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Series

Parallel.

$$R_{eq} = R_1 + R_2 + R_3 \dots$$

$$C_{eq} = \frac{1}{\frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}} \dots$$

$$L_{eq} = L_1 + L_2 + L_3 \dots$$

$$R_{eq} = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}} \quad (\text{or}) \quad \frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

$$C_{eq} = C_1 + C_2 + C_3$$

$$L_{eq} = \frac{1}{\frac{1}{L_1} + \frac{1}{L_2} + \frac{1}{L_3}}$$

Current	Same	different
Voltage	different.	Same.

Voltage divider Rule — Series.

$$\rightarrow V_1 = \frac{R_1}{R_T} \times V$$

$$V_1 = \frac{\text{Total Voltage} \times \text{own Resistor}}{\text{Total Resistance.}}$$

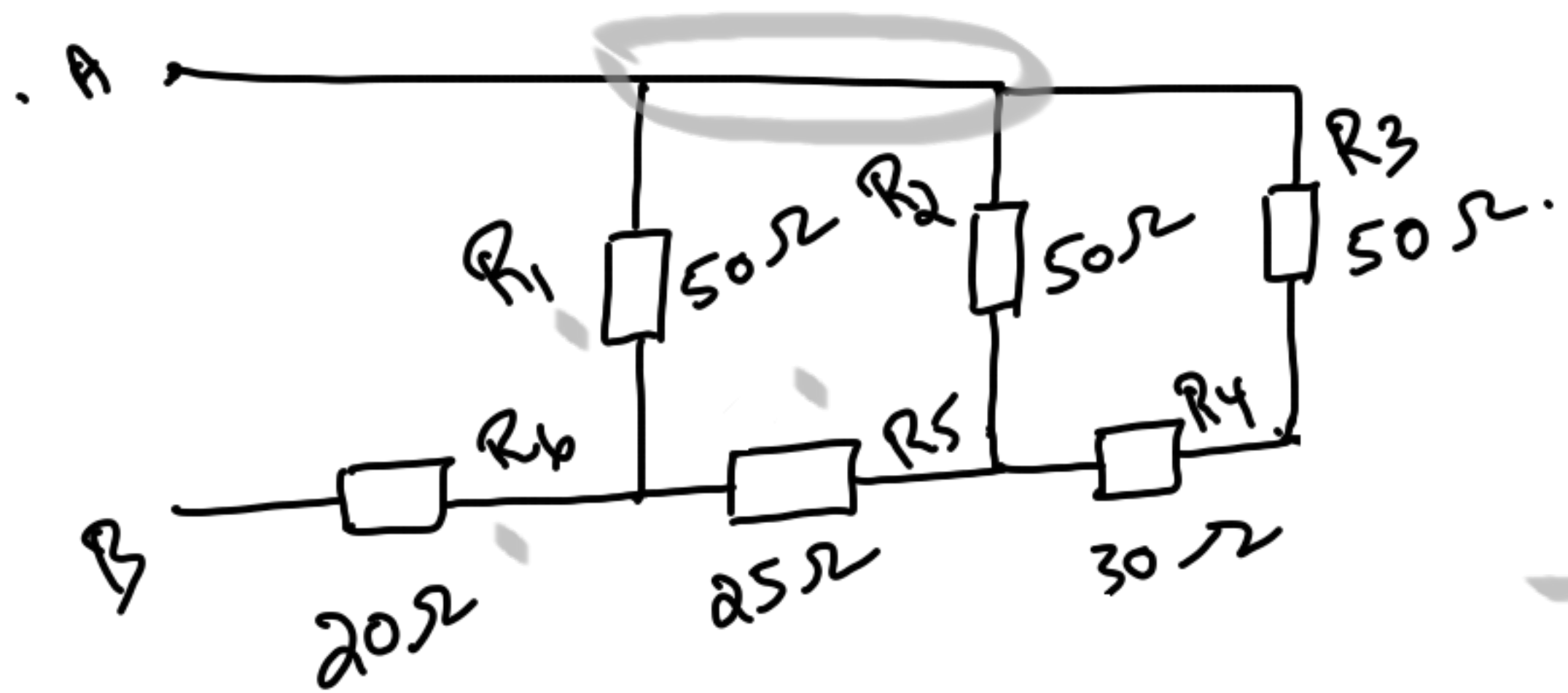
Current Divider Rule — Parallel.

$$I_1 = \frac{\text{Total Current} \times \text{Total Resistance}}{\text{Own Resistance.}}$$

$$I_1 = \frac{I}{R_1} \times R_T$$

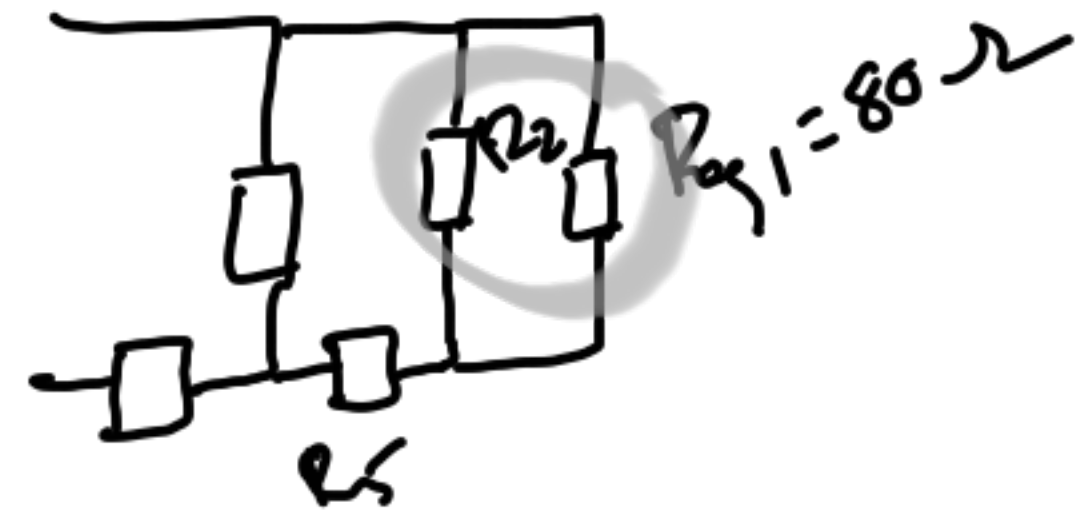
$$I_1 = \frac{I}{R_1} \times \left(\frac{1}{\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}} \right)$$

1) Calculate the equivalent Resistance for the following circuit



Soln. R_3 and R_4 are in series

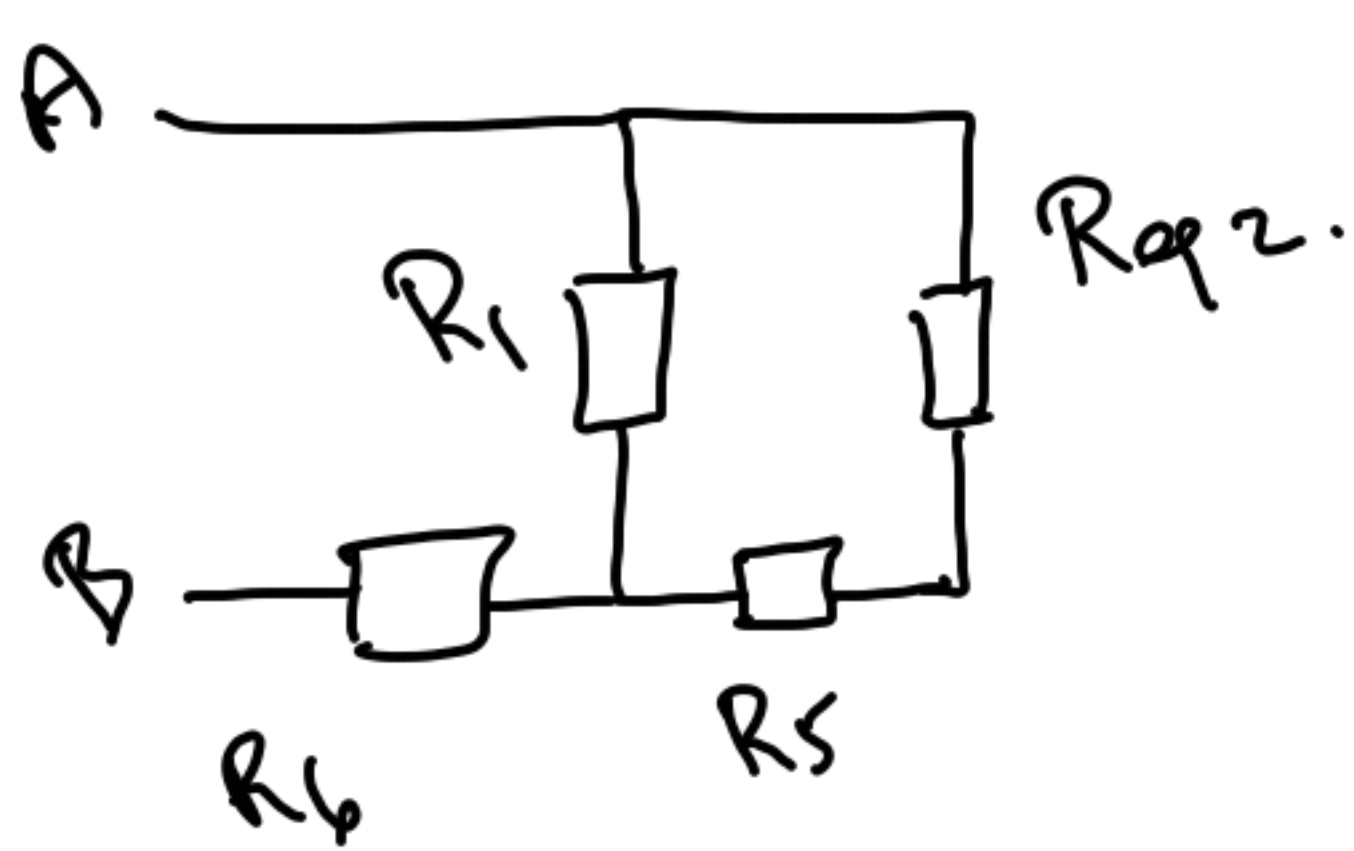
$$R_{eq1} = R_3 + R_4 = 50 + 30 = 80\Omega$$



R_2 and R_{eq1} are in parallel.

$$R_{eq2} = \frac{1}{\frac{1}{R_2} + \frac{1}{R_{eq1}}} = \frac{1}{\frac{1}{50} + \frac{1}{80}}$$

$$R_{eq2} = 30.77\Omega$$

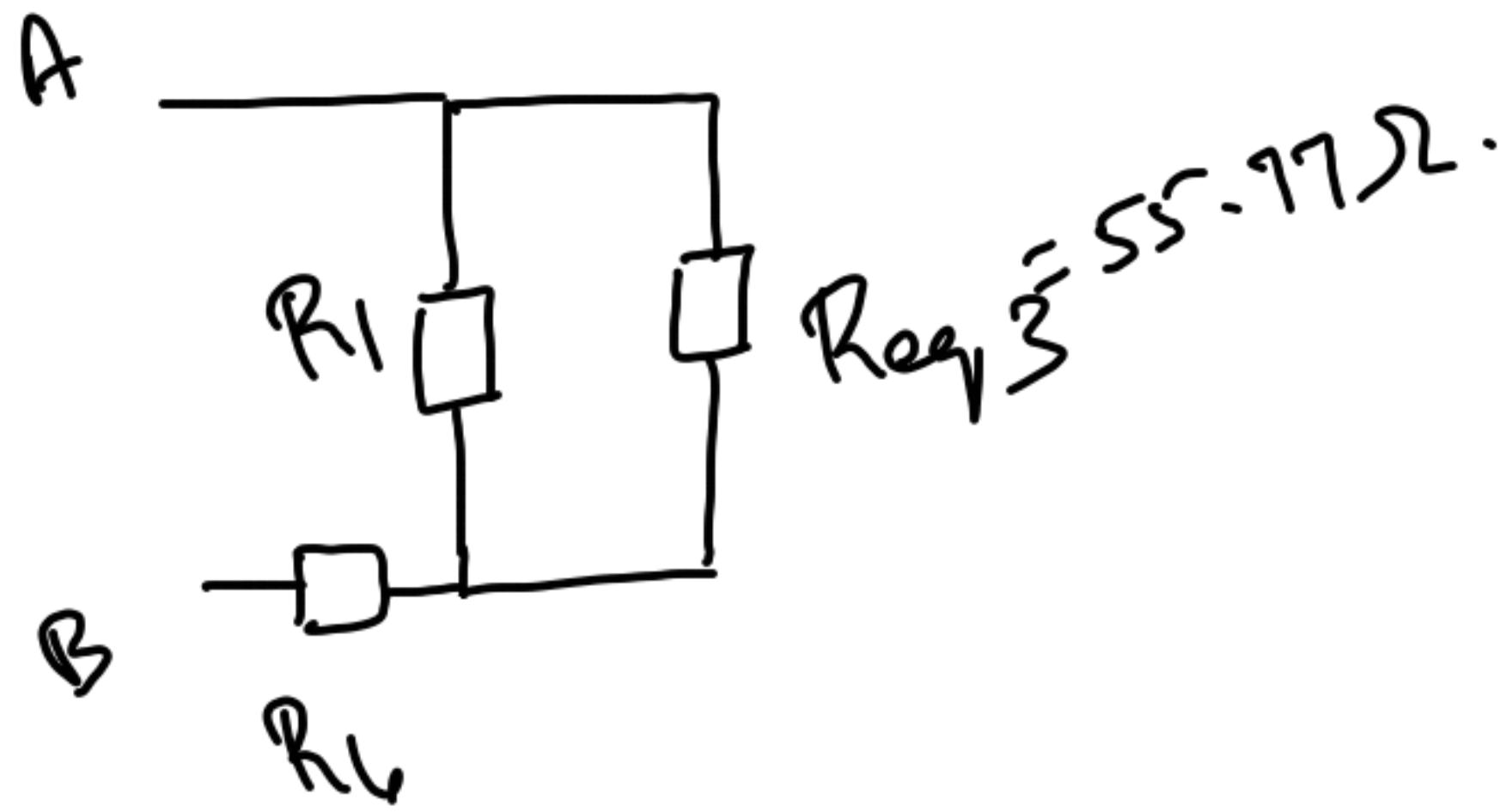


R_{eq2} and R_5 are in series

$$R_{eq3} = R_5 + R_{eq2}$$

$$R_{eq3} = 25 + 30.77$$

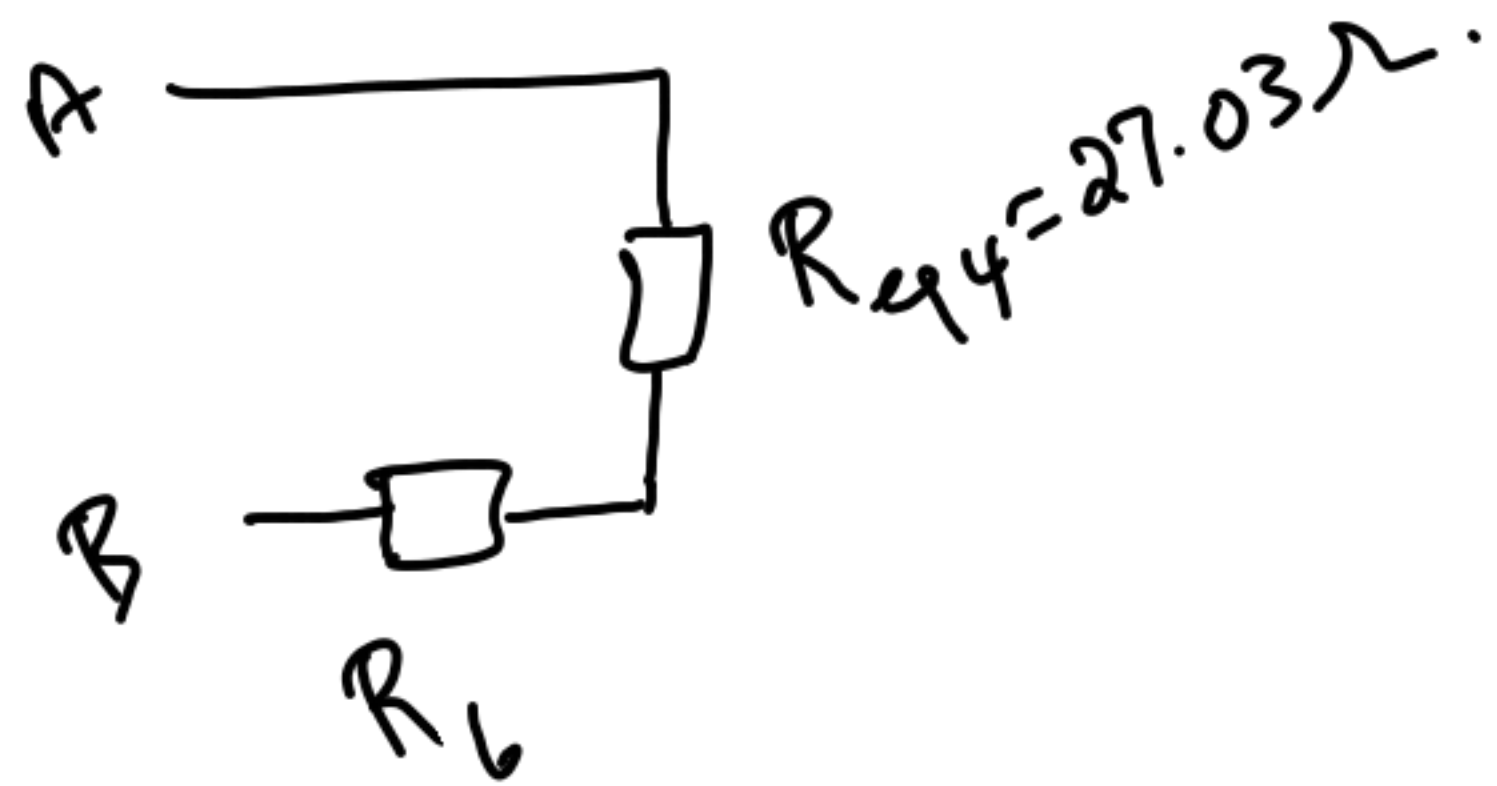
$$R_{eq3} = 55.77 \Omega$$



R_1 and R_{eq3} are in parallel.

$$R_{eq4} = \frac{1}{\frac{1}{R_1} + \frac{1}{R_{eq3}}} = \frac{1}{\frac{1}{50} + \frac{1}{55.77}}$$

$$R_{eq4} = 27.03 \Omega$$



R_6 and R_{eq4} are in series

$$R_{eq} = R_6 + R_{eq4}$$
$$= 20 + 27.03$$

$$R_{eq} = 47.03 \Omega$$

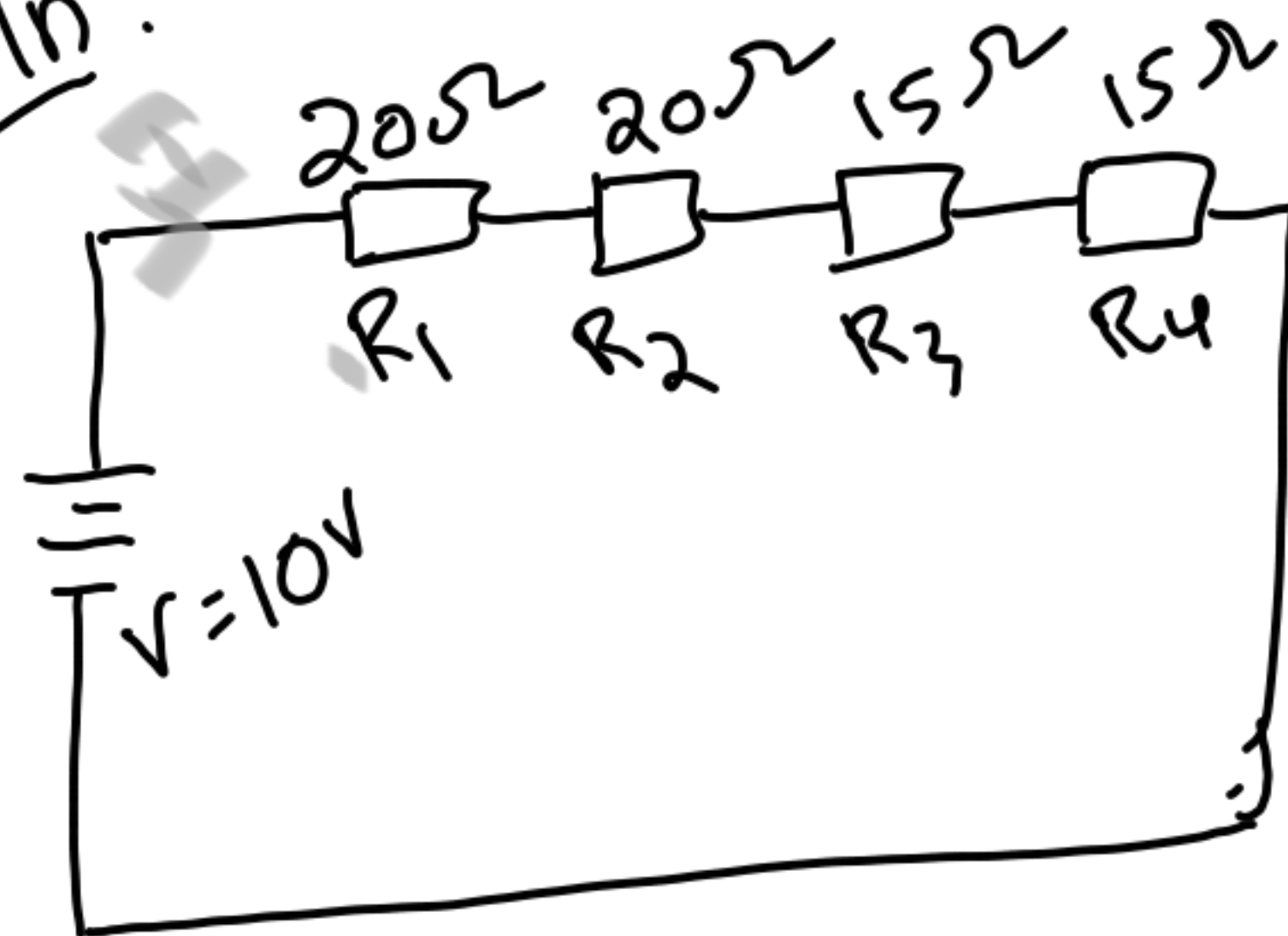
2) A battery with a terminal voltage of 10V is connected to a circuit consisting of two 20Ω and two 15Ω resistors, all connected in series. Assuming the battery has negligible internal

Resistance calculate

- Equivalent total Resistance of the circuit
- Current through each Resistor
- Potential drop across each Resistor

d) determine the total power dissipated by each Resistor and power supplied by the battery.

Soln:



a) Total Resistance.

$$R_T = 20 + 20 + 15 + 15$$

$$R_T = 70\Omega$$

b) Current;

$$I = \frac{V}{R} = \frac{10}{70} = 0.14A$$

As all the Resistors are in series.

Current across each Resistor is $0.14A$

c) Potential difference across each Resistor.

Voltage across 20Ω

$$V_1 = V_2 = I \cdot R$$
$$= 0.14 \times 20$$

$$V_1 = V_2 = 2.8V$$

Voltage across 15Ω .

$$V_3 = V_4 = I \cdot 15$$
$$= 0.14 \times 15 = 2.1$$

d) Power dissipated by the battery.

$$P = V \cdot I$$

$$V = IR$$

$$P = I \cdot R \cdot I$$

$$P = I^2 R$$

$$I = \frac{V}{R}$$

$$P = V \cdot \frac{V}{R} = \frac{V^2}{R}$$

$$P = 10 \times 0.14$$

$$P = 1.4 \text{ W}$$

Power dissipated by R_1

$$P_1 = V_1 I = 2.8 \times 0.14$$

$$P_1 = 0.39 \text{ W}$$

$$\text{As, } R_1 = R_2, \quad P_2 = 0.39 \text{ W}$$

Power dissipated by R_3

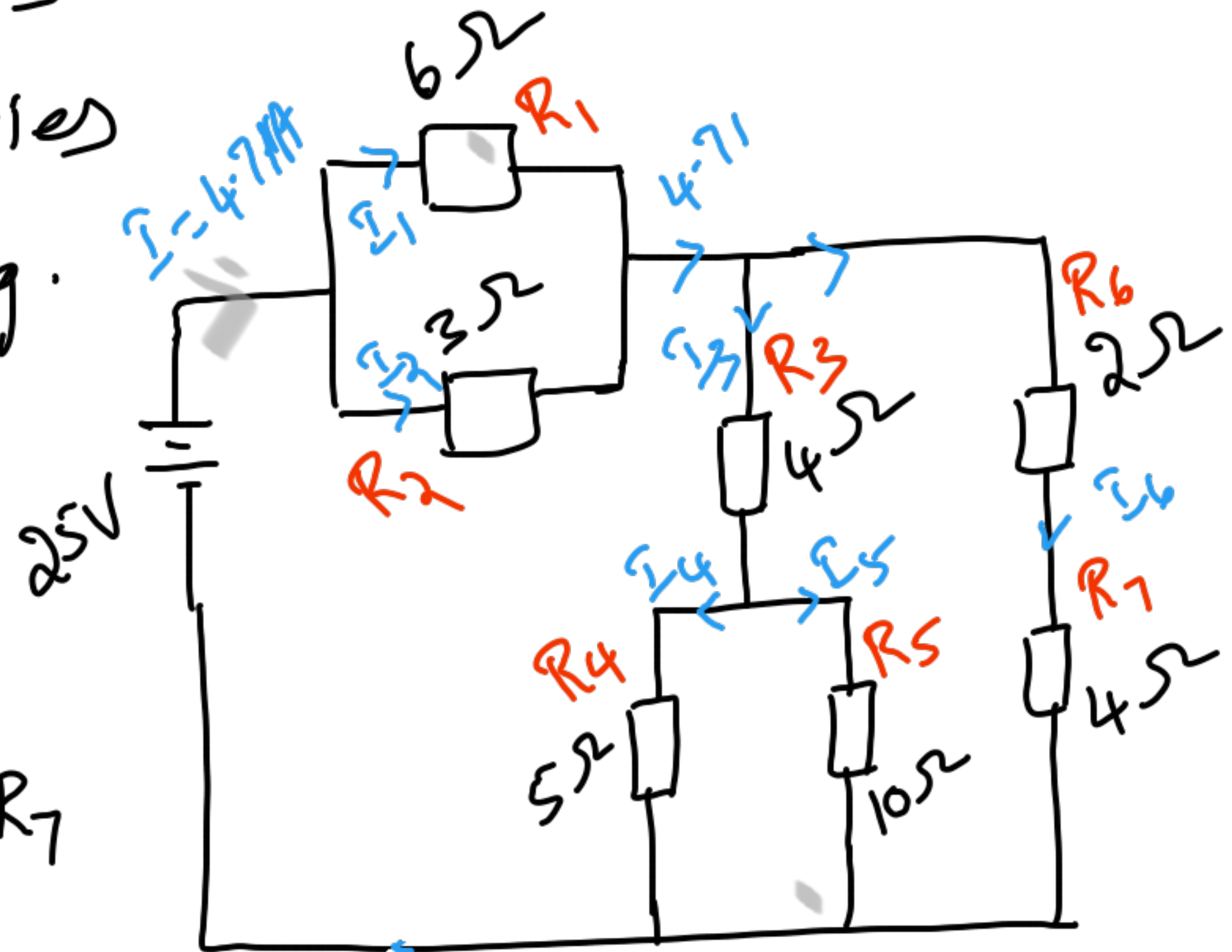
$$P_3 = V_3 I = 2.1 \times 0.14$$

$$P_3 = 0.29 \text{ W}$$

$$P_3 = P_4 = 0.29 \text{ W}$$

3) The following Resistive Circuit is powered by a 25V battery. The Resistors are connected in a combination of series parallel connection. Calculate the following.

- Total Resistance in the circuit
- Current across each Resistor
- Voltage across resistor R_3 , R_4 and R_7
- Power dissipated by Resistor R_7



Soln ∴

R_1 and R_2 are in parallel.

R_6 and R_7 are in series

R_4 and R_5 are in parallel.

R_1 and R_2

$$R_{eq1} = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2}} = \frac{1}{\frac{1}{6} + \frac{1}{3}} = 2\Omega$$

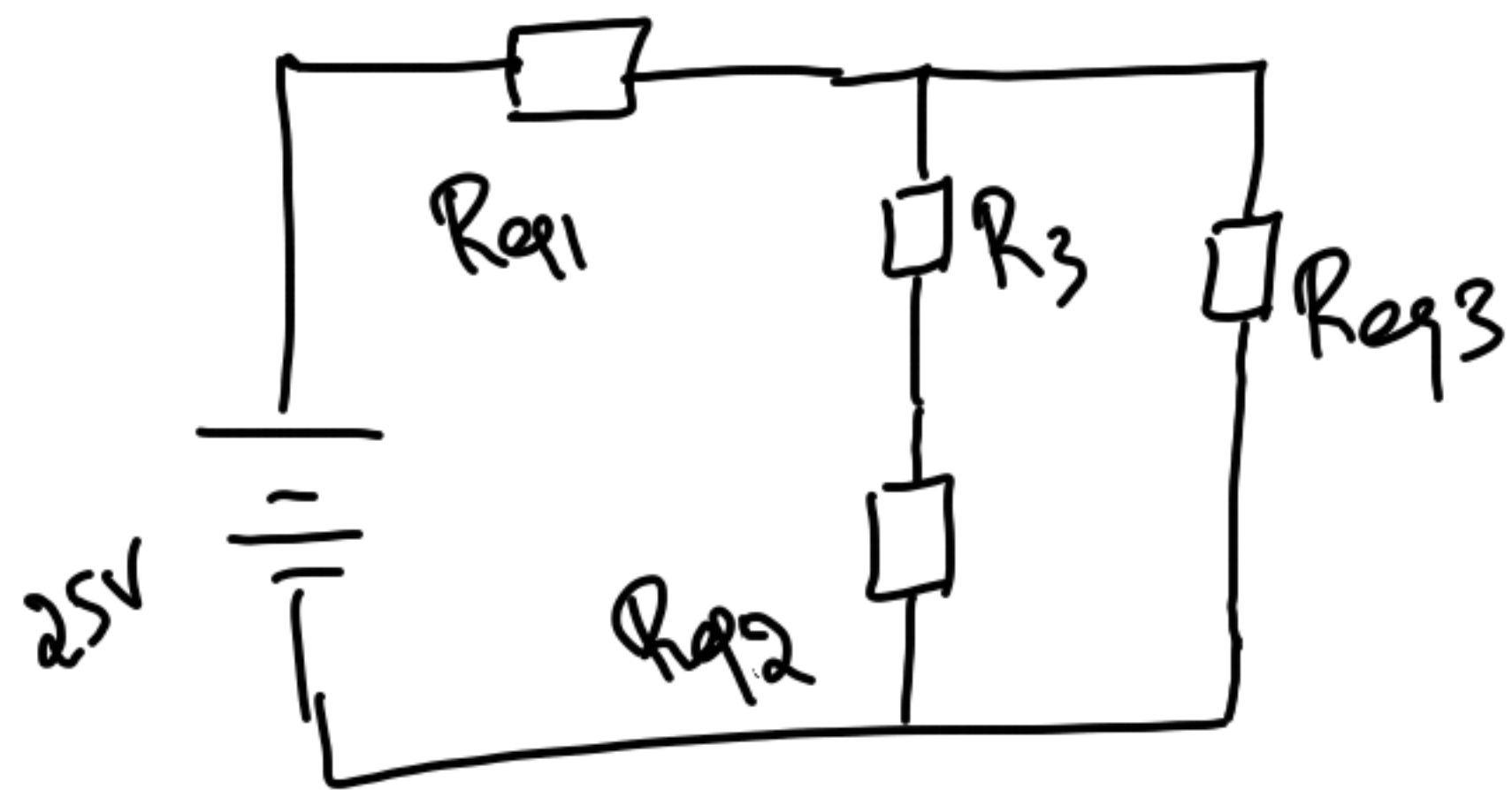
R_4 and R_5

$$R_{eq2} = \frac{1}{\frac{1}{R_4} + \frac{1}{R_5}} = \frac{1}{\frac{1}{5} + \frac{1}{10}} = 3.33\Omega.$$

$$R_{eq2} = 3.33\Omega$$

R_6 and R_7

$$R_{eq3} = R_6 + R_7 = 2 + 4 = 6\Omega$$

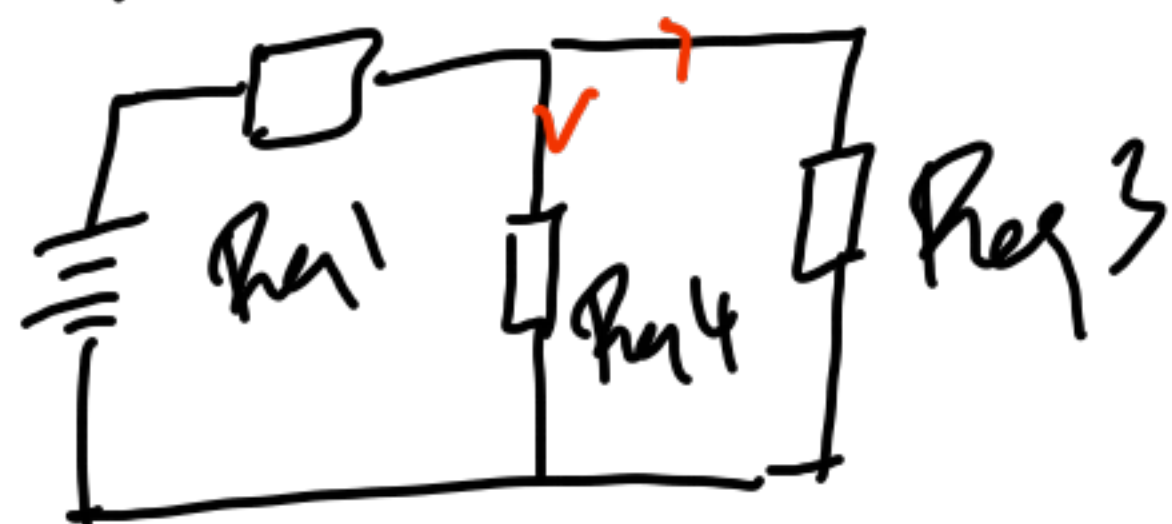


R_3 and R_{eq2} are in series

$$R_{eq4} = R_3 + R_{eq2}$$

$$= 4 + 3.33$$

$$R_{eq4} = 7.33 \Omega$$



R_{eq4} and R_{eq3} are in parallel.

$$R_{eq5} = \frac{1}{\frac{1}{R_{eq4}} + \frac{1}{R_{eq3}}}$$

$$= \frac{1}{\frac{1}{7.33} + \frac{1}{6}} = 3.3 \Omega$$

$$R_{eq5} = 3.3 \Omega$$



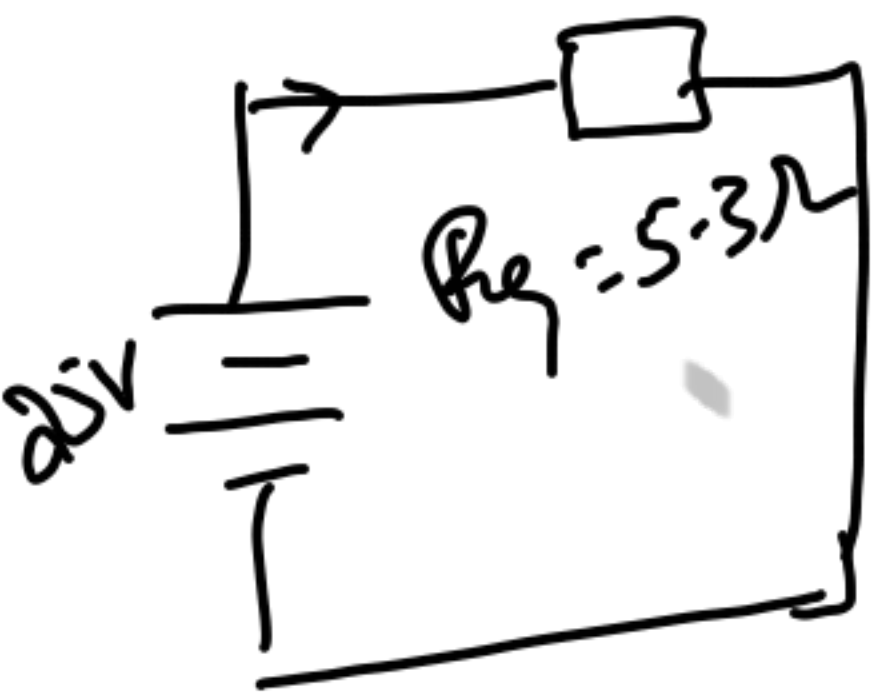
R_{eq1} and R_{eq5} are in series.

$$R_{eq} = R_{eq1} + R_{eq5}$$

$$= 2 + 3.3$$

$$= 5.3 \Omega$$

R_{eq}



$$I = \frac{V}{R} = \frac{25}{5.3} = 4.71 \text{ A}$$

To Calculate Current

Current divider Rule.

$$I_1 = \frac{\text{Total current} \times \text{Total Resistance}}{\text{Own Resistance}}$$

Current across R_1

$$I_1 = \frac{I}{R_1} \cdot R_T$$

$$= \frac{I}{R_1} \left(\frac{1}{\frac{1}{R_1} + \frac{1}{R_2}} \right)$$

$$= \frac{4.71}{6} \left(\frac{1}{\frac{1}{6} + \frac{1}{3}} \right)$$

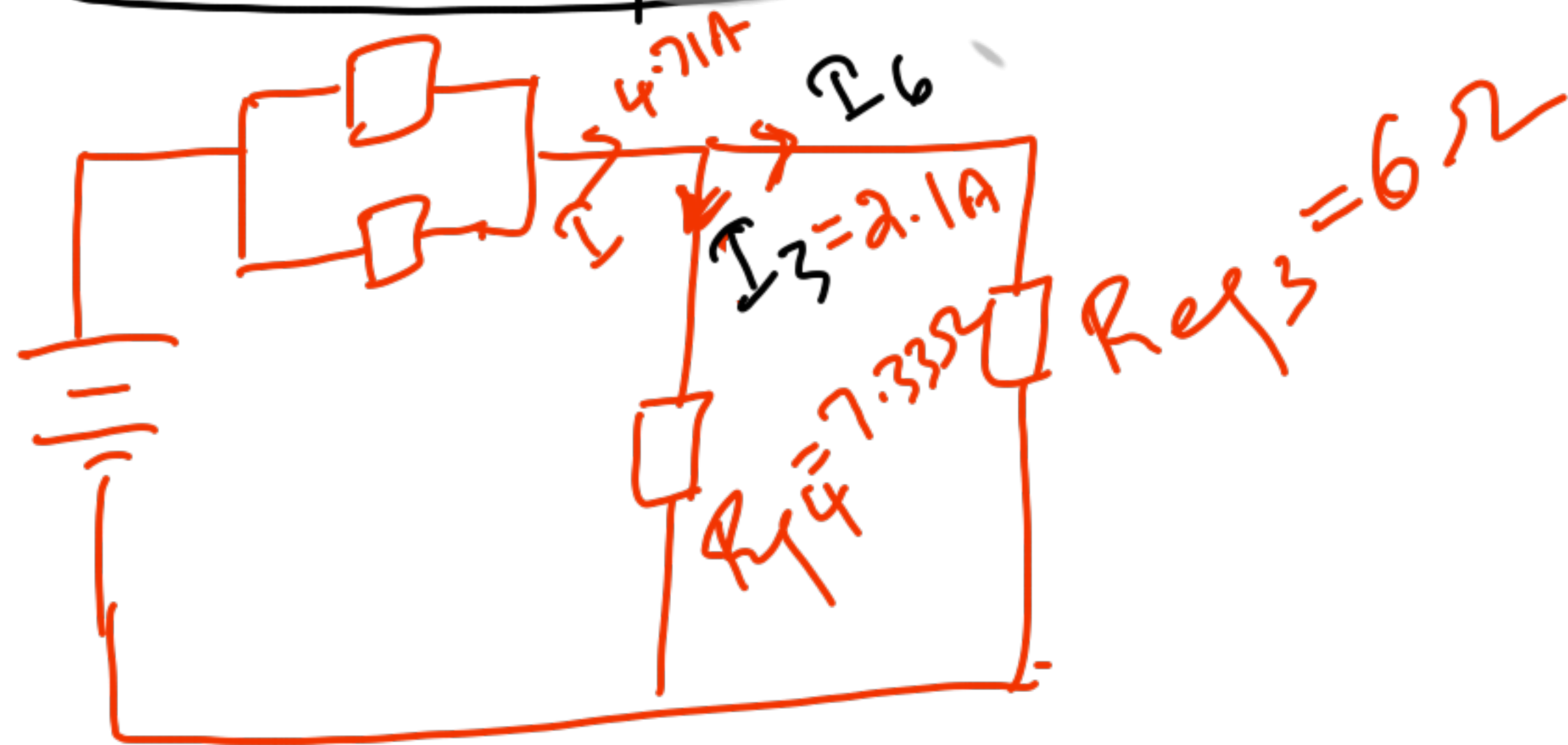
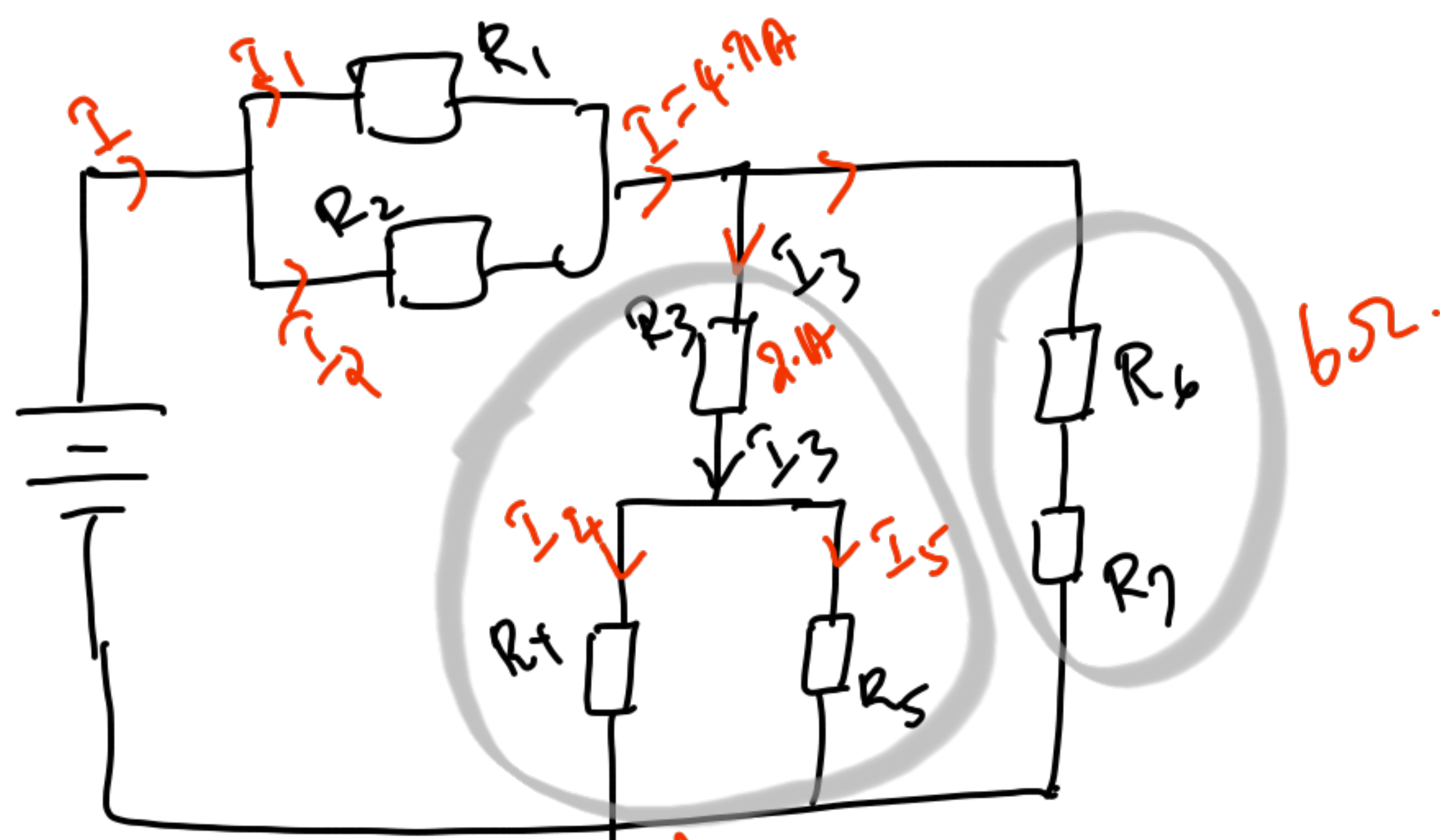
$$I_1 = 1.57 \text{ A}$$

Current across R_2

$$I_2 = \frac{I}{R_2} \left(\frac{1}{\frac{1}{R_1} + \frac{1}{R_2}} \right)$$

$$= \frac{4.71}{3} \left(\frac{1}{\frac{1}{6} + \frac{1}{3}} \right)$$

$$I_2 = 3.14 \text{ A}$$



To find current across R_{eq4}

$$I_3 = \frac{I}{R_{eq4}} \left(\frac{1}{\frac{1}{R_{eq4}} + \frac{1}{R_{13}}} \right)$$

$$I_3 = \frac{4.71}{7.33} \left(\frac{1}{\frac{1}{7.33} + \frac{1}{6}} \right)$$

$$I_3 = 2.1A$$

To find current across R_{eq3} .

$$I = I_3 + I_6$$

$$I_6 = I - I_3$$

$$I_6 = 4.71 - 2.1$$

$$I_6 = 2.61 \text{ A}$$

Current I_6 is the current through R_6 & R_7

Current across R_3 is $I_3 = 2.1 \text{ A}$

Voltage across R_3

$$V_3 = I_3 R_3$$

$$= 2.1 \times 4$$

$$V_3 = 8.4 \text{ V}$$

To find current I_4 and I_5

$$I_4 = \frac{I_3}{R_4} \left(\frac{1}{\frac{1}{R_4} + \frac{1}{R_5}} \right)$$

$$= \frac{2.1}{5} \left(\frac{1}{\frac{1}{5} + \frac{1}{10}} \right)$$

$$I_4 = 1.4 \text{ A}$$

$$I_5 = I_3 - I_4$$
$$= 2.1 - 1.4$$

$$I_5 = 0.7 \text{ A}$$

Voltage across R_4

$$V_4 = R_4 \hat{I}_4$$
$$= 5 \times 1.4$$

$$V_4 = 7 \text{ V}$$

Voltage across R_7

$$V_7 = R_7 \times \hat{I}_7$$

$$V_7 = 4 \times 2.61$$

$$V_7 = 10.44 \text{ V}$$

d) Power across R_7

$$P = V \hat{I}$$

$$P_7 = V_7 \hat{I}_7$$

$$= 10.44 \times 2.61$$

$$P_7 = 27.2 \text{ W}$$