HW7 Garrett + Haldrop Ch 27

PS: 1, 3, 12, 16, 18, 22, 29, 33, 58, 64

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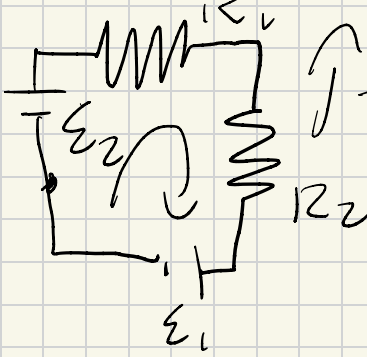
1) $\mathcal{E}_1 = 12V$ $\mathcal{E}_2 = 6V$ $R_1 = 4\Omega$ $R_2 = 8\Omega$



$I = \mathcal{E}_2 - IR_1 - IR_2 - \mathcal{E}_1 = 0$

IR_{eq}

$R_{eq} = R_1 + R_2$

$= 4\Omega + 8\Omega$

$R_{eq} = 12\Omega$

$6V - 12\Omega I - 12V = 0$

$-12\Omega I = 6V$

$I = -0.5A$

a) 0.5A

b) 1W

c) 2W

d) 6W

e) 3W

f) supplied

g) absorbed

$P = I^2R$

$P_1 = I^2R_1$ $P_2 = I^2R_2$

$P_1 = 0.5^2 \cdot 4\Omega$ $P_2 = 0.5^2 \cdot 8\Omega$

$P_1 = 1W$ $P_2 = 2W$

$P = IV$ $P_{V1} = 0.5A \cdot 12V$

$P_{V2} = I \cdot \mathcal{E}_2$ $P_{V1} = 6W$

$= 0.5A \cdot 6V$

$P_{V2} = 3W$

3) $\mathcal{E} = 12V \quad R = 0.04\Omega \quad I = 50A$

$\Delta V = \mathcal{E} - IR$

↙ being charged

$= 12V - 0.04\Omega \cdot 50A$

$= 12V + 2V$

$= 14V$

a) 14V
b) 100W
c) 600W
d) 10V
e) 100W

$P_r = V_r \cdot I$

$V_r = RI$

$V_r = 0.04 \cdot 50$

$V_r = 2$

$P_r = 2 \cdot 50A$

$P_r = 100W$

$P_{emf} = \mathcal{E} \cdot I$

$= 12V \cdot 50$

$= 600W$

↓ discharging

$\Delta V = \mathcal{E} - V_r$

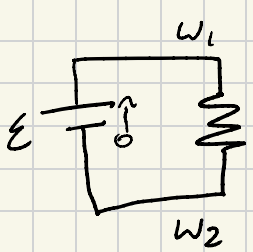
$= 12V - 2V$

$\Delta V = 10V$

$P_r = V_r \cdot I$

$P_r = 100W$

12) $R = 6\Omega \quad \mathcal{E} = 12V \quad n = 2 \quad l = 20cm \quad r = 1mm \quad \rho_{copper} = 1.69 \times 10^{-8}\,\Omega m$



$R_{W1} = \rho \frac{l}{A}$

$A = \pi r^2$

$A = \pi\, 1mm^2$

$R_{W1} = 1.69e\text{-}8 \cdot \frac{20cm}{3.14mm^2} \quad A = 3.14mm^2$

$R_{W1} = 1.08m\Omega$

$R_{W1} = R_{W2}$

$R_{eq} = R_{W1} + R + R_{W2}$

$= 1.08m\Omega + 6\Omega + 1.08m\Omega$

$R_{eq} = 6.002\Omega$

$I = \frac{\mathcal{E}}{R}$

$= \frac{12V}{6.002\Omega}$

$I = 1.999A$

$P_R = I^2 R \quad P_R = 1.999A^2 \cdot 6\Omega$

$P_R = 23.98W$

$P_W = I^2 \cdot R_{W1} = 1.999 \cdot 1.08m\Omega = 4.3mW$

$\Delta V_{W1} = I R_{W1}$

$= 1.999A \cdot 1.08m\Omega$

$\Delta V_{W1} = 2.15mV$

$\Delta V_{W1} = \Delta V_{W2}$

$\Delta V_R = IR$

$= 1.999A \cdot 6\Omega$

$\Delta V_R = 11.996V$

a) 11.996V b) 2.15mV
c) 23.98W d) 4.3mW

16) $\Delta V_1 = 0.1V$ $R_1 = 500\Omega$ $A = 5cm^2$ Power Rate $= 2\frac{mW}{cm^2}$

$\Delta V_2 = 0.15V$ $R_2 = 1000\Omega$ $P_{in} = A \cdot$ Power Rate

$= 5cm^2 \cdot 2mW/cm^2$

$I_1 = \frac{\Delta V_1}{R_1} = \frac{0.1V}{500\Omega} = 0.2mA$ $P_{in} = 10mW$

$I_2 = \frac{\Delta V_2}{R_2} = \frac{0.15V}{1000\Omega} = 0.15mA$ $P_{out} = \frac{V^2}{R} = \frac{0.15^2}{1000} = 0.0225mW$

$\mathcal{E} - I_1 r = \Delta V_1$ $\mathcal{E} - I_2 r = \Delta V_2$ $eff = \frac{P_{out}}{P_{in}} \times 100$

$\mathcal{E} = \Delta V_1 + I_1 r$ $\mathcal{E} = \Delta V_2 + I_2 r$ $= \frac{0.0225mW}{10mW} \times 100$

$\Delta V_1 + I_1 r = \Delta V_2 + I_2 r$

$0.1V + 0.2r = 0.15 + 0.15r$ $eff = 0.225\%$

$0.2V = 0.05V + 0.15r$

$0.05mAr = 0.05V$

$r = 1000\Omega$

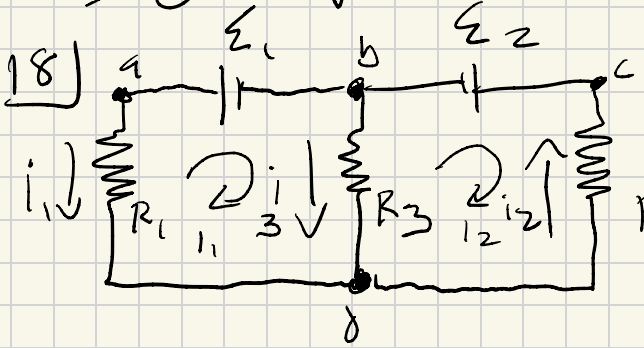
a) 1000Ω
b) $0.3V$
c) 0.225%

$\mathcal{E} = \Delta V_1 + I_1 r$

$= 0.1V + 0.2mA \cdot 1000\Omega$

$= 0.3V$

18)



$\mathcal{E}_1 = 4V$ $\mathcal{E}_2 = 1V$ $V_{dc} = V_{R2}$

$R_1 = R_2 = 10\Omega$ $V_{R2} = I_2 \cdot R_2$

$R_3 = 5\Omega$ $= 0.025A \cdot 10\Omega$

$V_{R2} = 0.25V$

$i_1 + i_3 = i_2$

$0.275A + -0.25A = i_2$

$i_2 = 0.025A$

$\Delta V_{dc} = 0.25V$

$I_1 \quad -\mathcal{E}_1 - i_3 R_3 + i_1 R_1 = 0$

$I_2 \quad \mathcal{E}_2 + i_2 R_2 + i_3 R_3 = 0$

$\mathcal{E}_2 + (i_1 + i_3) R_2 + i_3 R_3 = 0$

$\mathcal{E}_2 + i_1 R_2 + i_3 R_2 + i_3 R_3 = 0$

$i_3 = \frac{-\mathcal{E}_2 - i_1 R_2}{R_2 + R_3}$

$= \frac{-1V - 0.275A \cdot 10\Omega}{15\Omega}$

$i_3 = -0.25A$

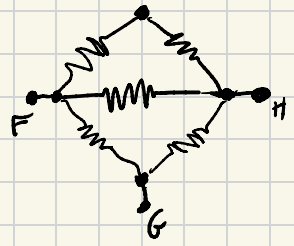
$-\mathcal{E}_1 - \left(\frac{-\mathcal{E}_2 - i_1 R_2}{R_2 + R_3}\right) R_3 + i_1 R_1 = 0$

$-4V - \left(\frac{-1V - i_1 10\Omega}{15\Omega}\right) 5\Omega + i_1 10\Omega = 0$

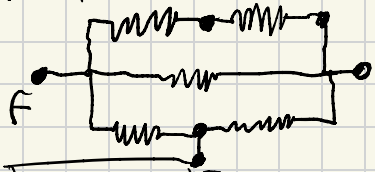
$-4V + \frac{1}{3}V + i_1 \frac{10}{3}\Omega + i_1 10\Omega = 0$

$i_1 = \frac{11}{110}A = 0.275A$ $i_1 \frac{40}{3}\Omega = \frac{11}{3}V$

22) $R = 5\Omega$



1) F to H



$R_{eq} = 1\Omega$

$\frac{1}{R_{eq}} = \frac{1}{R_{12}} + \frac{1}{R_3} + \frac{1}{R_{45}}$

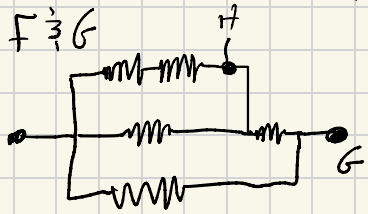
$\frac{1}{R_{12}} = \frac{1}{R_{45}} = \frac{1}{R_1} + \frac{1}{R_2}$

$= \frac{1}{5} + \frac{1}{5} = \frac{2}{5}$

$R_{12} = 2.5\Omega$

$\frac{1}{R_{eq}} = \frac{1}{2.5\Omega} + \frac{1}{5\Omega} + \frac{1}{2.5\Omega} = \boxed{1\Omega}$

2) F to G



$\frac{1}{R_{eq}} = \frac{1}{R_{1234}} + \frac{1}{R_5}$ $R_{12} = 10\Omega$

$R_{1234} = R_{123} + R_4$ $\frac{1}{R_{123}} = \frac{1}{10} + \frac{1}{5} = \frac{3}{10}$

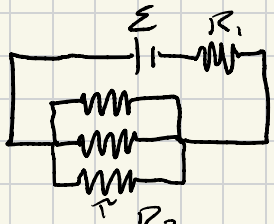
$\frac{1}{R_{123}} = \frac{1}{R_{12}} + \frac{1}{R_3}$ $R_{123} = \frac{10}{3}\Omega$

$R_{12} = R_1 + R_2$ $R_{1234} = \frac{10}{3}\Omega + 5\Omega = \frac{25}{3}\Omega$

$\frac{1}{R_{eq}} = \frac{3}{25} + \frac{1}{5} = \frac{8}{25}$

$R_{eq} = \frac{25}{8}\Omega = \boxed{3.125\Omega}$

29) $R_1 = 6\Omega$ $R_2 = 18\Omega$ $\mathcal{E} = 12V$



$R_{eq} = R_1 + \frac{1}{\frac{1}{R_2} + \frac{1}{R_2} + \frac{1}{R_2}}$

$R_{eq} = R_1 + \frac{R_2}{3}$

$R_{eq} = 6\Omega + \frac{18\Omega}{3}$

all above $R_{eq} = 12\Omega$

$I = \frac{V}{R_{eq}}$

$I = \frac{12V}{12\Omega}$

$I = 1A$

$i_1 = \frac{I}{3}$

$i_1 = \frac{1}{3}A$

a) $\frac{1}{3}A$

b) right

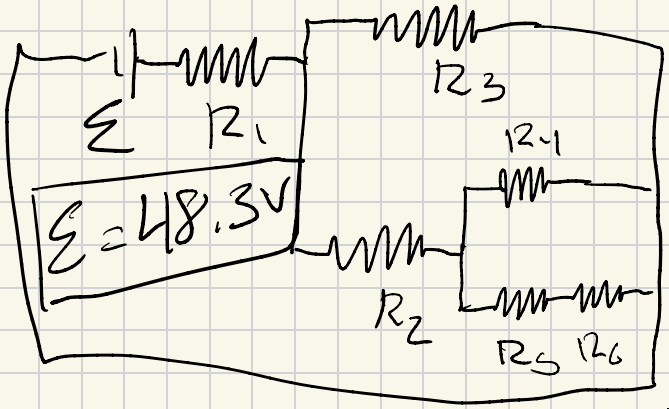
c) 720 J

$W = \frac{J}{s}$ $t = 60s$

$P = IV = 1A \cdot 12V = 12W$

$12W \cdot 60s = 720J$

33) $I_6 = 1.4A$ $R_1 = R_2 = R_3 = 2\Omega$ $R_4 = 16\Omega$ $R_5 = 8\Omega$ $R_6 = 4\Omega$ $I_5 = I_6$



$R_{eq} = R_1 + R_{2345G}$

$\frac{1}{R_{2345G}} = \frac{1}{R_3} + \frac{1}{R_{245G}}$

$R_{245G} = R_2 + R_{45G}$

$\frac{1}{R_{45G}} = \frac{1}{R_4} + \frac{1}{R_{5G}}$

$R_{5G} = R_5 + R_6$

$R_{5G} = 12\Omega$

$R_{45G} = 6.86\Omega$

$R_{245G} = 8.86\Omega$

$R_{2345G} = 1.63\Omega$

$R_{eq} = 3.63$

$V_6 = I_6 \cdot R_6$

$V_6 = 1.4 \cdot 4$

$V_6 = 5.6V$

$V_5 = I_6 R_5$

$V_5 = 1.4 \cdot 8$

$V_5 = 11.2V$

$V_{5G} = V_4$

$V_5 + V_6 = V_4$

$5.6 + 11.2 = V_4$

$V_4 = 16.8V$

$I_4 = \frac{V_4}{R_4}$

$I_4 = \frac{16.8V}{16\Omega}$

$I_4 = 1.05A$

$I_2 = I_4 + I_6$

$I_2 = 1.05A + 1.4A$

$I_2 = 2.45A$

$I_3 = \frac{V_3}{R_3}$

$I_3 = \frac{21.7V}{2\Omega}$

$I_3 = 10.85A$

$I_1 = I_3 + I_2$

$I_1 = 10.85 + 2.45$

$I_1 = 13.3A$

$V_2 = I_2 R_2$

$V_2 = 2.45A \cdot 2\Omega$

$V_2 = 4.9V$

$V_1 = I_1 R_1$

$V_1 = 13.3A \cdot 2$

$V_1 = 26.6V$

$V_3 = V_2 + V_{5G}$

$V_3 = 4.9V + 16.8V$

$V_3 = 21.7V$

$V_{tot} = V_1 + V_3$

$V_{tot} = 26.6V + 21.7V$

$V_{tot} = 48.3V$

58) $\mathcal{E}=12V$ $R=1.4M\Omega$ $C=1.8\mu F$ $q_{end}=16\mu C$

$\tau = R \cdot C$
$\tau = 1.4M\Omega \cdot 1.8\mu F = 2.52s$

$Q = \mathcal{E} \cdot C$
$Q = 12V \cdot 1.8\mu F = 21.6\mu C$

$q_{end} = Q(1-e^{-t/RC})$ $16\mu C = 21.6\mu C(1-e^{-t/2.52})$

$0.74 = 1-e^{-t/2.52}$

$e^{-t/2.52} = 0.259$

$\frac{-t}{2.52} = \ln(0.259)$

$-t = 2.52\ln(0.259)$

$t = 3.41$ seconds

a) $\tau = 2.52sec$
b) $Q = 21.6\mu C$
c) $3.41sec$

64) $V = 100V$

$V = V_0 e^{-\frac{t}{RC}}$ $V_{17} = 100Ve^{-\frac{17s}{2.17s}}$

$1V = 100Ve^{-\frac{10s}{RC}}$ $V_{17} = 39.6mV$

$\frac{1}{100} = e^{-\frac{10s}{RC}}$

$\ln(\frac{1}{100}) = -\frac{10s}{RC}$

$RC = \frac{-10s}{\ln(\frac{1}{100})}$

$RC = 2.17sec$

a) $2.17sec = \tau$
b) $39.6mV = V_{17}$