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Introduction to Sensors, Instrumentation, and Measurement

02/01/2024

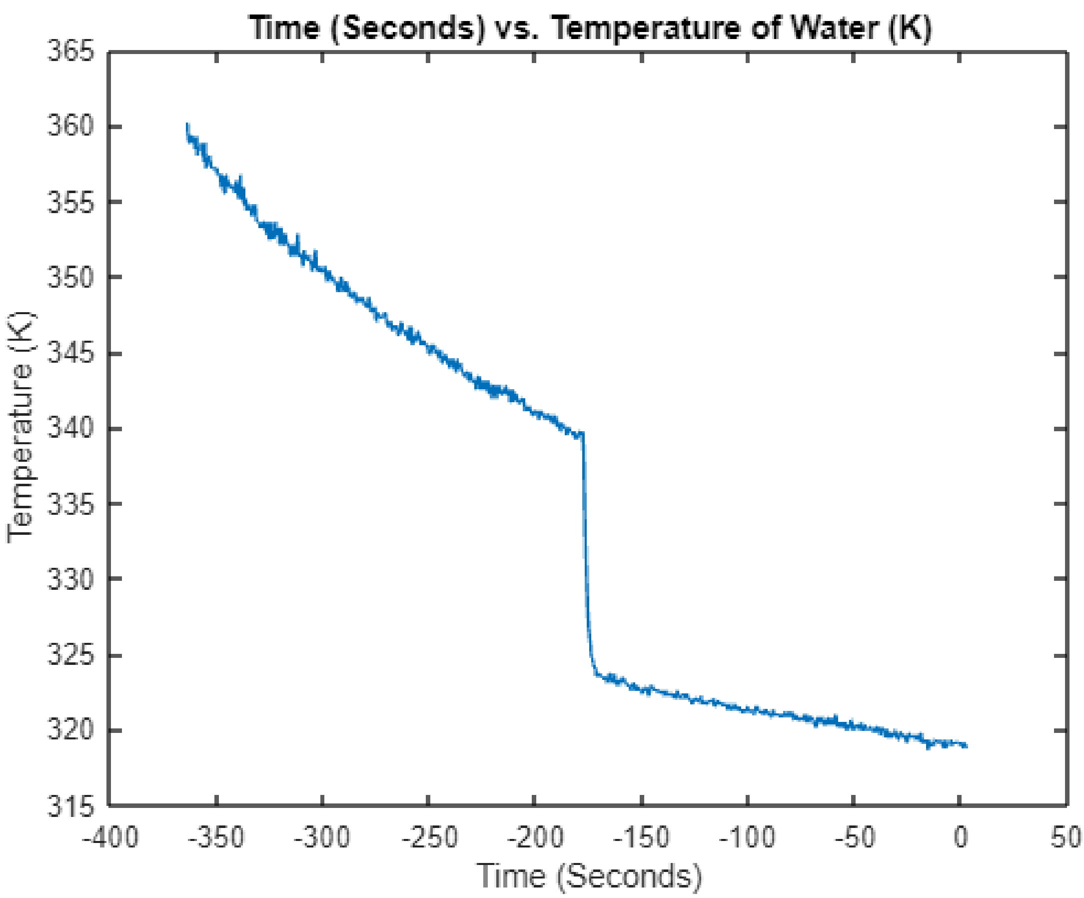
Lab Two: Thermistor

Purpose:

Design a temperature-sensing circuit using a thermistor and voltage divider.

Results:

1.) Graph of the Cooling of Water (T v. t)



Time vs. Temperature of a cooling cup of water. A 1 kΩ thermistor was used as a temperature sensor to measure the cup of water in a 4V voltage divider circuit with a regular 1 kΩ resistor. Time started at -360 seconds with 60 ml of boiling water, and after three minutes, 20 mL of ice water was added.

2.) Analysis of ΔT(1) v. ΔT(2)

The temperature drop in the first three minutes (ΔT(1)) is:

$$\Delta Temp(0\ to\ 180\ seconds) = 360.2\,°K - 339.4\,°K = 20.8\,°K$$

While the temperature drop from three minutes to six minutes (ΔT(2)) is:

$$\Delta Temp(180\ to\ 360\ seconds) = 339.4\,°K - 319.0\,°K = 20.4\,°K$$

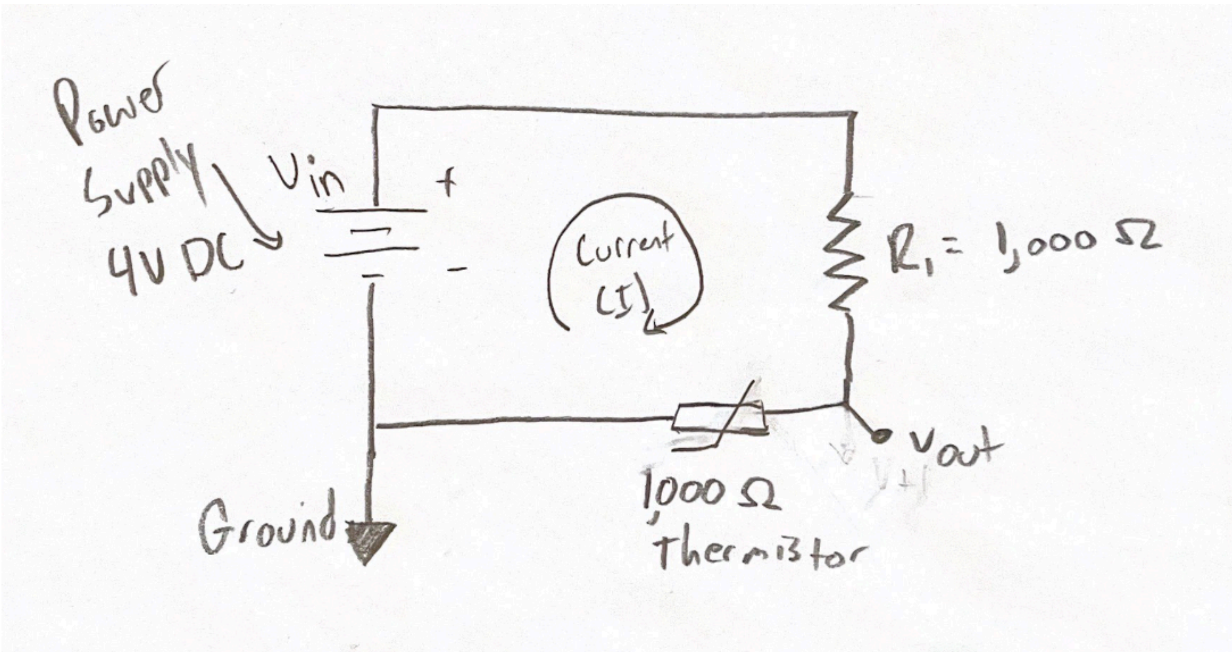
The temperature drop from zero minutes to three minutes is roughly equivalent to the temperature drop between three minutes and six minutes. However, this is for different reasons.

From zero to three minutes, the water begins to cool rapidly, then slows the rate at which it cools as it approaches room temperature. **This is because the closer the water is to room temperature, the less heat it disperses and the slower it cools.**

From three to six minutes, the water again cools rapidly when the ice water is added, but once the water reaches a lower temperature, it only cools very slowly. This is because the water is now much closer to room temperature and disperses much less heat.

Therefore, although ice water was added from three to six minutes, because water cools slower at lower temperatures, the temperature drop across T(1) and T(2) is nearly identical.

3.) Circuit diagram for the thermistor circuit:



4.) Code used for producing the cooling curve:

Unset
```
clear; % clears memory - useful if you run many scripts in the
same session
clf;

%take in data from csv file
tname='Thermistor_Lab.csv'; %importing file
datatable  = readtable(tname);%makes data table with headers

%interpret data as times and voltages
time1  = datatable.t1; % stores the t1 column of data in a
variable called time1
V1    = datatable.ch1; % stores the ch1 column of data in a
variable called V1

ResistanceTherm = (V1./(4-V1))*1000; %converts the voltage data
to the resistance of the thermistor
Temp = ((1/298)+(log(ResistanceTherm./1000)./3528)).^-1;
%converts the thermistor resistance data to temperature

plot(time1,Temp) %plots first channel
xlabel('Time (Seconds)'); % add x axis label
ylabel('Temperature (K)'); % add y axis label
title("Time (Seconds) vs. Temperature of Water (K)")
```

Conceptual Ideas:

1.) Choice of resistor in the thermistor circuit:

I chose a 1000 Ω resistor because I was using a 1000 Ω thermistor, and I chose to measure the voltage across the thermistor. This way, I was easily able to verify my hypothesis while testing the thermistor. When the thermistor was exposed to room temperature, the voltage divider would be evenly split (since I was using 4 volts, I would measure 2V across the thermistor). If my thermistor was exposed to warm environments, its resistance would lower and I would measure less than two volts. With cold environments, it would measure higher than two volts. With this in mind, as I conducted my experiment, I would mentally verify that my circuit worked correctly. It started off reading two volts, significantly dropped when exposed to boiling water, then rose as the water cooled.

2.) How the resistor value affects the performance of the thermistor circuit:

Choosing a 1000 Ω resistor also helped my circuit reach peak performance. If I would have used a resistor with much higher resistance (ex. 100 kΩ), then that all of the voltage would have been measured across that resistor and changing the resistance of the thermistor would have been almost negligible. Similarly, if I would have used a resistor with a much lower resistance (ex. 10 Ω), then almost all of the voltage would have been measured across the thermistor regardless of its resistance. Choosing a resistor in the range of 500 Ω - 2,000 Ω would be best for a thermistor of 1000 Ω.