1. Voltage Divider

(a) Find the voltage $V_R$ and current $i_R$ in the following circuits. Use KCL/KVL and Ohm’s law.

i.  
\[ V_R = 5V, \quad i_R = 5mA \]

ii.  
\[ V_R = 0V, \quad i_R = 0mA \]

iii.  
\[ V_R = 2.5V, \quad i_R = 2.5mA \]

iv.  
\[ V_R = \frac{5}{3}V, \quad i_R = \frac{10}{3}mA \]

v.  
\[ V_R = 4V, \quad i_R = 1mA \]

vi.  
\[ V_R = \frac{9}{2}V, \quad i_R = \frac{1}{2}mA \]

(b) Find the resistance $R$ that achieves the voltage $V_R$. What is the current $i_R$?
i. $R = 2\,\text{k}\Omega, \, i_R = \frac{5}{4}\,\text{mA}$

ii. $R = 8\,\text{k}\Omega, \, i_R = 0.5\,\text{mA}$

(c) Using the resistance $R$ from the last part (b. ii), what happens to the output voltage $V_R$ (and the current $i_R$) if we attach a $R_L$ of 8 k$\Omega$ to the output as depicted in the following circuit:

Answer: $V_R = \frac{10}{3}\,\text{V}, \, i_R = \frac{10}{21}\,\text{mA}$

(d) What if $R_L$ is $\frac{8}{3}\,\text{k}\Omega$? What if $R_L$ is 80 k$\Omega$?

Answer: $V_R = 2.5\,\text{V}, \, i_R = \frac{5}{16}\,\text{mA}$ and $V_R = \frac{40.5}{31}\,\text{V}, \, i_R = \frac{5.5}{31}\,\text{mA} = \frac{25}{31}\,\text{mA}$

(e) Say that we want to support values for $R_L$ in the range of 8k$\Omega$ to 10k$\Omega$. We would like to maintain 4V across this resistor, $R_L$. How can we approximately achieve this by setting $R_1$ and $R_2$ in the following circuit?
Answer: We need $\frac{R_2}{R_1+R_2} = \frac{4}{5}$ and $R_2 \ll 8\,\Omega$ (and as a result also $R_1 \ll 8\,\Omega$).