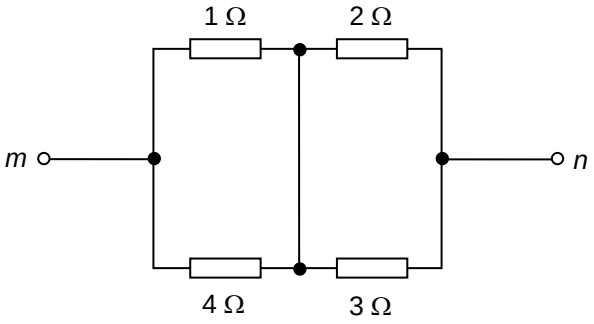
Redrawing a complicated network

Book 4 Ch 3 p.117
Skill: problem-solving

Sometimes, we need to deal with circuits consisting of several branches. We may not easily identify which circuit components are in parallel and which in series. To find the equivalent resistance of the network, we may need to redraw the circuit.

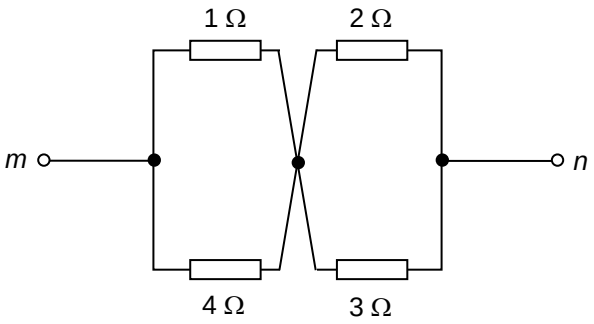
Example

Find the resistance between terminals *m* and *n* in the following network.

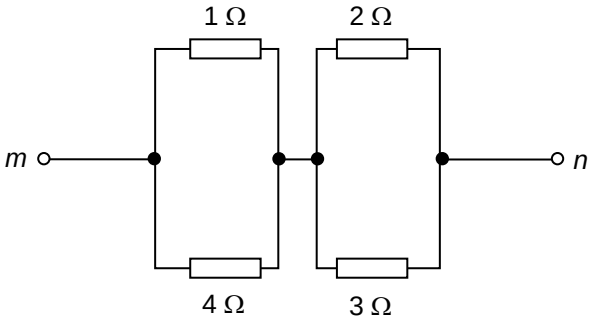


Solution

① Wires can be lengthened or shortened. Two junctions connected by a wire can be joined as one.



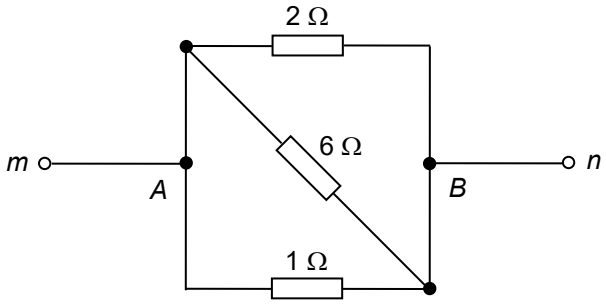
② A junction can be split into two connected by a wire.



Resistance between *m* and *n* $= \frac{1 \times 4}{1 + 4} + \frac{2 \times 3}{2 + 3} = 2\ \Omega$

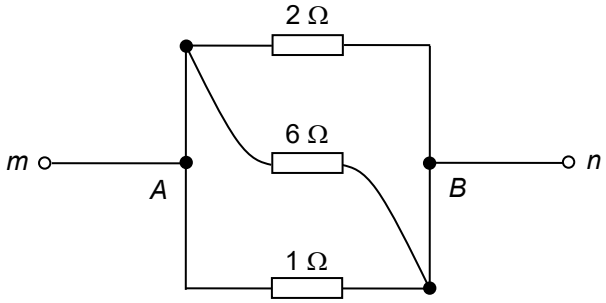
Example

Find the resistance between terminals *m* and *n* in the following network.



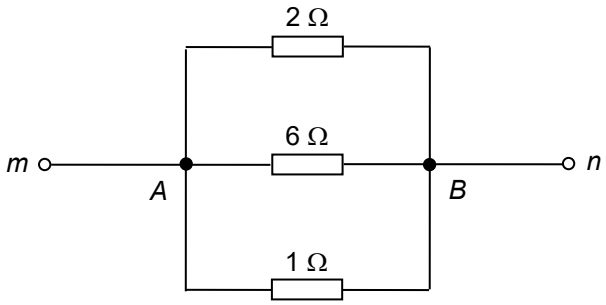
Solution

① Place the resistors either horizontally or vertically.



② Rearrange the wires. A junction can be moved along a wire without crossing a resistor.

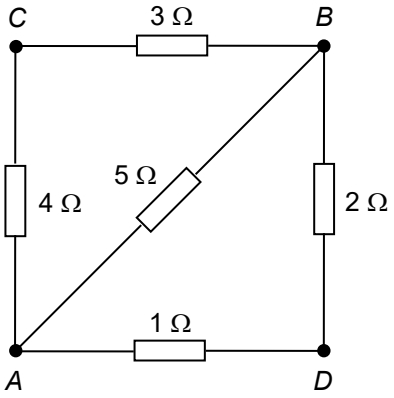
③ Make sure that all the junctions connect to the same resistors as in the given figure.



Resistance between *m* and *n* = $\left(\frac{1}{2}+\frac{1}{6}+\frac{1}{1}\right)^{-1}$ = 0.6 Ω

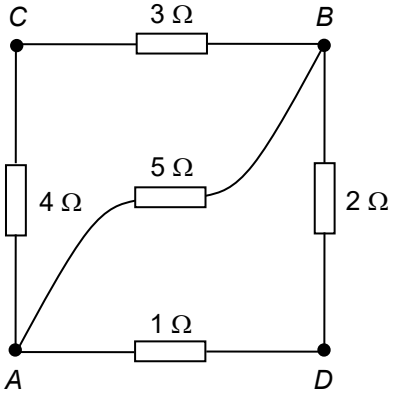
Example

Find the resistance between A and B in the following network.



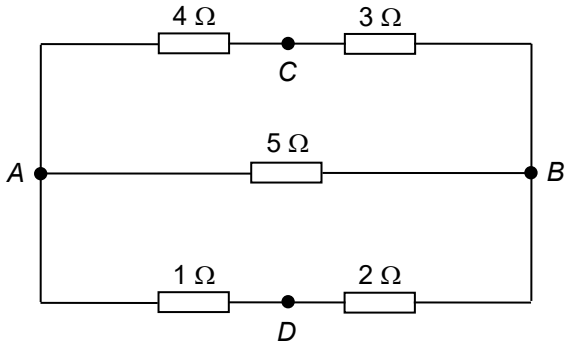
Solution

① Place the resistors either horizontally or vertically.



② Rearrange the wires. A junction can be moved along a wire without crossing a resistor.

③ Make sure that all the junctions connect to the same resistors as in the given figure.

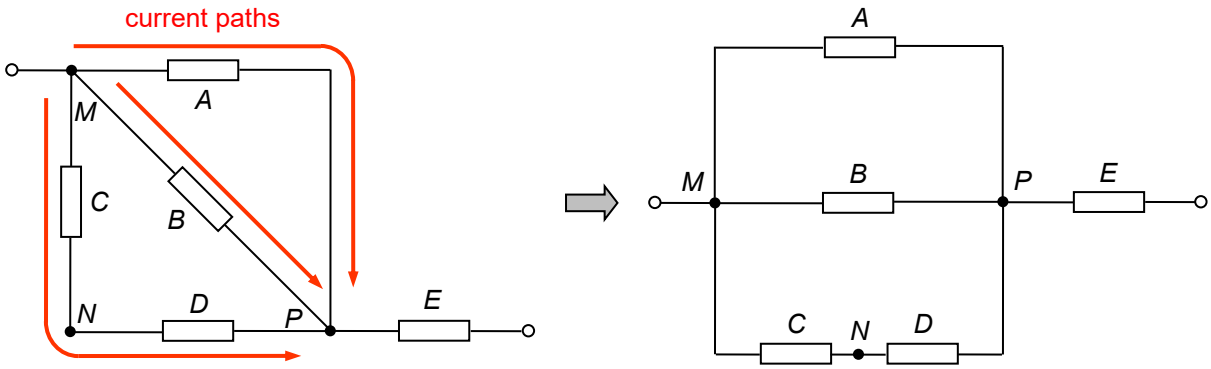


Resistance between A and B = $\left(\frac{1}{4+3}+\frac{1}{5}+\frac{1}{1+2}\right)^{-1}$ = 1.48 Ω

Redrawing a complicated network

Sometimes, identifying how current flows in a network helps rearrange the wires. The following example explains how this can be done.

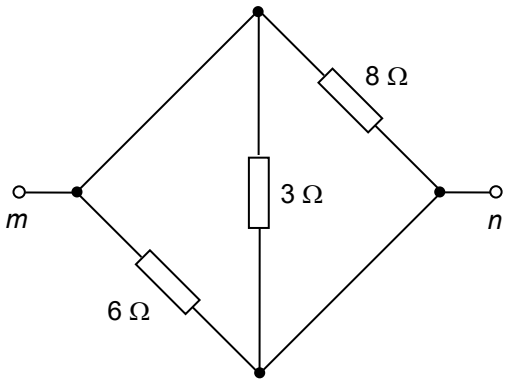
In network 1, a path splits into three branches at point *M*. These three branches then merge together at point *P*. This means that there are three parallel branches between *M* and *P*. Therefore, the network can be redrawn as network 2.



Network 1 ***Network 2***

Exercise

1 Find the resistance between terminals *m* and *n* in the following network.



① Place the resistors either horizontally or vertically.

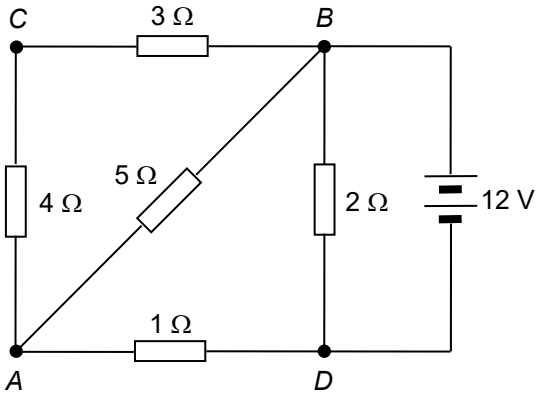
② Rearrange the wires. A junction can be moved along a wire without crossing a resistor.

③ Make sure that all the junctions connect to the same resistors as in the given figure.

Resistance between *m* and *n* =

Redrawing a complicated network

2 Find the resistance between *B* and *D* in the following circuit.



① Place the resistors either horizontally or vertically.

② Rearrange the wires. A junction can be moved along a wire without crossing a resistor.

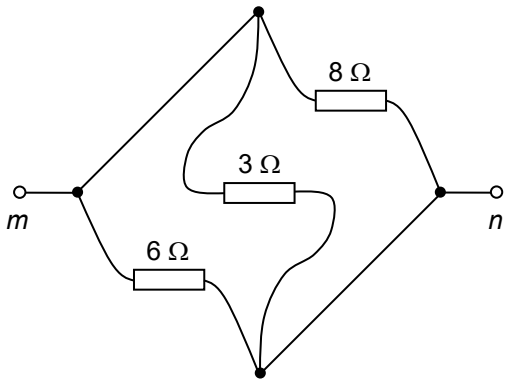
③ Make sure that all the junctions connect to the same resistors as in the given figure.

∴ The resistance between *B* and *D* is _____.

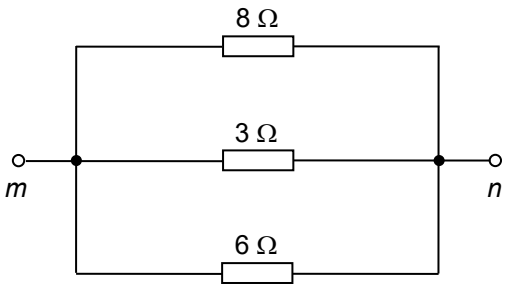
Answers

1

①



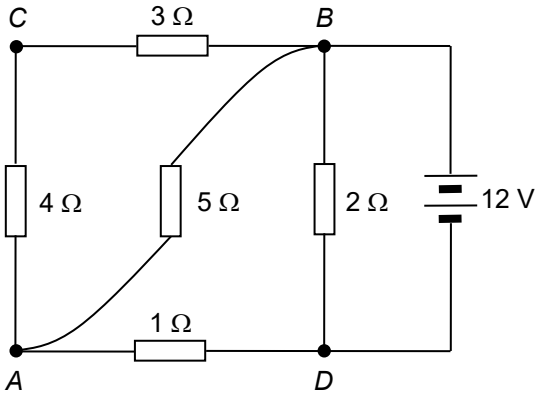
②



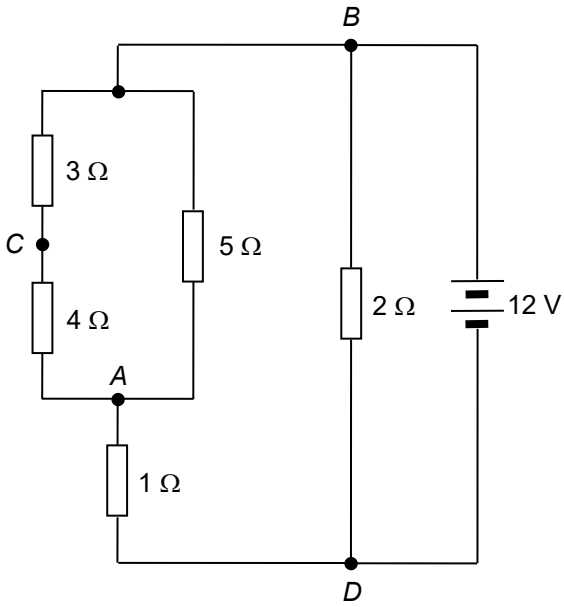
$= \left(\frac{1}{8} + \frac{1}{3} + \frac{1}{6}\right)^{-1} = 1.6\ \Omega$

2

①



②



Equivalent resistance of 3-Ω, 4-Ω and 5-Ω resistors = $\left(\frac{1}{3+4} + \frac{1}{5}\right)^{-1} = 2.92\ \Omega$

Resistance between *B* and *D* = $\left(\frac{1}{2.92+1} + \frac{1}{2}\right)^{-1} = 1.32\ \Omega$