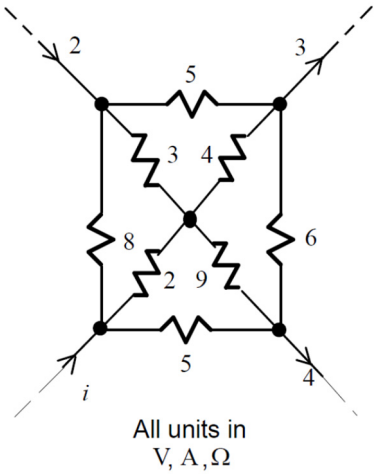
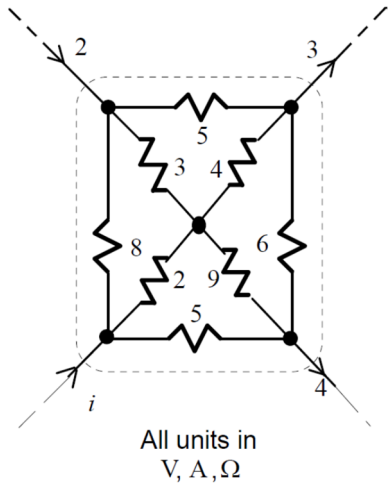
Practice Questions for DC Circuit Analysis

1. Determine the current *i* the following circuit:



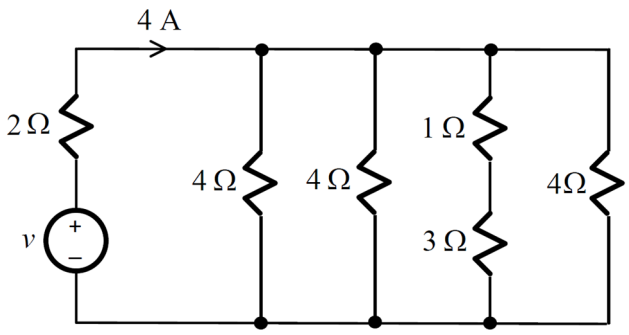
Ans:



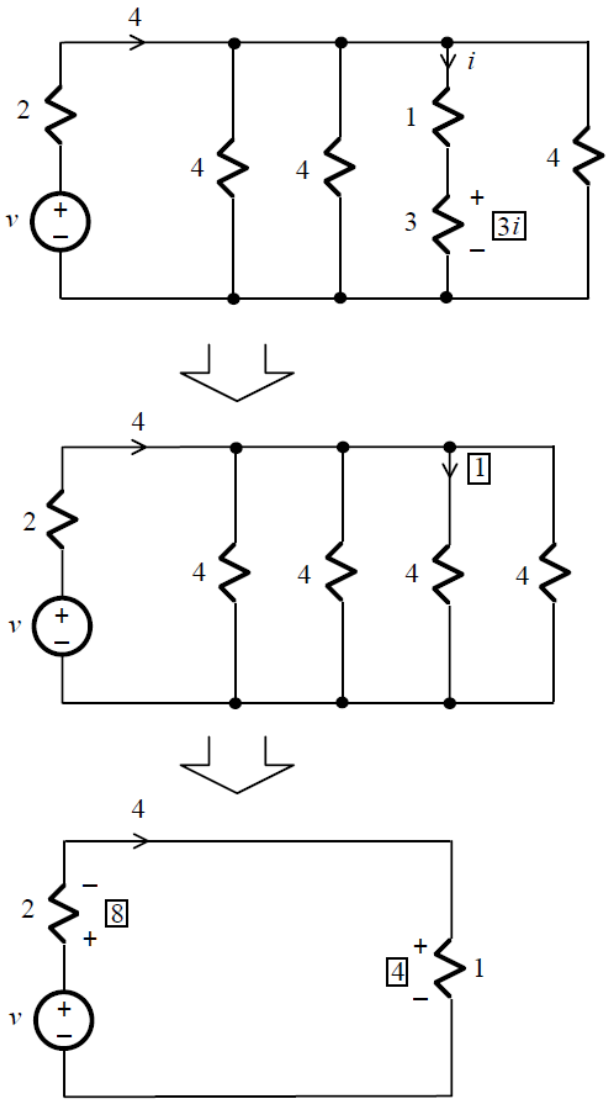
Applying KCL to the dotted surface:

$$i + 2 = 3 + 4 \Rightarrow i = 5$$

2. Determine the source voltage *v* and the voltage across the 3Ω resistor in the following circuit.



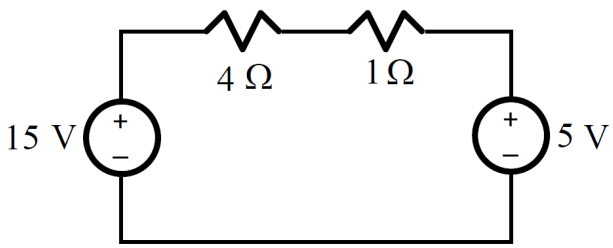
Ans:



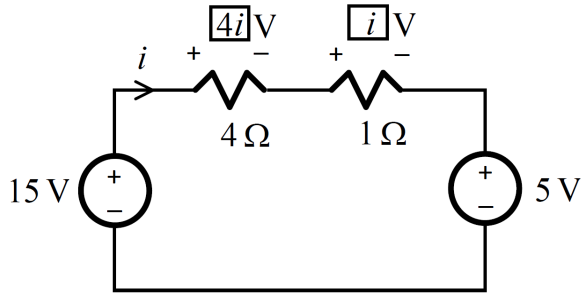
All units in V, A, Ω

$v = 8 + 4 = 12\,\text{V}$; $i = 1$; voltage across 3Ω resistor $= 3i = 3\,\text{V}$

3. Determine the current in the following circuit. How much power is each voltage source consuming or supplying?



Ans:



Applying KVL:

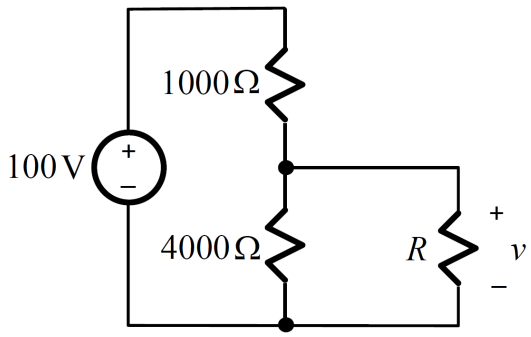
$$15 = 4i + i + 5 \Rightarrow i = 2$$

Using "passive sign convention", power consumed/supplied:

- Power consumed by 5 V source = 5 x i = 10 W

- Power consumed by 15 V source = 15 x ($-i$) = -30 W
  $\Rightarrow$ Since it is negative, therefore the 15 V source is supplying a power of 30 W.

4. The following circuit shows a common voltage divider for obtaining a certain voltage v across a load resistor R.

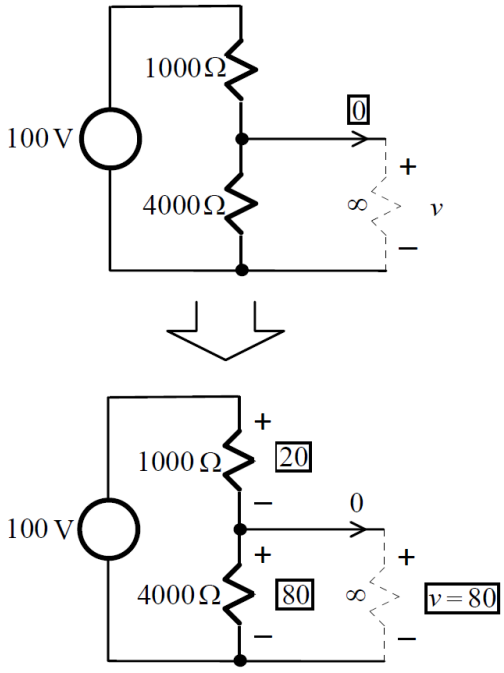


A novice may forget to include the loading effects of R. To understand these effects, determine v and the current in R when

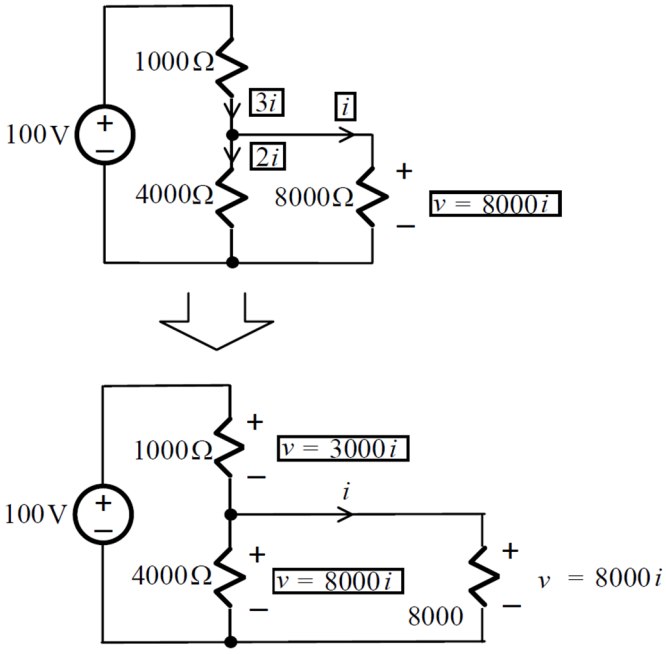
(a) $R = \infty$ (open-circuit)
(b) $R = 8000\ \Omega$
(c) $R = 200\ \Omega$
(d) $R = 0$ (short-circuit)

Ans:

(a) $R = \infty$ (open-circuit)



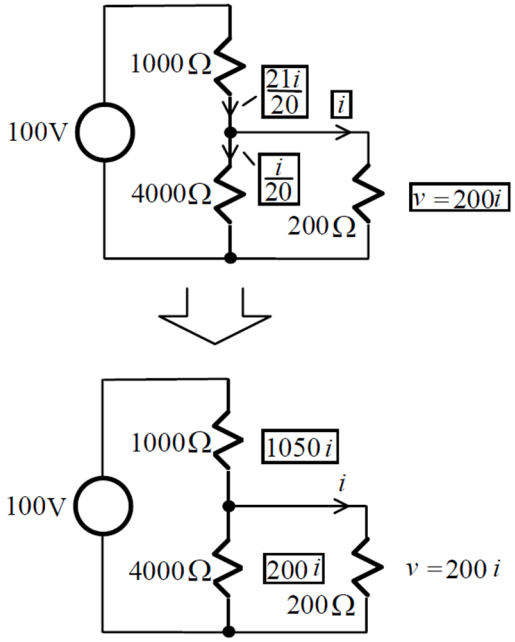
(b) $R = 8000\ \Omega$



$$100 = 3000i + 8000i \Rightarrow i = \frac{1}{110}\text{A}$$

$$v = 8000i = 72.73\text{V}$$

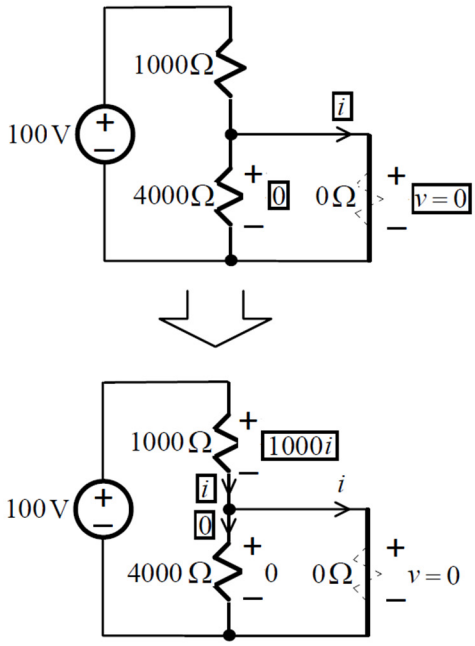
(c) $R = 200\ \Omega$



$$100 = 1050i + 200i \Rightarrow 100 = 1250i \Rightarrow i = \frac{2}{25}\text{A}$$

$$v = 200i = 16\,\text{V}$$

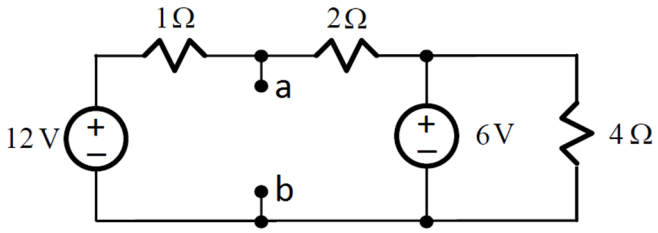
(d) $R = 0$ (short-circuit)



$$100 = 1000i \Rightarrow i = 0.1\text{A}$$

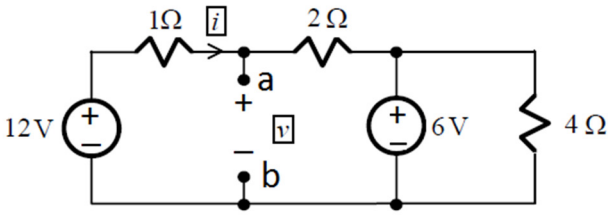
It may be slightly faster to derive two general formulas for v and i and then substitute the values for R.

5. Determine the maximum power that can be obtained from terminals **a** and **b** of the following circuit.



Ans:

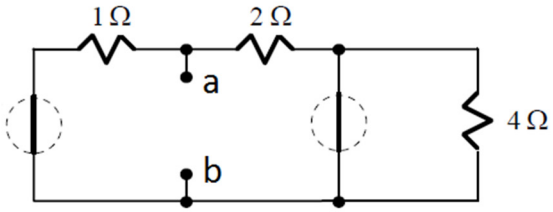
Open circuit voltage



$$i = \frac{12-6}{1+2} = 2$$

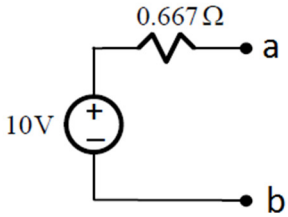
$$v = 12 - i = 10\,\text{V}$$

Equivalent resistance



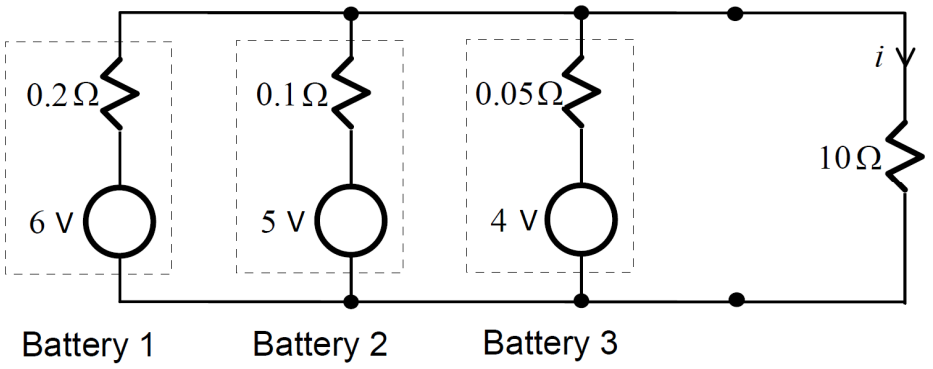
Resistance across terminals $= 1 \,||\, 2 = \dfrac{1}{1+\frac{1}{2}} = 0.667\,\Omega$

Thevenin's equivalent circuit and maximum power



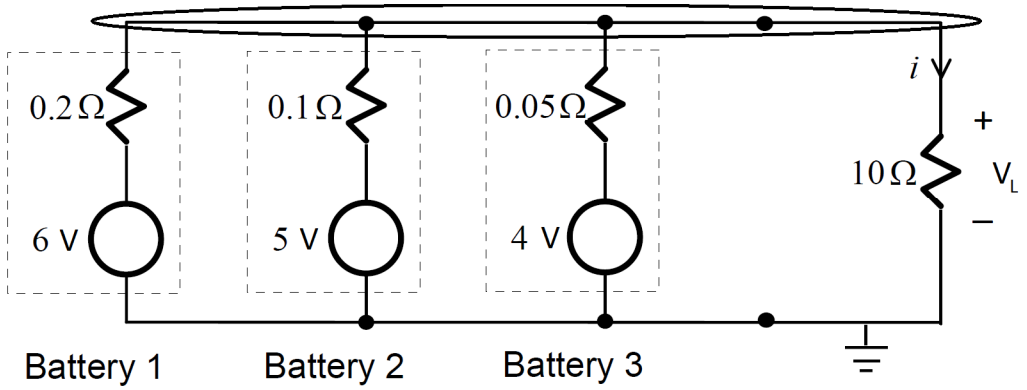
Maximum power transferable (with a $0.667\,\Omega$ load) $= \left(\dfrac{10}{2\times 0.667}\right)^2 0.667 = 37.5\,\text{W}$

6.



The circuit above shows a 10 Ω load connected to three batteries in parallel. Using node voltage analysis method, determine the voltage across the 10 Ω load, and also its current *i*.

Ans:



First, we assign the bottom wire as the reference node (earthed, with voltage 0).

We only need to have one unknown voltage variable for the above circuit, V_L.

Writing the KCL equation for the top node enclosed by the ellipse (equate the sum of currents leaving the node to zero):

$$\frac{V_L - 6}{0.2} + \frac{V_L - 5}{0.1} + \frac{V_L - 4}{0.05} + \frac{V_L}{10} = 0$$

Solving the above equation, we get V_L = 4.56 V, and i = 0.456 A.