Solutions for Chapter 1

Exercise 1.1

(a) $R = 5\text{k} + 10\text{k} = \boxed{\mathbf{15}\text{k}\boldsymbol{\Omega}}$

(b) $R = \dfrac{R_1 R_2}{R_1 + R_2} = \dfrac{5\text{k} \cdot 10\text{k}}{5\text{k} + 10\text{k}} = \boxed{\mathbf{3.33}\text{k}\boldsymbol{\Omega}}$

Exercise 1.2

$$P = IV = \left(\frac{V}{R}\right) V = \frac{(12\text{V})^2}{1\Omega} = \boxed{\mathbf{144}\text{W}}$$

Exercise 1.3

TODO: Solve this problem

Exercise 1.4

TODO: Solve this problem

Exercise 1.5

Given that $P = \dfrac{V^2}{R}$, we know that the maximum voltage we can achieve is 15V and the smallest resistance we can have across the resistor in question is 1kΩ. Therefore, the maximum amount of power dissipated can be given by

$$P = \frac{V^2}{R} = \frac{(15\text{V})^2}{1\text{k}\Omega} = \boxed{\mathbf{0.225}\text{W}}$$

This is less than the 1/4W power rating.

Exercise 1.10

(a) With two equal-value resistors, the output voltage is half the input voltage.

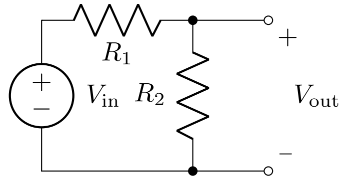
$$V_{out} = \frac{1}{2} V_{in} = \frac{30\text{V}}{2} = \boxed{\mathbf{15}\text{V}}$$

(b) To treat R_2 and R_{load} as a single resistor, combine the two resistors which are in parallel to find that the combined (equivalent) resistance is 5kΩ. Now, we have a simple voltage divider with a 10kΩ resistor in series with the 5kΩ equivalent resistor. The output voltage is across this equivalent resistance. The output voltage is given by

$$V_{out} = V_{in} \frac{5\text{k}\Omega}{10\text{k}\Omega + 5\text{k}\Omega} = \frac{30\text{V}}{3} = \boxed{\mathbf{10}\text{V}}$$

(c) We can redraw the voltage divider circuit to make the "port" clearer.

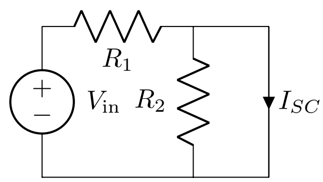
Figure 1: Voltage divider with port shown.



We can find V_{Th} by leaving the ports open (open circuit) and measuring V_{out}, the voltage across R_2. This comes out to be half the input voltage when $R_1 = R_2$, so $V_{\text{out}} = 15\text{V}$. Thus $V_{\text{Th}} = 15\text{V}$.

To find the Thévinen resistance, we need to find the short circuit current, I_{SC}. We short circuit the port and measure the current flowing through it.

Figure 2: Voltage divider with short circuit on the output.

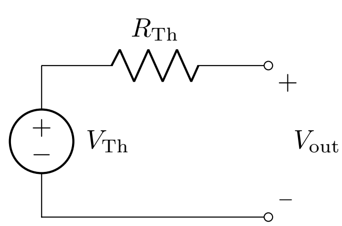


In this circuit, no current flows through R_2, flowing through the short instead. Thus we have $I_{SC} = \frac{V_{\text{in}}}{R_1}$.

From this, we can find R_{Th} from $R_{\text{Th}} = \frac{V_{\text{Th}}}{I_{SC}}$. This gives us $R_{\text{Th}} = \frac{15\text{V} \cdot R_1}{V_{\text{in}}} = \boxed{\frac{\mathbf{150}\text{k}}{\mathbf{V}_{\text{in}}}\boldsymbol{\Omega}}$.

The Thévenin equivalent circuit takes the form shown below.

Figure 3: Thévenin equivalent circuit.



This circuit is equivalent to the circuit in Figure 1.