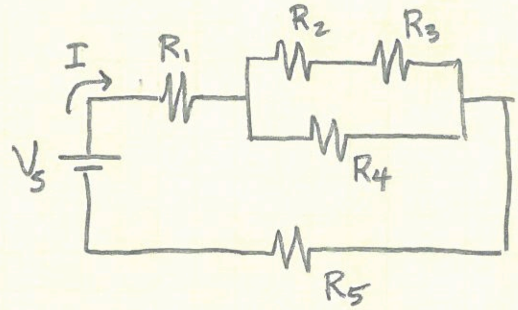
Given The network of resistors with known values shown in the sketch



$V_s = 10\,V$

$R_1 = R_4 = 470\,\Omega$

$R_2 = R_3 = R_5 = 330\,\Omega$

Find: The power dissipated by R_5, R_2 and the total power dissipated by the circuit

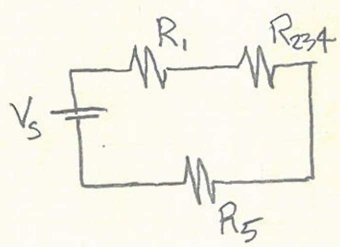
Analysis: The power dissipated by individual resistors is computed with

$$V_i I_i \quad \text{or} \quad I_i^2 R_i \quad \text{or} \quad \frac{V_i^2}{R_i^2}$$

where V_i is the voltage drop across resistor i, I_i is the current through resistor i, and R_i is the resistance of resistor i

The current through R_5 is the same as I, the total current delivered by the power supply. To find I we need to know the equivalent resistance of the entire network

Start by combining R_2, R_3 and R_4



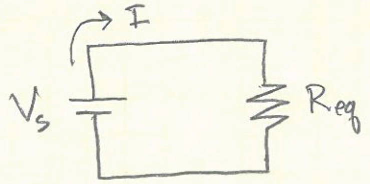
$$R_{234} = \left[\frac{1}{R_2 + R_3} + \frac{1}{R_4} \right]^{-1}$$

$$= \left[\frac{1}{660\,\Omega} + \frac{1}{470\,\Omega} \right]^{-1}$$

$$\boxed{R_{234} = 274.5\,\Omega}$$

← carry extra digits through intermediate calculations

Combine R_1, R_{234} and R_5 to get the equivalent resistance of the entire network



$$R_{eq} = R_1 + R_{234} + R_5$$

$$= R_1 + \underbrace{\frac{1}{\frac{1}{R_2+R_3} + \frac{1}{R_4}}}_{R_{234}} + R_5$$

Substitute known values and using the value of R_{234} computed above

$$R_{eq} = 470\,\Omega + 274.5\,\Omega + 330\,\Omega = 1074.5\,\Omega$$

$$\boxed{R_{eq} = 1074.5\,\Omega}$$

↑ continue to carry extra digits through intermediate calculations

Apply Ohm's law to the equivalent circuit

$$V_s = I R_{eq} \Rightarrow I = \frac{V_s}{R_{eq}} = \frac{10\,V}{1074.5\,\Omega}$$

$$\therefore \boxed{I = 9.31 \times 10^{-3}\,A = 9.31\,mA}$$

0.01 mA = 1 μA which is very difficult to measure. We carry this last digit to avoid introducing unecessary round-off in the intermedite calculations.

With $I_5 = I$ known, we can now compute the power dissipated by R_5

$$P_5 = I_5^2 R_5 = I^2 R_5 = (9.31 \times 10^{-3}\,A)(330\,\Omega) = 2.86 \times 10^{-2}\,W$$

$$\boxed{P_5 = 29\,mW}$$

↑ two significant digits in the final result is appropriate

Compute the total power dissipated by the resistor network

$$P_{total} = I^2 R_{eq} = \left(9.31\times10^{-3}\,\text{A}\right)^2\left(1074.5\,\Omega\right) = 9.31\times10^{-2}\,\text{W}$$

$$\boxed{P_{total} = 93\,\text{mW}}$$

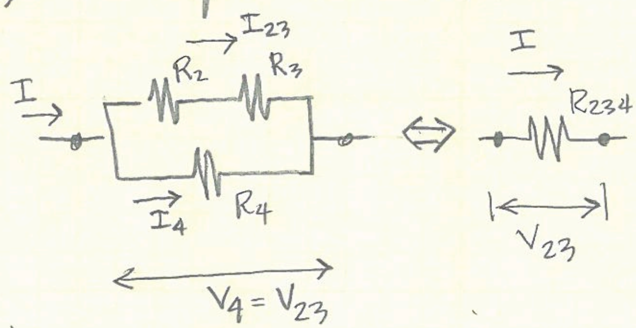
To compute the power dissipated by R_2 we need to find I_2 or V_2.

We know R_{234} and I, so $V_4 = V_{23}$ can be computed from Ohm's law

$$V_{23} = I R_{234}$$

$$= \left(9.31\times10^{-3}\,\text{A}\right)\left(274.5\,\Omega\right)$$

$$= 2.556\,\text{V}$$



With V_{23} known we apply Ohm's law again to compute I_{23}, the current through R_2 and R_3

$$V_{23} = I_{23}(R_2 + R_3) \Rightarrow I_{23} = \frac{V_{23}}{R_2 + R_3} = \frac{2.556\,\text{V}}{330 + 330\,\Omega}$$

$$I_{23} = 3.87\times10^{-3}\,\text{A}$$

Finally, compute $P_2 = I_2^2 R_2$ with $I_2 = I_{23}$

$$P_2 = I_2^2 R_2 = \left(3.87\times10^{-3}\,\text{A}\right)^2\left(330\,\Omega\right) = 4.95\times10^{-3}\,\text{W}$$

$$\boxed{P_2 = 5\,\text{mW}}$$

<u>Discussion</u> The values of P_2 and P_5 are less than the total power dissipated by the network

$P_2 = 5\,\text{mW} < P_{total} = 93\,\text{mW}$ $\quad$ $P_5 = 29\,\text{mW} < P_{total} = 93\,\text{mW}$

While this doesn't prove that the values of P_2, P_5 and P_{total} are correct, at least the relative magnitudes are consistent with common sense