Ex:

Find the values of the following quantities of the above circuit.

a) \( R_5 \)

b) \( V_S \)

c) \( P_S \) (the power delivered by the \( V_S \) source)

Soln a) We first redraw the circuit to show currents as arrows.

Q. How do we know the direction of the current?
A. Since \( V_S \) is the only source, current will flow out the + terminal and in the - terminal. The current through \( R_1 \) and \( R_2 \) must flow down, since \( V_S \) is across them with + at the top. Since \( R_4 \) and \( R_5 \) are in parallel, with the same \( V \) across them, the current in both is in the same direction, and this must be the direction of 18 mA.
Current must flow to the right in \( R_3 \), since \( R_3 \) is connected to the + of \( V_s \) on the left side.

Now we use Ohm’s law and Kirchhoff’s laws to deduce other quantities.

At the top right node, 18 mA flows in, so 18 mA must flow out. Thus, we have 6 mA flowing down through \( R_4 \).

\[ i_{R_4} = 6 \text{ mA} \]

By Ohm’s law, the voltage drop across \( R_4 \) is \( V_{R_4} = i_{R_4} R_4 = 6 \text{ mA} \cdot 1.2 \text{ k} \Omega = 7.2 \text{ V} \).

Since \( R_4 \) is in parallel with \( R_5 \), we also have 7.2 V across \( R_5 \). We find \( R_5 \) using Ohm’s law:

\[ R_5 = \frac{7.2 \text{ V}}{12 \text{ mA}} = 600 \text{ } \Omega \text{ or } 0.6 \text{ k} \Omega \]

b) Now we can use Ohm’s law to find the voltage across \( R_3 \), and then we can use a V-loop to find \( V_s \). (Outside V-loop, that is.)

\[ V_{R_3} = 18 \text{ mA} \cdot 300 \text{ } \Omega = 5.4 \text{ V} \]

\[ V_s = 7.2 \text{ V} + 5.4 \text{ V} = 12.6 \text{ V} \]

c) The total current flowing out of \( V_s \) is \( I_{R1} \) plus 18 mA:

\[ I_{R1} = \frac{V_s}{1 \text{ k} \Omega + 5 \text{ k} \Omega} = \frac{12.6 \text{ V}}{6 \text{ k} \Omega} = 2.1 \text{ mA} \]

\( P_s = V_s I_s = 12.6 \text{ V} \cdot 2.1 \text{ mA} + 18 \text{ mA} = 253.26 \text{ mW} \)