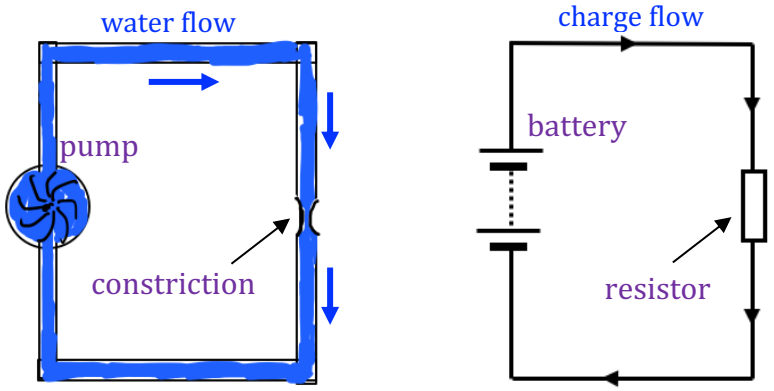
2.4.3 Adding resistance

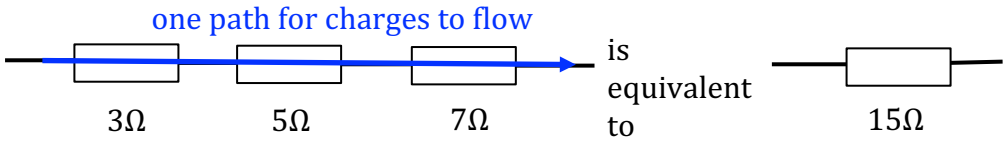
videos

We have seen that resistance is the opposition to the flow of charge (=current). All circuit components have some resistance. A resistor is specifically designed to produce resistance.

In the water model a constriction in a pipe can be used to represent a resistor. A constriction will slow down the flow of water.



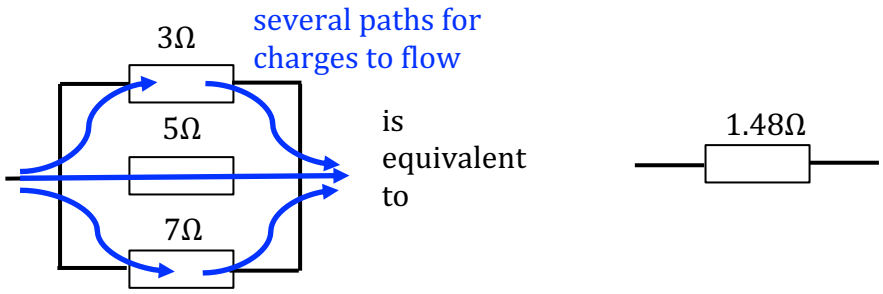
When we add resistors one after the other, the resistance increases. In the water model, this would represent multiple constrictions in the water pipe.



In fact, the rule for adding resistors <u>in series</u> is very simple. The total resistance is the sum of the resistances.

$$R_{total} = R_1 + R_2 + R_3 + \cdots$$

When we add resistors side by side, <u>in parallel</u>, the total resistance decreases. This is because there are now more paths for charge to flow, so overall more charge can pass through the parallel section of the circuit at a time (hence a greater current).



You do not need to know how to calculate the total resistance for resistors in parallel, but just the recognise that the resistance is always less than the <u>smallest</u> resistance value (e.g. in the example above, combined resistance < 3Ω).

Imagine modelling current and resistance using cars on a road/motorway.

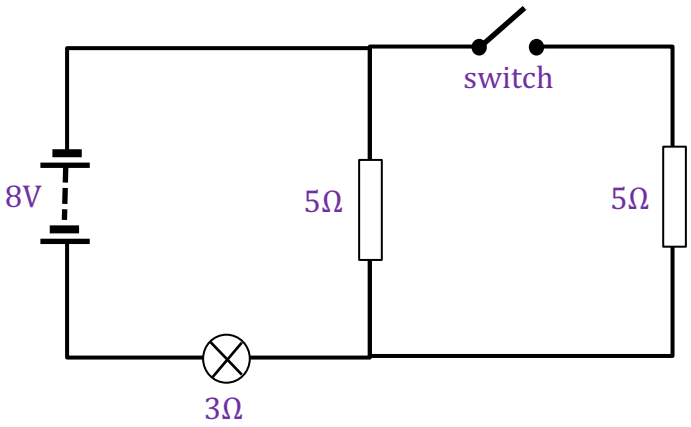
(1) What would the cars represent in the model?

(2) How would you model a resistor in the model?

(3) How would you model adding resistors in series in the model?

(4) How would you model adding resistors in parallel in the model?

Consider the circuit below:



(5) The bulb has a resistance of 3Ω. What is the combined resistance of the circuit, with the switch open?

(6) What current flows through the bulb when the switch is open? (Hint: Use the formula $I = \frac{V}{R}$. Use the combined resistance value.)

(7) What will happen to the total resistance in the circuit when the switch is closed? Explain why.

(8) What happens to the current through the bulb when the switch is closed? Explain why.

(9) What will happen to the brightness of the bulb when the switch is closed?