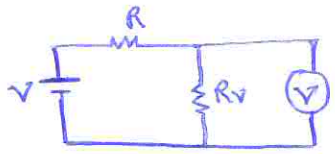
2.10.1)



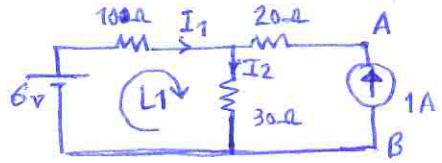
case I) $V = (R + R_V) I_1 = R I_1 + R_V I_1$ & $R_V I_1 = 15 \Rightarrow I_1 = 7.5 \times 10^{-4}$

case II) $V = (R + R_V) I_2 = R I_2 + R_V I_2$ & $R_V I_2 = 18 \Rightarrow I_2 = 3.6 \times 10^{-4}$

$\Rightarrow (7.5 \times 10^{-4}) R + 15 = (3.6 \times 10^{-4}) R + 18 \Rightarrow R = 770\ \Omega$

$V = 20.8\ V$

2.10.2)

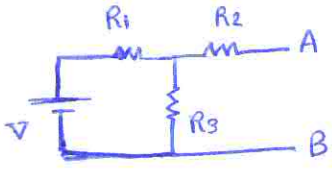


L1: $6 = 10 I_1 + 30 (I_1 + \underbrace{I_A}_{=1A}) \Rightarrow I_1 = -0.6\ A$

$I_2 = 1_A + I_1 = 0.4\ A$

$V_{AB} = I_A (20\Omega) + I_2 (30\Omega) \Rightarrow V_{AB} = 32\ V$

2.10.3)



$V_{eq} = I_1 R_3$

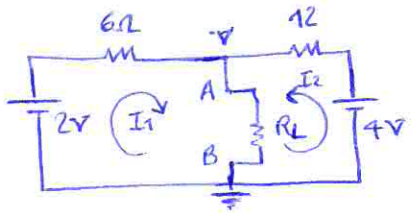
$I_1 = \frac{V}{R_1 + R_3}$

$\Rightarrow V_{eq} = \frac{V R_3}{R_1 + R_3}$

$R_{eq} = R_1 + \frac{1}{\frac{1}{R_2} + \frac{1}{R_3}} = \frac{R_1 R_2 + R_2 R_3 + R_3 R_1}{R_2 + R_3}$

$I_{eq} = \frac{V_{eq}}{R_{eq}} = \frac{V R_3}{R_1 R_2 + R_2 R_3 + R_3 R_1}$

2.10.4)



$= \frac{V}{R}$

$I_1 = \frac{2V}{6\Omega} = \frac{1}{3}A$

$I_2 = \frac{4V}{12\Omega} = \frac{1}{3}A$

$\Rightarrow I_{eq} = I_1 + I_2 = \frac{2}{3}A$

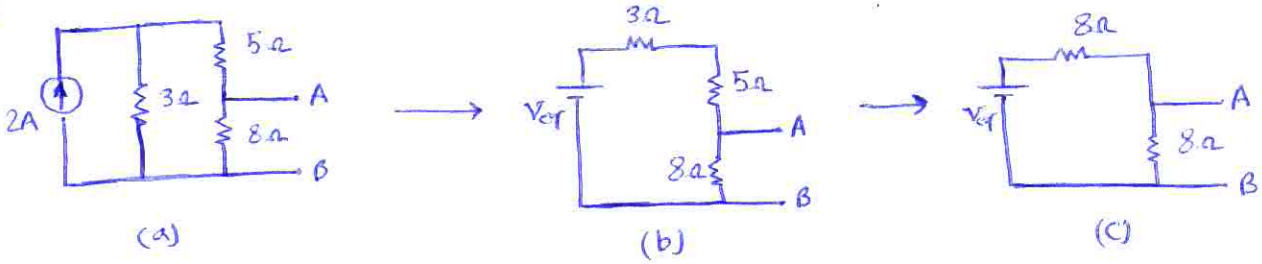
$R_{eq} = \frac{R_1 R_2}{R_1 + R_2} = 4\Omega$, $V_{eq} = I_{eq} R_{eq} = \frac{8}{3}V$

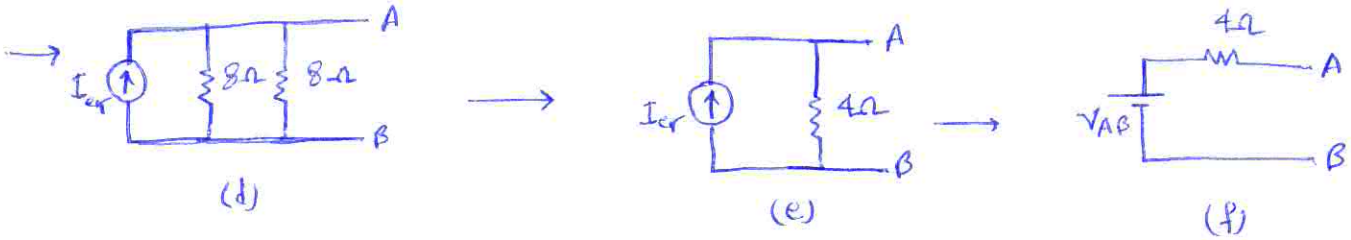
$V_{AB} = I_{eq} R$

$R = \frac{R_L R_{eq}}{R_L + R_{eq}}$

$\Rightarrow V_{AB} = \frac{8 R_L}{3(4 + R_L)}$

2.10.5)





(a) → (b) : $V_{eq} = I_{eq} R_{eq} = (2A)(3\Omega) = 6V$

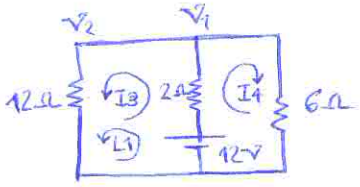
(c) : $\frac{V_{eq}}{16\Omega} = \frac{V_{AB}}{8\Omega} \longrightarrow V_{AB} = 3V$

$R_{eq} = \frac{(8\Omega)(8\Omega)}{(8\Omega + 8\Omega)} = 4\Omega$, $I_{eq} = \frac{V_{eq}}{R_{eq}} = \frac{3V}{4\Omega} = 0.75A$

2.10 6) a)
$$\begin{cases} 24 I_1 + 24(I_1 - I_2) = 0 \\ 24(I_2 - I_1) + 6(I_2 - I_3) = 0 \\ 2(I_3 + I_4) + 8 I_3 + 6(I_3 - I_2) = 12 \\ 2(I_3 + I_4) + 8 I_4 = 12 \end{cases}$$

b) $R_{eq} = 2\Omega + \dfrac{1}{\frac{1}{6\Omega} + \frac{1}{12\Omega}} = \underline{6\Omega}$

$I = \dfrac{V}{R_{eq}} = \underline{2A = I_3 + I_4}$



c) $12V - V_1 = 2\Omega \times \underbrace{(I_3 + I_4)}_{2A} \Rightarrow \underline{V_1 = 8V}$

L1: $12V = 2\Omega \times 2A + (12\Omega)(I_3) \Rightarrow \underline{I_3 = \frac{2}{3}A}$

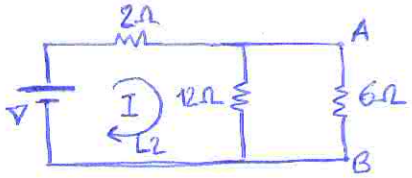
$V_2 - V_1 = 8 I_3 \Rightarrow \underline{V_2 = \frac{8}{3}V}$

d) $I_3 + I_4 = 2 \Rightarrow \underline{I_4 = \frac{4}{3}A}$

$V_2 = (I_3 - I_2)6\Omega \Rightarrow \frac{8}{3} = 4 - 6 I_2 \Rightarrow \underline{I_2 = \frac{2}{9}A}$

$V_2 = I_1(24\Omega) \Rightarrow \underline{I_1 = \frac{1}{9}A}$

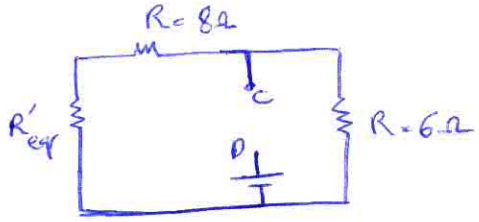
e)



$\dfrac{1}{R_{eq}} = \dfrac{1}{12} + \dfrac{1}{2} \Rightarrow \underline{R_{eq} = \frac{24}{14}\Omega}$

L2: $12 = 12I + 2I \Rightarrow \underline{I = \frac{12}{14}A} \Rightarrow \underline{V_{eq} = IR = \left(\frac{12}{14}A\right)(12\Omega) = \frac{144}{14}V}$

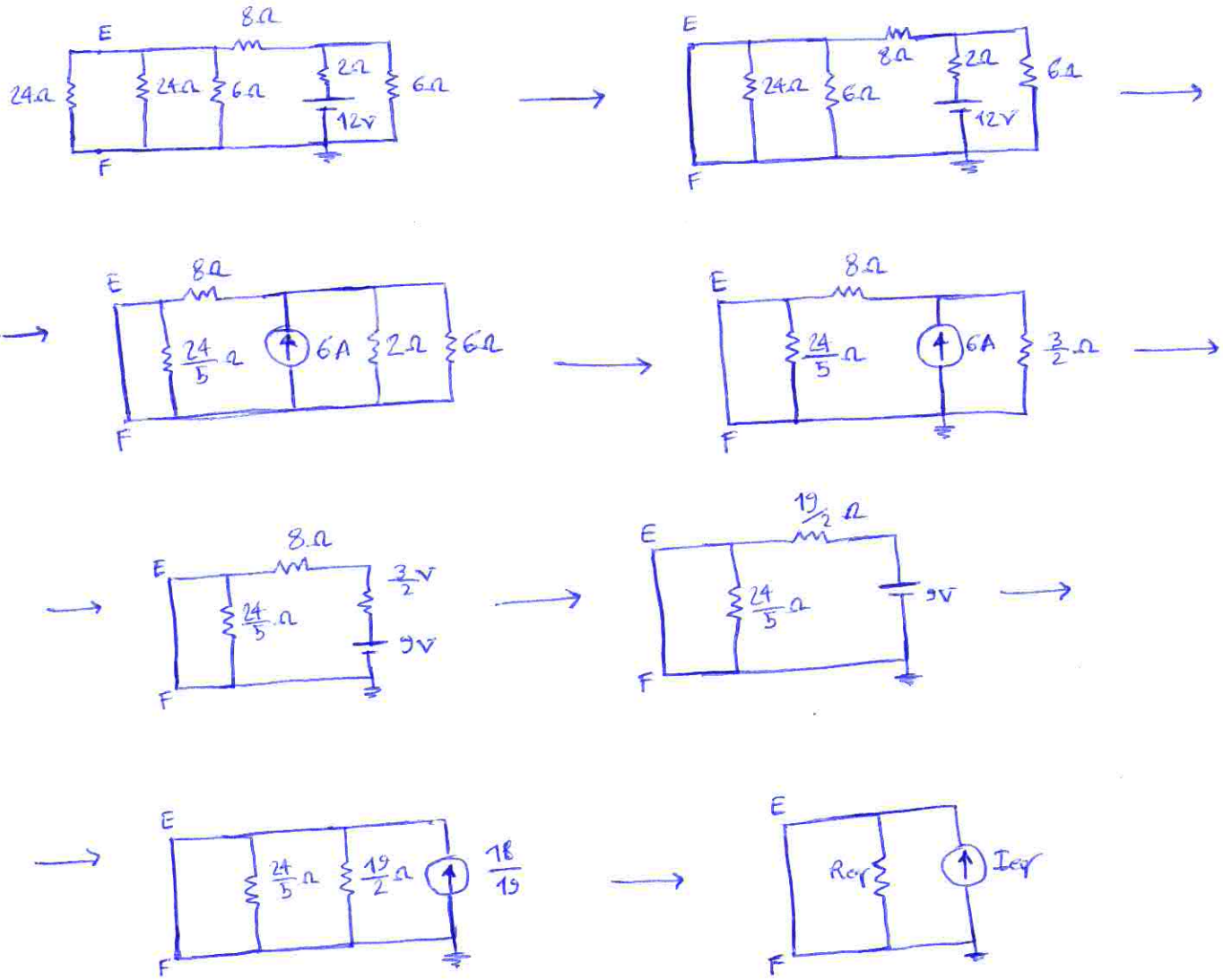
f)



$R'_{eq} = 4\Omega$, $R_N = \dfrac{1}{\dfrac{1}{R'_{eq} + 8\Omega} + \dfrac{1}{6\Omega}} \Rightarrow \boxed{R_N = 4\Omega}$

$I_N = \dfrac{V}{R_N} = \dfrac{12V}{4\Omega} = \boxed{3A}$

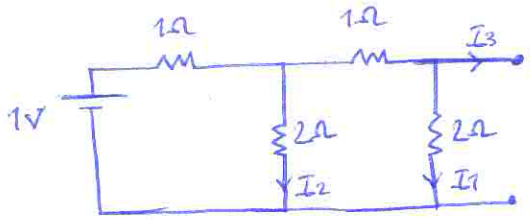
g) chris' solution :

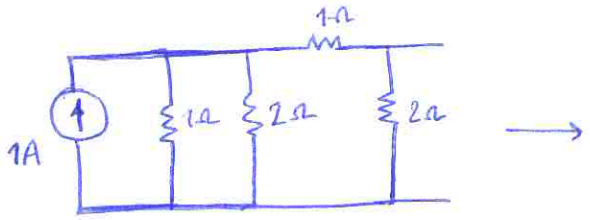


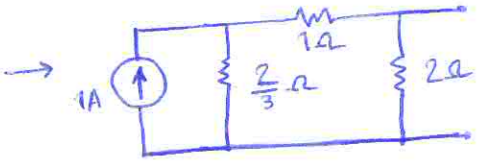
$I_{eq} = I_N = \boxed{\dfrac{18}{19} A}$

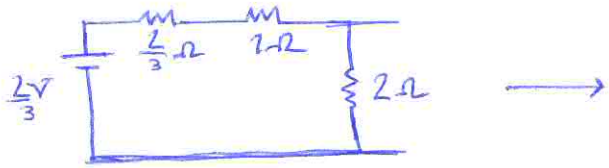
$R_{eq} = \dfrac{\frac{20}{5} \times \frac{19}{2}}{20 \cdot 19}\ \Omega \longrightarrow \boxed{R_{eq} = \dfrac{456}{143}\ \Omega}$

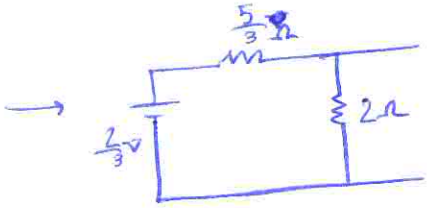
2.10.9)

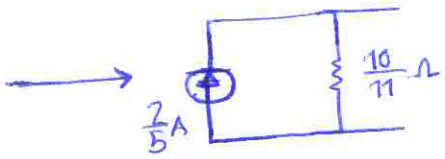




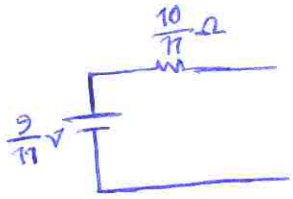








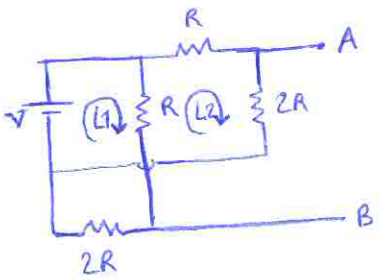
$$\epsilon \quad I = \frac{\frac{2}{3}V}{\frac{5}{3}\Omega} = \frac{2}{5}A$$

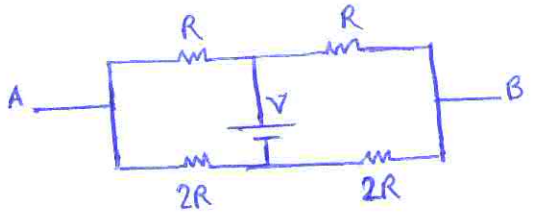


$$V = \left(\frac{2}{5}A\right)\left(\frac{10}{11}\Omega\right) = \frac{4}{11}V$$

$$R = \frac{1}{\frac{1}{\frac{5}{3}} + \frac{1}{2}} = \frac{10}{11}\Omega$$

2.10.10)





$$R_{eq} = \frac{1}{\frac{1}{R} + \frac{1}{2R}} + \frac{1}{\frac{1}{R} + \frac{1}{2R}} = \frac{4}{3}R$$

$$\left.\begin{array}{l} L1: \; V - 3RI_1 = 0 \\ L2: \; V - 3RI_2 = 0 \end{array}\right\} \Rightarrow I_1 = I_2 = \frac{V}{3R}$$

$$V_{AB} = RI_2 - RI_1 = 0$$

3.12.7)

$$\left.\begin{aligned} V_R(t) + V_C(t) &= 12V \\ V_R(t) &= V_0 e^{-\frac{t}{RC}} \end{aligned}\right\} \Rightarrow V_C(t) = 12\left(1 - e^{-\frac{t}{RC}}\right) \left.\begin{aligned} &\\ R &= 1\,M\Omega \\ C &= 20\,\mu F \end{aligned}\right\} \Rightarrow$$

$$\Rightarrow V_C(t) = 12\left(1 - e^{-\frac{t}{20}}\right)$$

3.12.8)

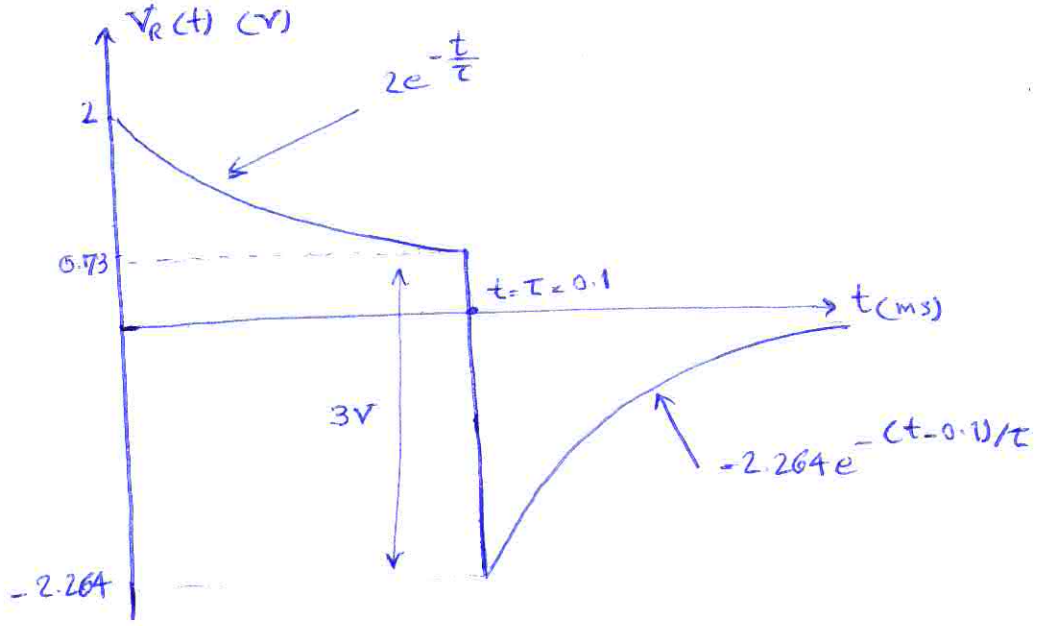
A : $V_A = V_0 e^{-\frac{t}{\tau}}$, $V_0 = 2V$, $\tau = RC$

after one time constant : $V_A = 2e^{-1} \simeq 0.736\,V$

B : $V_B = V' e^{-\frac{(t-t_0)}{\tau}}$

$V' = V_A - 3 \xrightarrow{-2-1}$ $\Rightarrow$ $V' = -2.264\,V$

$$V_B = -2.264\, e^{-\frac{(t-0.1)}{\tau}}$$



3.12.9)

$$V(t) = V\left(1 - e^{-\frac{t}{RC}}\right) \quad , \quad C = 20\,\mu F$$

$$R = \frac{1}{\frac{1}{10\,k\Omega} + \frac{1}{22\,k\Omega}} = \underline{6.875\,k\Omega}$$

$$\left.\begin{aligned} V &= 6 - I(10\,k\Omega) \\ I &= \frac{6V}{32\,k\Omega} = 187\,\mu A \end{aligned}\right\} \Rightarrow \underline{V = 4.125\,V}$$

$$\Rightarrow \underline{V(t) = 4.125\left(1 - e^{-\frac{t}{0.1375}}\right)}$$

3.12.10)

$$I(t) = \frac{V_0 - V_R(t)}{R} \quad , \quad V_0 = \frac{q}{C_1}$$

$$I(t) = \frac{V_0 - V_0 e^{-\frac{t}{RC'}}}{R} \quad , \quad C' = \left(\frac{1}{C_1} + \frac{1}{C_2}\right)^{-1}$$

$$\Rightarrow \underline{I(t) = \frac{q}{RC_1}\left(1 - e^{-\frac{t}{RC'}}\right)}$$

$$\Delta E = E_1 - E_2 = \frac{1}{2}\frac{q^2}{C_1} - \frac{1}{2}\frac{q^2}{C_1 + C_2} \Rightarrow \underline{\Delta E = \frac{1}{2}\frac{q^2 C_2}{C_1(C_1 + C_2)}}$$
