Chapters 17 and 18 DC - Electricity

$I = \frac{\Delta Q}{\Delta t} = \frac{1C}{s} = 1\,Amp$ $\quad 1\,Amp = 1\frac{C}{s} =$

$I = nqV_dA$

n = # of mobile Charge Carriers
q = Charge on Carrier
V_d = Drift Velocity
A = Cross Sectional Area

Ohms Law

$\frac{E}{I \times R}$

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

$\rho = \rho_0 (1 + \alpha (T - T_0))$
$R = R_0 (1 + \alpha (T - T_0))$

$P = IE = I^2R = \frac{E^2}{R}$

$1\,kwh = 3.60 \times 10^6\,J$

Series
$E = E_1 + E_2 + E_3 \ldots$
$I = I_1 = I_2 = I_3$
$R = R_1 + R_2 + R_3 \ldots$

Parallel
$E = E_1 = E_2 = E_3$
$I = I_1 + I_2 + I_3 \ldots$
$1/R_T = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \frac{1}{R_4}$

RC

$T = RC$
$q = Q(1 - e^{-t/T})$ Charging
$q = Q e^{-t/T}$ Discharge

Cu

Example 46 What is the drift Velocity in a wire carrying 100A of Current? Assume 1e⁻ per atom with the wire having a diameter of .001 m?

$v = \lambda f$

$f = \frac{1}{\lambda}$

$I = v_d n q A$

$100 = v_d \, 8.48 \times 10^{28} (1.60 \times 10^{-19}) (\pi (\frac{.001}{2})^2)$

$n = \frac{\text{mol wt}}{\text{Density}} \quad \# = \frac{6.02 \times 10^{23} \rho}{\text{mol wt}} = \frac{6.02 \times 10^{23} \, 8.92 \times 10^{3}}{63.5 \times 10^{-3}}$

$= 8.45 \times 10^{28} e^- / m^3$

$100 = v_d \, 8.48 \times 10^{28} (1.60 \times 10^{-19}) (\pi (5 \times 10^{-4})^2)$

$\boxed{v_d = .0093 \frac{m}{s}}$

Example 47 What is the Resistance of 500 m of Copper wire with the wire having a diameter of .001m

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

$R = \rho \frac{500}{(\pi (\frac{.001}{2})^2}$

$R = 1.7 \times 10^{-8} \frac{500}{\pi (5E^{-4})^2}$

$R = 10.82 \, \Omega$

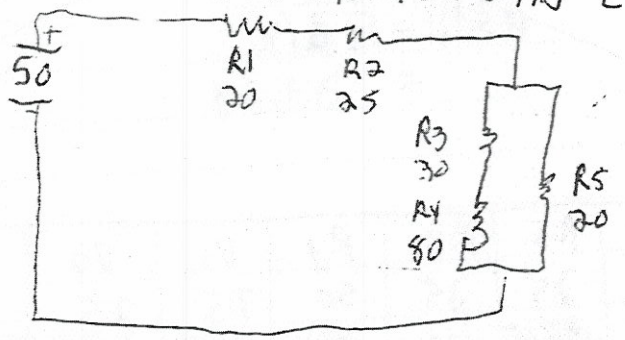
Example 48 The wire in Problem #47 is heated from 20°C to 500°C

$R = R_o[1 + \alpha T - T_o]$

$R = 10.82[1 + (3.9 \times 10^{-3})(500-20)]$

$= 31.07\ \Omega$

Example 49 Solve the following circuit

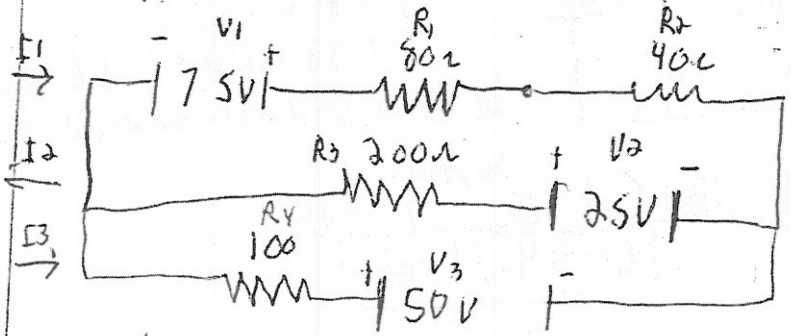


	Total	R_1	R_2	R_3	R_4	R_5	A	B	B_1	B_2
E	50	16.7	20.75	3.6	9.6	13.7	36.45	13.70	13.70	13.70
I	.81	.81	.81	.12	.12	.685	.31	.81	.12	.685
R	61.92	20	25	30	80	20	45	16.93	110	20
P	40.5W	13.12W	16.40W	.43W	1.15	4.38	24.52	11.10	1.64	9.38

$P_{IN} = P_{OUT}$

$40.5 = 40.48\ W$

Example 50



$-120 I_1 + -200 I_2 + 0 I_3 = -100$

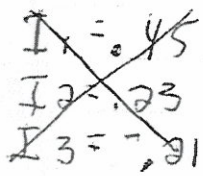
$0 I_1 + -200 I_2 + -100 I_3 = +25$

$1 I_1 + -I_2 + I_3 = 0$

$I_1 = .625$

$I_2 = .125$

$I_3 = -.5$



Example 50 cont.

	R_1	R_2	R_3	R_4	V_1	V_2	V_3
E	36	18	46	21	75	25	50
I	.45	.45	.23	.21	.45	.23	.21
R	80	40	200	100	—	—	—
P	16.2	8.1	10.58	4.41	33.75	5.75	10.5

$V = I$

$f = I$

$P_{in} = P_{out}$

$\mathcal{E}IV = \mathcal{E}I^2R$

$= 39.29$

	R_1	R_2	R_3	R_4	V_1	V_2	V_3
E	50	25	25	50	75	25	50
I	.625	.625	.125	.625	.625	.125	.5
R	80	40	200	100	—	—	—
P	31.25	15.63	3.13	25W	46.88	3.13	25W

$P_{in} = P_{out}$

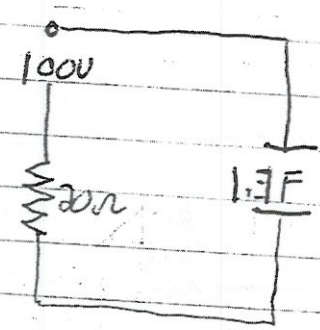
$75W = 75W$

Example 51

$Q = CV$

$Q = 100 \times 1.3$

$= 130C$



A) What is the Time Constant for this Circuit?

$\tau = RC$

$\tau = 20(1.3) = 26 sec$

B) When will the Charge be 125 C?

$B)\ q = 130(1 - e^{-t/\tau}) = 125$

$t = 84.71 sec$

How long will it take to discharge if the capacitor discharges through a 10Ω Resistor? Assume Discharge to be 1% of Max Charge

$T = RC$

$T = 10(13) = 13 sec$

$q = Q e^{-t/T}$

$1.3 = 130 e^{(-t/13)}$

$t = 59.86 sec.$

Example 57

Electricity Cost $0.15 kwh. How much does it Cost to run a 60 w Lightbulb for 1 year?

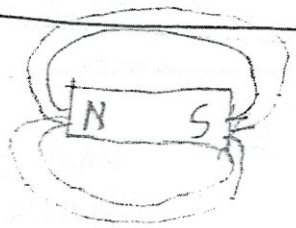
~~$0.15 kwh / 1 · 1000 w / 1 kw · 1 / 60 w ·~~

$$\frac{60 J}{s} \cdot \frac{31556925.9747 sec}{1 year} \cdot \frac{1 kwhr}{3.6 \times 10^6 J} \cdot \frac{\$0.15 sec}{1 kwhr} = \$78.89$$

Chapter 19

$F = qvB \sin\theta$ - Particle

$B = \frac{F}{qv \sin\theta}$



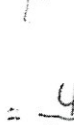
Motor

$T = BIAN \sin\theta$

$\mu = IAN$ so $\tau = \mu B \sin\theta$

$r = \frac{mv}{qB}$ ← Cyclotron Equation

O Out X In



$B_{wire} = \frac{\mu_0 I}{2\pi r}$

$\frac{F}{\ell} = \frac{\mu_0 I_1 I_2}{2\pi d}$ same direction → attract

- opposite direction → repulse

$B = N\frac{\mu_0 I}{2R}$

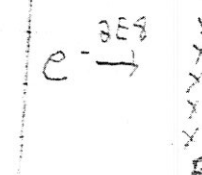
$B = \mu_0 n I = \mu_0 \frac{N}{\ell} I$ } Magnetic Field Solenoids

$1\ Tesla = 1 \times 10^4\ G$

$V = \Lambda$

$f = ;$

Example 53



What is the force and direction on the [illegible] shown?

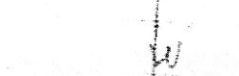
Down the Page

$F = qUB\sin\theta$

$= 1.60 \times 10^{-19}(2E8)(5E^{-5})\sin$

$= 6.59 \times 10^{-16}\ N$

Example 54



What is the force on this wire if it is carrying 100 Amp to the West, in the Earths Magnetic field?

Down

$F = BIl$

$F = 5E^{-5})100(500)$

$F = 2.5\ N$

Example 55

What is the Torque on a 5 mm x 5 mm Square Loop with 200 turns with 1.5 Amp of Current running