X2.6a **1150**

PHYS-1150(6) (Kaldon-40451) Name S O L U T I O
N

WMU - Fall 2007

Exam 2A - 100,000 points Book Title ______________________

Rev. 10/22/07 Mo.4.r1

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-6)

FALL 2007

WMU

$k = 8.988 \times 10^{9}\ N \cdot m^2 / C^2$ $\quad e = 1.602 \times 10^{-19}\ C$

$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2 / N \cdot m^2$ $\quad \mu_0 = 4\pi \times 10^{-7}\ T \cdot m / A$

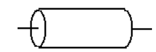
Physics Tricks or Treats

Cookies, Candies, Problems…

Boo!

You Can't Spell "Resistance" Without Ω (50,000 points)

1.) Consider a resistor made from a cylinder of resistivity $\rho = 8.125\ \Omega \cdot m$, with a length of 2.50 cm and a diameter of 1.00 cm. (a) What would be the resistance R of this cylinder?

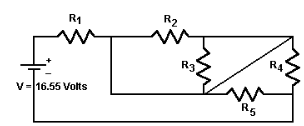


$$D = 1.00cm = 0.0100m \quad ; \quad r = \tfrac{1}{2} D = 0.00500m$$
$$R = \rho \frac{L}{A}$$
$$= (8.125\Omega \cdot m) \frac{(0.0250m)}{\pi (0.00500m)^2}$$
$$= 2586\Omega$$

(b) Hook this resistor up to a 16.55 volt battery. Find the voltage drop, the current and power lost of this resistor. *If you didn't get an answer to (a), use R = 812 Ω.*

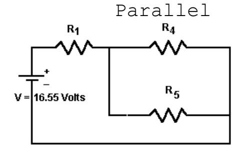
$$V = 16.55volts$$
$$V = I\,R$$
$$I = \frac{V}{R} = \frac{16.55volts}{2586\Omega} = 0.006400A$$
$$P = IV = (0.006400A)(16.55volts) = 0.1059W$$
$$OR \qquad P = \frac{V^2}{R} = \frac{(16.55volts)^2}{2586\Omega} = 0.1059W$$

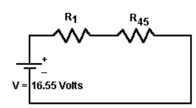
(c) Take five identical 625 Ω resistors and our 16.55 volt battery and hook them up in the circuit as shown. Find the equivalent resistance of the circuit, R_{12345}, by reducing the resistor network.



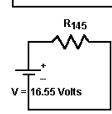
`Resistors R2 and R3 don't contribute due to short circuits which route the current around them.`

Parallel Series

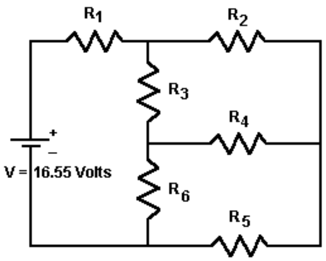




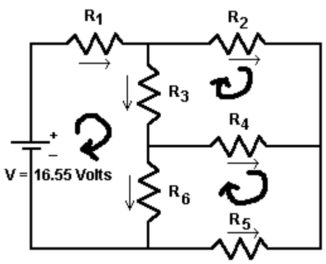
$$\frac{1}{R_{45}} = \frac{1}{R_4} + \frac{1}{R_5} = \frac{1}{625\Omega} + \frac{1}{625\Omega} = \frac{2}{625\Omega}$$
$$R_{45} = 312.5\Omega$$
$$R_{145} = R_1 + R_{45} = 625\Omega + 312.5\Omega = 937.5\Omega$$



`Done!`



(d) This circuit cannot be reduced by network reduction. Use Kirchhoff's Laws and write down the necessary junction and loop equations – BUT DO NOT SOLVE THEM. *In order to make life easier for grading, take all resistor currents as pointing either to the right or down as needed. Draw the direction of your currents and loops on the circuit diagram for full credit.*



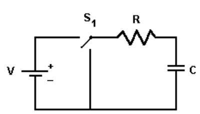
Junctions
(corrected)

$$i_1 = i_2 + i_3 \quad OR \quad i_1 - i_2 - i_3 = 0$$
$$i_3 = i_4 + i_6$$
$$i_2 + i_4 + i_5 = 0$$
$$(i_6 = i_1 + i_5)$$

Loops

$$+V - i_1R_1 - i_3R_3 - i_6R_6 = 0$$
$$-i_2R_2 + i_4R_4 + i_3R_3 = 0$$
$$-i_4R_4 + i_5R_5 + i_6R_6 = 0$$

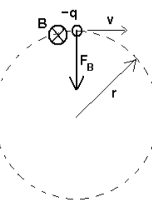
(e) An RC circuit consists of a 1150 Ω resistor and a 511 μF capacitor. Find the time *t* in seconds it takes for the fully charged capacitor to discharge to two-thirds of its maximum value, i.e. $q = 0.667\,Q_{max}$.



$$\tau = RC = (1150\Omega)(511\times10^{-6}F) = 0.5877\,\text{sec}$$
$$q = Qe^{-t/RC} \;;\; q = 0.667Q$$
$$0.667Q = Qe^{-t/RC}$$
$$0.667 = e^{-t/RC}$$
$$\ln\left(e^{-t/RC}\right) = \ln(0.667)$$
$$\frac{-t}{RC} = -0.4050$$
$$t = (0.4050)RC = (0.4050)(0.5877\,\text{sec})$$
$$= 0.2380\,\text{sec}$$

These Aren't Your Grandmother's Kitchen Magnets (50,000 points)

2.) (a) If a magnetic field $B_1 = 0.150\ T$ is turned on, a negative charge $-q$ will go around in circular path of radius *r* as shown. Sketch on the diagram the directions of the vectors for the magnetic field and the magnetic force.

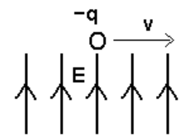


The charged particle problem above has the following properties: charge $q = -0.0350\ C$, speed $v = 2220\ m/s$, and radius $r = 0.120\ m$. Find (b) the magnitude of the magnetic force and (c) the mass of the charged particle.

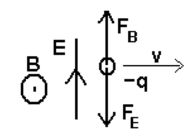
(b)
$$F_B = qvB$$
$$= (-0.0350C)(2220m/s)(0.150T)$$
$$= (-)11.66N$$

(c)
$$F_B = F_c = m\frac{v^2}{r}$$
$$m = \frac{F_B r}{v^2} = \frac{(11.66N)(0.120m)}{(2220m/s)^2}$$
$$= 2.839\times10^{-7}\,kg$$

To get only charged particles traveling at 2220 m/s, we must pass them through a velocity selector. If the electric field $E = 1250\ N/C$ as shown, find (d) the magnitude and direction of the magnetic force F_B and (e) the magnitude and direction of the applied magnetic field *B,* to make this velocity selector work.



(d)
$$F_B = F_E = qE$$
$$= (0.0350C)(1250N/C)$$
$$= 43.75N$$



F_B points UP (+*y*-direction)

(because F_E has to point down because q is negative)

(e)
$$F_B = qvB$$
$$B = \frac{F_B}{qv} = \frac{43.75N}{(0.0350C)(2220m/s)}$$
$$= 0.5631T$$

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