

# Conductors And Insulators



## Topic

Testing the ability of different materials to conduct electricity

## Introduction

All materials resist the flow of electricity (all have a resistance measured in ohms), but some allow no current to flow (these materials are used as insulators) and others are good conductors of electricity. Good conductors of electricity – mostly metals – contain electrons that are only weakly attached to their atoms and are thus free to move. In this experiment, you will test various materials and classify them according to their ability to conduct electricity. You will use a circuit containing a light bulb to do this. If the bulb lights, it shows that the material being tested conducts electricity; the brightness of the bulb indicates how good a conductor the material is. If the bulb does not light, it shows that the material being tested does not conduct electricity.

## Time required

30 minutes

## Materials

3 × 1.5 volt D cell batteries in holders  
4.5 volt (0.3 amp) bulb in holder  
knife switch (single pole, single throw type)  
6 clip leads  
connecting wires or clip leads (depending on fittings on components)  
a collection of items to be tested, e.g., metal spoon, plastic spoon, pencil (sharpened at both ends), rubber band, plastic ruler, wooden ruler, hard rubber rod, Plexiglas™ rod, copper wire, rods of copper, lead, wire aluminum, etc.  
bare copper wire (i.e., no plastic covering)

The appearance of the components may vary among suppliers (see Appendix A for website addresses of possible suppliers). Diagram 1 below shows the symbols used in the circuit diagram given in this experiment to show the arrangement of the components.



*Symbols used in circuit diagram*

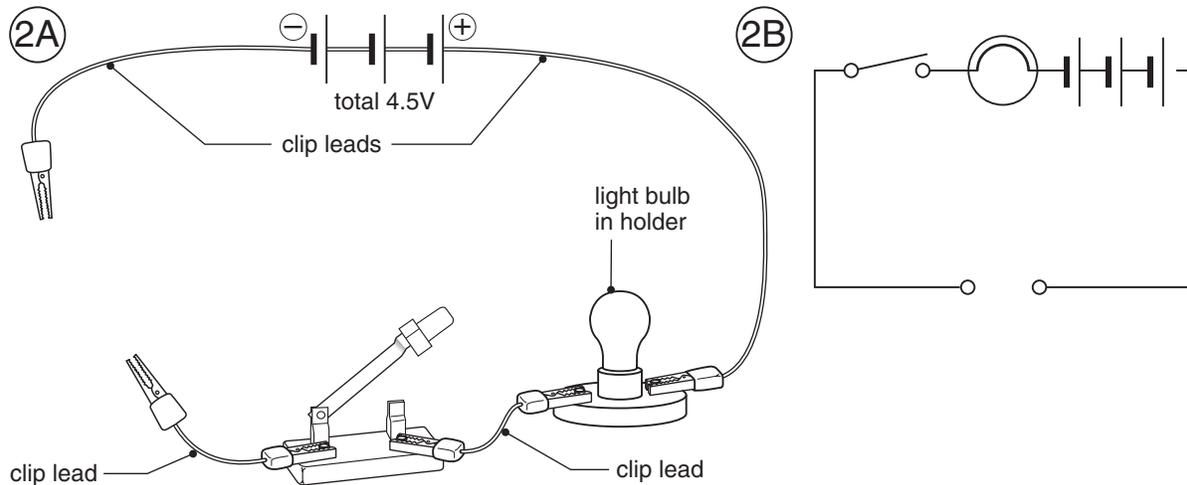
## Safety note



Do not use an electrical outlet.

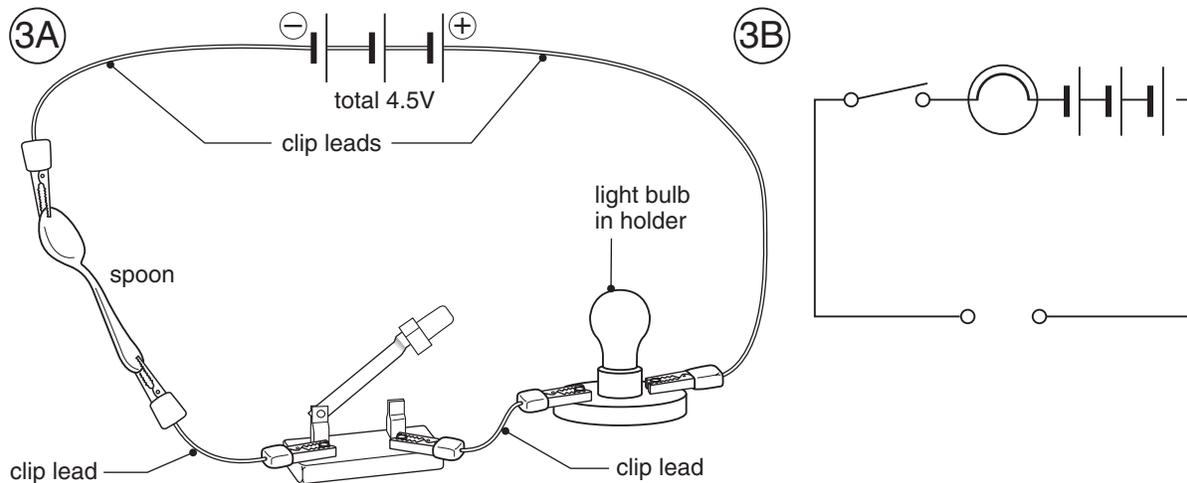
## Procedure

1. Arrange the cells, bulb, and switch (in the open position) as shown in diagram 2 below.



Arrangement of cells, bulb, and switch: wiring diagram (A) and circuit diagram (B)

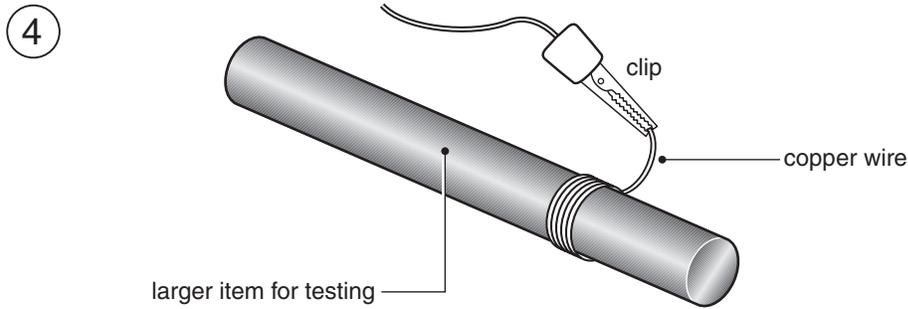
2. Attach one of the items to be tested between the clips (see diagram 3 below) and close the switch.



Circuit containing test item (switch in open position)

3. Record the condition of the light bulb (glowing brightly, glowing dimly, not lit) in the data table on the next page.

4. Open the switch.
5. Repeat steps 2 – 4 for all the items to be tested. If any of the items to be tested is too large to fit in the jaws of the clip, take a piece of copper wire and wrap it tightly around one end of the item. Now attach the clip to the piece of copper wire as shown in diagram 4. Repeat at the other end of the item.



*Use of copper wire to obtain connection to larger items*

<b>DATA TABLE</b>			
Material/item tested	Condition of light bulb		
	Glowing brightly	Glowing dimly	Not lit

### **Analysis**

1. Which of the three columns in the data table describes the materials that are good conductors of electricity?
2. Which of the three columns describes the materials that do not conduct electricity?

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1. The good conductors of electricity are in the column headed “glowing brightly.” The bulb lights brightly because the material used allows electricity to flow through it. The materials in the column headed “glowing dimly” also conduct electricity, but they do not allow as much electricity to flow as those in the “glowing brightly” column. They are therefore not such good conductors of electricity.
2. The column headed “not lit” contains materials that do not conduct electricity. These can be used as insulators.

The materials that allow electricity to flow are all metals (apart from the pencil lead, which is made of carbon). All metals are good conductors because they have free electrons (see Introduction to Experiment 3.01: Gradual Movement Of Heat Through Solids). These free electrons pass through the metal to conduct electricity. Unusually for a non-metal, carbon also contains free electrons. Non-metals are used as insulators because they do not allow electrons to pass through them. In Experiment 7.01: Sparks, the materials used are insulators – they allow charge to build up on the surface and do not allow it to pass through as a conductor would.