STUDENT INSTRUCTIONS

SERIES AND PARALLEL CIRCUITS — PRACTICAL ACTIVITY

NAME: _____ **CLASS:** _____

Big ideas

- **What is a series circuit?**
- **What is a parallel circuit?**
- **How are electrical circuits represented?**
- **What are the differences in how series and parallel circuits work?**

Inquiry questions

1 Can light globes remain on if one globe is unscrewed from its holder when they are connected in series or in parallel?

2 Does the position of the switch in the circuit affect which globes light up?

3 What happens to the brightness of the globes when an extra globe is connected into a series circuit?

4 What happens to the brightness of the globes when an extra globe is connected in parallel to the other two?

Introduction

An **electrical circuit** is a continuous pathway in which an electric current flows from one terminal of a source of electrical energy, through wires and various other objects, and back to the other terminal. The objects through which the electrical current flows, including the wire, are called the **components** of the circuit.

A **series circuit** is one in which the electrical current can only travel along one continuous path.

A **parallel circuit** is one in which the electrical current can travel along more than one continuous path. Each path must include the source of electrical energy, of course.

Example of a series circuit

An example of a series circuit and the matching conventional circuit diagram are shown in Figures 1 and 2.

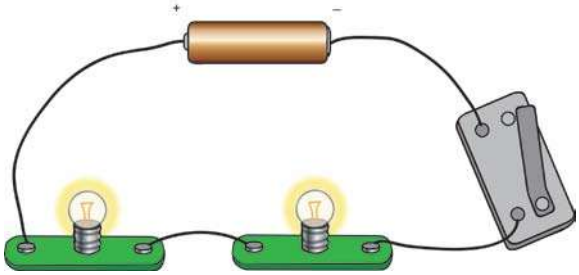

Figure 1. A series circuit containing a single battery, a switch and two light globes.

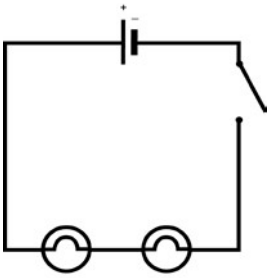

Figure 2. The conventional circuit diagram for the series circuit shown in Figure 1.

In Figure 2, the switch is shown open (off). It must be closed (on) for the globes to light up. Figure 3 shows the symbol for a closed switch.

Figure 3. The symbol for a closed switch.

Example of a parallel circuit

An example of a parallel circuit and the matching conventional circuit diagram are shown in Figures 4 and 5.

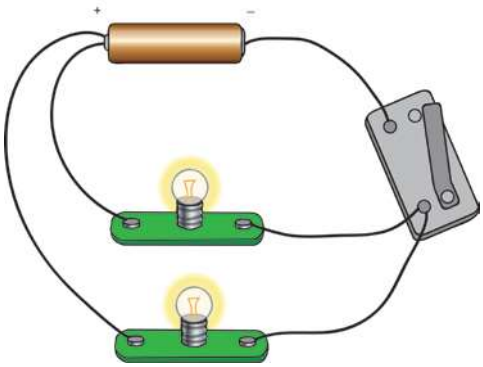

Figure 4. A circuit containing a single battery, a switch, and two light globes in parallel with one another.

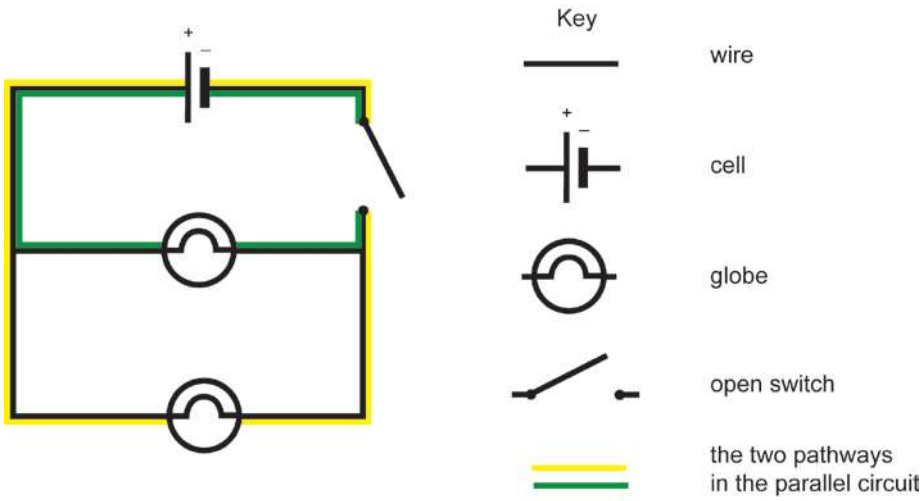

Figure 5. The circuit diagram for the circuit shown in Figure 4 and key to the circuit symbols. It can be seen that the cell (battery) and the switch are within both pathways. The switch must be closed (on) for the electrical current to flow along the two pathways.

What you will do in this experiment

You will set up series and parallel circuits and investigate what happens when you change the circuits in certain ways. Then you will use your discoveries to try some fun challenges.

But first you need to read the introduction and make some predictions about what might happen.

Predictions

1 Suppose you set up the series circuit in Figure 1.

a Will either globe light up if the switch is moved from where it is now to between the two globes, then closed and opened? Explain why you think this.

b What do you think will happen to the other globe if you move the switch back to where it was, then unscrew one of the globes from its holder? Will it light up when the switch is closed? Explain why you think this.

c What do you think will happen to the brightness of the globes if you screw the second globe back into its holder, then connect a third globe in series with the other two? Assume the switch is closed. Explain why you think this.

2 Suppose you set up the parallel circuit in Figure 4.

a How bright do you think the globes will be in this case, compared with the globes in Figure 1, when the switch is closed? Explain why you think this.

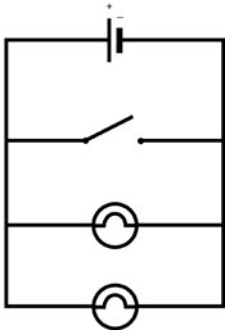

Figure 6.

b What will happen to the globes if the switch is placed along a third pathway, as in Figure 6, instead of where it is in Figure 4, and then closed? Explain why you think this. (Figure 6 shows this circuit before the switch is closed.)

c What do you think will happen to the other globe if you move the switch back where it was, then unscrew one of the globes from its holder? Will it light up when the switch is closed? Explain why you think this.

d What do you think will happen to the brightness of the globes if you screw the second globe back into its holder, then connect a third globe in parallel with the other two? Assume the switch is closed. Explain why you think this.

What you need

- 3-V battery (or two 1.5-V batteries in a holder)
- 3 x 1.5-V light globes
- connecting leads
- switch

Note: Ensure that the globes you use are identical.

Assessing the risks

Read the facts, imagine what could happen that might hurt someone or cause damage, and think about what you could do to prevent that problem. Insert your answers into the last two columns of Table 1.

Table 1. Risk assessment

The facts	What might be the risks?	What precautions will we take?
1 The globes can get very hot when they are turned on.		
2 In certain parallel circuits, even the wires and switch can get very hot when the switch is closed.		

What to do and what you discover

PART A: Testing a series circuit

Inquiry question 1: Can light globes remain on if one globe is unscrewed from its holder when they are connected in series?

Inquiry question 2: Does the position of the switch in the series circuit affect which globes light up?

Inquiry question 3: What happens to the brightness of the globes when an extra globe is connected into a series circuit?

Table 2. Instructions for Part A

Step	What to do
1	Set up the circuit shown in Figure 1, but use a 3-V battery. Does either globe light up when the switch is open? Now close the switch for a few seconds. Are the globes bright or dim? Is this what you predicted? Record your observations in the results table (Table 3 on page 10), then open the switch so the battery does not go flat.
2	Unscrew one of the globes from its holder. What happens to the other globe when you close the switch for a few seconds? Is it on or off? If it is on, is it brighter or dimmer than before? Is this what you predicted? Record your observations in Table 3, then screw the globe back into its holder and open the switch.
3	Move the switch so that it is now connected between the two globes. What happens to the globes when it is open then closed for a few seconds? Are they on or off? If they are on, are they bright or dim? Is this what you predicted? Record your observations in Table 3, then move the switch back to where it was and leave it open.
4	Connect a third globe into the circuit, next to the other two. Then close the switch for a few seconds. What happens to the brightness of the globes? Is this what you predicted? Record your observations in Table 3, then open the switch.

Table 3. Results for Part A

Step	Switch open or closed?	Globe(s) on or off?	Globe(s) bright or dim (if on)?	Prediction correct?
1 switch and two globes	Open			
	Closed			
2 one globe unscrewed	Closed			
3 switch between globes	Open			
	Closed			
4 add third globe	Closed			

PART B: Testing a parallel circuit

Inquiry question 1: Can light globes remain on if one globe is unscrewed from its holder when they are connected in parallel?

Inquiry question 2: Does the position of the switch in the parallel circuit affect which globes light up?

Inquiry question 4: What happens to the brightness of the globes when an extra globe is connected in parallel with the other two?

Table 4. Instructions for Part B

Step	What to do
1	Set up the circuit shown in Figure 4, but use a 3-V battery. Does either globe light up when the switch is open? Now close the switch for a few seconds. Are the globes bright or dim? Is this what you predicted? Record your observations in the results table (Table 5 on page 12), then open the switch so the battery does not go flat.
2	Unscrew one of the globes from its holder. What happens to the other globe when you close the switch for a few seconds? Is it on or off? If it is on, is it brighter or dimmer than before? Is this what you predicted? Record your observations in Table 5, then screw the globe back into its holder and open the switch.
3	Move the switch so that the circuit is the same as shown in Figure 5. The switch is now on a separate path to those of the two globes. What happens to the globes when it is open then closed for a few seconds? Are they on or off? If they are on, are they bright or dim? Is this what you predicted? Record your observations in Table 5, then move the switch back to where it was and leave it open.
4	Connect a third globe into the circuit, in parallel to the other two like the switch was in Step 3. Then close the switch for a few seconds. What happens to the brightness of the globes? Is this what you predicted? Record your observations in Table 5, then open the switch.

Table 5. Results for Part B

Step	Switch open or closed?	Globe(s) on or off?	Globe(s) bright or dim (if on)?	Prediction correct?
1 two globes in parallel	Open			
	Closed			
2 one globe unscrewed	Closed			
3 switch on third path	Open			
	Closed			
4 three globes in parallel	Closed			

PART C: Fun challenges

Can you set up circuits containing one cell, three light globes and one switch, that obey the following conditions?

Circuit 1: When the switch is closed, one globe is brighter than the other two.

Circuit 2: When the switch is closed, all three globes light up, but when it is open, one globe remains on.

Circuit 3: When the switch is closed, none of the globes are on, but when it is open, they all light up.

In each case, when you have succeeded, draw a circuit diagram of the circuit that worked. Try explaining why it worked. You may annotate your circuit diagrams to show your explanation. Attach your answers to your report.

Conclusions

Part A

What is your answer to Inquiry question 1: Can globes remain on if one globe is unscrewed from its holder when they are connected in series?

What is your answer to Inquiry question 2: Does the position of the switch in the series circuit affect which globes light up?

What is your answer to Inquiry question 3: What happens to the brightness of the globes when an extra globe is connected into a series circuit?

Part B

What is your answer to Inquiry question 1: Can globes remain on if one globe is unscrewed from its holder when they are connected in parallel?

What is your answer to Inquiry question 2: Does the position of the switch in the parallel circuit affect which globes light up?

What is your answer to Inquiry question 4: What happens to the brightness of the globes when an extra globe is connected in parallel with the other two?

Discussion questions

1 Compare your results with those obtained by the rest of the class. Did you all draw the same conclusions?

2 Did any of the results surprise you? If so, which ones? Can you suggest an explanation?

3 Are Christmas lights installed in parallel circuits or in a series circuit? Give your reasoning.