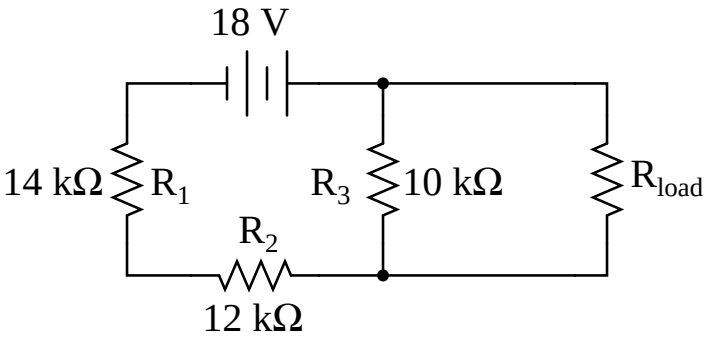
Question 1

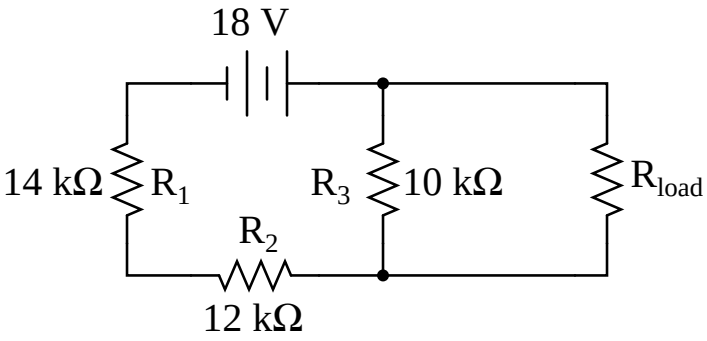
Animation: Applying Thévenin's theorem

This question consists of a series of images (one per page) that form an animation. Flip the pages with your fingers to view this animation (or click on the "next" button on your viewer) frame-by-frame.

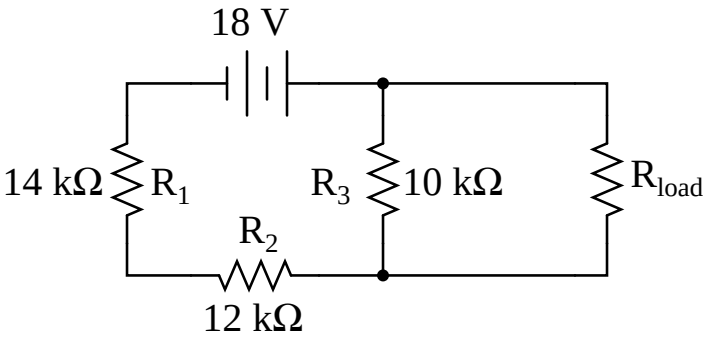
The following animation shows the steps involved in "Thévenizing" a circuit.


18 V
14 kΩ
R1
R3
10 kΩ
Rload
R2
12 kΩ

This is our original circuit:



We may use Thevenin's theorem
to simplify this portion of the circuit . . .



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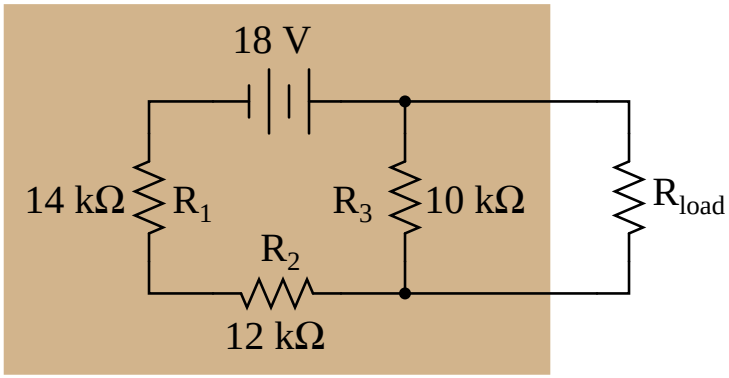
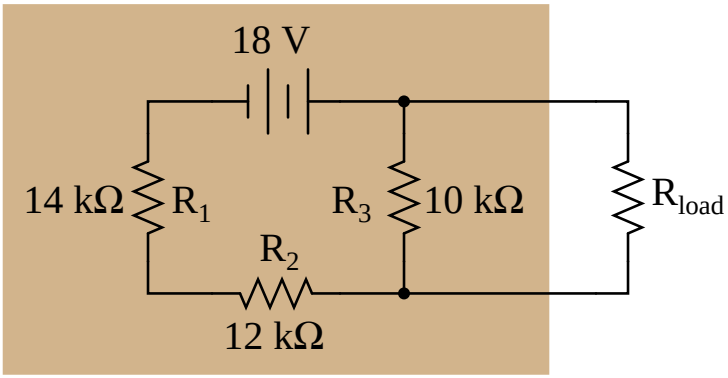
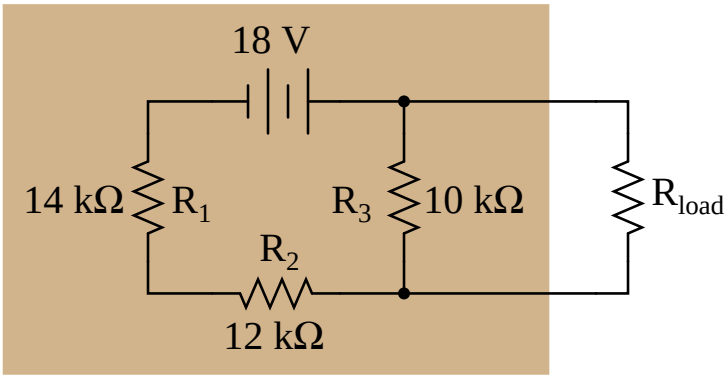
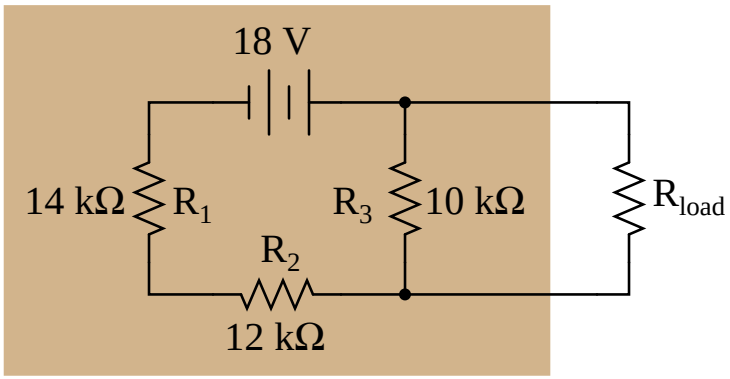


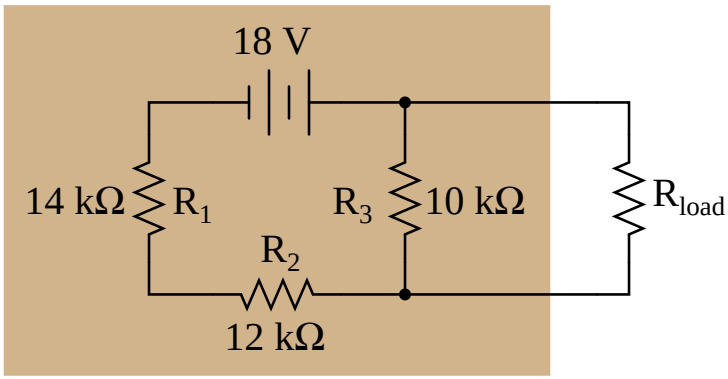
We may use Thevenin's theorem to simplify this portion of the circuit . . .



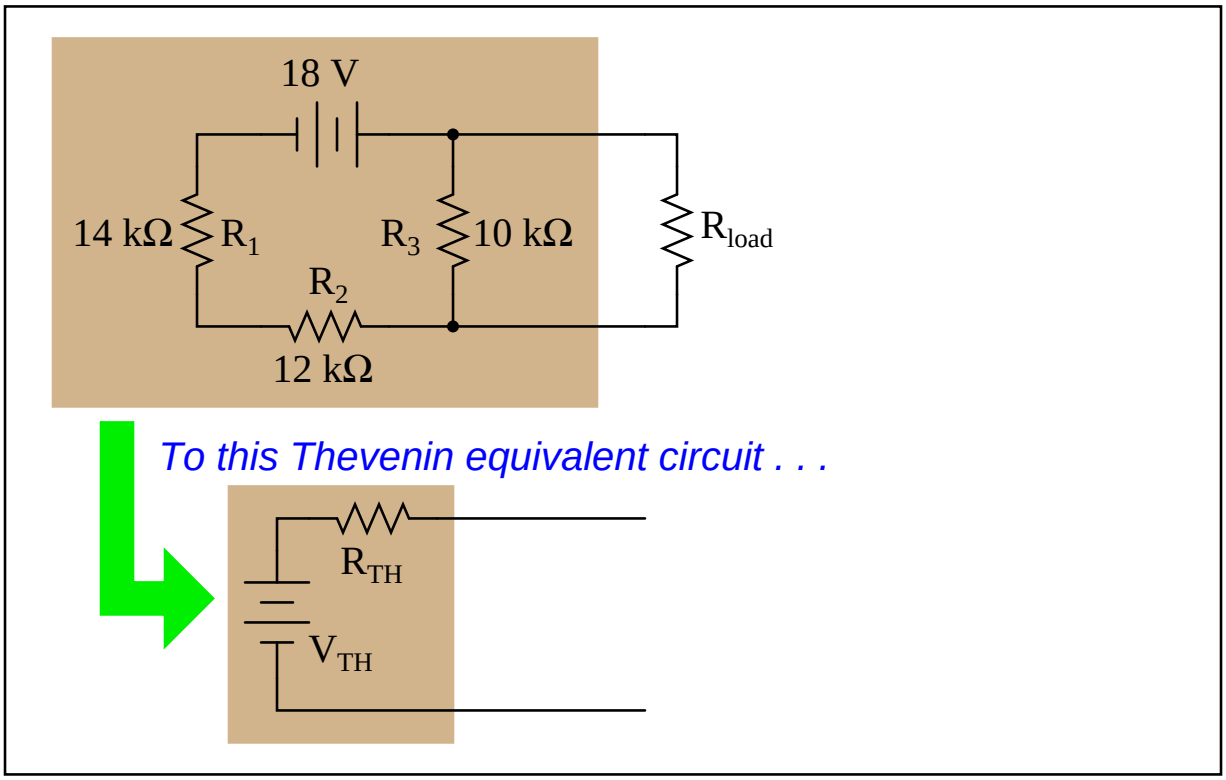
We may use Thevenin's theorem
to simplify this portion of the circuit . . .

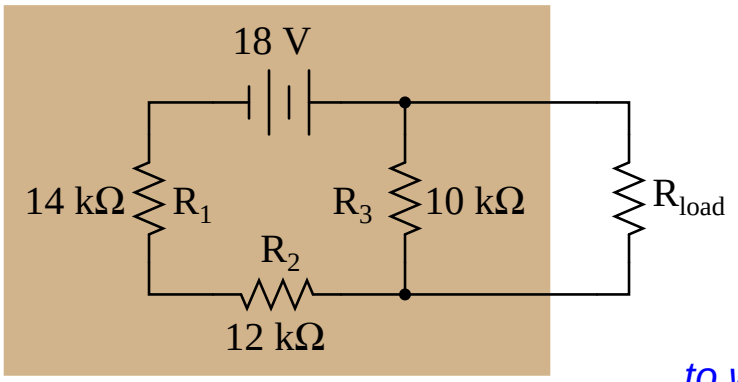



18 V
14 kΩ
R1
R3
10 kΩ
Rload
R2
12 kΩ

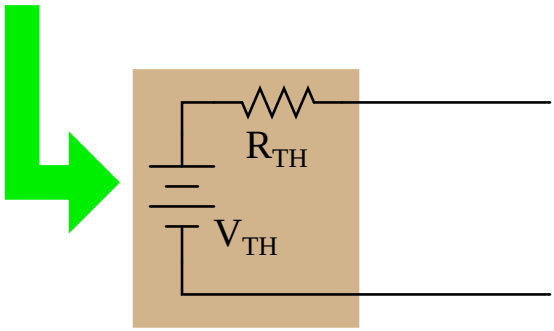


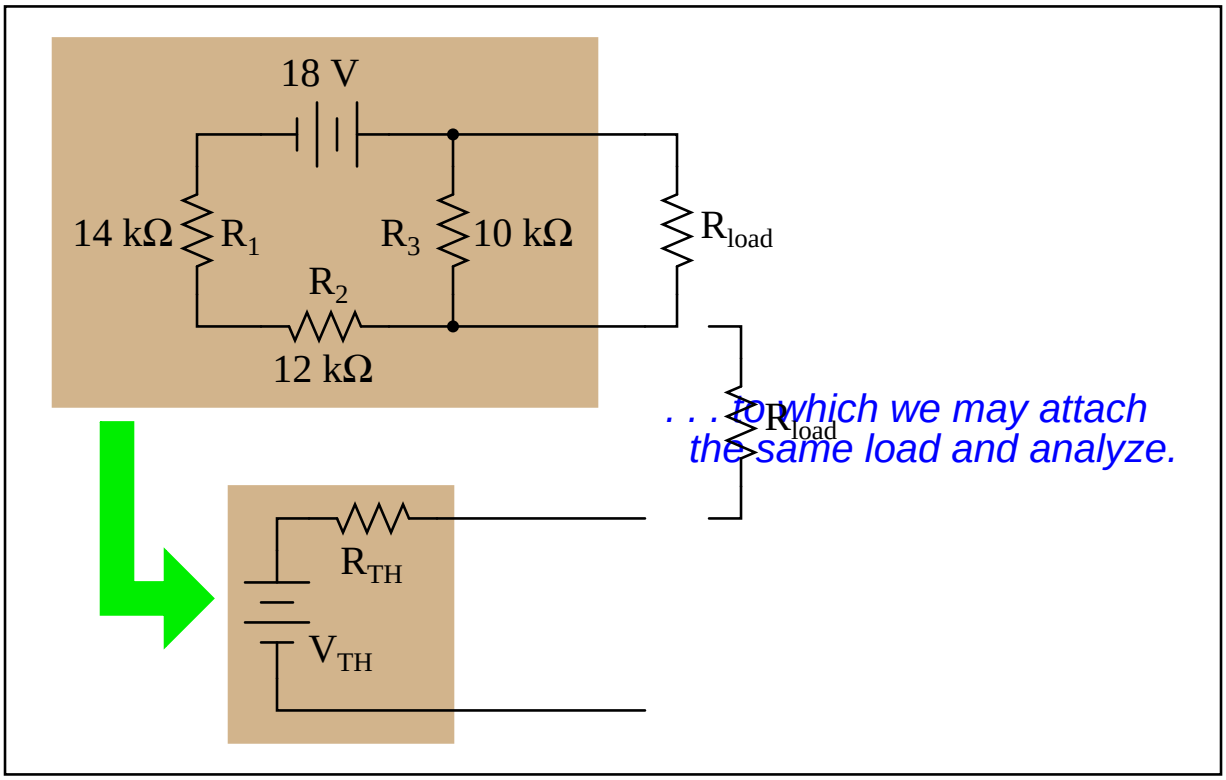
To this Thevenin equivalent circuit . . .

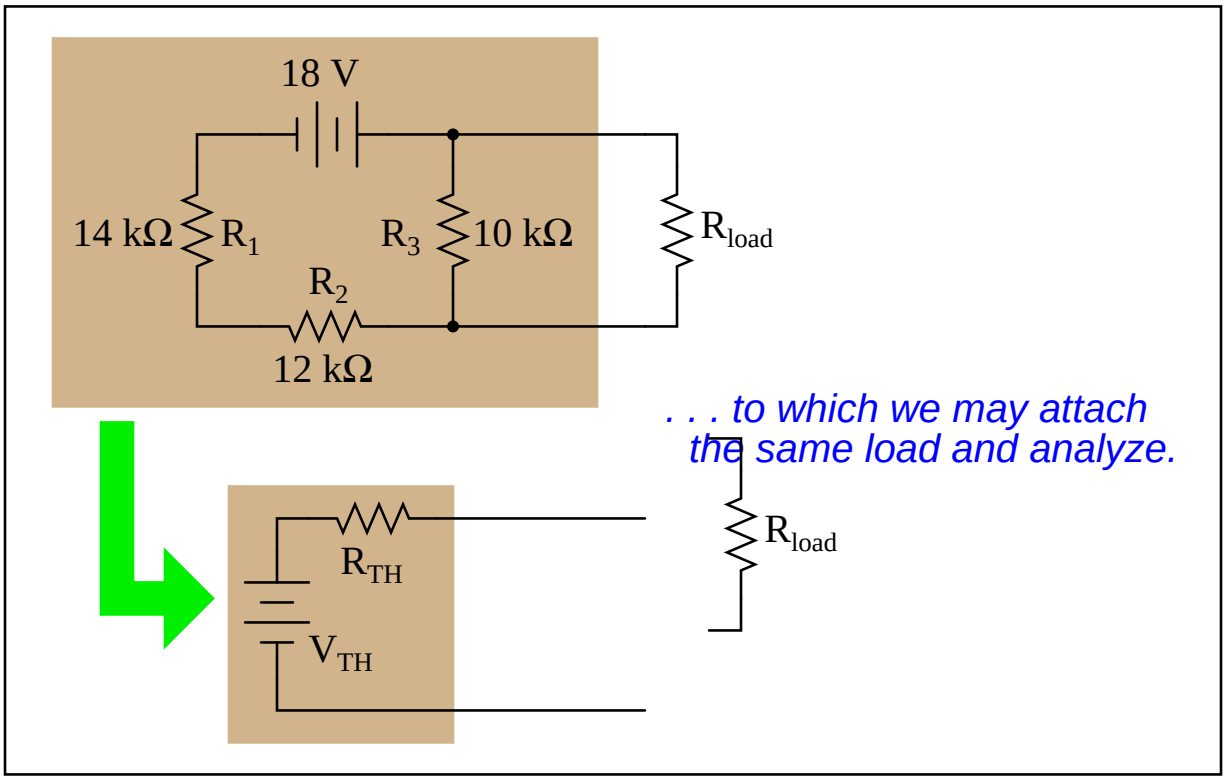

18 V
14 kΩ
R1
R3
10 kΩ
Rload
R2
12 kΩ
To this Thevenin equivalent circuit . . .
RTH
VTH



. . . to which we may attach the same load and analyze.




18 V
14 kΩ
R1
R3
10 kΩ
R2
12 kΩ
Rload
. . . to which we may attach
the same load and analyze.
Rload
RTH
VTH


18 V
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RTH
VTH
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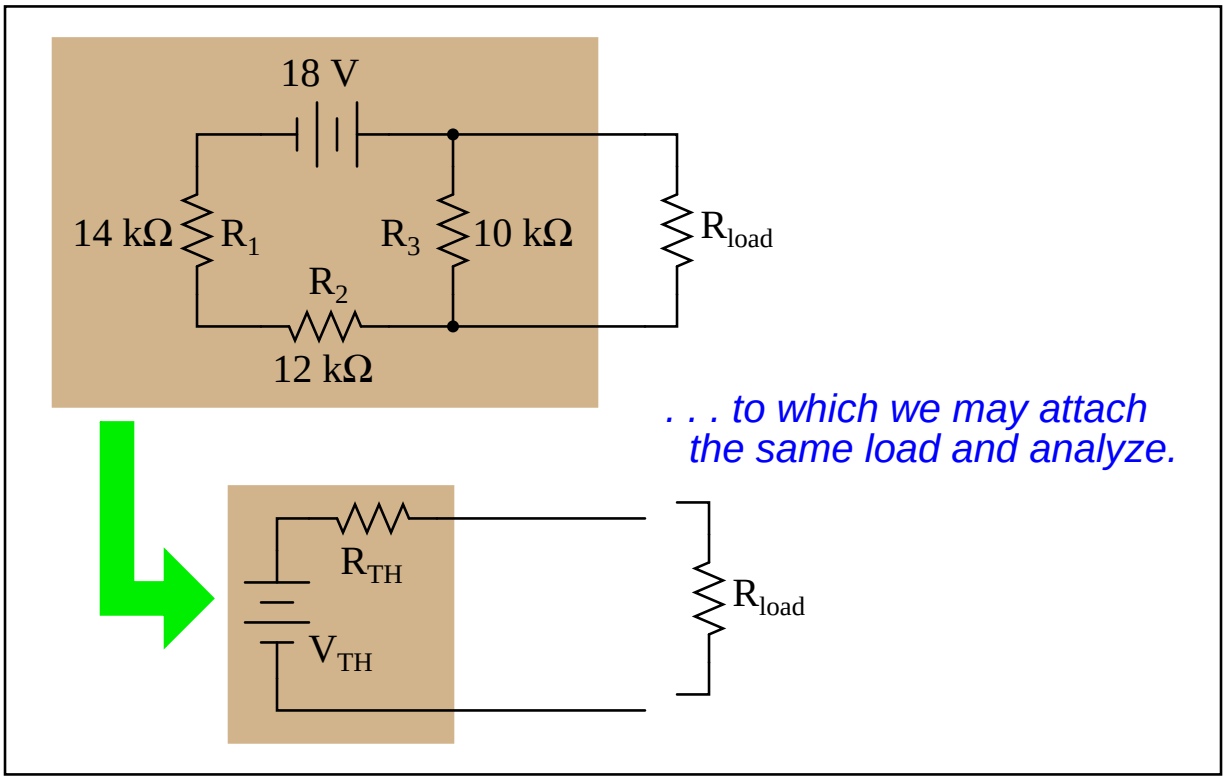
18 V
14 kΩ
R1
R3
10 kΩ
Rload
R2
12 kΩ
. . . to which we may attach
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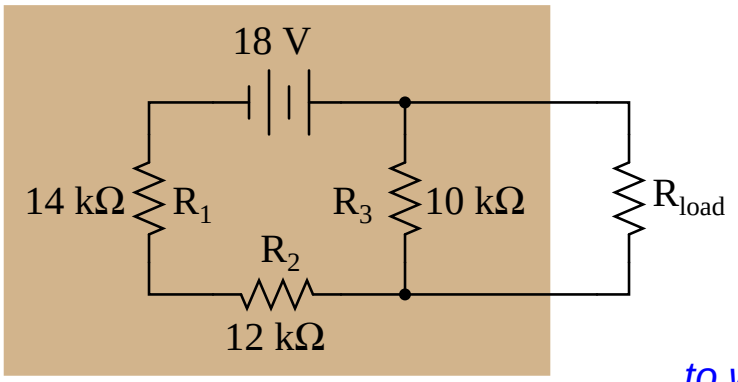
RTH
VTH
Rload



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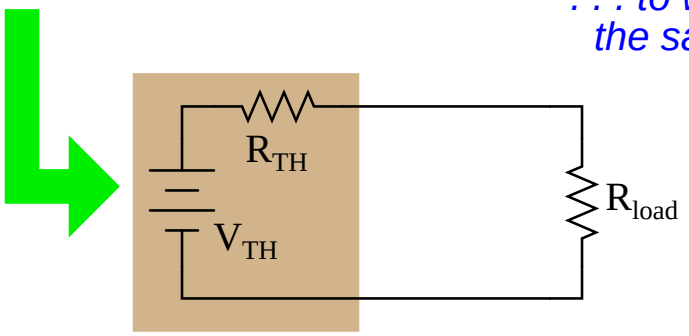

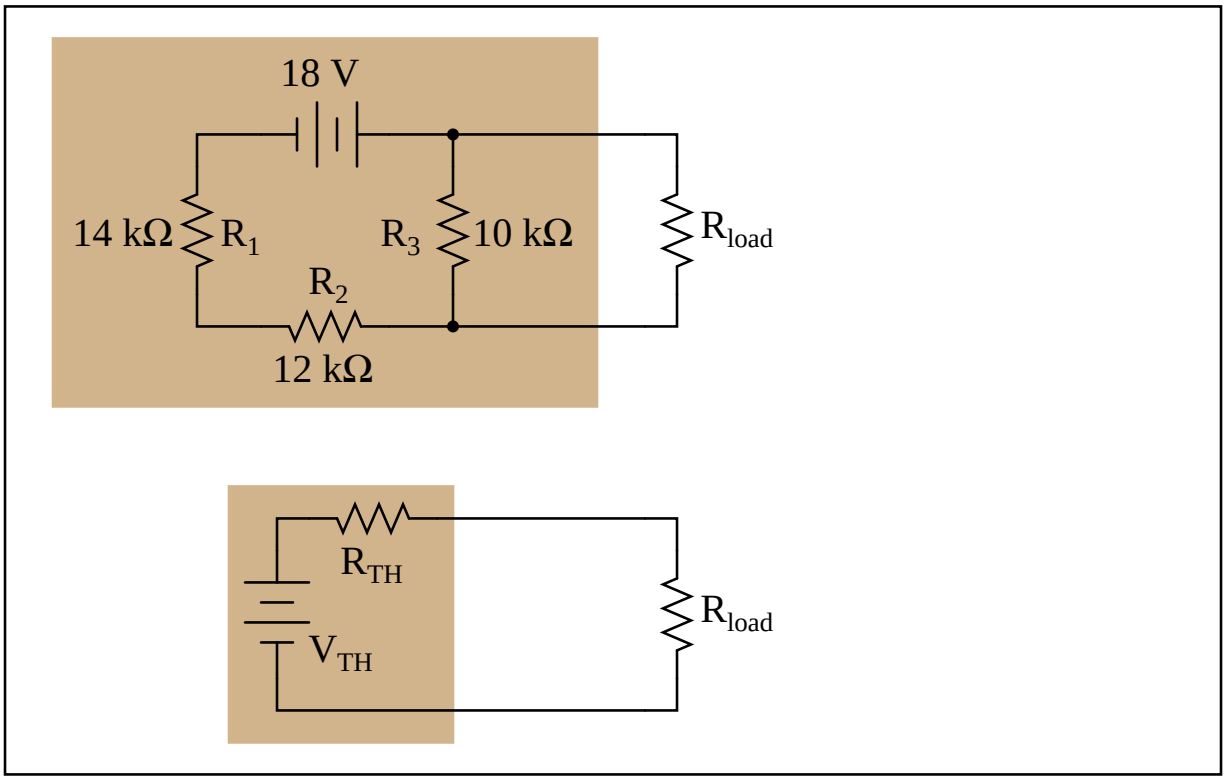
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R1
R3
10 kΩ
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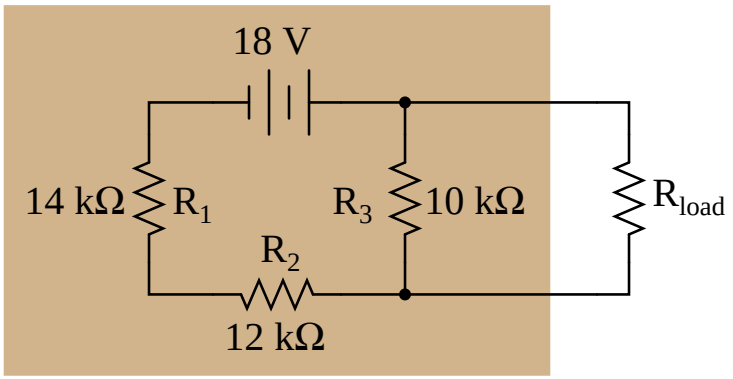
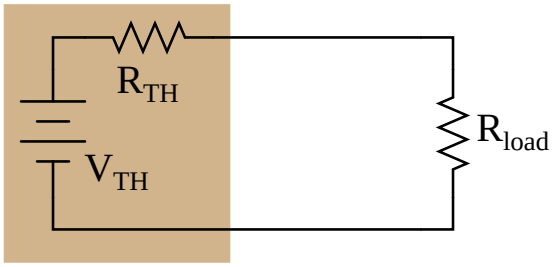
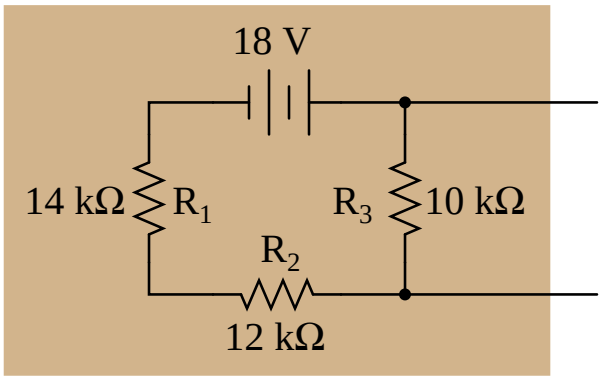
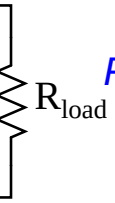
R2
12 kΩ
RTH
VTH
Rload



First we disconnect the load resistor.







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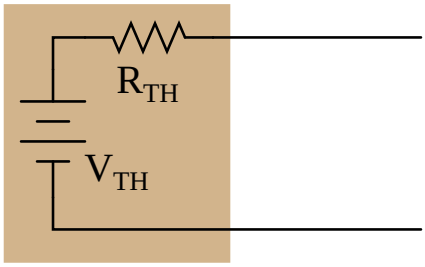

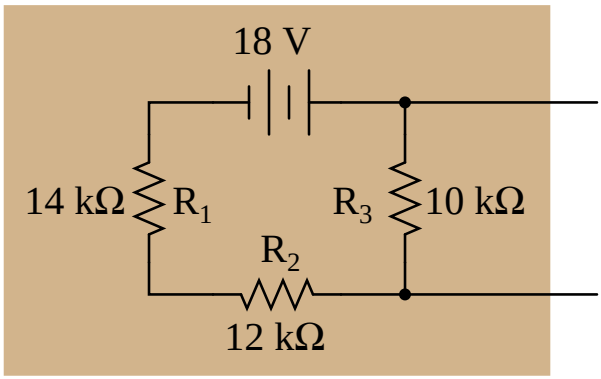

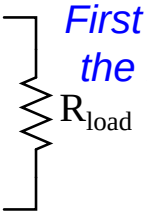

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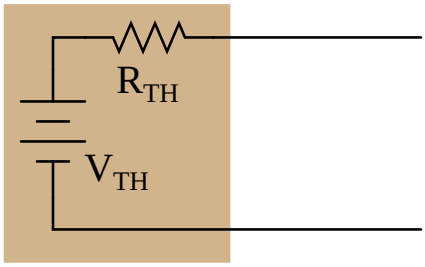

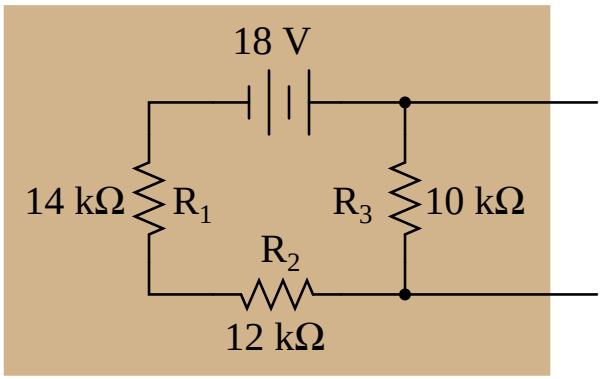

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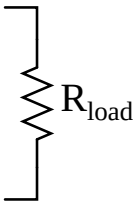
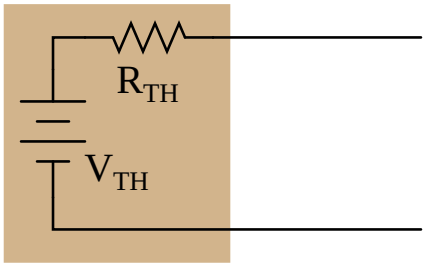
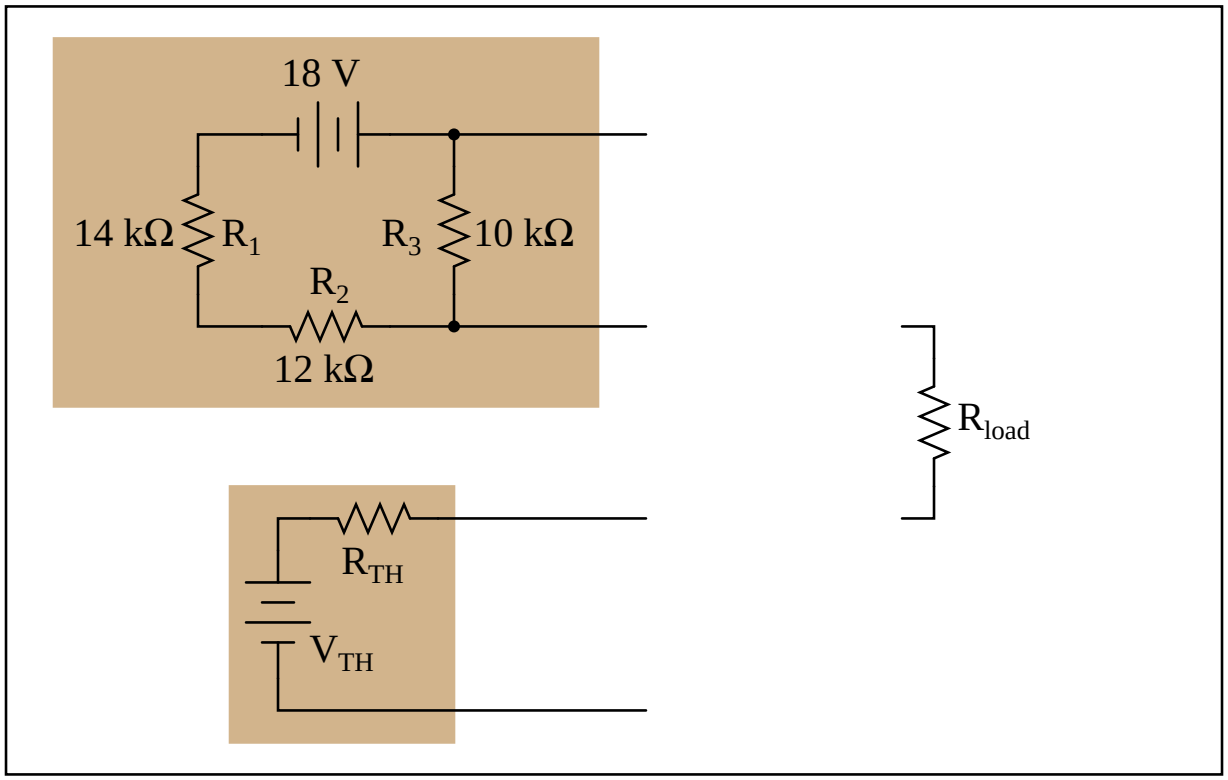
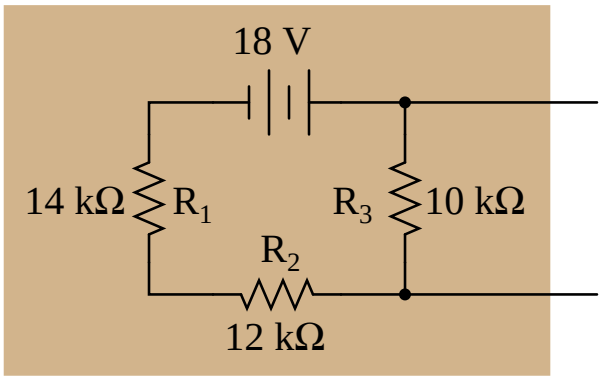
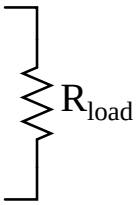


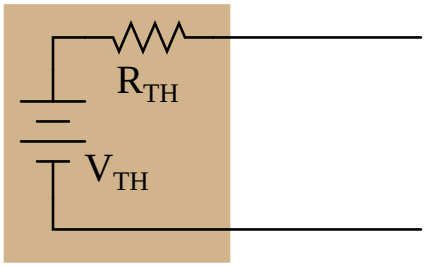


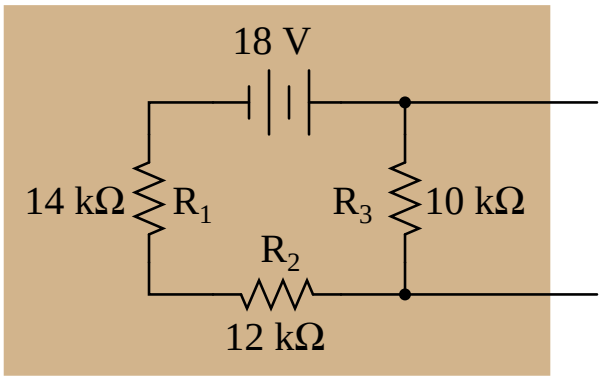

18 V
14 kΩ
R1
R3
10 kΩ
R2
12 kΩ
Rload
RTH
VTH



Then we calculate how much voltage appears across the open load terminals.







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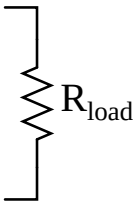
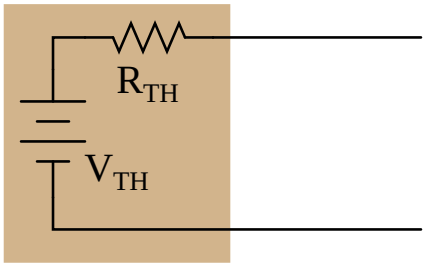
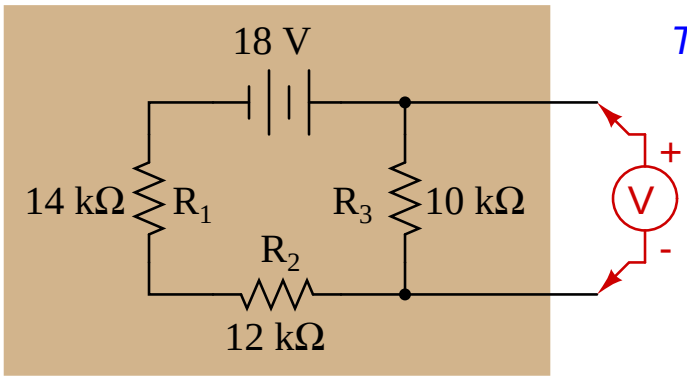
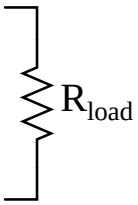
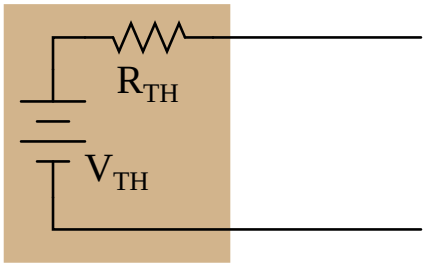


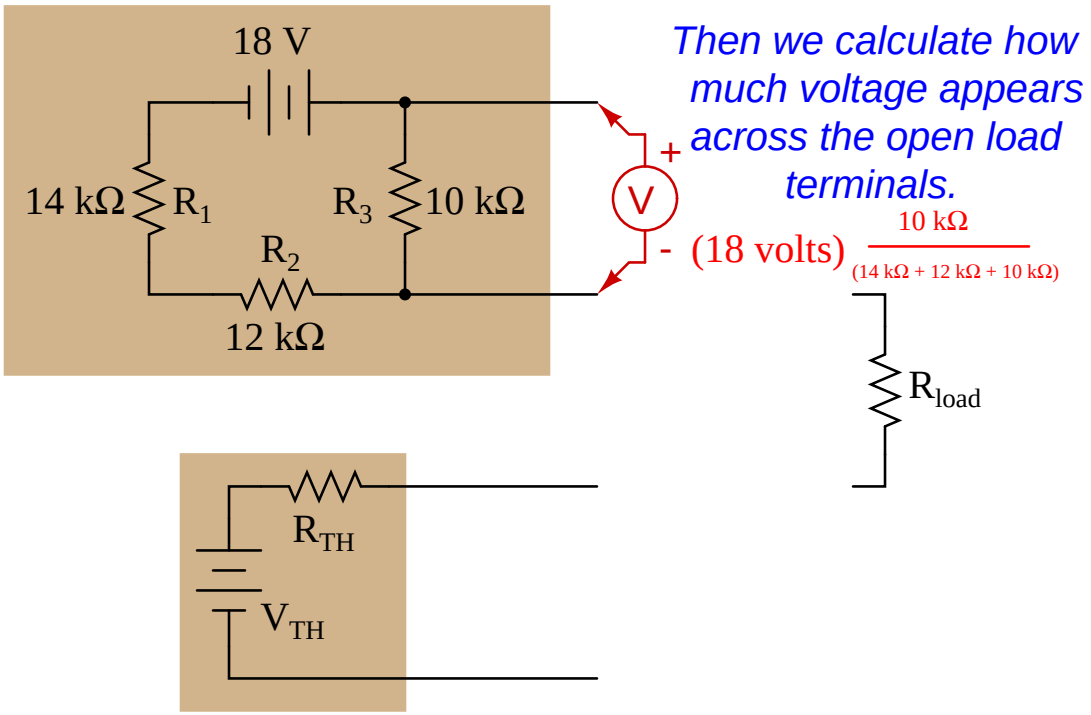


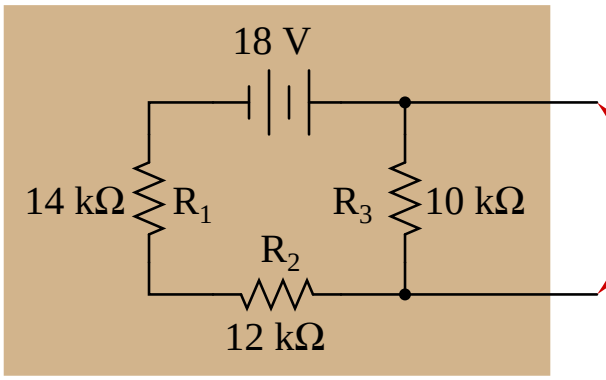


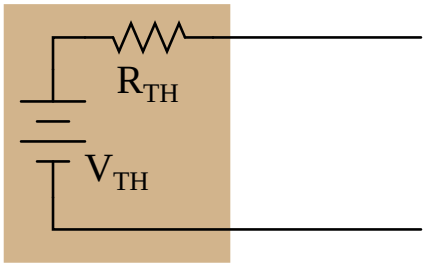
Then we calculate how much voltage appears across the open load terminals.



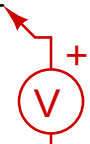



18 V
14 kΩ
R1
R3
10 kΩ
R2
12 kΩ
+
V
-
Then we calculate how much voltage appears across the open load terminals.
(18 volts) 10 kΩ / (14 kΩ + 12 kΩ + 10 kΩ)
Rload
RTH
VTH

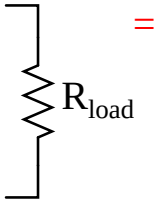


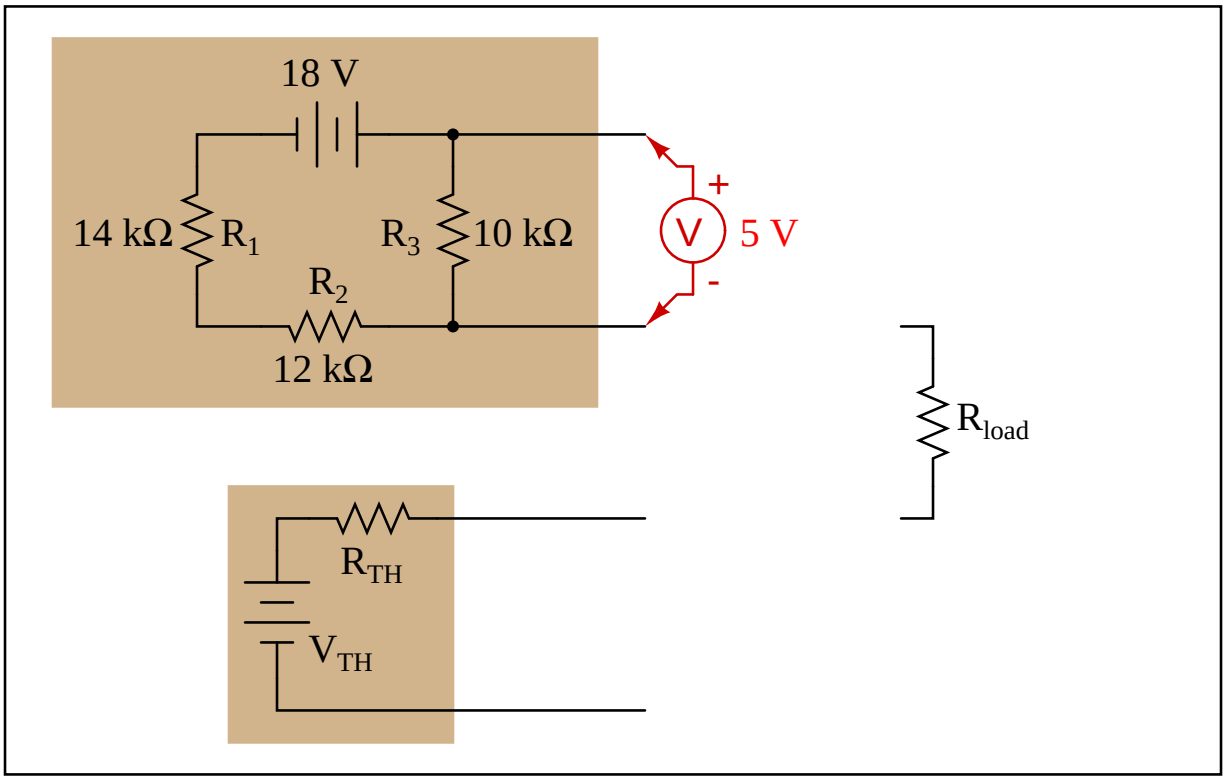


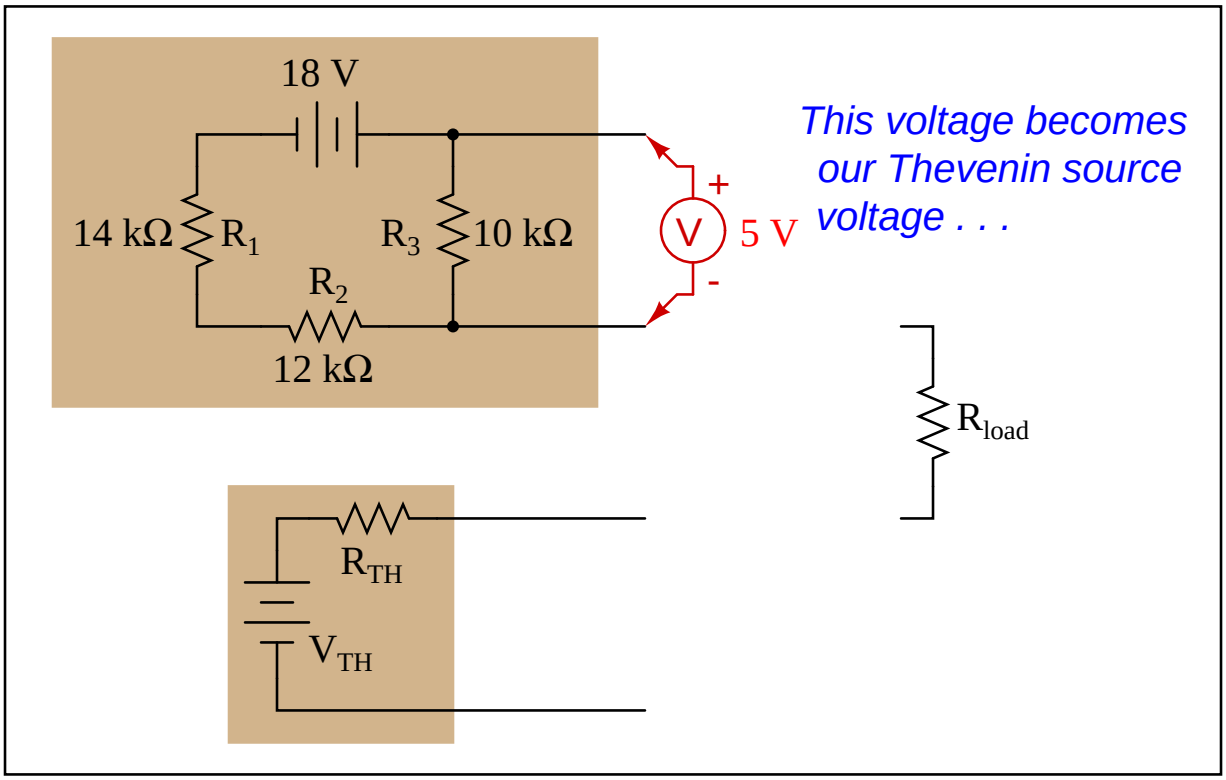
Then we calculate how much voltage appears across the open load terminals.

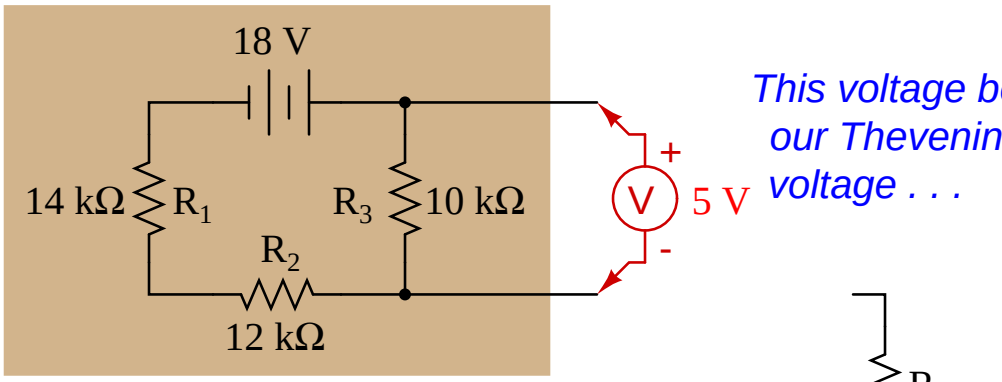


$$(18 \text{ volts}) \frac{10\ \text{k}\Omega}{(14\ \text{k}\Omega + 12\ \text{k}\Omega + 10\ \text{k}\Omega)} = 5 \text{ volts}$$

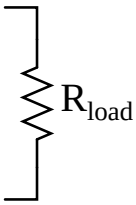


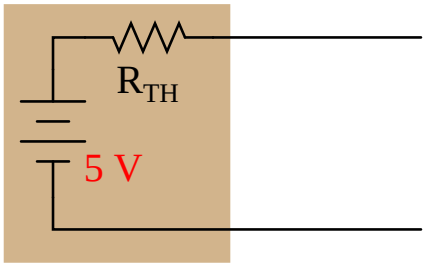

18 V
14 kΩ
R1
R3
10 kΩ
R2
12 kΩ
+
V
5 V
-
Rload
RTH
VTH

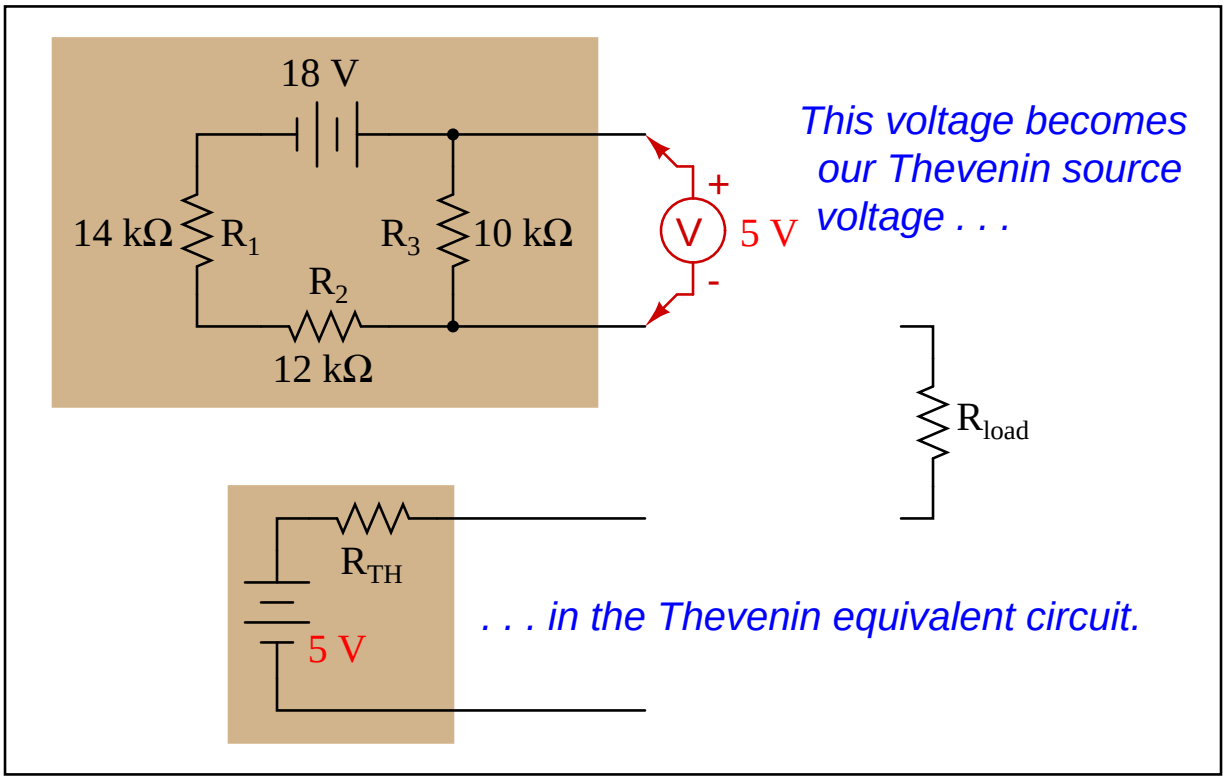

18 V
14 kΩ
R1
R3
10 kΩ
R2
12 kΩ
+
V
5 V
-
This voltage becomes our Thevenin source voltage . . .
Rload
RTH
VTH

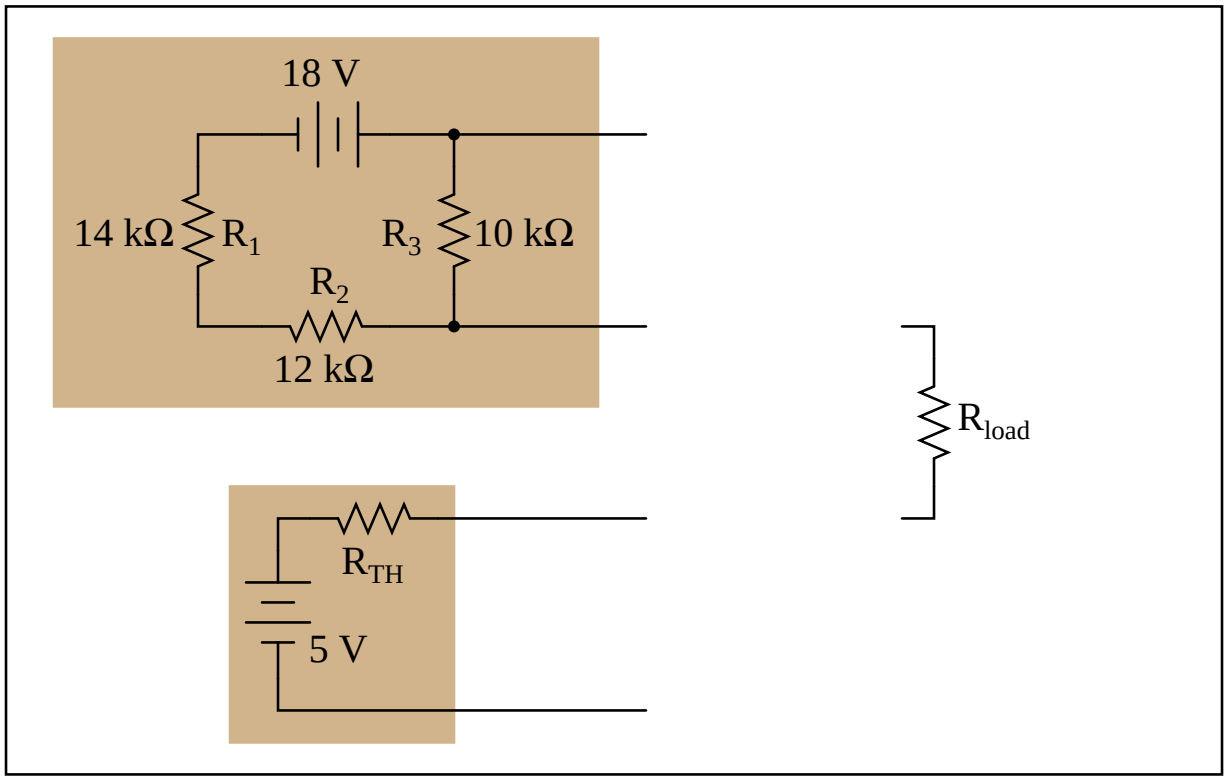


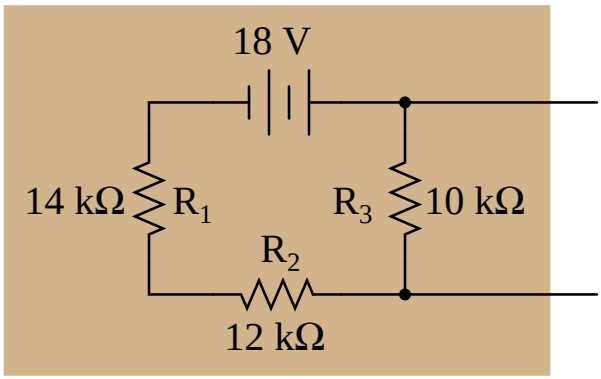
This voltage becomes our Thevenin source voltage . . .



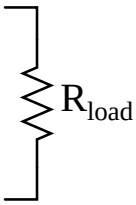


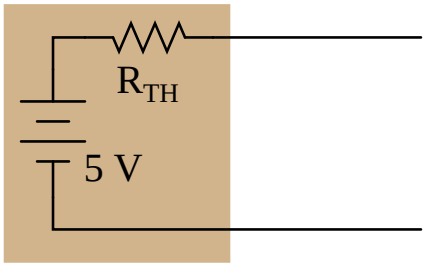

18 V
14 kΩ
R1
R3
10 kΩ
R2
12 kΩ
+
V
5 V
-
This voltage becomes our Thevenin source voltage . . .
Rload
RTH
5 V
. . . in the Thevenin equivalent circuit.

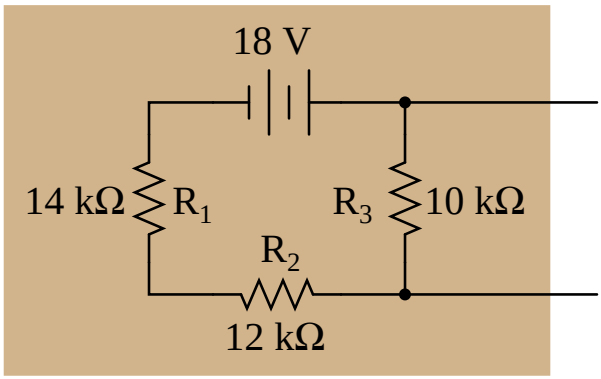

18 V
14 kΩ
R1
R3
10 kΩ
R2
12 kΩ
Rload
RTH
5 V



Now we replace each source in the original circuit with its own internal resistance.

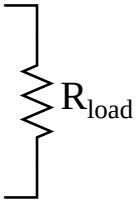


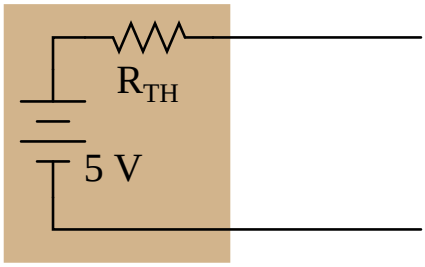


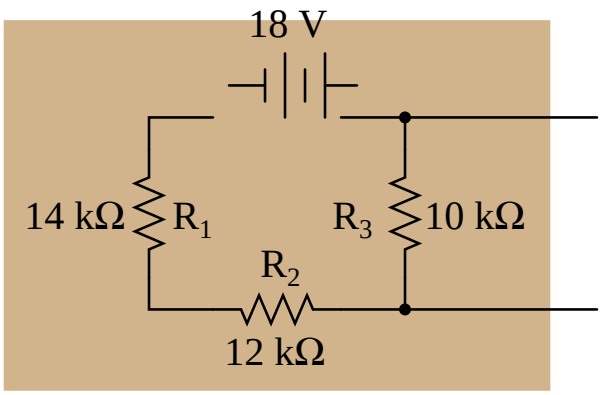


Now we replace each source in the original circuit with its own internal resistance.

For voltage sources, this means a short-circuit.







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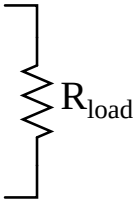

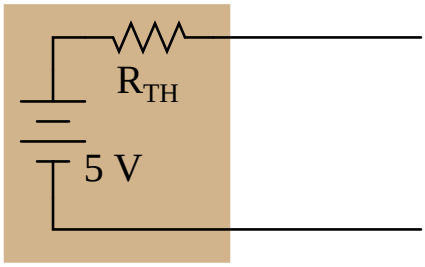

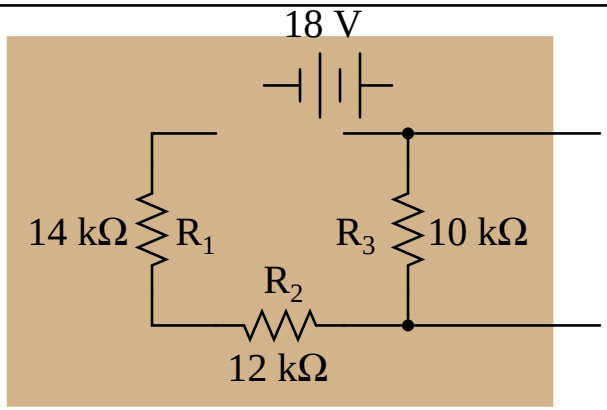

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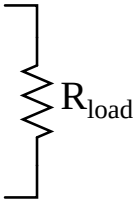

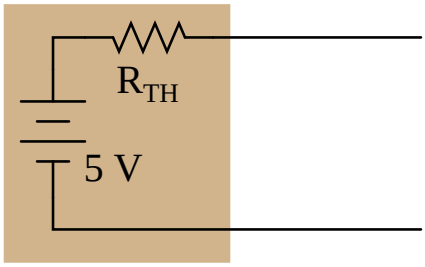

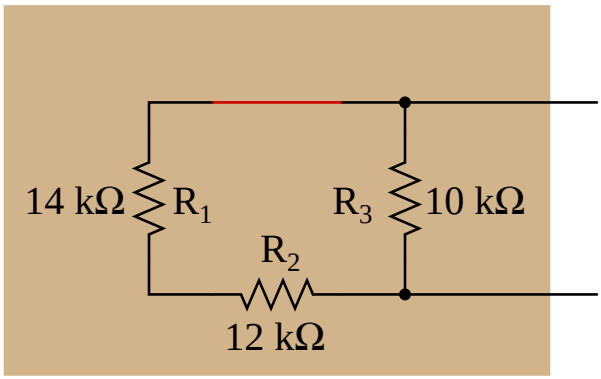

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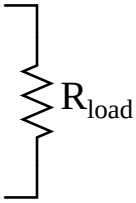
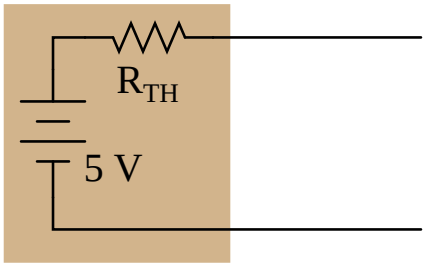
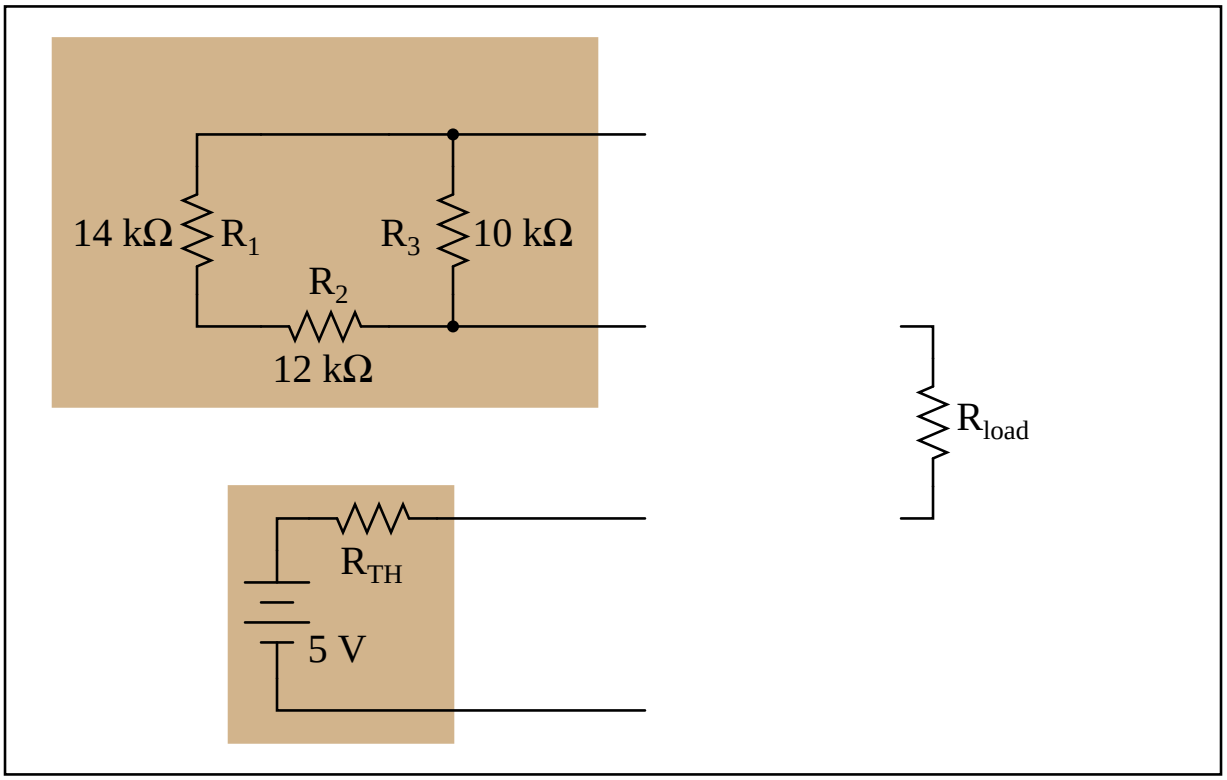
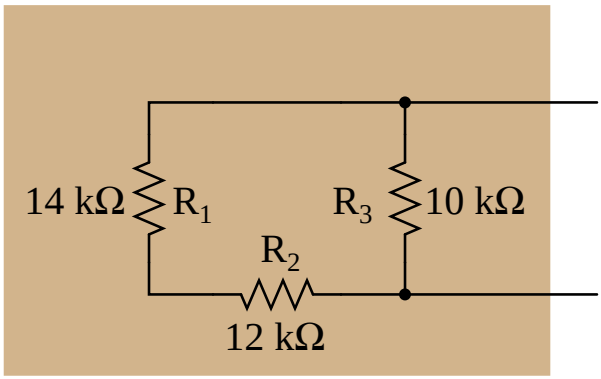
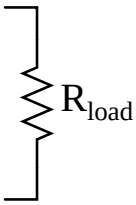


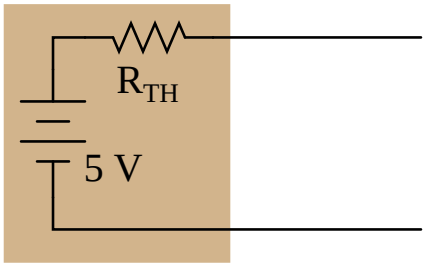


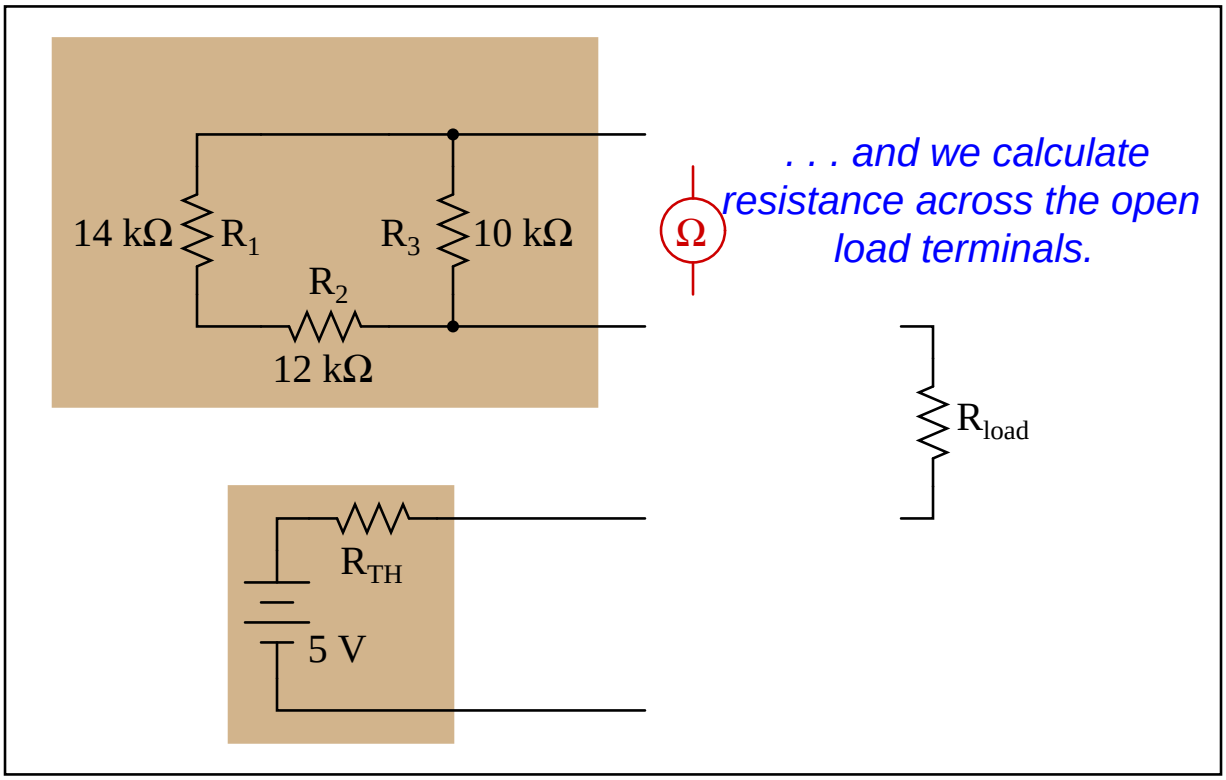

14 kΩ
R1
R3
10 kΩ
R2
12 kΩ
Rload
RTH
5 V

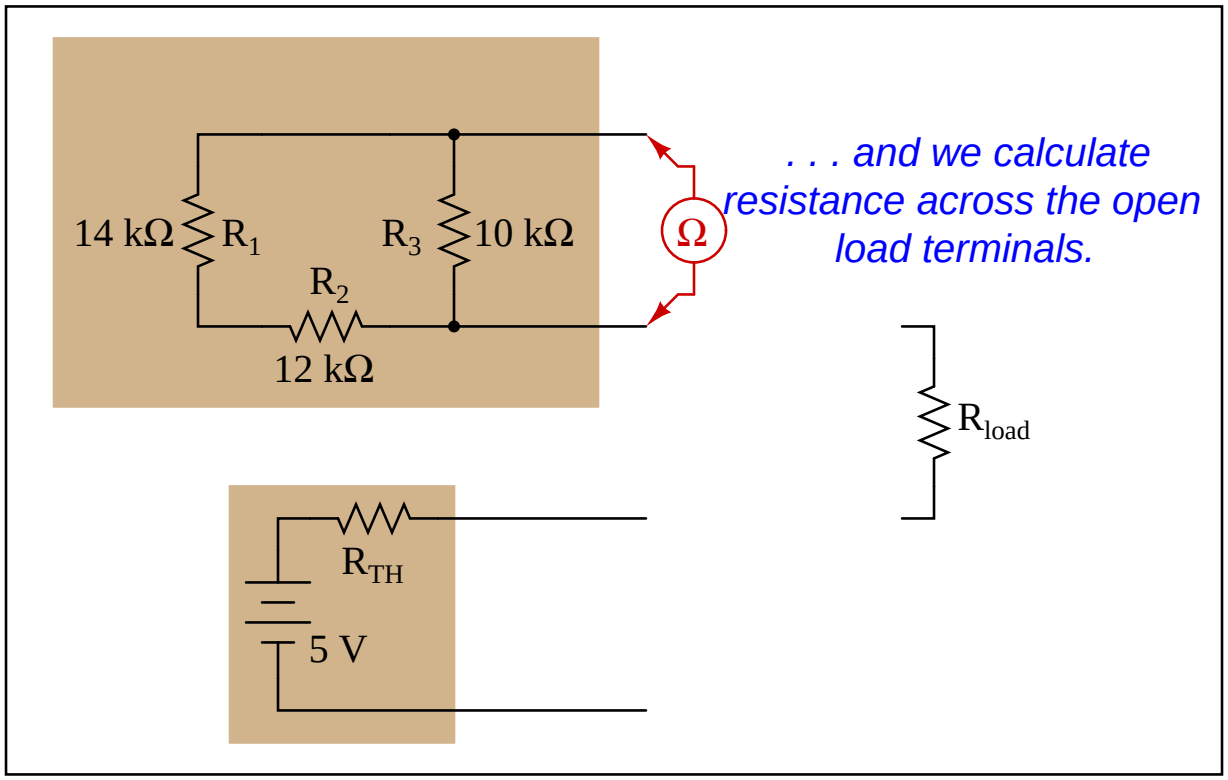


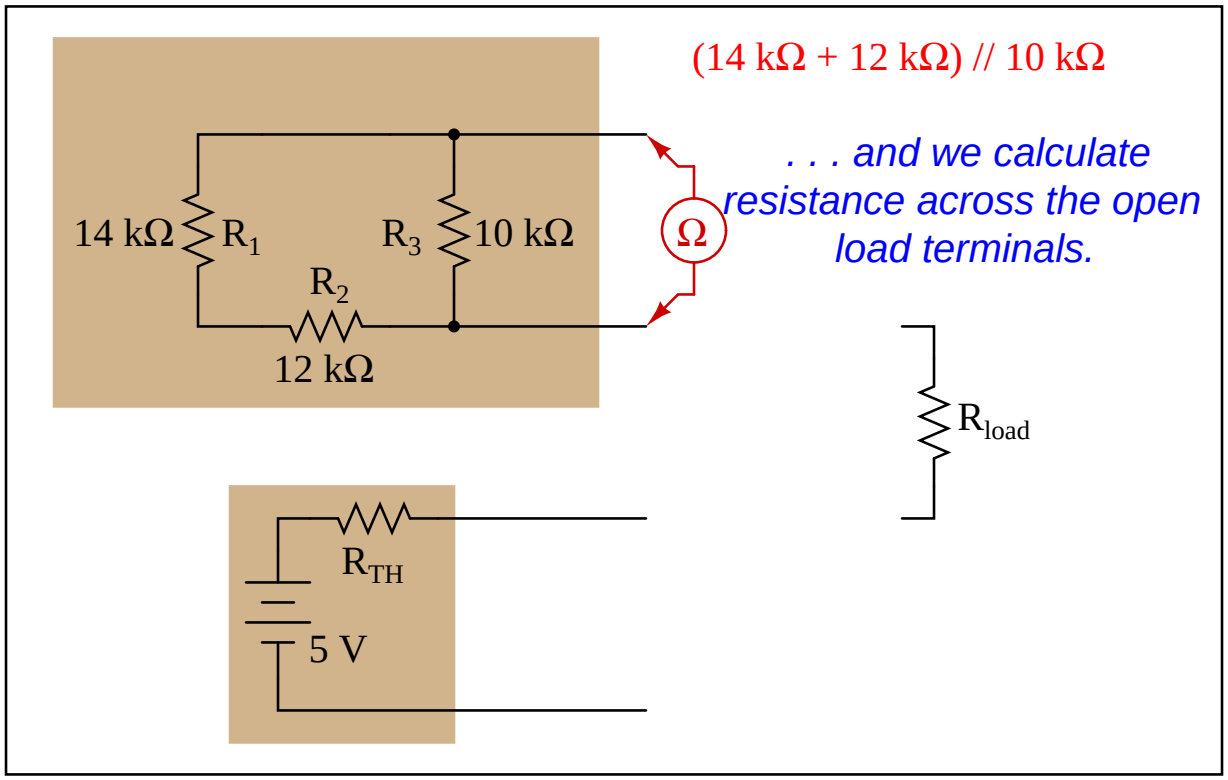
. . . and we calculate resistance across the open load terminals.

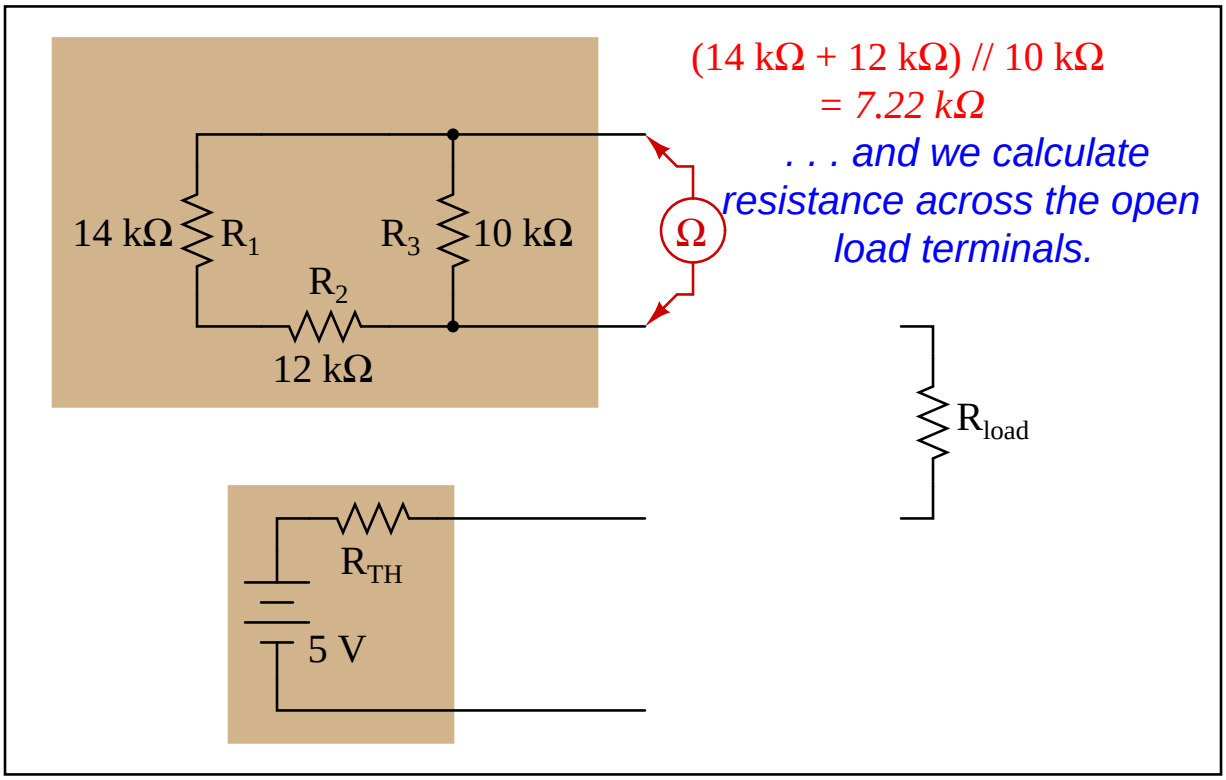


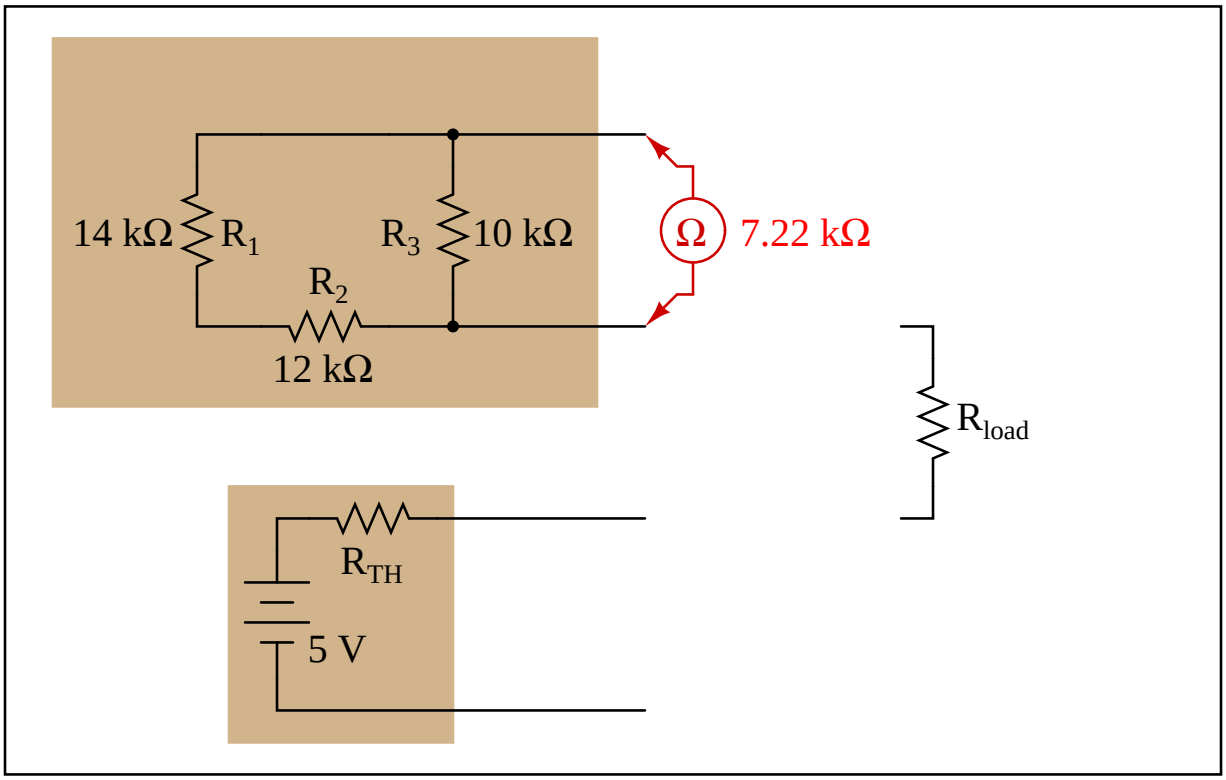


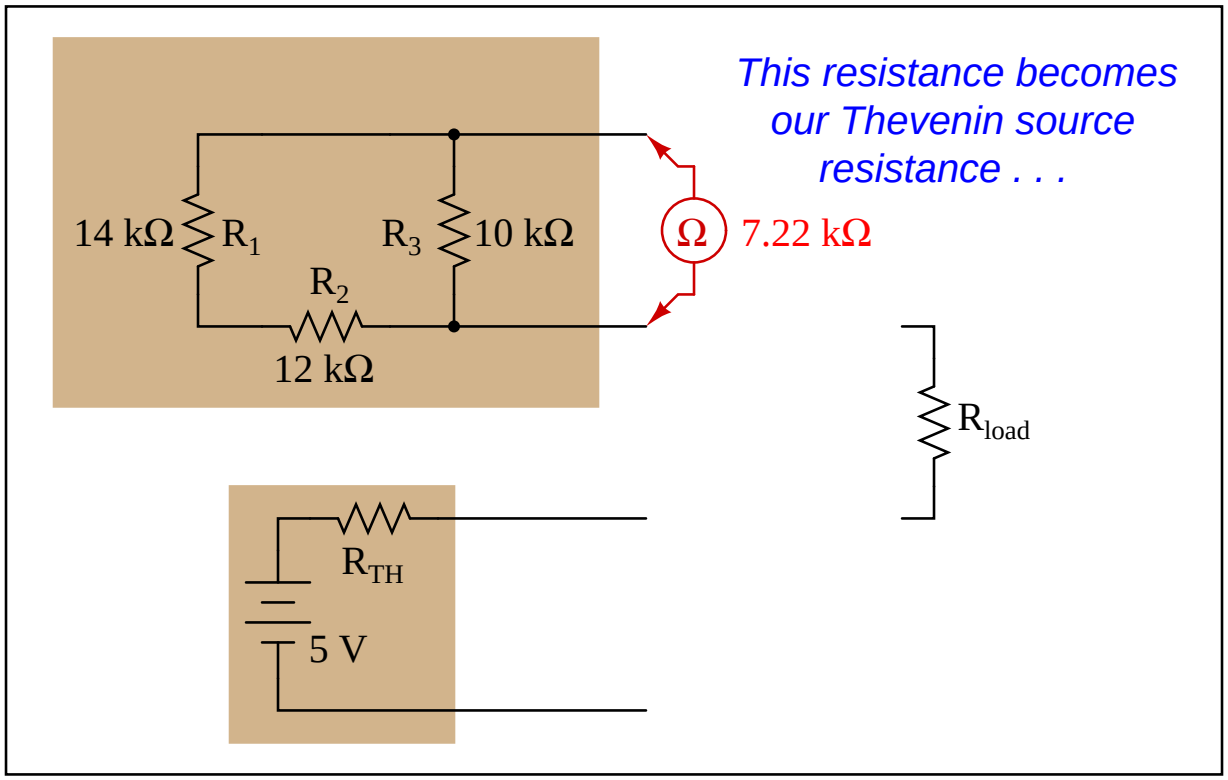

14 kΩ
R1
R3
10 kΩ
R2
12 kΩ
Ω
. . . and we calculate resistance across the open load terminals.
Rload
RTH
5 V

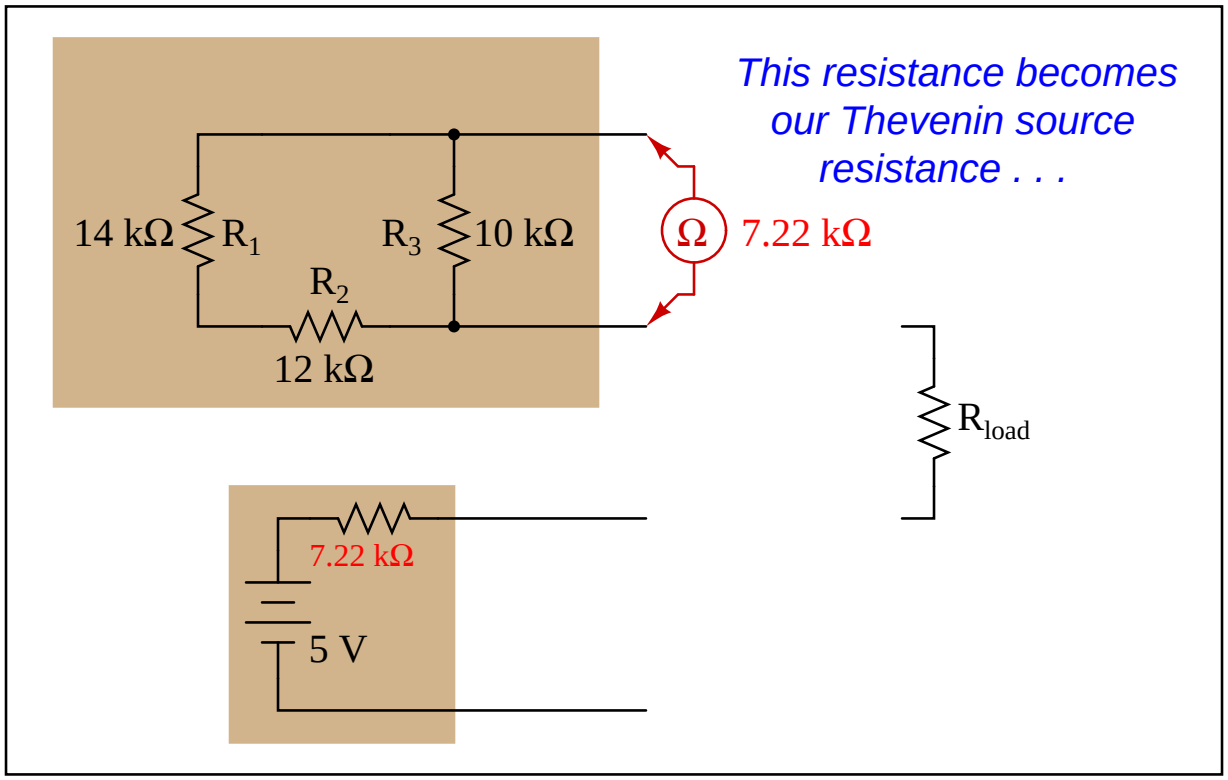

14 kΩ
R1
R3
10 kΩ
R2
12 kΩ
Ω
. . . and we calculate resistance across the open load terminals.
Rload
RTH
5 V

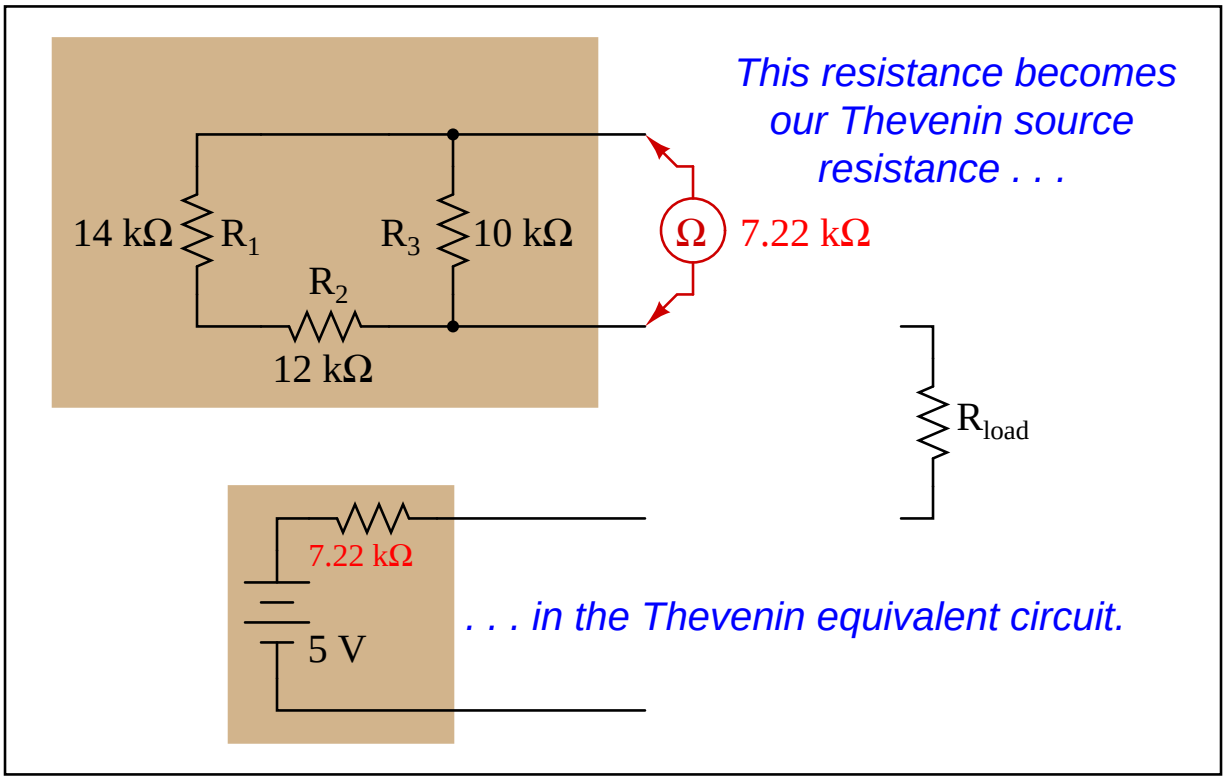

(14 kΩ + 12 kΩ) // 10 kΩ
. . . and we calculate resistance across the open load terminals.
14 kΩ
R1
R3
10 kΩ
R2
12 kΩ
Ω
Rload
RTH
5 V

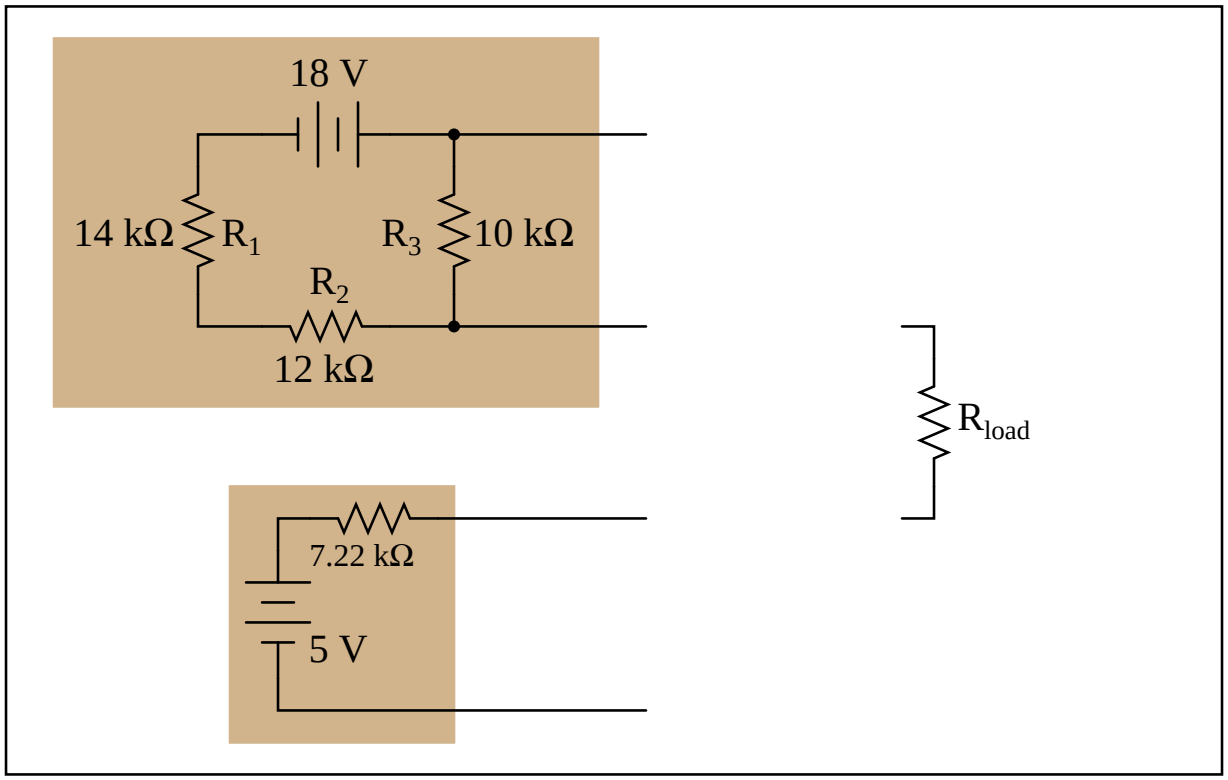

(14 kΩ + 12 kΩ) // 10 kΩ
= 7.22 kΩ
. . . and we calculate resistance across the open load terminals.
14 kΩ
R1
R3
10 kΩ
R2
12 kΩ
Ω
Rload
RTH
5 V

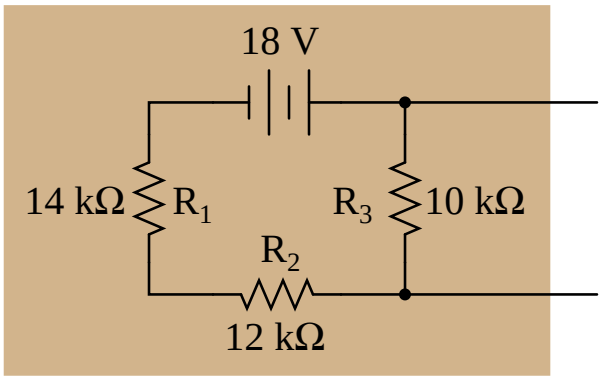

14 kΩ
R1
R3
10 kΩ
R2
12 kΩ
Ω
7.22 kΩ
Rload
RTH
5 V

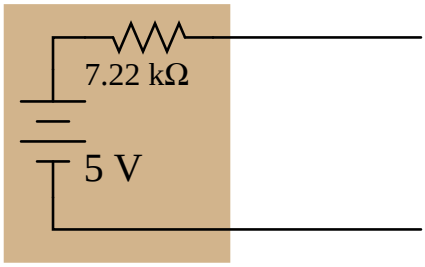

This resistance becomes our Thevenin source resistance . . .
14 kΩ
R1
R3
10 kΩ
R2
12 kΩ
Ω
7.22 kΩ
Rload
RTH
5 V


This resistance becomes our Thevenin source resistance . . .
14 kΩ
R1
R3
10 kΩ
R2
12 kΩ
Ω
7.22 kΩ
Rload
7.22 kΩ
5 V

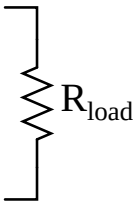

This resistance becomes our Thevenin source resistance . . .
14 kΩ
R1
R3
10 kΩ
R2
12 kΩ
Ω
7.22 kΩ
Rload
7.22 kΩ
5 V
. . . in the Thevenin equivalent circuit.

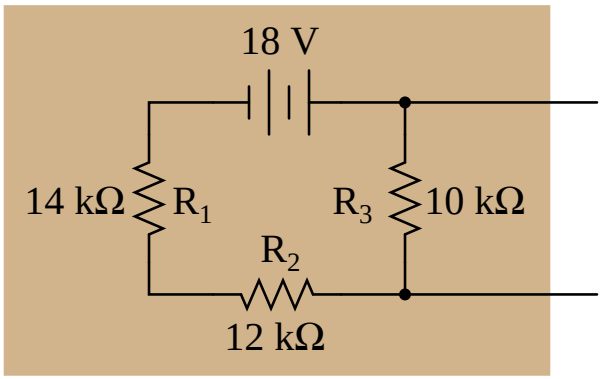

18 V
14 kΩ
R1
R3
10 kΩ
R2
12 kΩ
Rload
7.22 kΩ
5 V



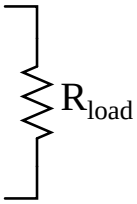


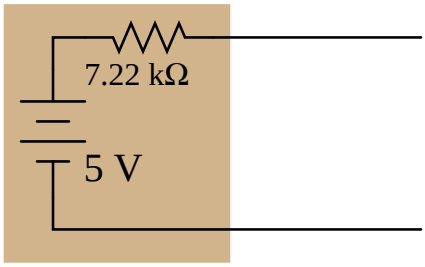
Now that we have an equivalent circuit to work with, we may insert the load there to see what happens!

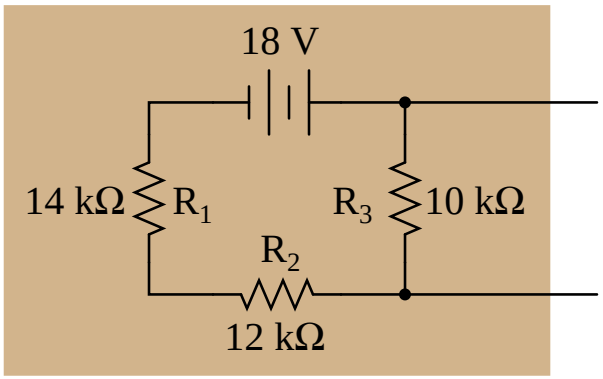




Now that we have an equivalent circuit to work with, we may insert the load there to see what happens!







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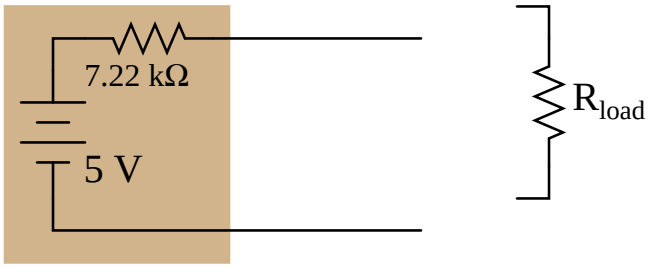

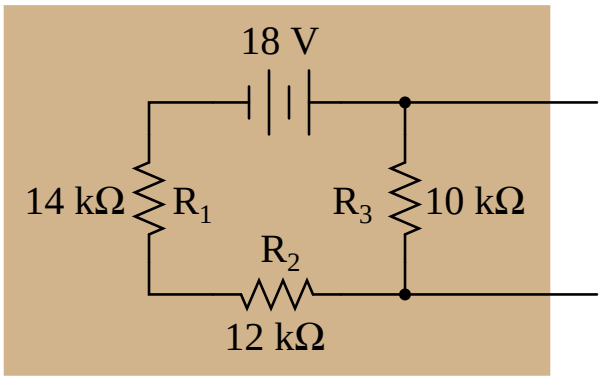

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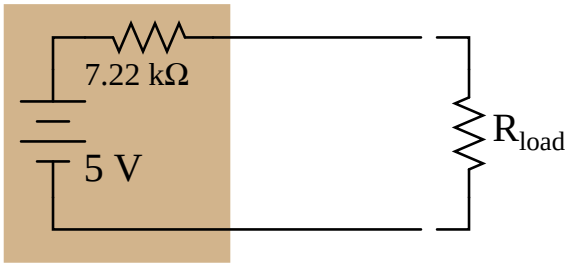

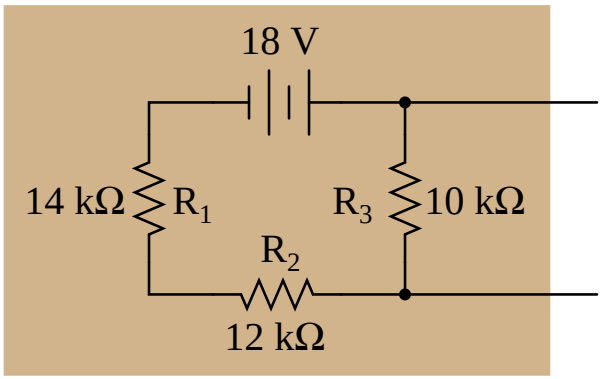

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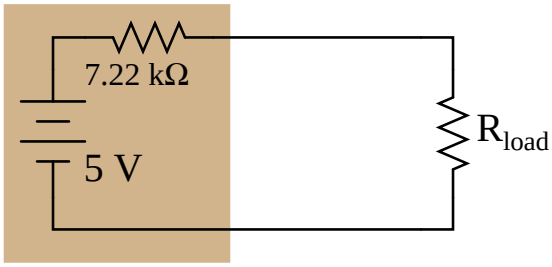

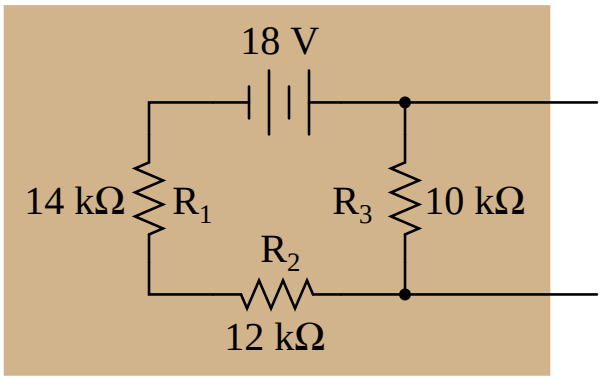

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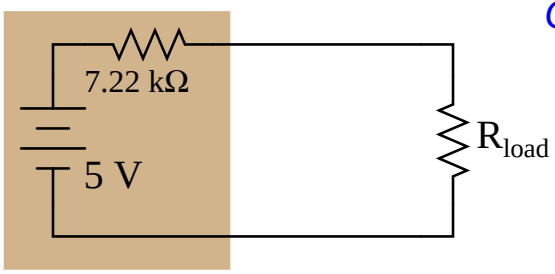
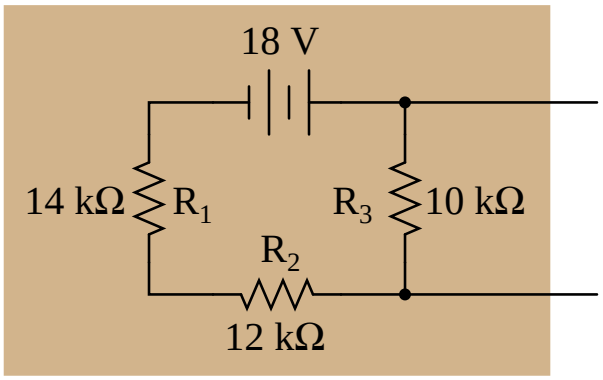
Calculate:





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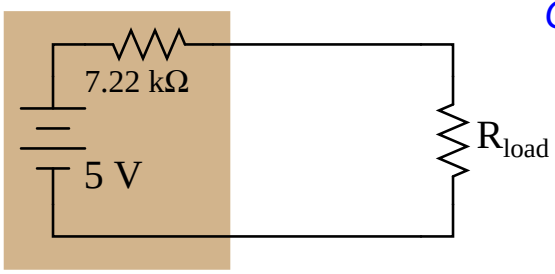
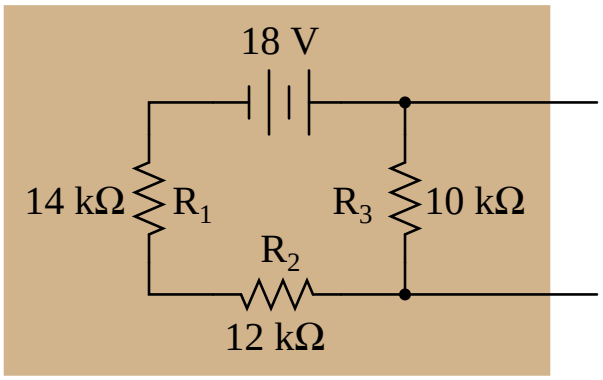


Calculate:

V_{load}



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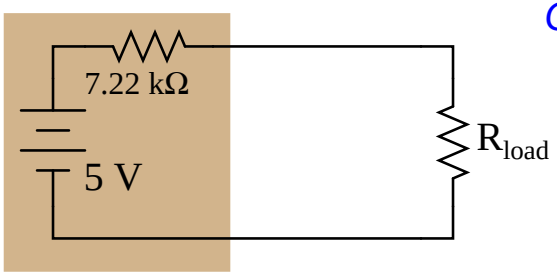
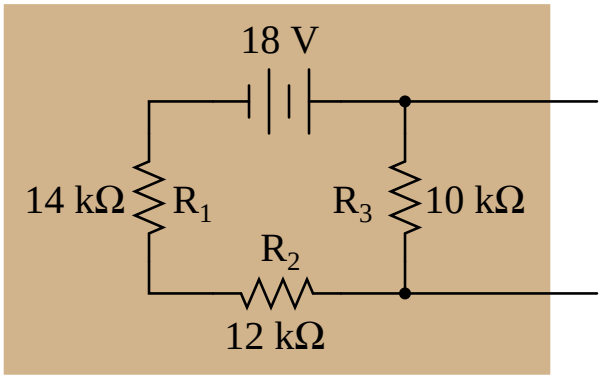


Calculate:

V_{load}

I_{load}



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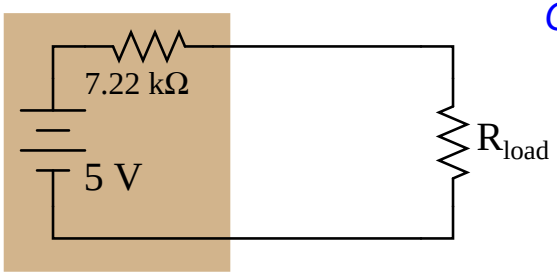
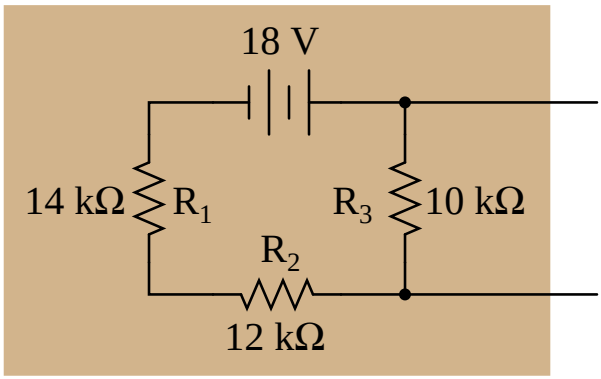


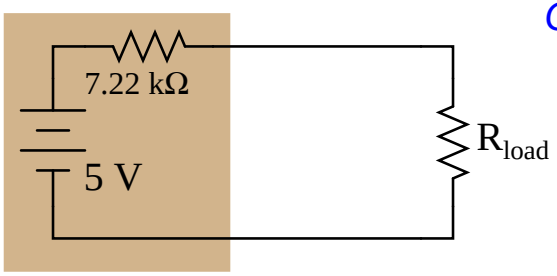
Calculate:

V_{load}

I_{load}

P_{load}



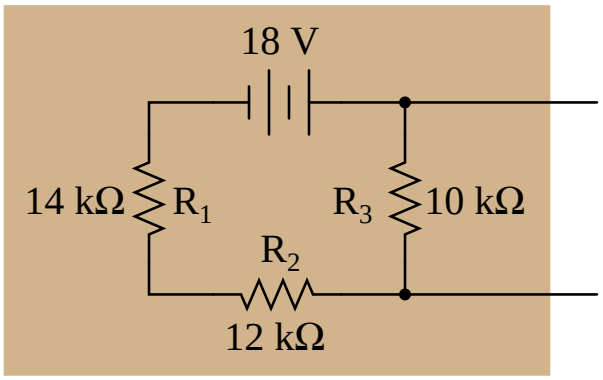


Calculate:

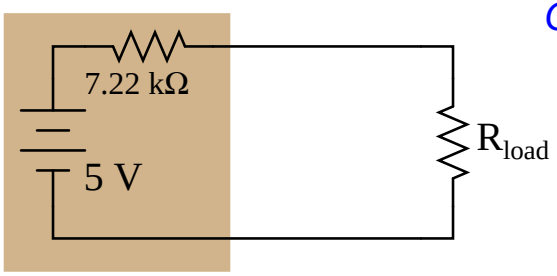
V_{load}

I_{load}

P_{load}



These load calculations will reflect what happens in the original circuit!

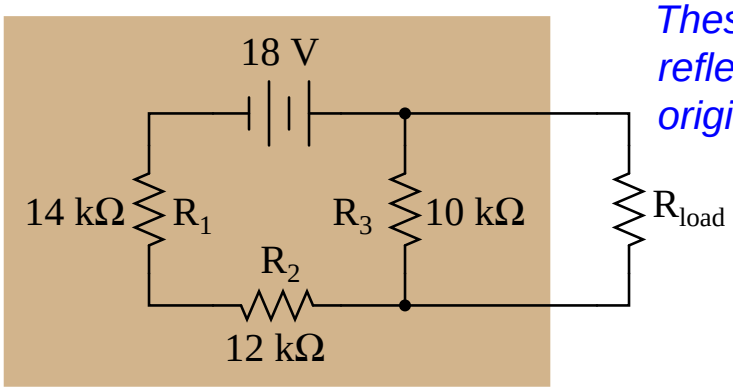


Calculate:

V_{load}

I_{load}

P_{load}



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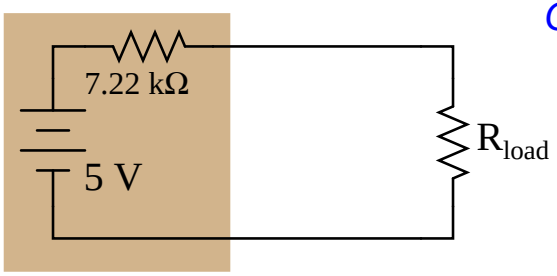
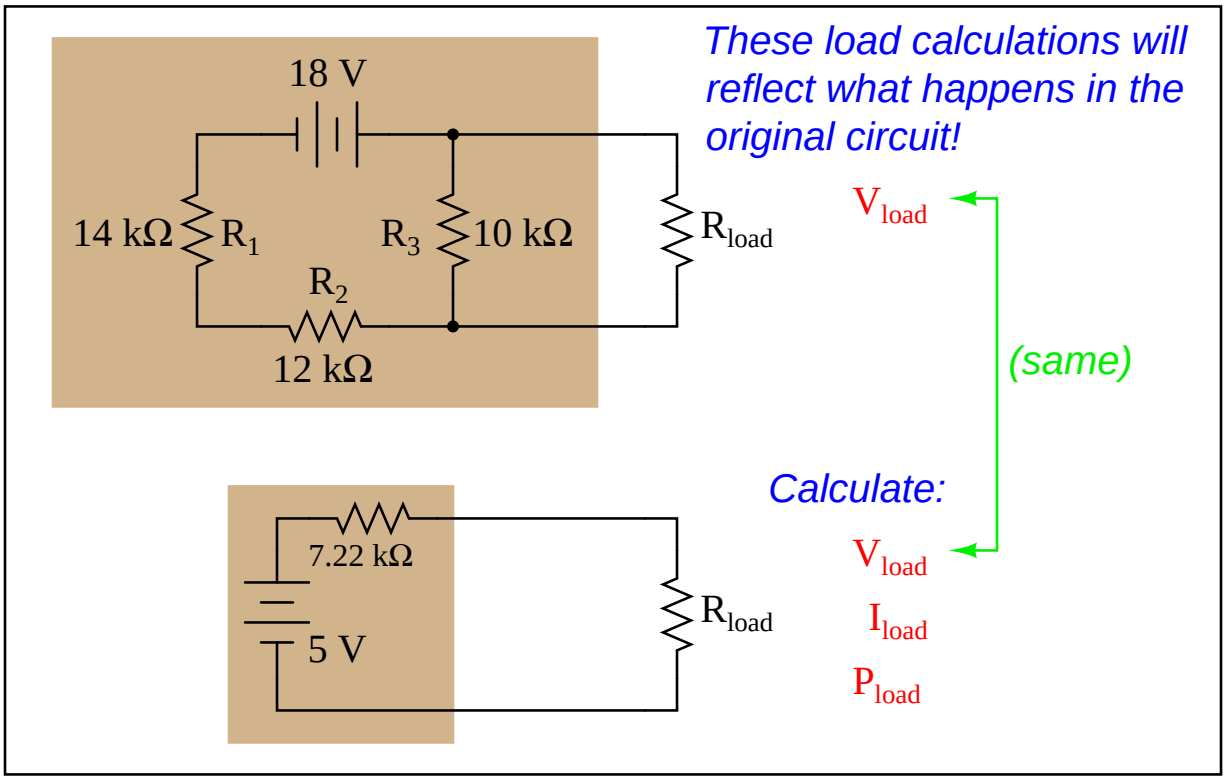


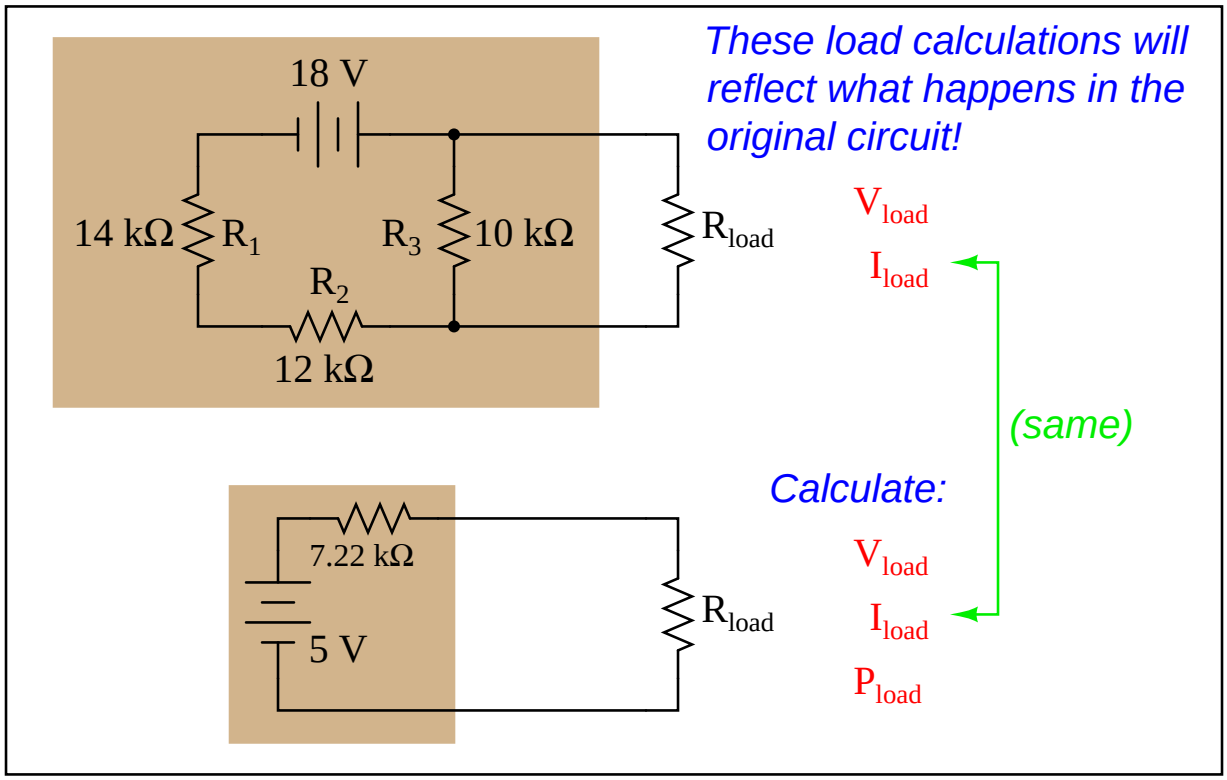
Calculate:

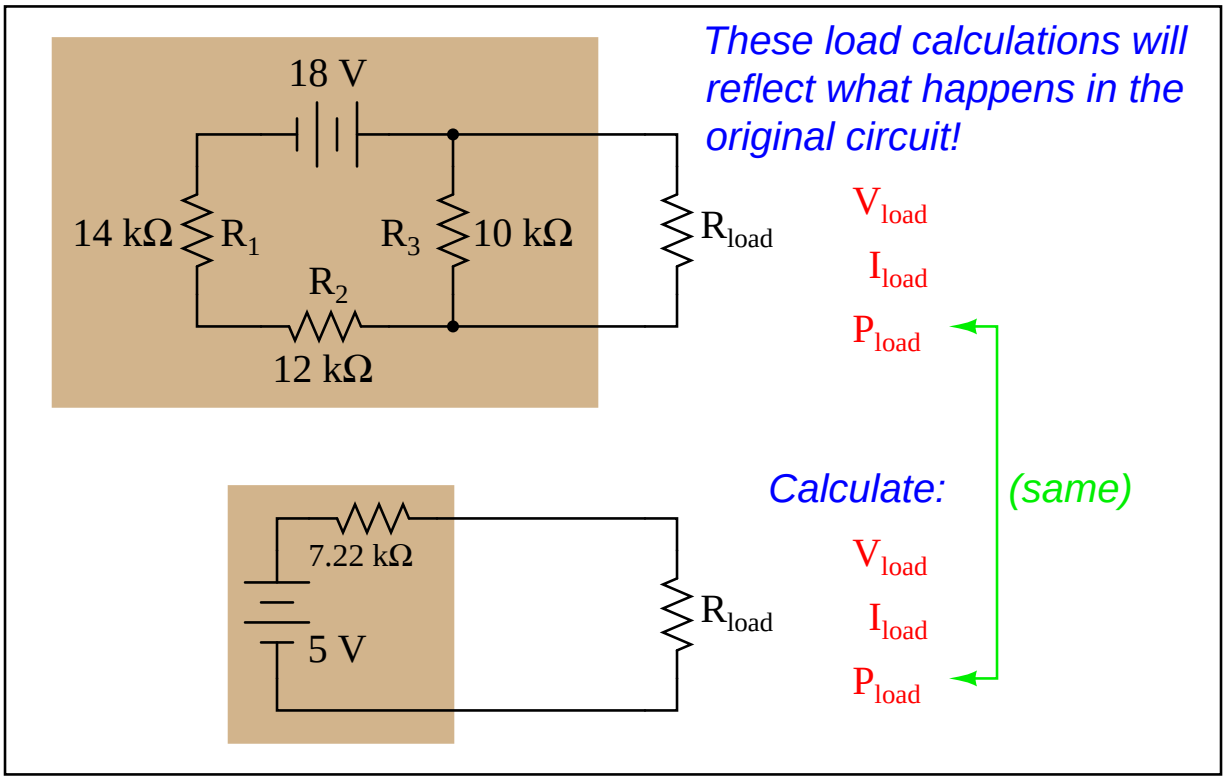
V_{load}

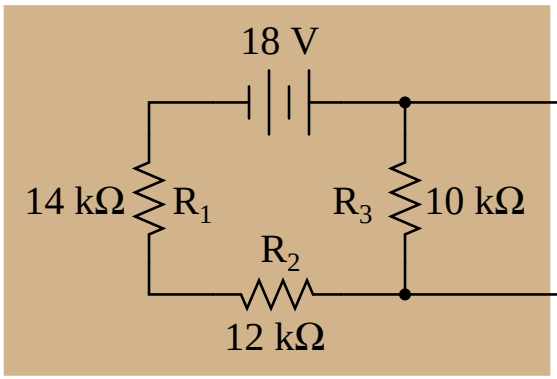
I_{load}

P_{load}


18 V
14 kΩ
R1
R3
10 kΩ
R2
12 kΩ
Rload
These load calculations will reflect what happens in the original circuit!
Vload
(same)
Calculate:
Vload
Iload
Pload
7.22 kΩ
5 V
Rload


These load calculations will reflect what happens in the original circuit!
18 V
14 kΩ
R1
R3
10 kΩ
R2
12 kΩ
Rload
Vload
Iload
(same)
Calculate:
7.22 kΩ
5 V
Rload
Vload
Iload
Pload


18 V
14 kΩ
R1
R3
10 kΩ
R2
12 kΩ
Rload
7.22 kΩ
5 V
Rload
These load calculations will reflect what happens in the original circuit!
Vload
Iload
Pload
Calculate:
(same)
Vload
Iload
Pload

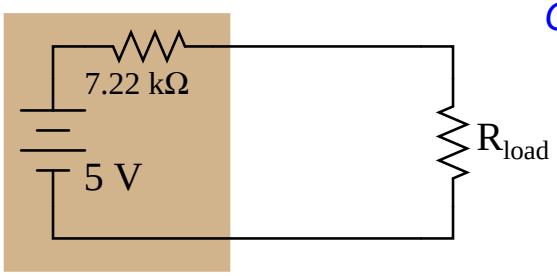


These load calculations will reflect what happens in the original circuit!

V_{load}

I_{load}

P_{load}

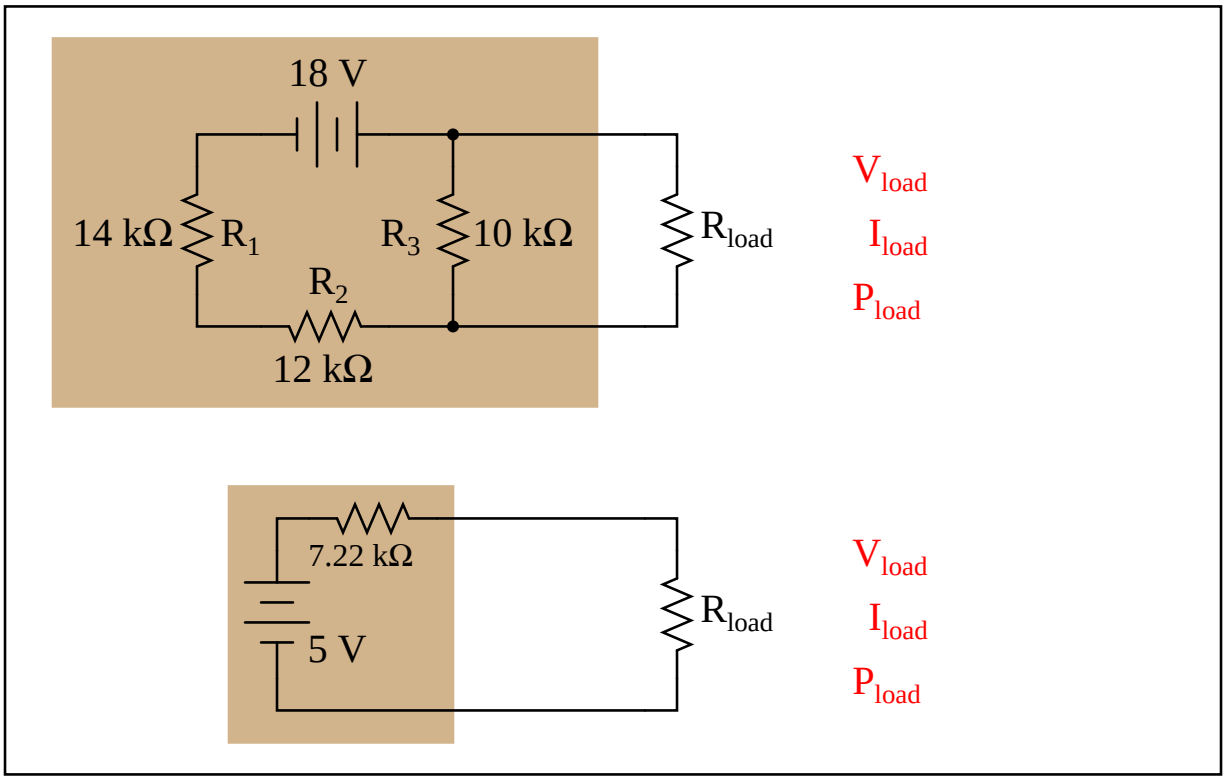


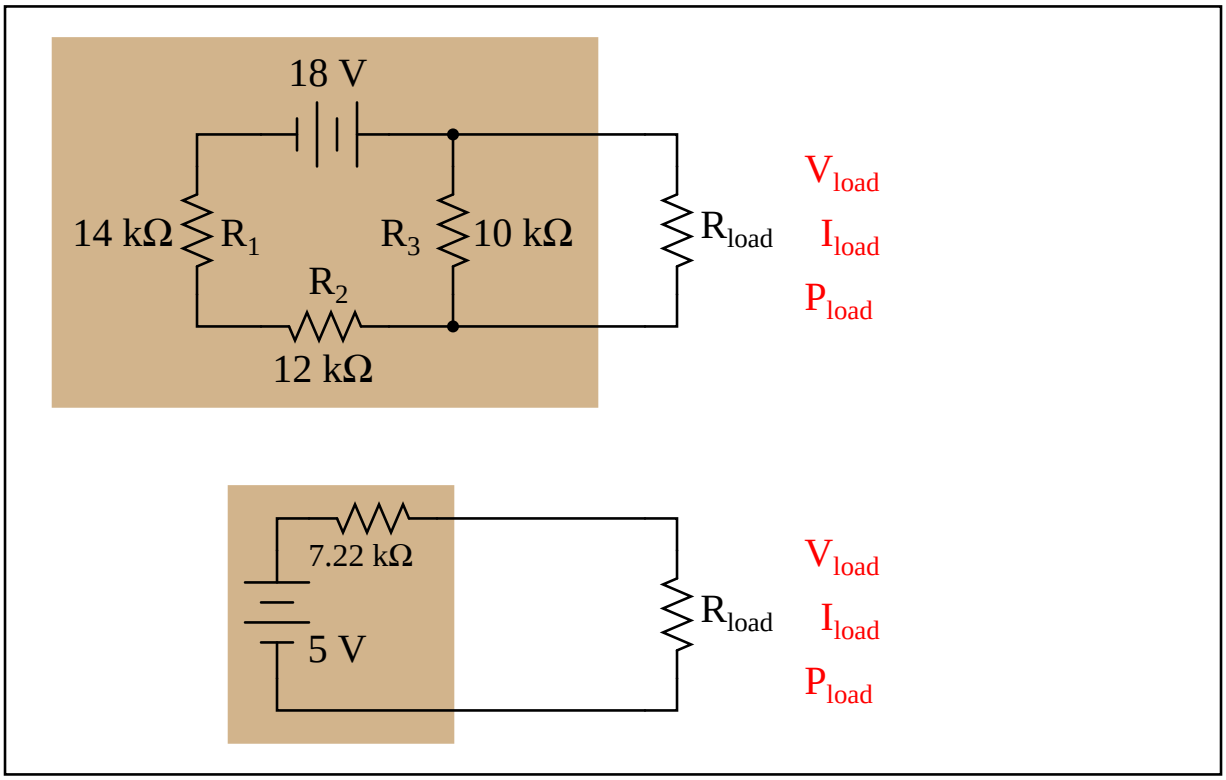
Calculate:

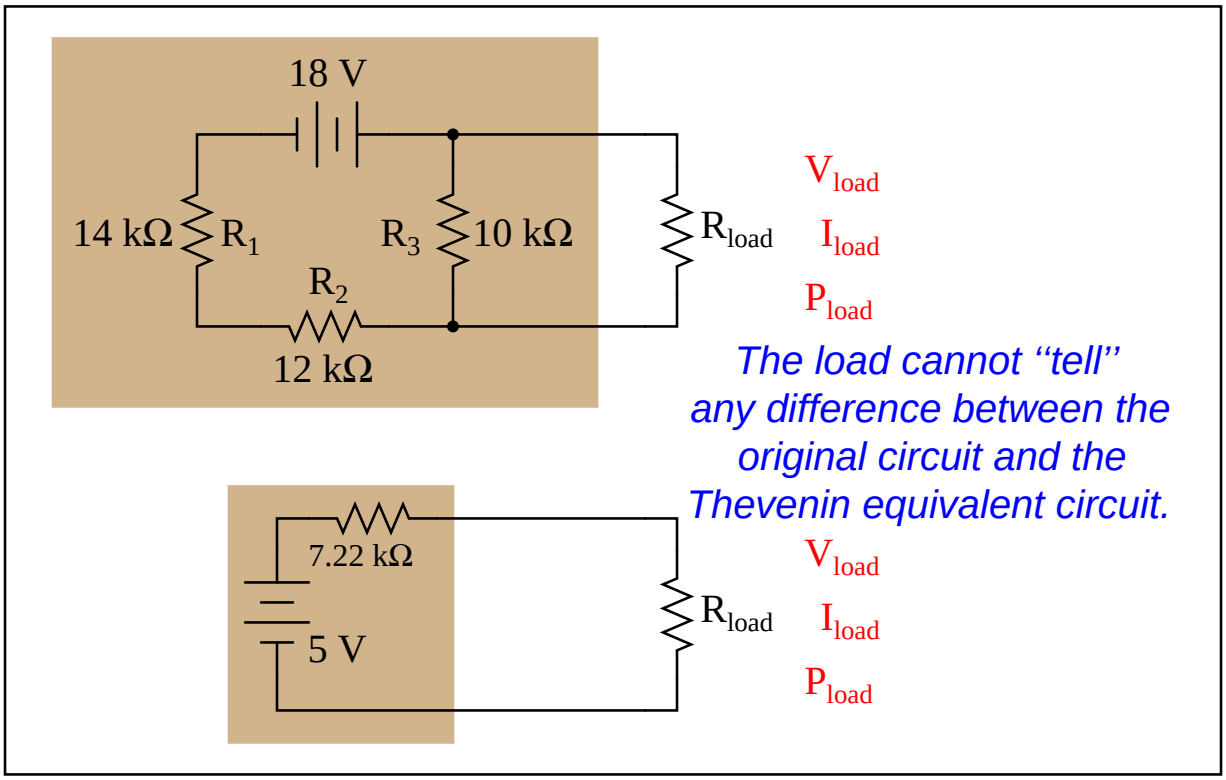
V_{load}

I_{load}

P_{load}


18 V
14 kΩ
R1
R3
10 kΩ
R2
12 kΩ
Rload
Vload
Iload
Pload
7.22 kΩ
5 V
Rload
Vload
Iload
Pload


18 V
14 kΩ
R1
R3
10 kΩ
R2
12 kΩ
Rload
Vload
Iload
Pload
7.22 kΩ
5 V
Rload
Vload
Iload
Pload


18 V
14 kΩ
R1
R3
10 kΩ
R2
12 kΩ
Rload
Vload
Iload
Pload
The load cannot "tell" any difference between the original circuit and the Thevenin equivalent circuit.
7.22 kΩ
5 V
Rload
Vload
Iload
Pload

file 03261

Answer 1

Nothing to note here.

Notes 1

The purpose of this animation is to let students see how Thévenin's theorem may be applied to the simplification of a resistor network.