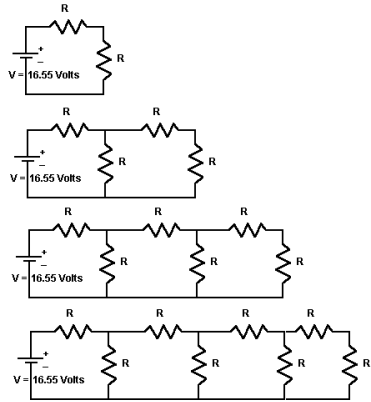
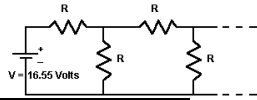
(c) Take four identical 625Ω resistors and our 16.55 volt battery and hook them up in the circuit as shown. Find the equivalent resistance of the circuit, R_{1234} , by reducing the resistor network.

 **R_2 is shorted out, so doesn't count.**

$$\frac{1}{R_{34}} = \frac{1}{R_3} + \frac{1}{R_4} = \frac{1}{625\Omega} + \frac{1}{625\Omega} = \frac{2}{625\Omega} = \frac{1}{312.5\Omega}$$

$$R_{1234} = R_{134} = R_1 + R_{34} = 625\Omega + 312.5\Omega = 937.5\Omega$$

(d) For an infinite system of 100 Ω resistors, as shown below, find the equivalent resistance. *Hint: This isn't impossible. You may need to try some shorter, finite systems first.*



$$R + R = 2R = 2(100\Omega) = 200\Omega$$

$$100\Omega + 100\Omega = 200\Omega$$

$$\frac{1}{100\Omega} + \frac{1}{200\Omega} = \frac{1}{66.67\Omega}$$

$$100\Omega + 66.67\Omega = 166.7\Omega$$

$$\frac{1}{100\Omega} + \frac{1}{166.7\Omega} = \frac{1}{62.50\Omega}$$

$$100\Omega + 62.50\Omega = 162.5\Omega$$

$$\frac{1}{100\Omega} + \frac{1}{162.5\Omega} = \frac{1}{61.90\Omega}$$

$$100\Omega + 61.90\Omega = 161.9\Omega$$

$$\frac{1}{100\Omega} + \frac{1}{161.9\Omega} = \frac{1}{61.82\Omega}$$

$$100\Omega + 61.82\Omega = 161.8\Omega$$

$$\frac{1}{100\Omega} + \frac{1}{161.8\Omega} = \frac{1}{61.80\Omega}$$

$$100\Omega + 61.80\Omega = 161.8\Omega$$

(e) An RC circuit consists of a 1130 Ω resistor and a 311 μF capacitor. Find the time t in seconds it takes for the fully discharged capacitor to charge to two-thirds of its maximum value, i.e. $q = 0.667 Q_{max}$.

$$q = 0.667 Q_0$$

$$q = Q_0(1 - e^{-t/RC})$$

$$0.667 Q_0 = Q_0(1 - e^{-t/RC})$$

$$0.667 = 1 - e^{-t/RC}$$

$$e^{-t/RC} = 1 - 0.667 = 0.333$$

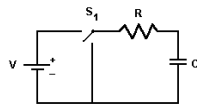
$$\ln(e^{-t/RC}) = \ln(0.333)$$

$$-t/RC = \ln 0.333$$

$$t = -\ln 0.333(RC)$$

$$= -\ln 0.333(1130\Omega)(311\mu F)$$

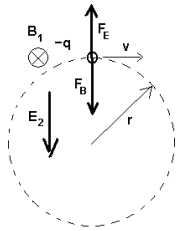
$$= 386,400\mu\text{sec} = 0.3864\text{sec}$$



It Must Be My Animal Magnetism (50,000 points)

(a)

2.) (a) If a magnetic field B_1 is turned on, a negative charge $-q$ will go around in circular path of radius r as shown. If an electric field E_2 is turned on as well, the charge will go in a straight line. Sketch on the diagram the directions of the vectors for the magnetic field, the magnetic force, the electric field and the electric force.



The charged particle problem above has the following properties: mass $m = 0.0100\text{ kg}$, charge $q = -0.0350\text{ C}$, speed $v = 222\text{ m/s}$, and radius $r = 0.120\text{ m}$. Find the magnitudes of (b) the magnetic force and magnetic field, and (c) the electric force and electric field.

$$F_B = F_c = \frac{mv^2}{r} = \frac{(0.0100\text{kg})(222\text{m/s})^2}{(0.120\text{m})} = 4107\text{ N}$$

$$F_B = qvB$$

$$B = \frac{F_B}{qv} = \frac{4107\text{ N}}{(0.0350\text{C})(222\text{m/s})} = 528.6\text{ T}$$

(b)

(c)

$$F_E = F_B = 4107\text{ N}$$

$$F_E = qE$$

$$E = \frac{F_E}{q} = \frac{4107\text{ N}}{0.0350\text{ C}} = 117,300\text{ N/C}$$

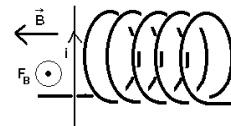
(d) A coil consists of 4550 turns of wire in a length of 15.0 cm and a diameter of 8.00 cm. The B-field in the solenoid measures $B = 0.00135\text{ T}$, as shown. Find the magnitude of the current I in the coil and indicate whether the current comes out the LEFT or the RIGHT of the coil.



$$B = \frac{\mu_0 NI}{\ell}$$

$$I = \frac{B\ell}{\mu_0 N} = \frac{(0.00135\text{ T})(0.150\text{ m})}{(4\pi \times 10^{-7}\text{ T}\cdot\text{m/A})(4550)} = 0.03542\text{ A}$$

(e) For the same solenoid coil as in (d), with $B = 0.00135\text{ T}$, a second wire is centered directly in front of the coil so it gets hit with the coil's B-field. If the current in this second wire is $i = 0.500\text{ A}$ as shown, find the magnitude and direction of the magnetic force, F_B , on this second wire. Use the diameter of the coil as the length of the second wire.



$$F_B = iLB = (0.500\text{ A})(0.0800\text{ m})(0.00135\text{ T}) = 0.0005400\text{ N} = 5.400 \times 10^{-5}\text{ N}$$

Magnetic force on the wire, F_B , points OUT of the page.