
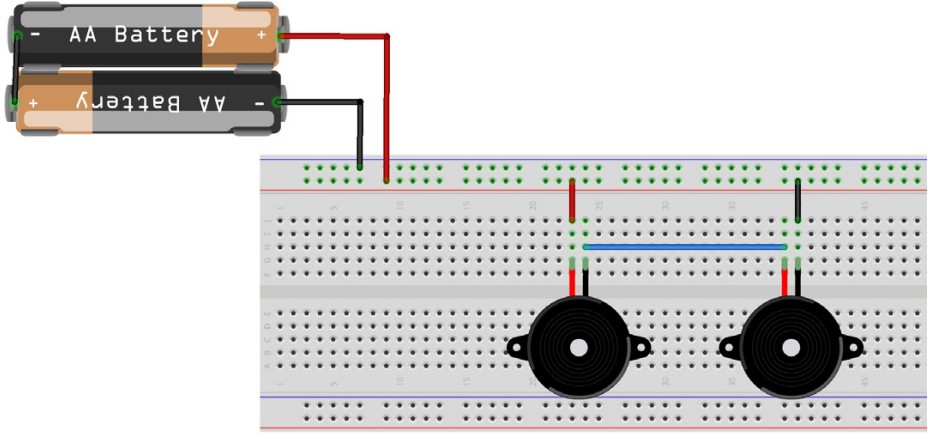
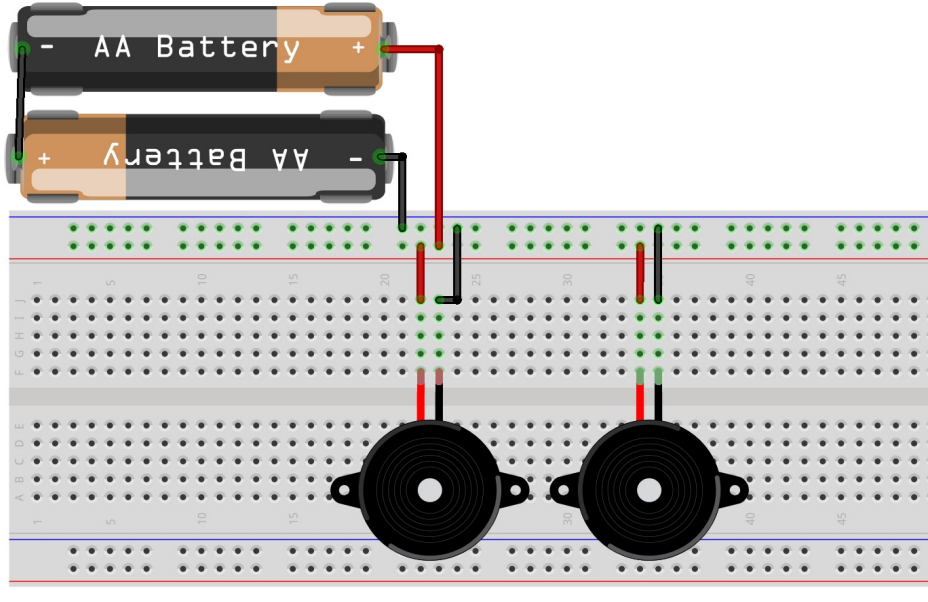
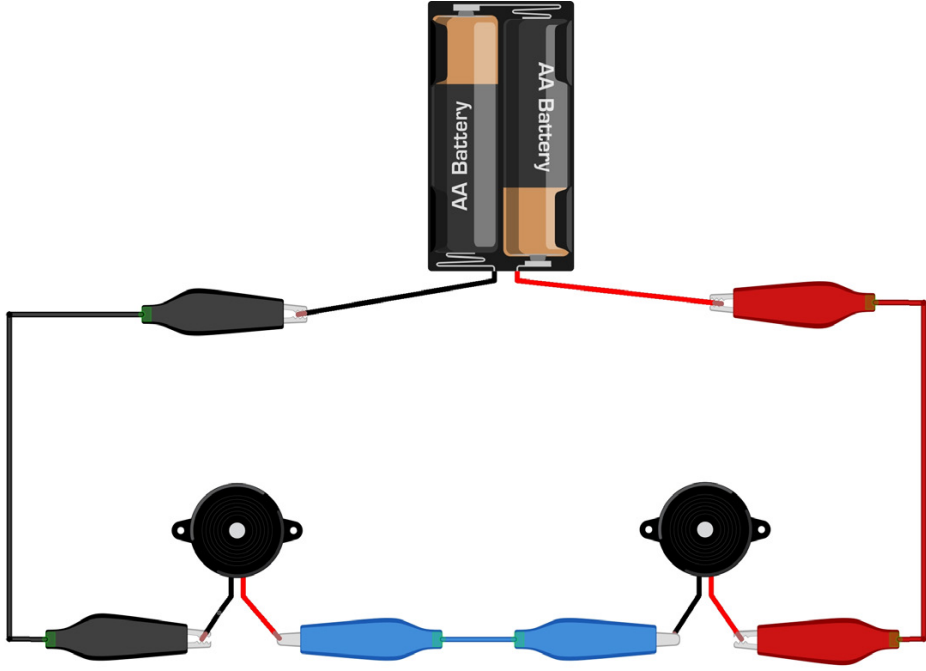
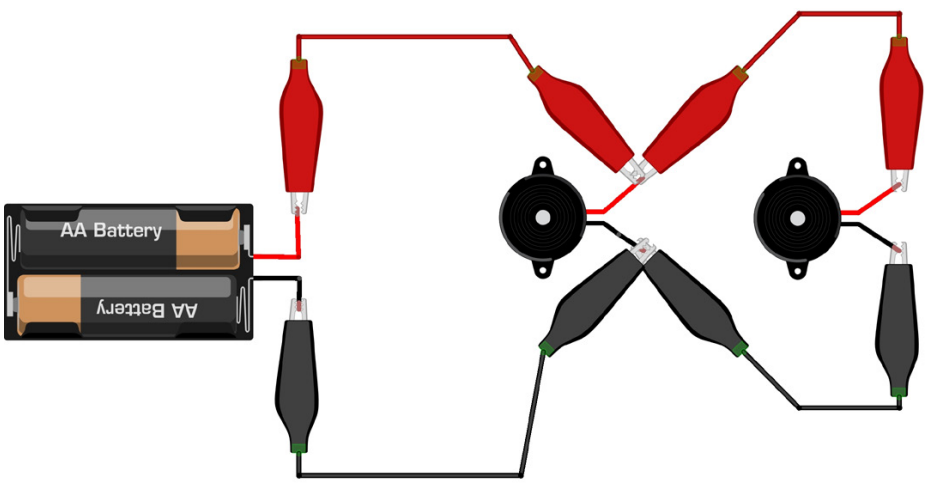

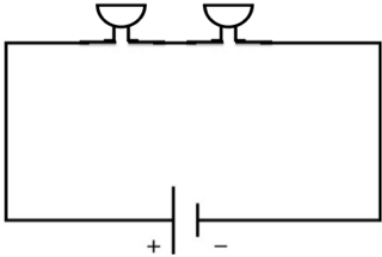
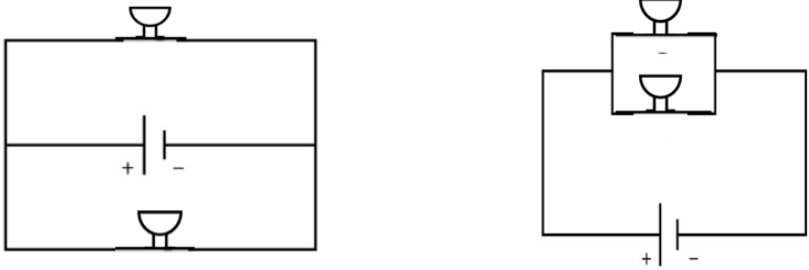



6.5 Complex electrical circuits

<p>Basic information and collecting ideas</p> 	<p>In this experiment, student will learn about parallel and series connections. The knowledge gained is foundational for further understanding of subsequent concepts.</p> <p>The experiment builds upon previous student learning, e.g. the simple electrical circuit in 6.1, and upon students' experience in doing experiments. Students can do the experiment either with the breadboard, or with cables with crocodile clips. The experimentation instruction for students purposefully does not provide graphics for setting up this experiment. The graphics for series/parallel connections on breadboards respective crocodile clips look like this:</p>
	
	

	
	
<p>Observing and documenting</p> 	<p>Option and diagram for buzzers connected in series:</p>  <p>Options and diagrams for buzzers connected parallel:</p> 

Technical and vocational application 	<p>You would wire the bulbs in parallel for two reasons:</p> <ol style="list-style-type: none"> 1. You can individually switch the bulbs on and off, and one broken bulb will not cause the whole house to be dark. 2. The bulbs will shine more brightly. Electricians wire not only lights in houses; they also wire power sockets and probably even electric appliances like electric stoves. Electricians also do other wiring outside of houses.
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Additional information

Students have two options for constructing an electrical circuit with two buzzers: they can either insert two buzzers in series connection (more likely) or in parallel connection. Either option is correct.

The experiment works with buzzers; however, students have to listen carefully to distinguish those buzzers in series ring less loudly. If you have incandescent bulbs, we recommend you to do the experiment with incandescent bulbs instead.

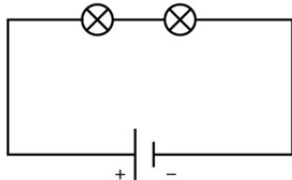
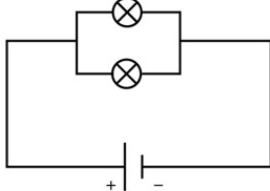
Depending on the option the students choose first, the observations and documented circuit will differ. Note that there are several possibilities for installing the wiring. Despite the different appearances, they are functionally equivalent. No matter how the wiring for the parallel circuit is installed, the circuit diagram should be drawn correspondingly. Two options plus the diagram for two buzzers connected in series are shown below. Depending on the electrical circuit built by the students first, “Doing further research” should lead to the second option of connecting two buzzers. We strongly recommend teachers to conclude the topic of series and parallel circuits by having the entire class reflect upon the observed differences (see table below in the Miscellaneous notes).

Some possible guesses are:

- Our batteries work for only one buzzer.
- The batteries are too weak; you need more batteries.
- This clearly works; we also have bulbs at home that work like this.

Miscellaneous notes

The students may add more buzzers or bulbs to the series circuit. They could also use a higher-capacity battery. To increase the battery capacity, they can connect batteries in series.

	Series circuit	Parallel circuit
Sketched circuit diagram (with incandescent bulbs, NOT buzzers)		 (one of the possible variants)
Electric circuit	Un-branched; the components are installed in a common circuit.	Branched; each component has its own circuit.
Voltage	Only a portion of the voltage is applied to each component.	The same voltage is applied to every component.
Current	The same current flows through each component.	The current is divided among the parallel circuits.
Compared with a simple circuit with only one buzzer	Buzzers ring less loudly. (bulbs shine less brightly).	Buzzers ring equally loud. (bulbs shine equally brightly).
Switches in the circuit	Turn all components on/off.	Depending on where the switch is installed, it turns all components on/off or only the component in the partial circuit.
Advantages	The battery lasts just as long as with one component.	If a component is broken or missing, the others are still supplied with current.
Disadvantages	If a component is broken or missing, then no other component is supplied with current.	The battery drains more quickly than with one component.
Applications in technology	Switches: safety switches (for example, on a washing machine or microwave oven), fuses in a fuse box	Bulbs: strings of lights, bicycle lighting.