Module 1, Lesson 3 – Temperature vs. resistance characteristics of a thermistor

Student

45 minutes

Purpose of this lesson

- How thermistors are used to measure temperature.
- Using a multimeter to measure the resistance of a thermistor.
- Investigating the variation of thermistor resistance with temperature.
- Graph data and reason about curves and linear relationships.

Materials

Copy of the lesson

1 Multimeter

2 Alligator clips

1 Thermistor

1 Beaker

Hot water

Ice

1 Thermometer

Graph paper (or Excel)

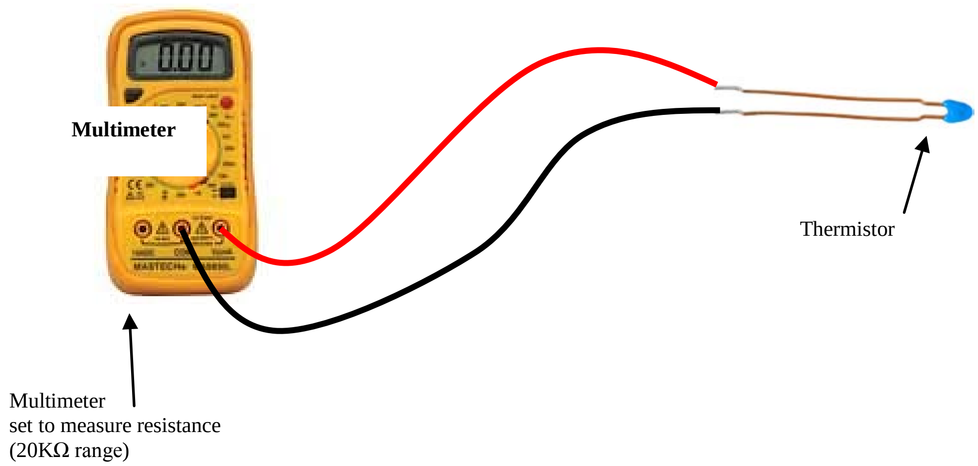
Background and Discussion

Conductors, like metals, are materials in which many of the electrons are free to move easily between atoms. Because of this, they have low resistance, and can conduct electricity easily. Insulators, such as rubber, are materials in which none of the electrons can move freely between atoms, have very high resistance and do not conduct electricity. Semiconductors (or semimetals), such as silicon, can sometimes act like conductors and sometimes like insulators, depending on how they are used.

The thermistors used in this module are made of semiconductor material. The ability of a thermistor's electrons to move between atoms depends strongly on temperature which makes them a useful device for using electricity to measure changes in temperature.

Procedure

1) Use alligator clips to connect the ends of the thermistor to the multimeter probes.



2) Set the multimeter to measure resistance in kOhms by turning the dial to the “20 kΩ” setting. This means that the number on the screen represents kOhms (i.e. “1.5” means 1.5kOhms which equals 1500Ohms) and will go up to a maximum of 20kOhms.

(NOTE: If the multimeter displays “OL” (overload), the resistance is too high to be measured, and you will have to use a higher setting on the multimeter.)

3) Place the thermistor in a cup of hot water. (**NOTE: Make sure the clips stay out of the water, water will conduct electricity and result in an inaccurate measurement.**)

4) Measure the temperature with a thermometer and at the same time read the thermistor resistance from the multimeter. (**NOTE: When connecting the alligator clips to the thermistor, make sure you connect to the silver-colored segments at the ends. The brown coloring along most of the leads is an insulating layer**.)

5) Record the data in the table on the following page. Now reduce the temperature by adding a little cold water and stirring/mixing well, and then measure temperature and resistance again. Repeat over a range of temperatures, eventually adding ice to get down to 0°C, recording data for each temperature.

Assessment

1) Record the data you have measured, listing temperatures and thermistor resistances.

Temperature °C	0	10	20	30	40	50	60	70	80
Resistance kΩ									

It is not necessary for readings to be taken exactly every ten degrees or even at exactly equally spaced intervals, as long as readings adequately cover the temperature range

2) Plot a graph of thermistor resistance versus temperature. Use the vertical (y) axis for resistance, and the horizontal (x) axis for temperature.

3) Describe the relationship between resistance and temperature for a thermistor.

Further questions for group discussion with your teacher

i) One way to measure temperatures in the environment would be to use the graph you have just plotted. You could place your thermistor in the environment, measure its resistance, and then look the resistance up on your graph to read off the corresponding temperature. Is this procedure a useful system for measuring temperature? What might be difficulties with using this method as a temperature measuring system?

ii) What kind of mathematical relationship between temperature and sensor output signal would be most desirable for a simple temperature measuring sensor?

Imagine that you would like to connect your temperature sensor to a computer. You could then leave the computer to do all the hard work of recording temperature over a long period of time (i.e. automate your data gathering). The computer could also calculate the temperature, instead of you having to look up the temperature values on your temperature-resistance graph.

iii) How do computers measure the outputs of sensors? How might the computer convert measurements of the transducer (resistances or voltages) into figures for temperature?