

## Investigation

### Making a temperature sensor

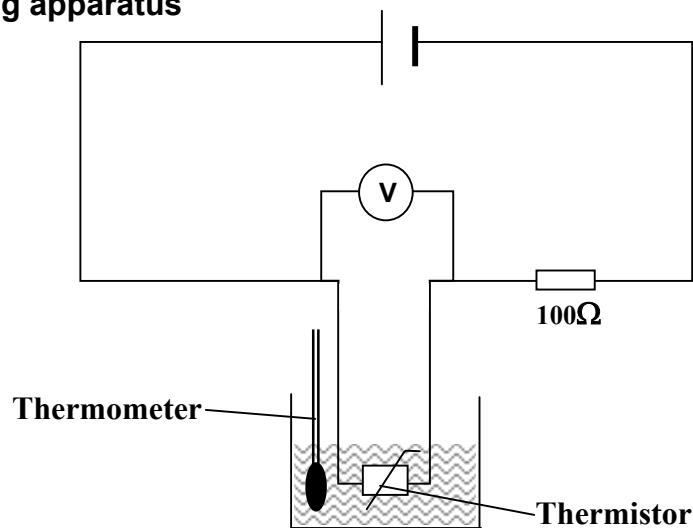
If an external variable causes a change in the voltage across an electrical device, then this can be used as the basis of a sensor. Thermistors are electronic components that are made of mixtures of transition elements. The conductivity of a thermistor varies with its temperature. Therefore, if the thermistor has current flowing through it, the voltage across it will vary with temperature.

#### Materials



TI Graphing Calculator with DataMate program installed  
CBL2 interface  
Voltage probe  
Temperature probe  
Thermometer  
3 Cables

4.5 volt battery  
4 Crocodile clips  
Resistor  $100\Omega$   
Thermistor  
Supply of hot and cold water  
Ice cubes

#### Set up the following apparatus





#### Starting the DataMate Program and setting up

- Use the following steps to start the DataMate program on your calculator:  
Press **APPS**, then press the calculator key for the number that proceeds **DATAMATE**. Press **ENTER**. An introductory screen will appear, followed by the main screen.
- Plug the Voltage Probe into channel **CH 1** on the CBL2 interface.
- Start the DataMate program. Press **CLEAR** to reset the program. DataMate will detect the auto-ID sensor, set the data collection parameters, and display the current sensor reading.
- Press **1**: **SETUP** and using the cursor buttons,  or  (be patient it's a bit sluggish!) Select **MODE** press **ENTER** (scroll up to get to the last item on the menu).
- In the **SELECT MODE** menu choose **3**: **EVENTS WITH ENTRY**.
- Press **1**: **OK** to return to the main screen.

## Collecting data

1. Put the thermistor into the beaker with water at room temperature. Stir the water using the thermometer and measure the temperature of the water using the thermometer.
2. Select **2: START** to begin data collection. Press **ENTER** to record your first voltage measurement. Then enter the temperature. Press **ENTER** again.
3. Change the water temperature by adding small pieces of ice or hot water and press **ENTER**. Then type in the temperature. Press **ENTER** again and you will find the calculator producing an autoscaled scattergram of the measurements.
4. Continue to take measurements at as many different temperatures as possible between 5°C and 60°C. take at least 10 different temperatures spread across the range.
5. You may stop data collection at any time by pressing the **STO→** key.
6. Store your data if you are satisfied with it or to repeat an experimental run return to the main screen by pressing **ENTER**.

## Analysing the data

1. Describe the overall shape of the line set out by the scattered points on the graph. (Is it linear or curved? Which way does the trend go?).
2. Use the cursor keys  or  to examine the data points and record the voltage for each of the temperatures.
3. This graph represents a **calibration curve**. The voltage registered by the thermistor can be used to measure the temperature of its environment. Read off the temperature that corresponds to the voltage recorded.

## Application

1. Use the thermistor to measure the temperature of the air in the room, the air outside the lab or in the courtyard. Hold the thermistor between your finger and thumb and determine the temperature rise. Verify your measurements with those using a thermometer.
2. Compare the performance of your home made temperature probe with that of the Vernier stainless steel temperature probe.
3. Refer back to the technical data on the Vernier probe to determine why there may be differences between your probe and the Vernier probe.
4. If your thermometer gives unusual readings or readings different from the Vernier probe or the thermometer what sources of error might be producing these differences.