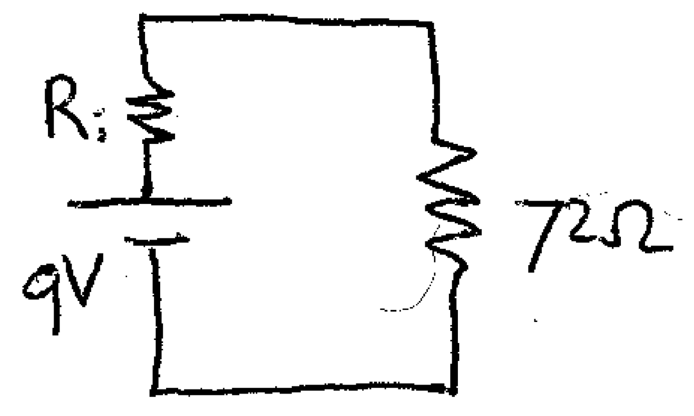
Ch 18

1)



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

$\left.\begin{array}{l} \Delta V = I \cdot R \\ I = 117\,mA \\ R = 72\,\Omega \end{array}\right\} \Delta V = 8.42\,V$

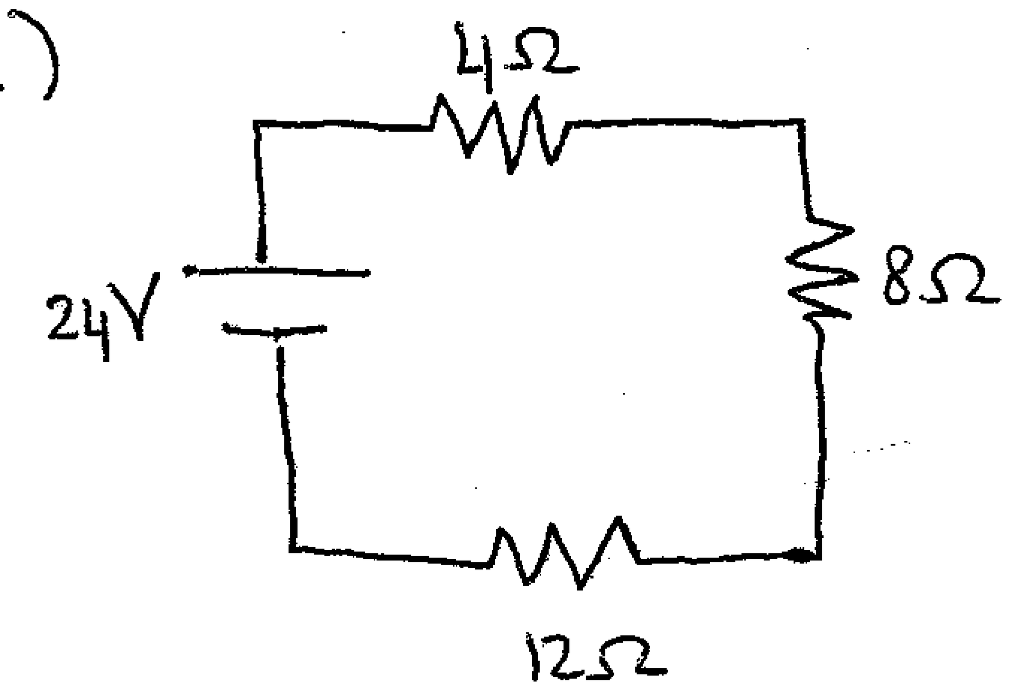
$\mathcal{E} = 9V \quad I = 117\,mA \quad \Delta V = 8.42\,V \;\}\; R_i = (\mathcal{E} - \Delta V)/I = 4.92\,\Omega$

Note: This is one way of solving the problem using the formula given. Two (better) ways of solving this problem is:

① pretend R_i is just a regular resistor and add the two resistors up in series

② use Kirchhoffs' voltage loop law/rule

2)

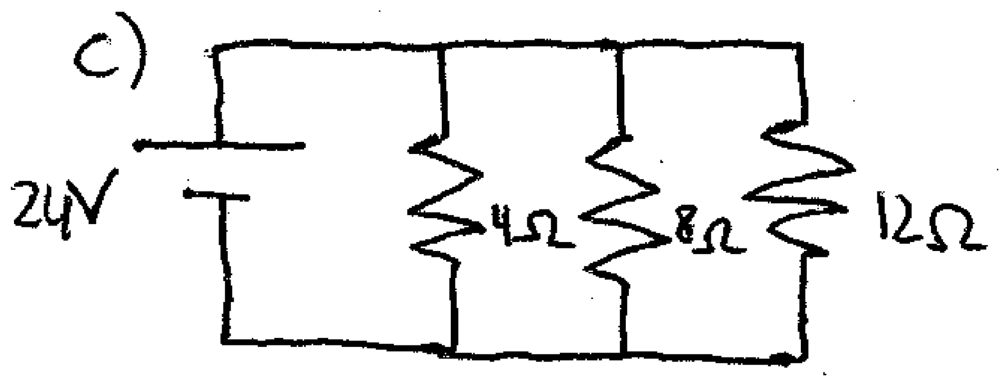


a) the resistors are connected in series:

$R_{eq} = 4\Omega + 8\Omega + 12\Omega = 24\Omega$

b) $I = V/R = 24V/24\Omega = 1.0A$ in each resistor because current is the same in series.

c)



a) the resistors are in parallel:

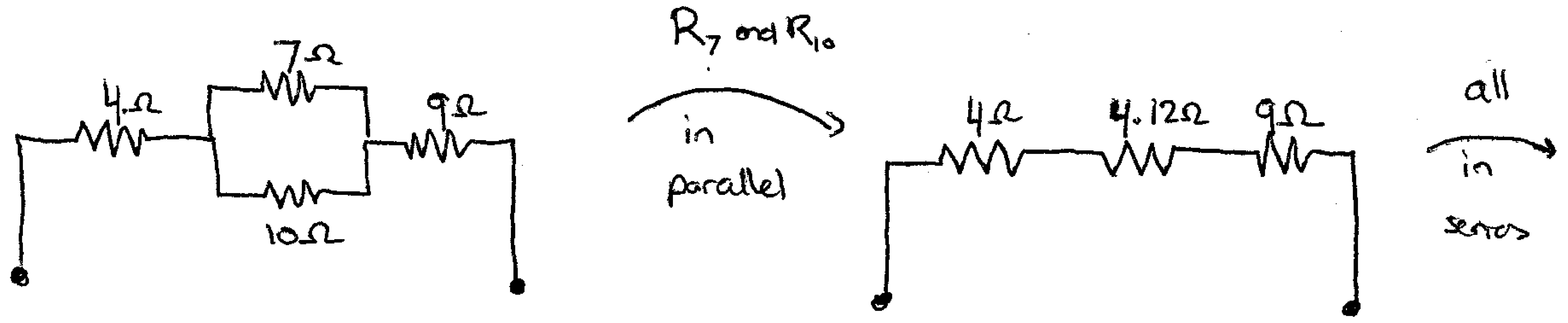
$R_{eq} = 1/R_1 + 1/R_2 + 1/R_3 = \mathbf{2.2}\,\Omega$

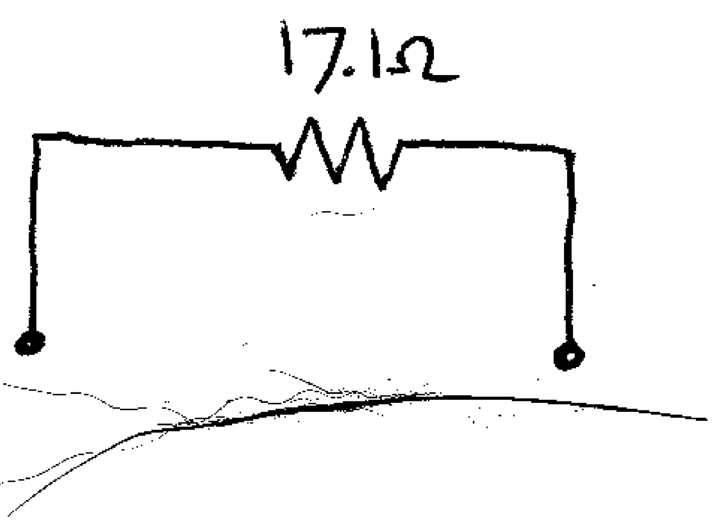
b) $I = V/R$ the voltage is the same in parallel:

$V = 24V$ for all resistors

$I_{4\Omega} = 6.0A \quad I_{8\Omega} = 3.0A \quad I_{12\Omega} = 2.0A$

5a)





$R_{eq} = 17.1\Omega$

b) As with capacitors, work your way backwards:

$R_{17\Omega}$: $V_{17} = 34.0V$ $I_{17} = 2.00A$

$R_{9\Omega}$: $\boxed{I_9 = 2.00A}$ because the current is equal for resistors in series, therefore $R_{4\Omega}$: $\boxed{I_4 = 2.00A}$ and $I_{4.12} = 2.00A$ also.

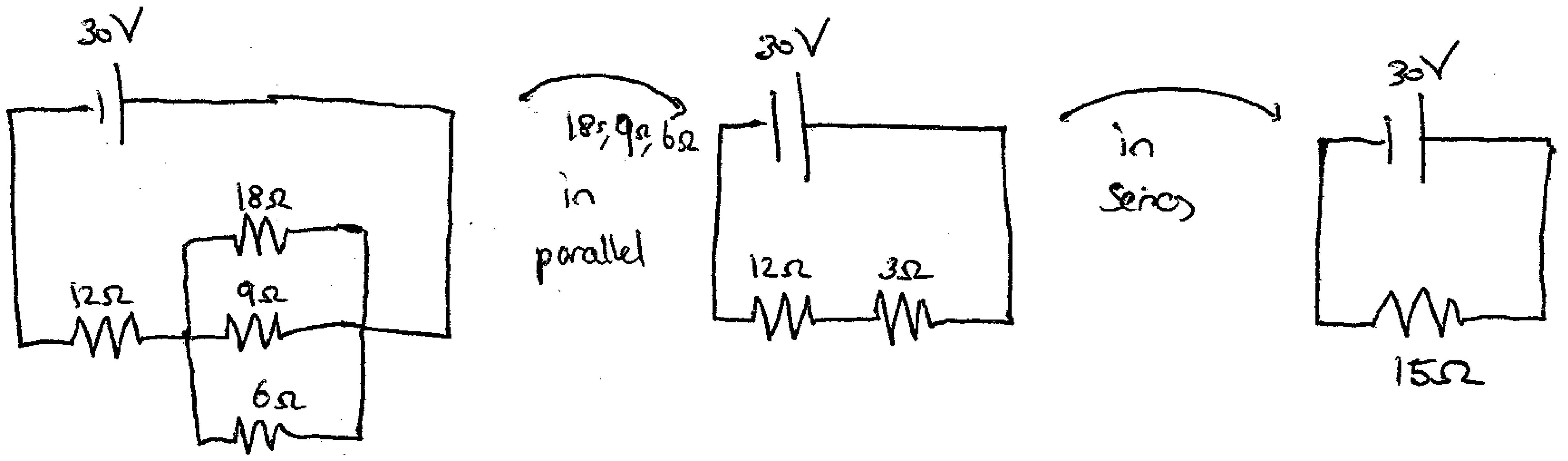
The voltage drop across the 4.12Ω resistor is:

$V = I \cdot R = 8.24V$ we found this because voltage is the same for resistors in parallel:

$R_{7\Omega}$: $V = 8.24V \Rightarrow \boxed{I_{7\Omega} = V/R = 1.18A}$ $R_{10\Omega}$: $V = 8.24V \Rightarrow \boxed{I_{10\Omega} = V/R = 0.824A}$

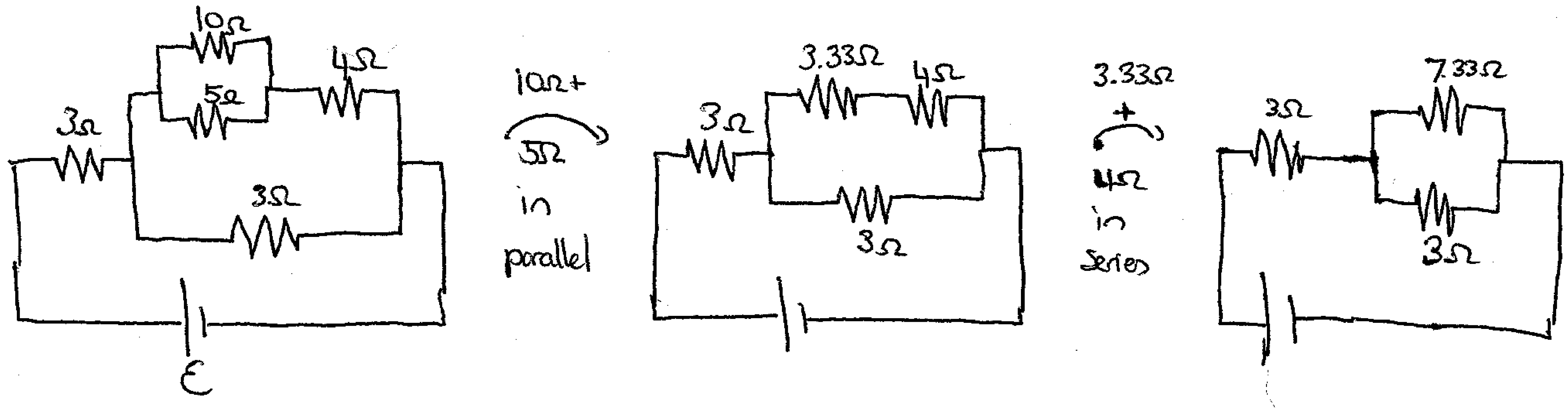
(Note the answers are slightly off because of rounding).

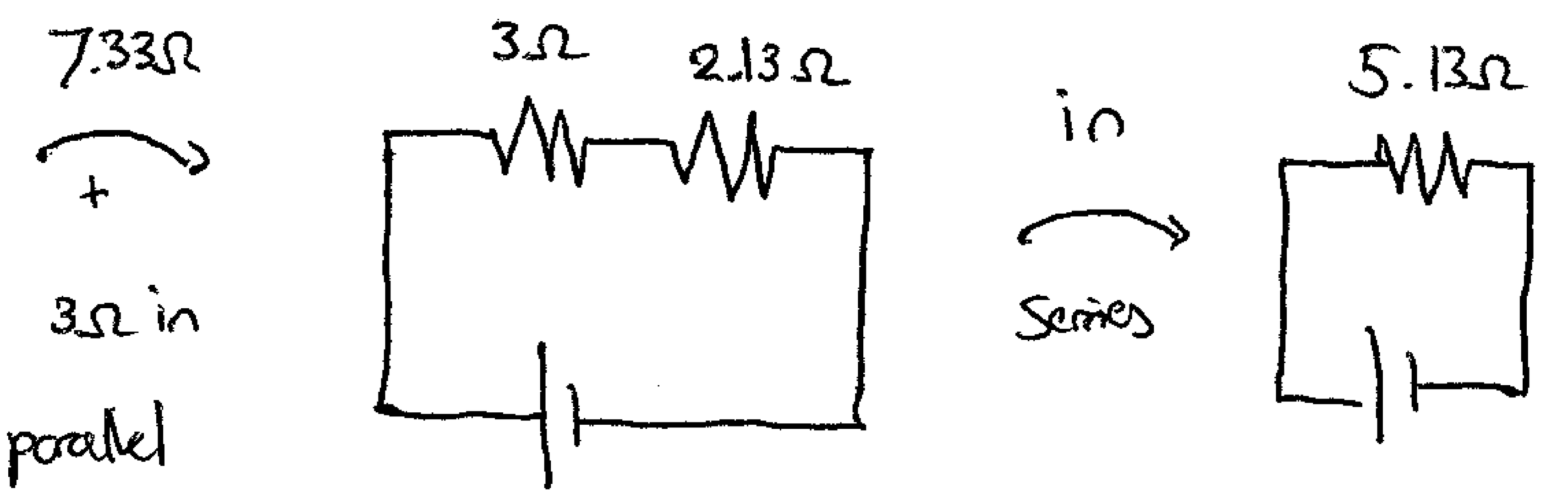
6)



$R_{eq} = 15\Omega$

8a)

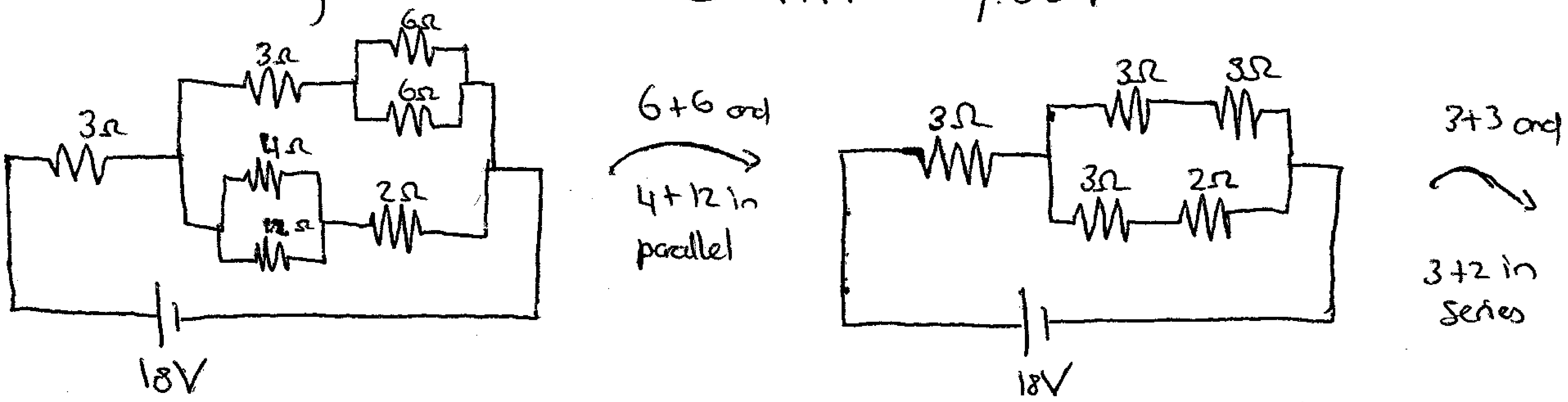


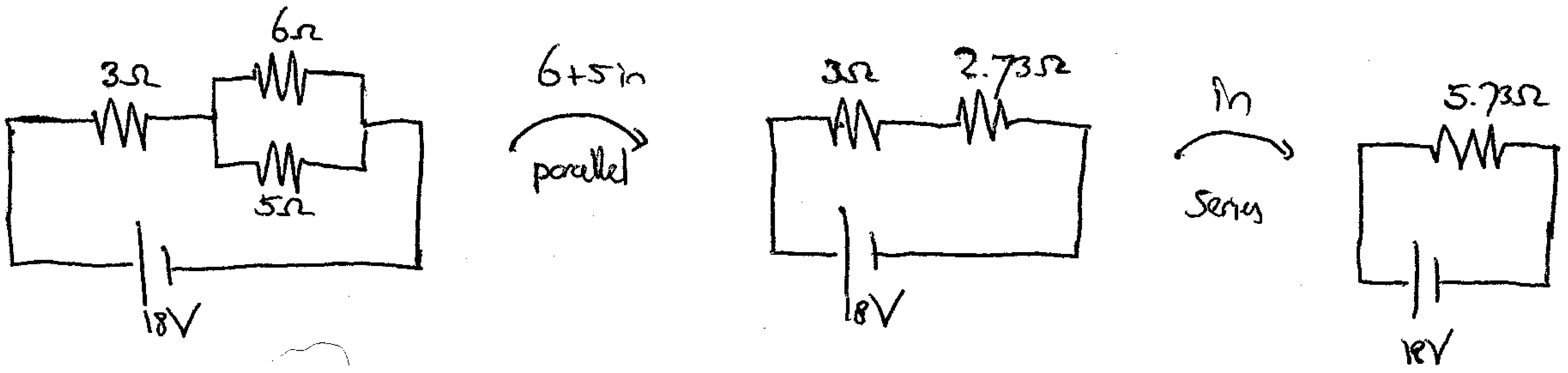


$R_{eq} = 5.13\Omega$

b) Power = $P = V^2/R$ where $V = \text{Emf} = \mathcal{E}$ and $R = R_{eq}$ the equivalent resistance of the circuit $\mathcal{E} = \sqrt{R \cdot P} = 4.53V$

13)





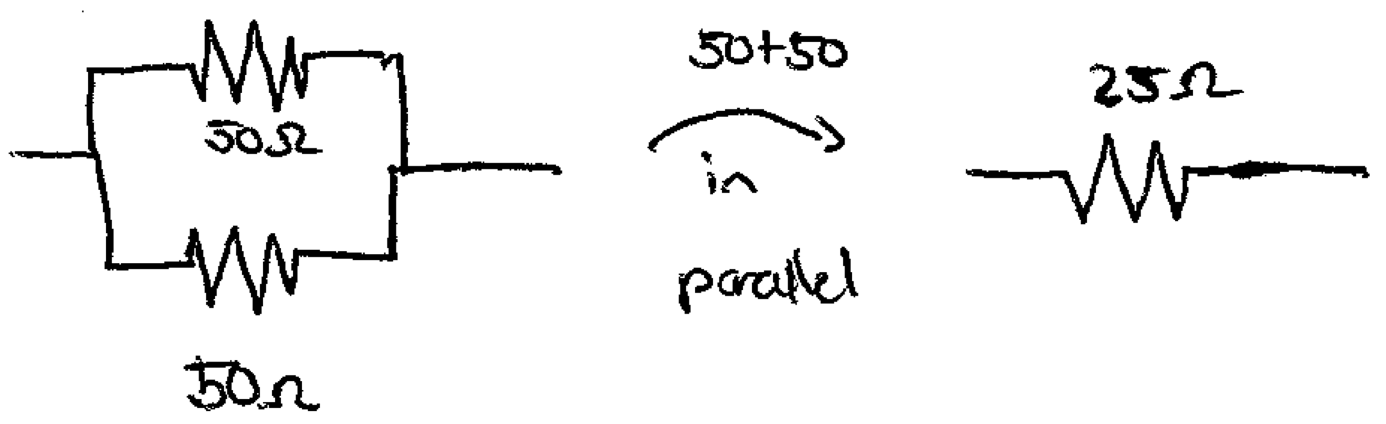
Again the trick is work your way backward remembering

1) Voltage is equal in parallel ~~ar~~ resistors
2) Current is equal in series resistors

} The ~~[illegible]~~ ordering to get the answer is:

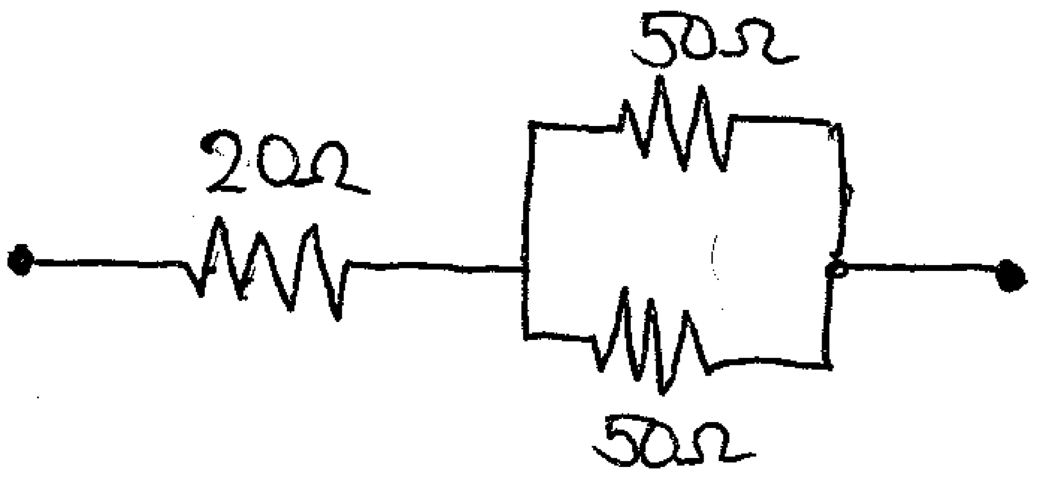
$I_{5.73} = 3.14A \Rightarrow V_{2.73} = 8.57V \Rightarrow I_5 = 1.71A \Rightarrow V_3 = 5.14V \Rightarrow I_{12\Omega} = 0.428\,A$

15) There is no clever way of doing this problem. Just play around until you get the right value. One helpful hint: two equal resistors in parallel will have an equivalent resistance of ½ the resistance value:



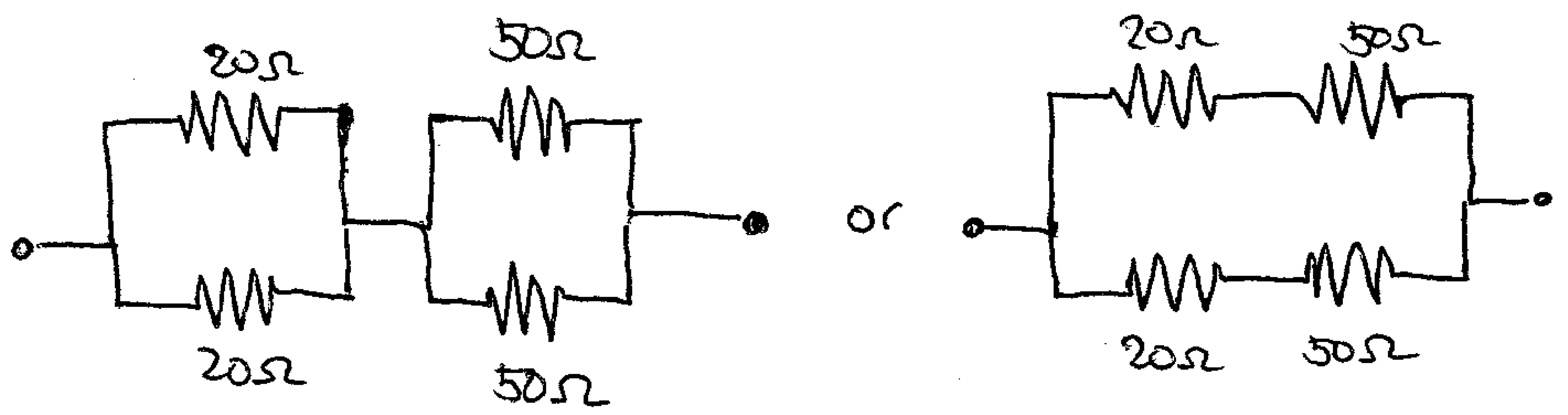
$R_{eq} = 25\Omega$

a) to get 45Ω use the above + 20Ω :



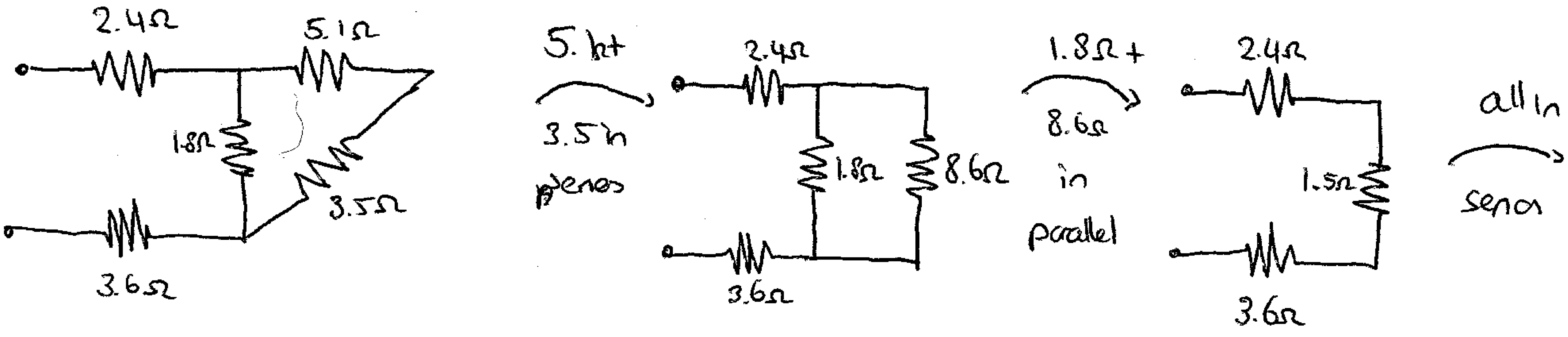
$\rightarrow R_{eq} = 45\Omega$

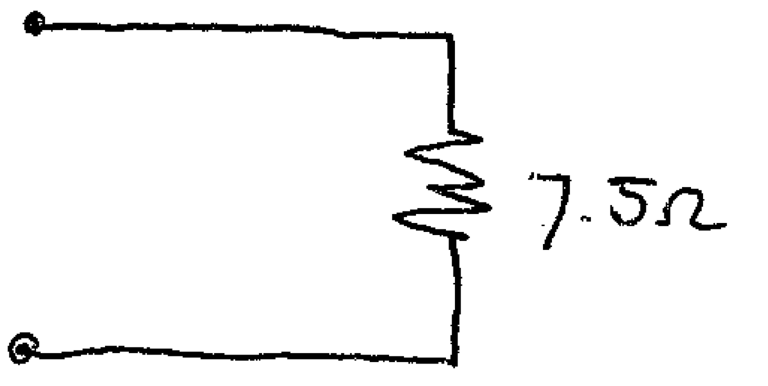
b) to get 35Ω you need to get 10Ω ie 20Ω in parallel:



$\rightarrow R_{eq} = 35\Omega$

45)

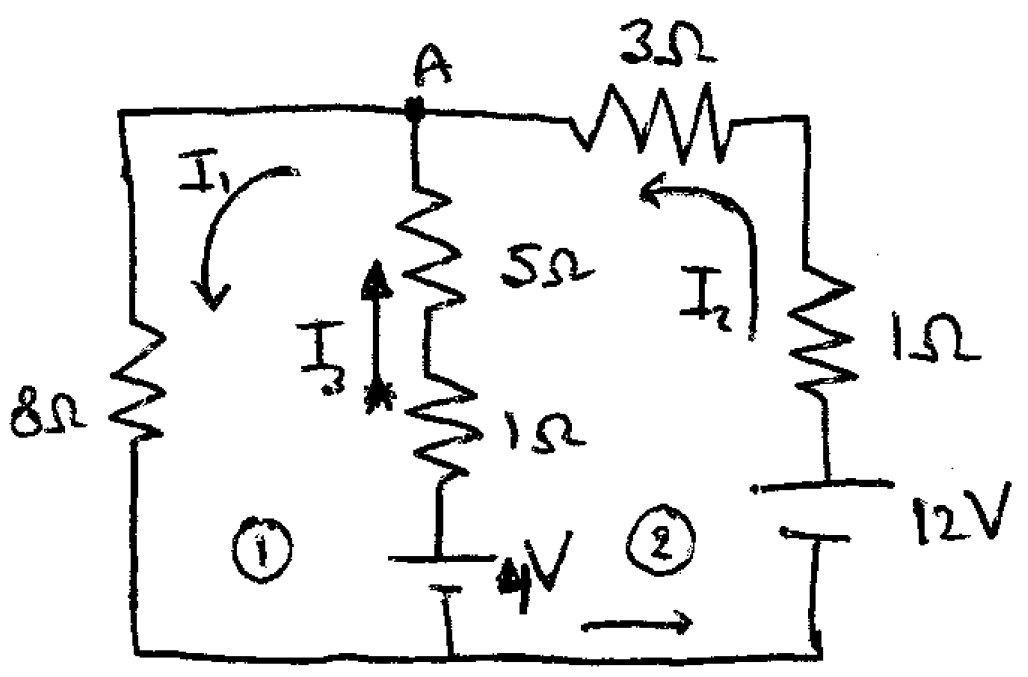




$R_{eq} = 7.5\Omega$

Don't let the beginning picture fool you they are still in ~~paral~~ series

17)



lets look at loop ① loop law gives:

$4V - 1\cdot I_3 - 5\cdot I_3 - 8\, I_1 = 0$

Now loop ② will give:

$12V - 1\cdot I_2 - 3\cdot I_2 + 5 I_3 + 1\cdot I_3 - 4 = 0$

* Note the + in front of the I_3's if you go against the current, it gives positive and with the current will give a negative. The same for a voltage source, if you go from − to + the voltage is positive, otherwise it is negative.

The last equation comes from the junction law: $I_2 + I_3 = I_1$ (from junction A) rewriting these gives:

$-8\, I_1 - 6 I_3 + 4 = 0 \Rightarrow I_1 = -\frac{3}{4} I_3 + \frac{1}{2}$

$-4 I_2 + 6 I_3 + 8 = 0 \Rightarrow I_2 = \frac{3}{2} I_3 + 2$

$I_1 - I_2 - I_3 = 0 \Rightarrow \left(-\frac{3}{4} I_3 + \frac{1}{2}\right) - \left(\frac{3}{2} I_3 + 2\right) - I_3 = 0$

$-\frac{13}{4} I_3 - \frac{3}{2} = 0 \quad I_3 = \frac{3}{2} \cdot \frac{-4}{13} = -6/13\ A \approx -0.462\ A$

$I_1 = -\frac{3}{4}(-0.462) + \frac{1}{2} \approx 0.847\ A$

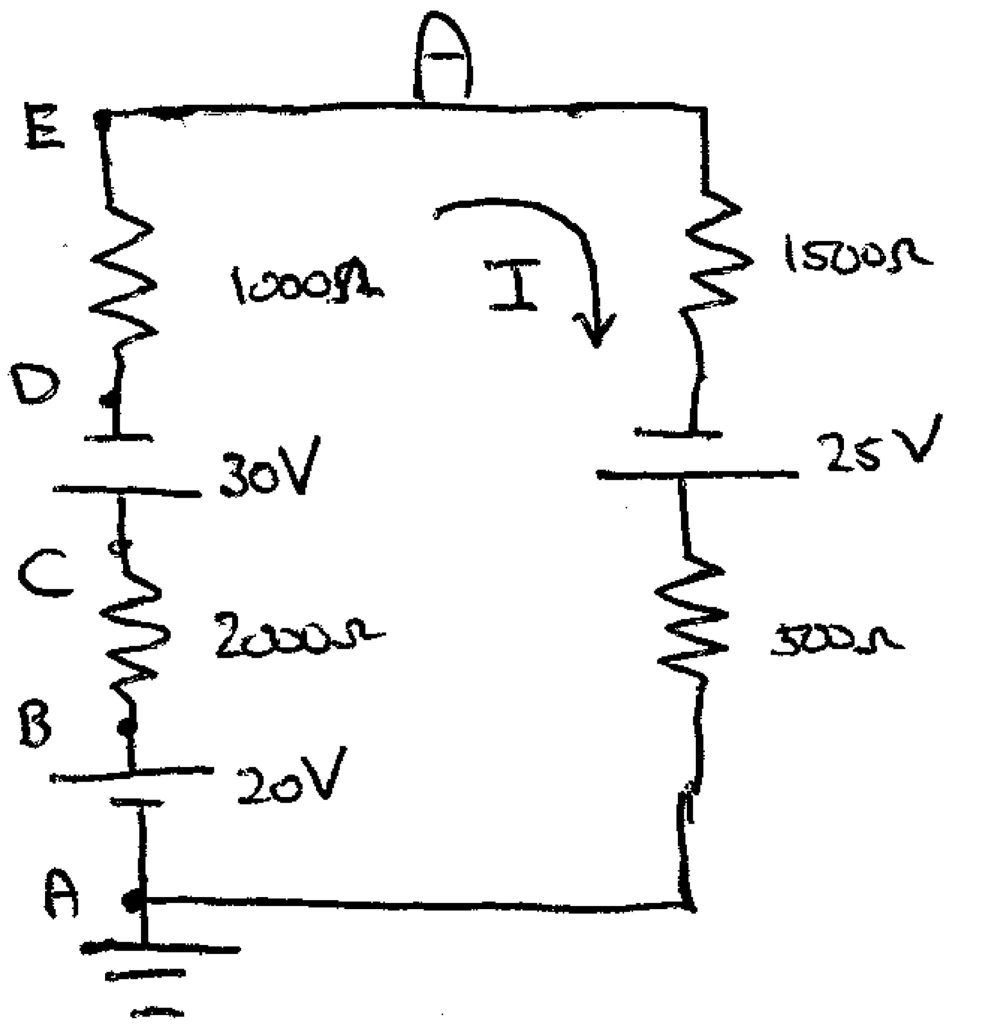
$I_2 = \frac{3}{2}(-0.462) + 2 \approx 1.31\ A$

Note that I guessed the direction of I_3 wrong, I thought it would flow up, but since I_3 is negative it flows down.

$I_{8\Omega} = 0.847A$ downward.

$I_{5\Omega} = 0.462A$ down ward

$I_{3\Omega} = 1.31A$ left.

19a) 

loop law gives:

$20 - 2000 \cdot I - 30 - 1000 \cdot I - 1500 \cdot I + 25 - 500 \cdot I = 0$

$15 - 5000 I = 0$

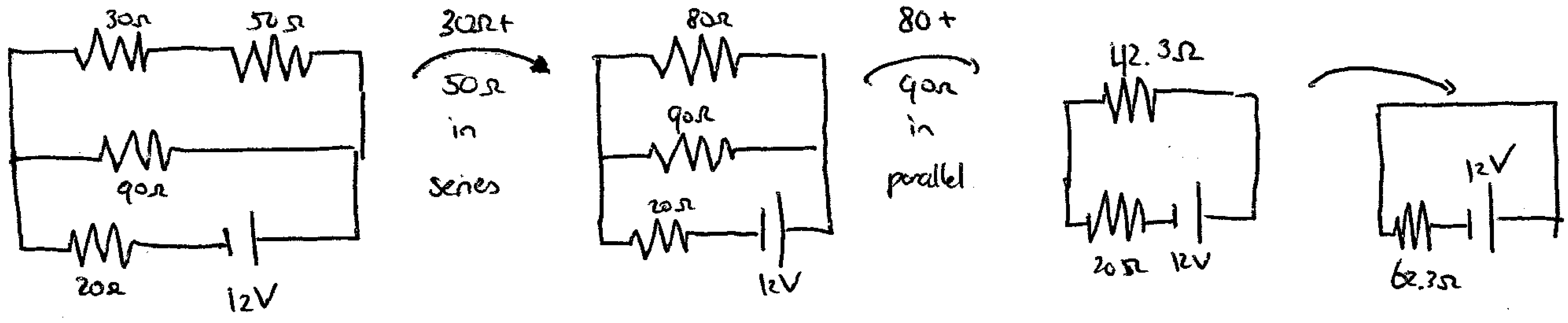
a) $I = 15/5000 = 3 \cdot 10^{-3} A = 3\ mA$

b) point A = 0V
point B = 20V
point C = 20 − 2000 · 3mA = 14V
point D = 14 − 30 = −16V
point E = −19V

I.E the wire is at −19V.

c) $\Delta V = I \cdot R = 3 \cdot 10^{-3} A \cdot 1500 \Omega = 4.5 V$

22) The easiest way to do this is using equivalent resistors:

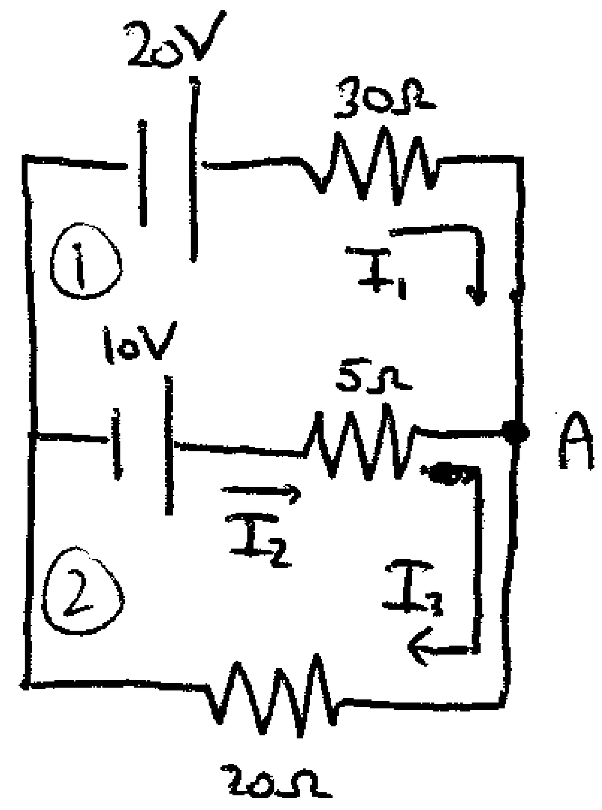


$I_{62.3\Omega} = 0.193 A \Rightarrow V_{42.3\Omega} = 8.16 V \Rightarrow I_{80\Omega} = 0.102 A \Rightarrow V_{50\Omega} = 5.1 V$

Power = $V^2/R = (5.1)^2/50\Omega = 0.52 W$.

The other way of doing this problem is using Kirchhoff's laws, but then you get a mess like problem 17).

27)



loop①: $20V - 30 \cdot I_1 + 5 I_2 - 10 = 0$

loop②: $10V - 5 I_2 - 20 I_3 = 0$

Junction Ⓐ: $I_1 + I_2 = I_3$

① $-30 I_1 + 5 I_2 + 10 = 0 \quad \Rightarrow \quad I_1 = \frac{1}{6} I_2 + \frac{1}{3}$

② $-5 I_2 - 20 I_3 + 10 = 0 \quad \Rightarrow \quad I_3 = -\frac{1}{4} I_2 + \frac{1}{2}$

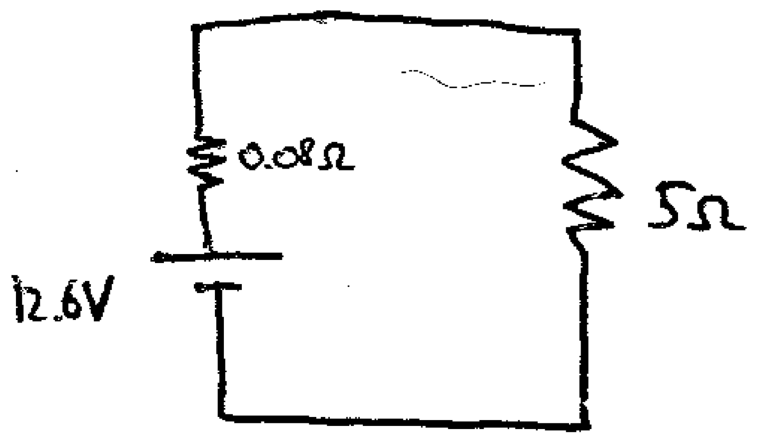
Ⓐ $\left(\frac{1}{6} I_2 + \frac{1}{3}\right) + (I_2) = \left(-\frac{1}{4} I_2 + \frac{1}{2}\right)$

$\frac{17}{12} I_2 = \frac{1}{6} \quad I_2 = \frac{2}{17} A \simeq 0.118 A \qquad I_{5\Omega} = 0.118 A$ to the right

$I_3 = -\frac{1}{4}(0.118) + \frac{1}{2} \simeq 0.471 A \qquad I_{20\Omega} = 0.471 A$ to the left

$I_1 = \frac{1}{6} I_2 + \frac{1}{3} \simeq 0.353 A \qquad I_{30\Omega} = 0.353 A$ to the right

49 a)

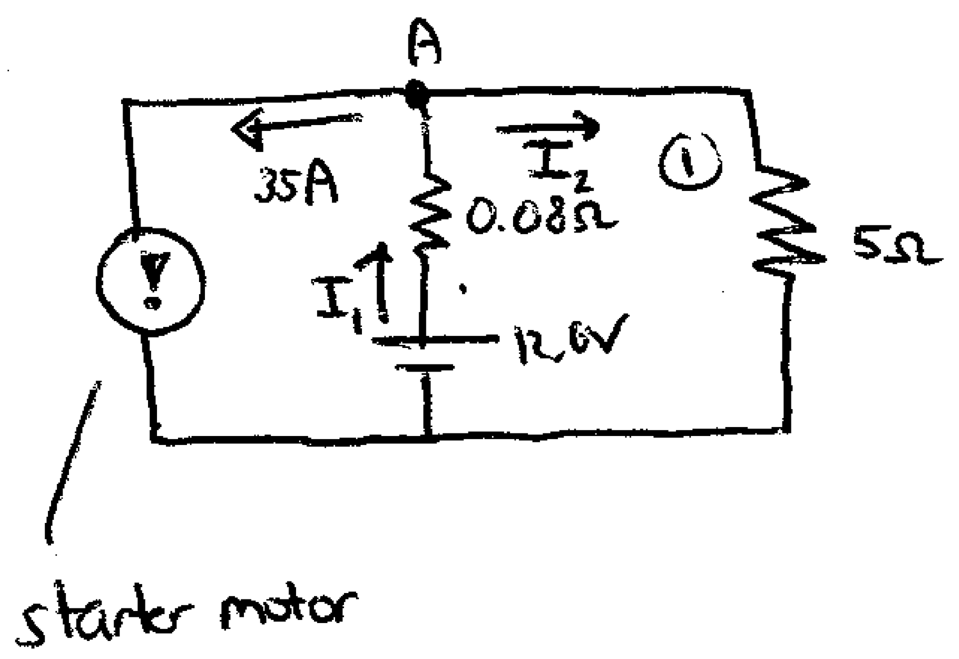


$R_{eq} = 5.08\Omega$

$I = 12.6V / 5.08\Omega = 2.48 A$

$V = I \cdot R = 2.48 \cdot 5 = 12.4V$

b)



Use Kirchhoff's loop law on loop ①

$12.6 - 0.08 I_1 - 5 \cdot I_2 = 0$

$I_1 = 35 + I_2$ ← junction law at A

$12.6 - 0.08(I_2 + 35) - 5 I_2 = 0 \quad 5.08 I_2 = 9.8 \quad I_2 = 1.93 A$

Hence $V = I \cdot R = 1.93 A \cdot 5\Omega = 9.65V$

31 a) $$\left.\begin{aligned} &\tau = R\cdot C \\ &R = 2\cdot10^{6}\,\Omega \\ &C = 6\cdot10^{-6}\,F \end{aligned}\right\} \tau = 12\ \text{Sec is the timeconstant}$$

b) When the switch is closed a long time, the voltage over the capacitor will be equal to the Emf, because no charges are flowing :

$$\left.\begin{aligned} &Q = C\cdot V \\ &C = 6\cdot10^{-6}\,F \\ &V = 20\,V \end{aligned}\right\} Q = 1.2\cdot10^{-4}\,C.$$

32 a) $$\left.\begin{aligned} &\tau = R\cdot C \\ &R = 100\,\Omega \\ &C = 2\cdot10^{-5}\,F \end{aligned}\right\} \tau = 2\ \text{ms (millsecond)}$$

b) $$\left.\begin{aligned} &Q = C\cdot V \\ &C = 2\cdot10^{-5}\,F \\ &V = 9\,V \end{aligned}\right\} Q = 1.8\cdot10^{-4}\,C$$

c) $$\left.\begin{aligned} &Q = Q_0\,(1 - e^{-t/RC}) \\ &t = RC\ \text{(one time constant)} \\ &Q_0 = 1.8\cdot10^{-4}\,C \end{aligned}\right\} Q = 1.8\cdot10^{-4}(1 - e^{-1}) = 1.14\cdot10^{-4}\,C$$

33) first find the time constant : $\tau = R\cdot C = (1\cdot10^{6}\,\Omega)(5\cdot10^{-6}\,F) = 5\ \text{sec}$
then find the charge (maximum) on the capacitor :
$Q = C\cdot V = (5\cdot10^{-6}\,F)(30\,V) = 1.50\cdot10^{-4}\,C$ Hence

$$\left.\begin{aligned} &Q = Q_0\,(1 - e^{-t/RC}) \\ &RC = 5\ \text{sec} \\ &t = 10\ \text{sec} \\ &Q_0 = 1.50\cdot10^{-4}\,C \end{aligned}\right\} Q = 1.5\cdot10^{-4}(1 - e^{-2}) = 1.30\cdot10^{-4}\,C$$

35) $Q = Q_o(1-e^{-t/RC})$ dividing both sides by Q_o will give

$Q/Q_o = (1-e^{-t/RC})$ now Q/Q_o = the fraction charged ie

in this problem $Q/Q_o = 0.6$ at $t = 0.9$ sec Hence:

$$0.6 = (1-e^{-0.900/\tau})$$

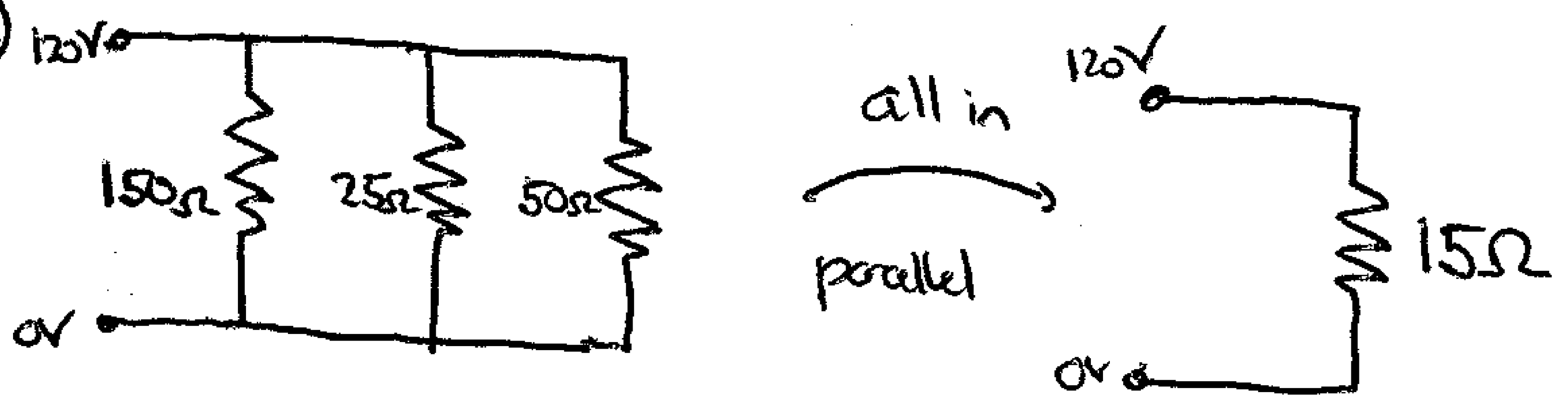
$$e^{-0.900/\tau} = 0.4 \Rightarrow -0.900/\tau = \ln(0.4) \Rightarrow \tau = -0.900/\ln(0.4)$$

$\tau = 0.982$ sec

44) from above: $Q/Q_o = (1-e^{-t/\tau})$ if $t = 2\tau$ (two time constants)

then $Q/Q_o = (1-e^{-2\tau/\tau}) = (1-e^{-2}) = 0.865 \Rightarrow 86.5\%$ is

present on the capacitor after two time constants.

38a) 

$I = V/R = 120/15 = 8$ A is the total current.

b) All have voltages of 120V

c) $\left.\begin{array}{l} R = 150\,\Omega \\ V = 120\,V \end{array}\right\} I = V/R = 0.800$ A is the current in the lamp

d) $P = V^2/R = (120V)^2/25\Omega = 576$ W. is the power dissipated

39a) $P = V^2/R$ need to find the resistance

$R = V^2/P$
$V = 240V$
$P = 3000W$
$\Big\}$ $R = 19.2\Omega$

b) $V = I \cdot R$

$I = V/R$
$V = 120V$
$R = 19.2\Omega$
$\Big\}$ $I = 6.25A$ is the current at 120 V

b) $P = VI$
$V = 120V$
$I = 6.25A$
$\Big\}$ $P = 750W$.