Thevenin & Norton equivalent circuits
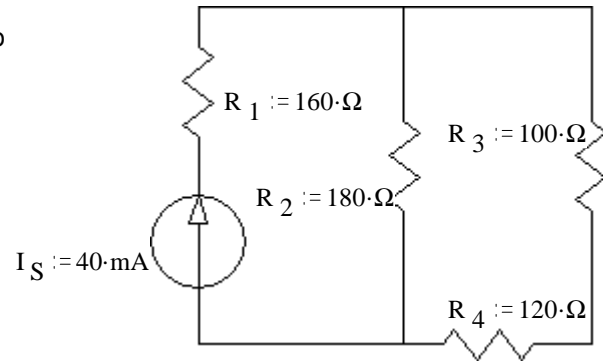
1. For the circuit shown at right, use Thevenin's theorem to find the current through the $120\text{-}\Omega$ resistor, R_4.

$R_1 := 160\cdot\Omega$

$R_3 := 100\cdot\Omega$

$R_2 := 180\cdot\Omega$

$I_S := 40\cdot mA$

$R_4 := 120\cdot\Omega$

2. For the circuit shown, use Norton's theorem to find the value
   of the current in R_5. Hint: You can find I_N either by
   calculation of the open circuit voltage (V_{OC}) and R_N or by
   direct calculation of the short-circuit current (I_{SC}), however,
   there is something about the values of the resistors which
   makes the second method easier than it would at first
   appear.

$R_1 := 20 \cdot \Omega$

$R_2 := 10 \cdot \Omega$

$R_4 := 20 \cdot \Omega$

R_1

1A

$R_3 := 20 \cdot \Omega$ $R_5 := 10 \cdot \Omega$
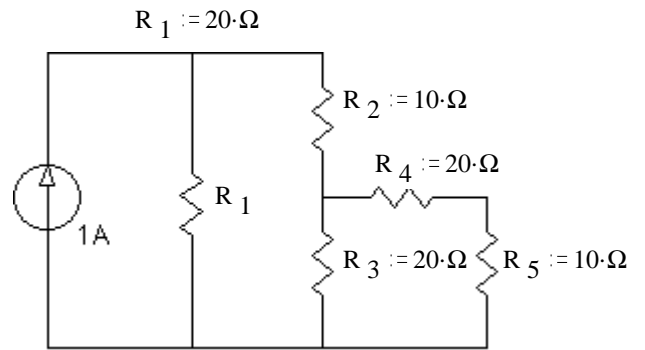
3. The terminal voltage of a car's battery drops from 12.5 V to
   8.5 volts when starting. The starter motor draws 80 A of current.

   a) Draw the voltage-source model (Thevenin equivalent) of this battery. Include the values of V_S and R_S.

   b) Draw the current-source model (Norton equivalent) of this battery. Include the values of I_S and R_S.

   c) Which of these two models is more appropriate for the car battery?

   d) What terminal voltage would you expect if this battery were being charged at 20 A?

Answers   1. $18 \cdot mA$ 2. $0.19 \cdot A$
3. a) $V_S = 12.5 \cdot V$ $R_S := 0.05 \cdot \Omega$ b) $I_S = 250 \cdot A$ $R_S := 0.05 \cdot \Omega$ c) Thevenin   d) $13.5 \cdot V$