Lesson 5: Finding a Relationship Between Current and Voltage

5.1 Design an Experiment

You have a set of resistors, an ammeter, a voltmeter and a battery. Design an experiment to find a relationship between a current through a resistor and a potential difference across it.

a) Think of how you can use available resistors to vary the current through the resistor of your choice. What circuits will you build? Draw circuit diagrams.

b) Think of how you will measure the potential difference across that resistor.

c) Think what data you will collect and how you will record them. What are your dependent and independent variables?

d) Build the circuits and collect data. What is the uncertainty in each measurement? How should you represent it in the table of data?

e) Represent the data with the graph. How big is each data point? What does the trend line look like? Does it make sense? Explain your answer.

f) Write a mathematical relation that represents current through your resistor as a function of potential difference across it.

g) If you had to describe in words what the relationship between current through a resistor and potential difference across it is, what would you say?

Use the rubrics on the next page to self-assess and improve your work.

Did you know?

The mathematical pattern you found in activity one is the basis of the relationship for **Ohm's Law**. As current is proportional to potential difference, a proportionality constant must be included in the equation. The relationship between current and voltage can be written as follows:

$$I = \frac{1}{R}\Delta V$$

Where the current, I, is the dependent variable, and ΔV and R are the independent variables. R is the resistance, and ΔV is the potential difference.

Resistance is a physical quantity and is measured in ohms (the symbol isΩ).

Ability	Absent	An attempt	Needs some improvement	Acceptable
Is able formulate the question to be investigated	The question to be investigated. Is not mentioned.	The question is posed but it is not clear.	The question is posed but it involves more than one variable.	The question is posed and it involves only one variable.
Is able to design an experiment to answer the question	The experiment does not answer the question.	The experiment is related to the question but will not help answer it.	The experiment investigates the question but might not produce the data to find a pattern.	The experiment investigates the question and might produce the data to find a pattern.
Is able to decide what is to be measured and identify independent and dependent variables	It is not clear what will be measured.	It is clear what will be measured but independent and dependent variables are not identified.	It is clear what will be measured and independent and dependent variables are identified but the choice is not explained.	It is clear what will be measured and independent and dependent variables are identified and the choice is explained.
Is able to use available equipment to make measurements	At least one of the chosen measurements cannot be made with the available equipment.	All chosen measurements can be made, but no details are given about how it is done.	All chosen measurements can be made, but the details of how it is done are vague or incomplete.	All chosen measurements can be made and all details of how it is done are clearly provided.
Is able to describe what is observed in words, pictures and diagrams.	There is no description of what was observed.	A description is mentioned but it is incomplete. No picture is present.	A description exists, but it is mixed up with explanations or other elements of the experiment. A labeled picture is present.	Clearly describes what happens in the experiments both verbally and by means of a labeled picture.
Is able to construct a mathematical (if applicable) relationship that represents a trend in data	No attempt is made to construct a relationship that represents a trend in the data.	An attempt is made, but the relationship does not represent the trend.	The relationship represents the trend but no analysis of how well it agrees with the data is included (if applicable), or some features of the relationship are missing.	The relationship represents the trend accurately and completely and an analysis of how well it agrees with the data is included (if applicable).

5.2 Predict and Test

On activity 5.1 we found that the relationship between current through a commercial resistor and potential difference across it is linear. Design an experiment to test whether the linear relationship for current and voltage holds for different resistive elements in a circuit. Use commercial resistors, light bulbs, and so forth.

Describe an experiment in words and specify what type of resistive device you will study.	Draw an electric circuit and measure the value of the resistance of the resistor using an ohmmeter (an electric device that measures the electric resistance of an object).	Write your prediction using the relationship $I = (1/R)\Delta V$ where R has a constant value.	Perform the experiment, record the outcome, and decide whether the relationship holds for this particular type of resistor.

Based on your findings, what can you say about the hypothesis under test?

5.3 Explain

Examine the results of the activity 4.9. How can you explain them now?

4.9 Observe and explain

Build a series circuit consisting of a battery, a switch, a lightbulb, an ammeter and connecting wires. Have a voltmeter ready. After you build the circuit, close the switch and observe the bulb glow and record the reading of the ammeter.

a) Does it matter where the ammeter is in the circuit for its reading: before or after the bulb?

b) Use the voltmeter to measure the potential difference across the battery, the bulb, the connecting wires and a switch. Record the readings. Explain using the energy ideas.

c) Now open the switch the repeat the voltmeter measurements. Explain.