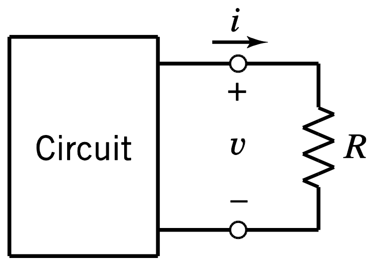
P 5.4-9 A resistor, *R*, was connected to a circuit box as shown in Figure P 5.4-9. The current, *i*, was measured. The resistance was changed, and the current was measured again. The results are shown in the table.
(a) Specify the value of *R* required to cause *i* = 2 mA.
(b) Given that *R* > 0, determine the maximum possible value of the current *i*.

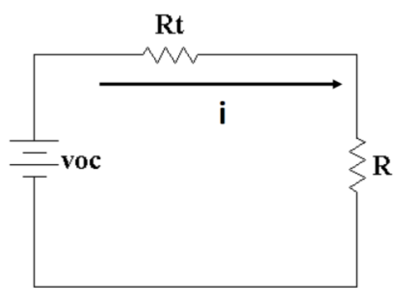
Hint: Use the data in the table to represent the circuit by a Thévenin equivalent.



R	*i*
2 kΩ	4 mA
4 kΩ	3 mA

Figure P 5.4-9

Assume the circuit is a Thevenin circuit we would have the following



We would find the current from

$$i = \frac{v_{oc}}{R_t + R}$$

Plug in the two data points given

$$i = \frac{v_{oc}}{R_t + R} = 4\ mA = \frac{v_{oc}}{R_t + 2\ k\Omega}$$

and

$$i = \frac{v_{oc}}{R_t + R} = 3\ mA = \frac{v_{oc}}{R_t + 4\ k\Omega}$$

Rearrange equations and we have two equations and two unknowns

$$(4\ mA)(R_t + 2\ k\Omega) = v_{oc}$$

$$(3\ mA)(R_t + 4\ k\Omega) = v_{oc}$$

Since v_{oc} is the same we can write

$$(4\ mA)(R_t + 2\ k\Omega) = (3\ mA)(R_t + 4\ k\Omega)$$

Solve for R_t

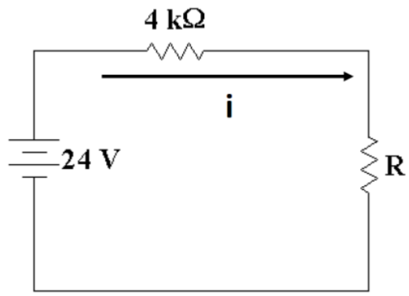
$$(4\ mA - 3\ mA)R_t = 12\ V - 8\ V = 4\ V$$

$$R_t = \frac{4\ V}{1\ mA} = 4\ k\Omega$$

And v_{oc} is

$$v_{oc} = (4\ mA)(R_t + 2\ k\Omega) = (4\ mA)(4\ k\Omega + 2\ k\Omega) = (4\ mA)(6\ k\Omega) = 24\ V$$

So the circuit is



(a) Specify the value of *R* required to cause *i* = 2 mA.

$$i = \frac{24\ V}{4\ k\Omega + R}$$

Solve for R

$$R = \frac{24\ V}{i} - 4\ k\Omega = \frac{24\ V}{2\ mA} - 4\ k\Omega = 12\ k\Omega - 4\ k\Omega = 8\ k\Omega$$

(b) Given that *R* > 0, determine the maximum possible value of the current *i*.

Since

$$i = \frac{24\ V}{4\ k\Omega + R}$$

i is maximized when the denominator is minimized, so make R = 0 and you would have greatest possible i

$$i = \frac{24\ V}{4\ k\Omega + R} = \frac{24\ V}{4\ k\Omega} = 6\ mA$$

$$R_{i=2\ mA} = 8\ k\Omega$$
$$i_{max} = 6\ mA$$

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Please send any comments or questions about this page to ddonovan@nmu.edu

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