• Chapter 2:

2.1, 2.4, 2.16, 2.25, 2.32, 2.40,
2.67, 2.71, 2.77, 2.83, 2.85, 2.97

P2.1* (a) $R_{eq} = 20\,\Omega$ (b) $R_{eq} = 23\,\Omega$

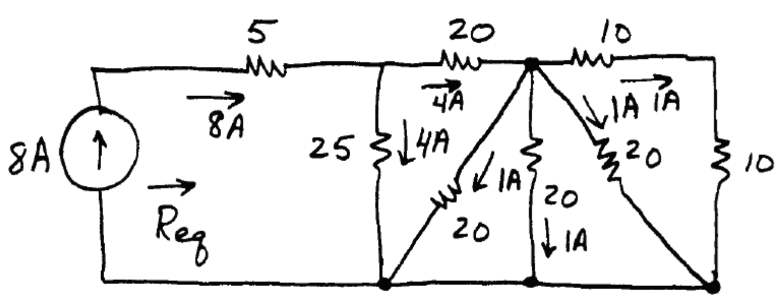
P2.4* The 12-Ω and 6-Ω resistances are in parallel having an equivalent resistance of 4 Ω. Similarly, the 18-Ω and 9-Ω resistances are in parallel and have an equivalent resistance of 6 Ω. Finally, the two parallel combinations are in series, and we have

$$R_{ab} = 4 + 6 = 10\ \Omega$$

P2.16 $R = 10\ \Omega$.

P2.25* Combining resistors in series and parallel, we find that the equivalent resistance seen by the current source is $R_{eq} = 17.5\ \Omega$.

Thus, $v = 8 \times 17.5 = 140$ V. Also, $i = 1$ A.



P2.32 With the switch open, the current flowing clockwise in the circuit is given by $i = \dfrac{16}{6 + R_2}$, and we have $v_2 = R_2 i = \dfrac{16R_2}{6 + R_2} = 10$. Solving, we find $R_2 = 10$ Ω.

With the switch closed, R_2 and R_L are in parallel with an equivalent resistance given by $R_{eq} = \frac{1}{1/R_2 + 1/R_L} = \frac{1}{1/10 + 1/R_L}$. The current through R_{eq} is given by $i = \frac{16}{6 + R_{eq}}$ and we have $v_2 = R_{eq} i = \frac{16R_{eq}}{6 + R_{eq}} = 8$.

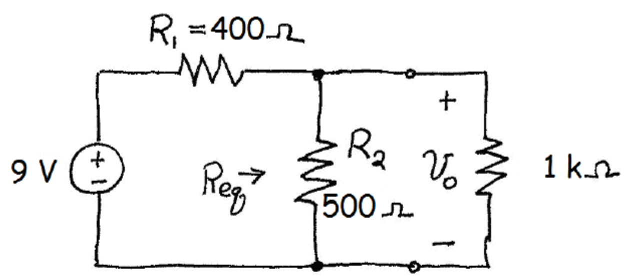
Solving, we find $R_{eq} = 6\ \Omega$. Then, we can write $R_{eq} = \frac{1}{1/10 + 1/R_L} = 6$.

Solving, we find $R_L = 15\ \Omega$.

P2.40 (a) $R_1 + R_2 = \frac{9\text{ V}}{10\text{ mA}} = 900\ \Omega$ $\qquad\qquad \frac{R_2}{R_1 + R_2} \times 9 = 5$

Solving, we find $R_2 = 500\ \Omega$ and $R_1 = 400\ \Omega$.

(b)



The equivalent resistance for the parallel combination of R_2 and the load is

$$R_{eq} = \frac{1}{1/500 + 1/1000} = 333.3\ \Omega$$

Then, using the voltage division principle, we have

$$v_o = \frac{R_{eq}}{R_1 + R_{eq}} \times 9\text{ V} = 4.091\text{ V}$$

(c) If we choose a larger current in part (a), resulting in smaller values for R_1 and R_2, the loaded voltage in part (b) would be closer to 5 V. However, this would result in shorter battery life.

P2.67* Writing KVL equations around each mesh, we have

$$5i_1 + 15(i_1 - i_2) = 20 \quad \text{and} \quad 15(i_2 - i_1) + 10i_2 = 10$$

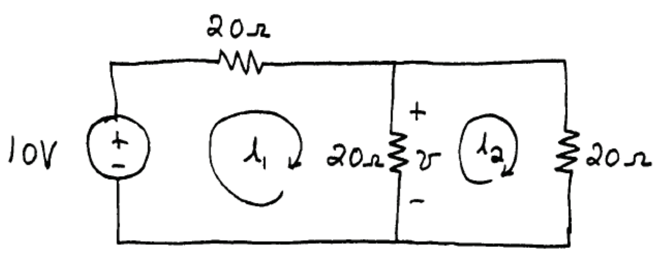
Putting the equations into standard from we have

$$20i_1 - 15i_2 = 20 \quad \text{and} \quad -15i_1 + 25i_2 = 10$$

Solving, we obtain $i_1 = 2.364$ A and $i_2 = 1.818$ A.
Then, the power delivered to the 15-Ω resistor is $P = (i_1 - i_2)^2 15 = 4.471$ W.

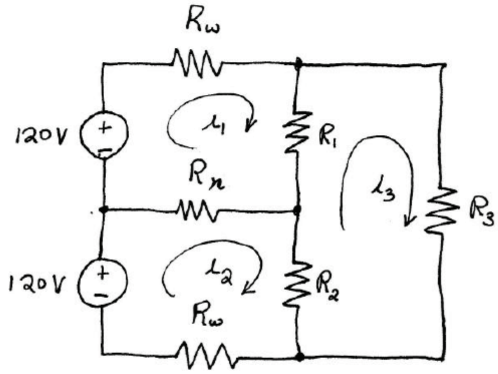
P2.71 Writing and simplifying the mesh equations, we obtain:

$$40i_1 - 20i_2 = 10 \qquad\qquad -20i_1 + 40i_2 = 0$$



Solving, we find $i_1 = 0.3333$ and $i_2 = 0.1667$.
Thus, $v = 20(i_1 - i_2) = 3.333$ V.

P2.77 (a) First, we select mesh-current variables as shown.



Then, we can write

$$(R_w + R_n + R_1)i_1 - R_n i_2 - R_1 i_3 = 120$$

$$-R_n i_1 + (R_w + R_n + R_2)i_2 - R_2 i_3 = 120$$

$$-R_1 i_1 - R_2 i_2 + (R_1 + R_2 + R_3)i_3 = 0$$

Alternatively, because the network consists of independent voltage sources and resistances, and all of the mesh currents flow clockwise, we can enter the matrices directly into MATLAB.

```
Rw = 0.1; Rn=0.1; R1 = 20; R2 = 10; R3 = 16;
R = [Rw+Rn+R1 -Rn -R1; -Rn Rw+Rn+R2 -R2; -R1 -R2 R1+R2+R3];
V = [120; 120; 0];
I = R\V;
% Finally, we compute the voltages across the loads.
Vr1 = R1*(I(1) - I(3)), Vr2 = R2*(I(2) - I(3)), Vr3 = R3*I(3)...
% which results in:
Vr1 =
 118.5121
Vr2 =
 116.7862
Vr3 =
 235.2983
```

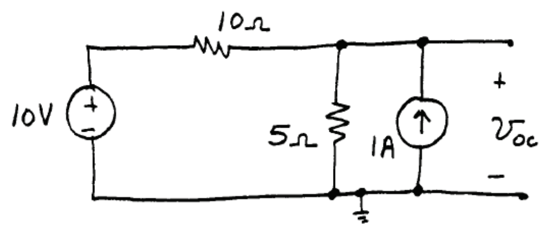
These values are within the normal range for nearly all devices.

(b) Next, we change Rn to a very high value such as 10^9 which for practical calculations is equivalent to an open circuit, and again compute the voltages resulting in:

Vr1 =
156.9910
Vr2 =
78.4955
Vr3 =
235.4865

The voltage across R_1 is certainly high enough to damage most loads designed to operate at 110 to 120 V.

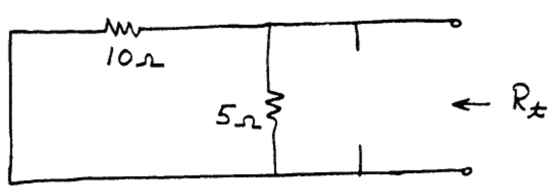
P2.83* First, we write a node voltage equation to solve for the open-circuit voltage:



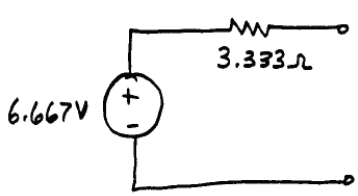
$$\frac{v_{oc}-10}{10}+\frac{v_{oc}}{5}=1$$

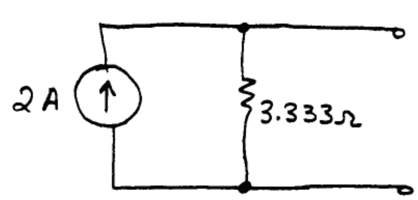
Solving, we find $v_{oc}=6.667\text{ V}$.

Then zeroing the sources, we have this circuit:

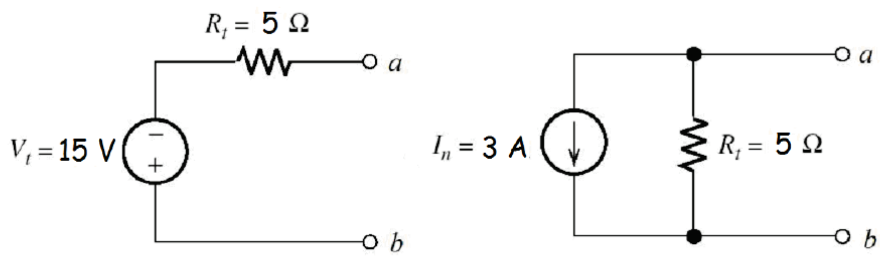


Thus, $R_t=\dfrac{1}{1/10+1/5}=3.333\ \Omega$. The Thévenin and Norton equivalents are:

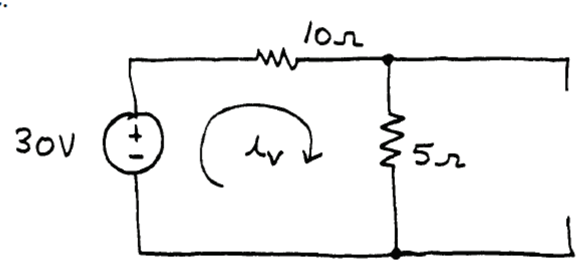




P2.85 The 9-Ω resistor has no effect on the equivalent circuits because the voltage across the 12-V source is independent of the resistor value.

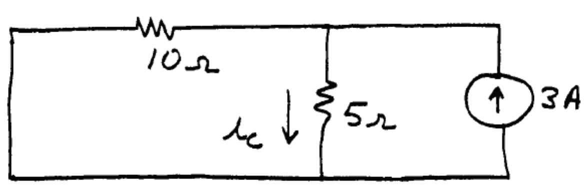


P2.97* First, we zero the current source and find the current due to the voltage source.



$i_v = 30/15 = 2\text{ A}$

Then, we zero the voltage source and use the current-division principle to find the current due to the current source.



$$i_c = 3\frac{10}{5+10} = 2\text{ A}$$

Finally, the total current is the sum of the contributions from each source.

$i = i_v + i_c = 4\text{ A}$