chapter 19 examples

1) $I = qnA\langle v\rangle$

$\langle v\rangle = \frac{I}{qnA} = \frac{15.0\ A}{(1.602\times10^{-19}C)(1.41\times10^{5})(6.0\times10^{-3})(\pi)(0.00103\ m)^2}$

$n = 8.93\times10^{3}\frac{kg}{m^3}\times\frac{1\ mol}{63.5\ g}\times\frac{0.001\ kg}{g}$

$= 1.41\times10^{5}\frac{mol}{m^3}$

$= 3.31\times10^{-4}\ m/s$

b) $\Delta x = vt$ $\quad t = \frac{\Delta x}{v} = \frac{1\ m}{3.31\times10^{-4}\ m/s}$

$= 3.02\times10^{3}\ s$

2) $R = \frac{\rho l}{A} = \frac{(1.77e^{-8}\ \Omega m)(10m)}{(3.31e^{-6}\ m^2)}$

$= 5.35\times10^{-2}\ \Omega$

3) $\Delta V = \Sigma\Omega$

$V = El$

$E = \frac{V}{l} = \frac{IR}{l} = \frac{(15.0A)(3.35e^{-2}\Omega)}{(10m)}$

$= 9.03\times10^{-2}\ V/m$

4) $R = R_0[1+\alpha(T-T_0)]$

$\frac{R}{R_0} = 1.10$ $\quad 1.10 = [1+(3.8e^{-3}\frac{1}{K})(\Delta T)]$

$\Delta T = \frac{0.10}{3.8e^{-3}\frac{1}{K}} = 26.3\ K$

5) $R = R_0[1+\alpha(T-T_0)]$

$R_2 = R_0 + R_0\alpha T - R_0\alpha T_0$

$\frac{\Delta V}{I} + R_0 + R_0\alpha T_0 = R_0\alpha T$

$T = \frac{\left(\frac{\Delta V}{I} + R_0(\alpha T_0 - 1)\right)}{R_0\alpha}$

$= \frac{\left(\frac{30V}{0.285A}\right) + 18\Omega\left((4.5e^{-3}\frac{1}{K})(273.20K) - 1\right)}{(18\Omega)(4.5e^{-3}\frac{1}{K})}$

$= 2.07\times10^{3}\ K$

6) $R_{eq} = 1+3+5k\Omega = 9k\Omega$

7) $R_{eq} = \left(\frac{1}{2.0k\Omega} + \frac{1}{4.0k\Omega} + \frac{1}{6.0k\Omega}\right)^{-1}$

$= 1.09\ k\Omega$

8) a) $I = \frac{V}{R} = \frac{12.0V}{10.0\Omega} = 1.20A$

b) $P = IV = (1.20A)(12.0V) = 14.4\ W$

c) $P_{batt.} = -P_{res} = +14.4\ W$

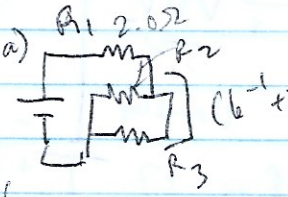
d) $P_{batt} + P_{res} = 0$

e) $P = (-1.20A)(12.0V) = -14.4$

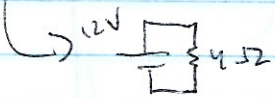
9) a) $I = \frac{V}{R} = \frac{15.0V}{5.0\Omega} = 3.0\ A$

b) $P = IV = (3.0A)(15.0V) = 45\ W$

$P_{batt} = -P_{res} = -45W$

10) a) 

$(6^{-1}+3^{-1})^{-1} = 2\Omega$



b) $I_{through} = \frac{V}{R_{eq}} = \frac{12V}{4\Omega} = 3.0\ A$

$R_1 = 2\Omega$ $\quad R_2 = 6\Omega$ $\quad R_3 = 3\Omega$

R_1 gets all the current, so $I_1 = 3.0A$

through $\Delta V = IR = (3.0A)(2.0\Omega) = 6V$

R_2 & R_3 - voltage =, current >, 1/R

$V_2 = 6V$, $V_3 = 6V$ $\quad I_2 = \frac{V_2}{R_2} = \frac{6V}{6\Omega} = 1.0A$

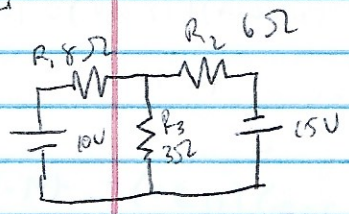
$I_3 = \frac{V_3}{R_3} = \frac{6V}{3\Omega} = 2A$

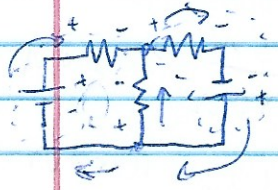
battery $\Rightarrow I = 3.0A,\ R = 0,\ V = 12V$

$P_{batt} = I^2R = IV = (12V)(3.0A)$
$= -36.0W$

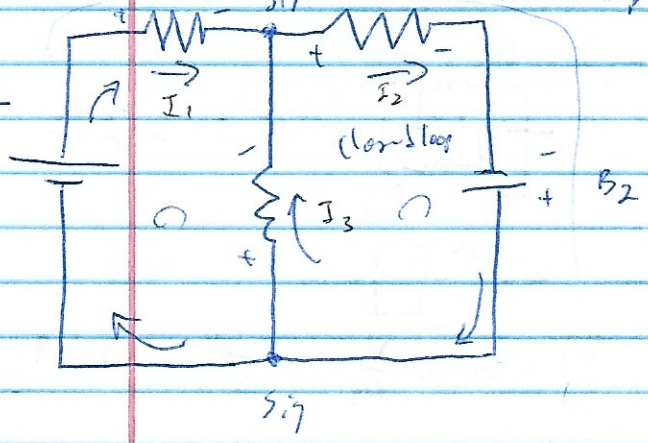
$P_1 = IV = (6V)(3.0A) = 18W$
$P_2 = IV = (1A)(6V) = 6W$
$P_3 = IV = (2A)(6V) = 12W$
$P_{My\ batt} = 36W$

(1)





current in = current out



$15V = V_3 + V_2$ $\quad -I_1 + I_2 + I_3 = 0$

$V_1 + V_2 = 25V$ $\quad -I_2 + I_1 - I_3 = 0$

blue loop

$V_1 = I_1R_1$ $\quad V_3 = I_3R_3$
$V_2 = I_2R_2$

$15V = I_3R_3 + I_2R_2$

$I_1 = I_2 + I_3$

$10V = I_1R_1 - I_3R_3$

$(3\Omega)I_3 + (6\Omega)I_2 + 0I_1 = 15V$
$(8\Omega)I_1 + 0I_2 - (3\Omega)I_3 = 10V$
$-I_1 + I_2 + I_3 = 0V$

↓ eqn solver

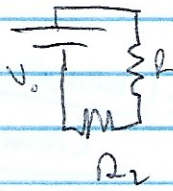
$I_1 = -2.5A$ $I_2 = 7.5A$ $I_3 = -10A$

$10V = (I_2)R_1 + I_3R_1 - I_3R_3$

$I_2 \quad 15V - I_3R_3$ / R_2

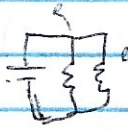
$I_1 = 1.5A$ $\quad I_2 = 2.2A$ $\quad I_3 = -0.67A$

(1)



$P = I^2R_{Eq}$
$\Delta V = IR$
$I = \frac{\Delta V}{R}$
$R_{Eq} = (R_1 + R_2)$

$P_{ser} = \frac{V_0^2}{R_{Eq}} = \frac{V_0^2}{(R_1 + R_2)}$



$R_{Eq} = \left(\frac{1}{R_1} + \frac{1}{R_2}\right)^{-1}$
$= \left(\frac{R_1 + R_2}{R_1R_2}\right)^{-1}$
$= \frac{R_1R_2}{R_1 + R_2}$

$P_{par} = \frac{V_0^2(R_1 + R_2)}{R_1R_2}$

$\frac{P_{par}}{P_{ser}} = \frac{(R_1 + R_2)^2}{R_1R_2}$

13) $\Delta V = IR = (0.001\,A)(5.0\times10^{4}\,\Omega)$

$= \boxed{50\,V}$

14) a) $I = \frac{V}{R} = \frac{12.0\,V}{10.53\,\Omega}$

$= 1.14\,A$

b) $V_{term} = V_{bat} - V_{res.}$

$= 12.0\,V - IR$

$= 12.0\,V - (1.14\,A)(0.53\,\Omega)$

$= \boxed{11.4\,V}$

c) $\Delta V = IR = (1.1\,A)(10\,\Omega)$

$= 11.4\,V$

d) $P_r = I^2 r = (1.14\,A)^2(0.53\,\Omega)$

$= \boxed{0.69\,W}$

15) $I = \frac{\Delta V}{r} = \frac{12\,V}{0.53\,\Omega} = \boxed{22.6\,A}$

$P = I^2 r = (22.6\,A)^2(0.53\,\Omega)$

$= \boxed{271\,W}$

16) $r = R_{eq}$

$R_{eq} = R + \left(\frac{1}{R} + \frac{1}{R}\right)^{-1}$

$= R + \frac{R}{2} = \frac{3}{2}R$

$r = \frac{3}{2}R$

17) $I = I_0 e^{-t/RC}$

$\frac{I_0}{2} = I_0 e^{-t/RC}$

$e^{-t/RC} = \frac{1}{2}$

$\ln\left(\frac{1}{2}\right) = -\frac{t}{RC}$

$t = -\ln\left(\frac{1}{2}\right)RC$

$= 0.693(RC) = 0.693\,\tau$

18) $I = \frac{V_0}{R} e^{-t/RC}$

$= -I_0 e^{-t/RC}$

$\frac{I_0}{2} = -I_0 e^{-t/RC}$

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

$\frac{Q_0}{2} = Q_0 e^{-t/RC}$

$\ln\left(\frac{1}{2}\right) = -e^{-t/RC}$

$\boxed{t = 0.693\,\tau}$

19) $PE = \frac{1}{2}QV = \frac{1}{2}Q_0V_0 e^{-t/RC}$

$PE = \frac{1}{2}\frac{Q^2}{C}$

$\frac{Q^2}{C} = \frac{Q_0^2}{C} e^{-t/RC}$

$PE = \frac{1}{2C} Q_0^2 e^{-2t/\tau} \rightarrow = PE_0$

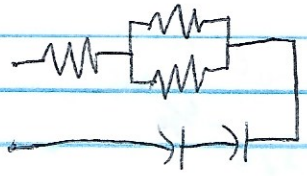
$PE = PE_0 e^{-2t/\tau}$

$\frac{PE_0}{2} = PE_0 e^{-2t/\tau}$

$-\frac{2t}{\tau} = \ln\left(\frac{1}{2}\right)$

$\boxed{t = 0.347\,\tau}$

20) $\tau = RC$



$R_{eq} = R + \frac{1}{2}R = \frac{3}{2}R$

$C_{eq} = \left(\frac{1}{C} + \frac{1}{C}\right)^{-1} = \frac{1}{2}C$

$\tau_C = \frac{3}{4}RC$