Experiment ADS-CEK-3: Temperature and Relative Humidity

Background

Humidity refers to the amount of water vapor present in the air. The amount of water vapor present in the air is dependent upon temperature.

In this lab, students investigate how the temperature of water influences the surrounding air's temperature and relative humidity. By placing temperature and humidity sensors directly above beakers of room temperature and ice-cold water, students can observe how evaporation and temperature differences affect local atmospheric conditions.

Experiment ADS-CEK-3: Humidity and Temperature

Equipment Required

PC or Mac Computer

ADS or ADS MAX Board, USB cable, ADS power supply

HSN-100 Humidity sensor

TMN-100 Temperature sensor

Stand clamp or alternative method for holding the sensors in place

250 mL beaker

Ice water

Room temperature water

Note: To ease setup, connect the sensor(s) to the A-ADS-IA adapter *before* plugging the adapter into the board. To disconnect, unplug the adapter from the board *first*, then remove the sensor(s).

Note*: Calibration of the HSN-100 Humidity sensor will take approximately 1 – 2 hours for most accurate readings.*

Setup (ADS)

1. Locate the HSN-100 Humidity sensor and the TMN-100 Temperature Sensor.
2. Plug the connector of the TMN-100 into the Channel 1 input on the A-ADS-IA.
3. Plug the connector of the HSN-100 into the Channel 2 input on the A-ADS-IA.

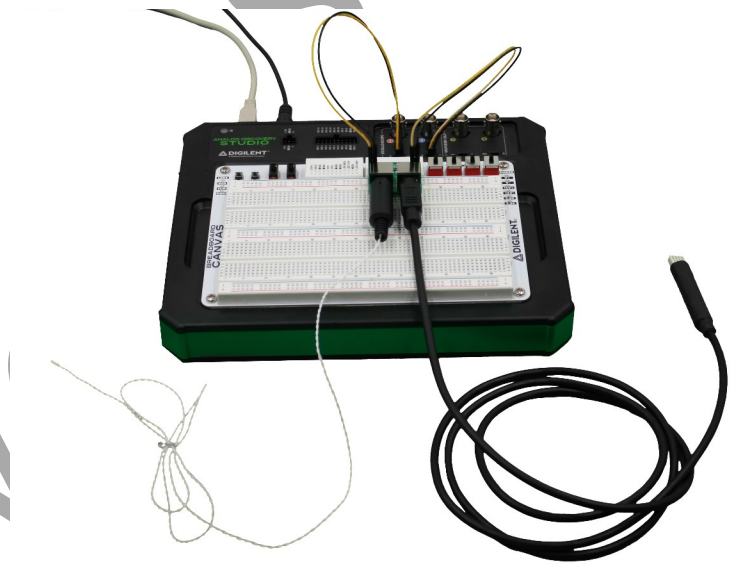


Figure ADS-CEK-3-S1: The TMN-100 and HSN-100 connected to the ADS Board.

***Note**: Any condensation on the humidity sensor will yield incorrect readings. Do not use steaming water with the humidity sensor.*

Setup (ADS MAX)

If using the ADS MAX, setup instructions will be the same. Channel connections are labeled on the A-ADS-IA board, as shown below.

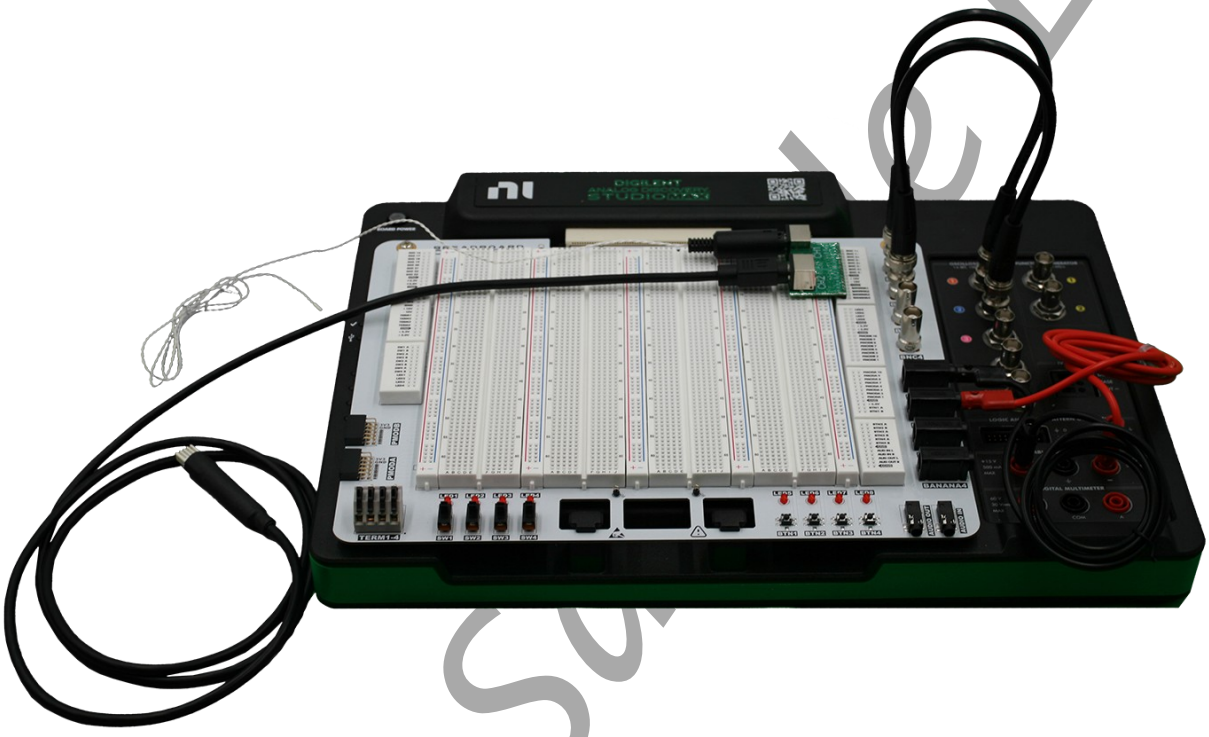


Figure ADS-CEK-3-S2: The TMN-100 and HSN-100 connections on the ADS MAX.

Calibration of the Temperature Sensor

Prepare two beakers of water, one at 30 ºC, and the other at 40 ºC.

1. Click the red 'REC' button to start the recording.
2. Place the tip of the temperature sensor in the first beaker containing enough water to submerge the tip.
3. Type **30 C** into the mark box. Mark the recording when the temperature stabilizes, or about 20 seconds.
4. Remove the sensor from the first beaker and place it into the second beaker.

5. Type **40 C** into the mark box. Mark the recording when the temperature stabilizes, or about 20 seconds.
6. Click stop to halt the recording.
7. Select Save As in the File menu, type a name for the file. Click on the Save button to save the data file.

Units Conversion

1. Scroll to the beginning of the calibration data for the TMN-100.
2. Use the Display Time icons to adjust the Display Time of the Main window to show the data collected at 30 ºC, and 40 ºC. on the Main window at the same time.
3. Click the 2-Cursor icon so that two cursors appear on the Main window. Place one cursor on the flat section of data collected when the TMN-100 was in the 30 ºC beaker and the second cursor on the flat section of data collected when the TMN-100 was in the 40 ºC beaker. The calibration data should look similar to Channel 1 data below.

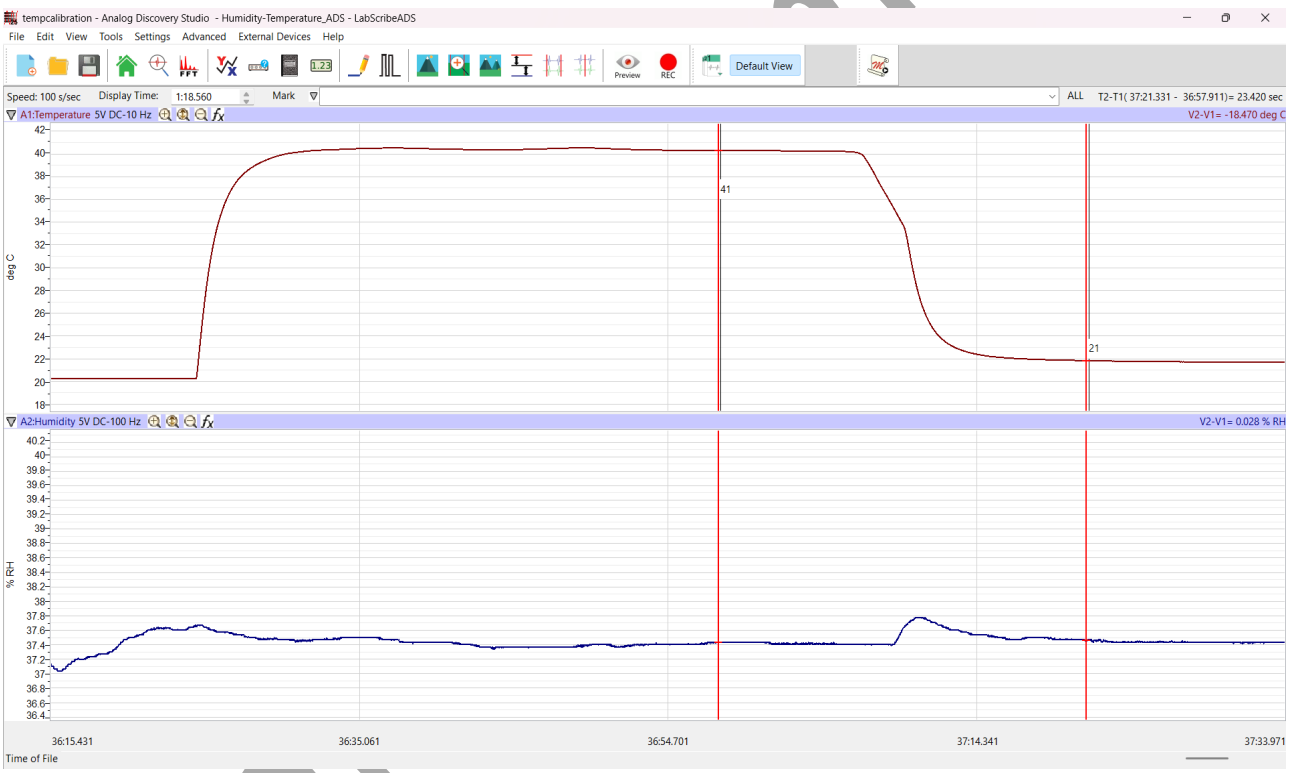


Figure ADS-CEK-3-S3: Temperature sensor calibration data. The sensor was calibrated with temperatures of 41 and 21 deg C.

4. To convert the voltages at the positions of the cursors to temperature values in deg C, use the Simple Units Conversion dialogue window. Click V2-V1 on the temperature channel, then select Units, and select Simple.
5. Enter the temperature reading values for cursor 1 and cursor 2. Press OK.

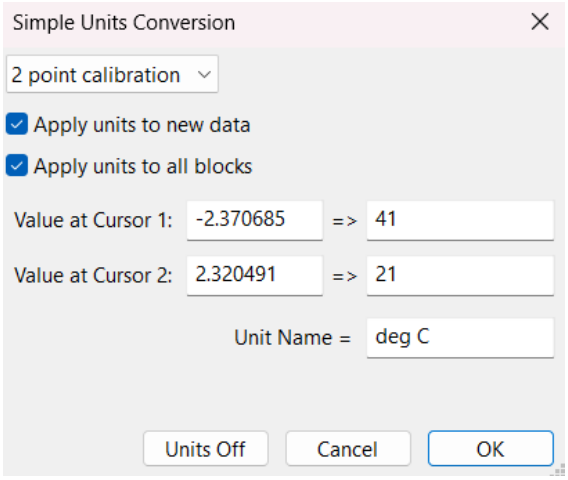


Figure ADS-CEK-3-S4: Units conversion dialog window.

Calibration of the Humidity Sensor

1. Place a handful of salt in the bottom of a jar (quart or liter size is fine).
2. Add a little water to the jar so that the salt is wet.

Note: The goal is to end up with wet salt, not to totally dissolve the salt.

3. Place the Relative Humidity Sensor in the jar.

Note: Do not get the salt or salt solution on the sensor.

4. Seal the jar using plastic wrap and rubber bands. Allow some time (~2 hours) for the air inside the sensor to reach the proper relative humidity level.
5. Connect the Relative Humidity Sensor to the A-ADS-IA and start the recording. Go through the procedure for the first calibration point. Enter the relative humidity for the salt you used, as determined from the table on the page below.
6. For better accuracy, repeat the procedure for the second calibration point using a different salt. Be sure to allow enough time for the Relative Humidity Sensor to adjust for the change in humidity.

Units Conversion

1. Repeat the instructions listed above from the temperature calibration.

Salt	15°C	20°C	25°C	30°C	35°C
Lithium Bromide	6.86	6.61	6.37	6.16	5.97
Lithium Chloride	11.3	11.31	11.3	11.28	11.25
Potassium Acetate	23.4	23.11	22.51	21.61	–
Magnesium Chloride	33.3	33.07	32.78	32.44	32.05
Potassium Carbonate	43.15	43.16	43.16	43.17	–
Magnesium Nitrate	55.87	54.38	52.89	51.4	49.91
Potassium Iodide	70.98	69.9	68.86	67.89	66.96
Sodium Chloride	75.61	75.47	75.29	75.09	74.87
Ammonium Sulfate	81.7	81.34	80.99	80.63	80.27
Potassium Chloride	85.92	85.11	84.34	83.62	82.95
Potassium Nitrate	95.41	94.62	93.58	92.31	90.79

Figure ADS-CEK-3-S5: Relative humidity values for various salts at different temperatures.

Experiment ADS-CEK-3: Humidity and Temperature

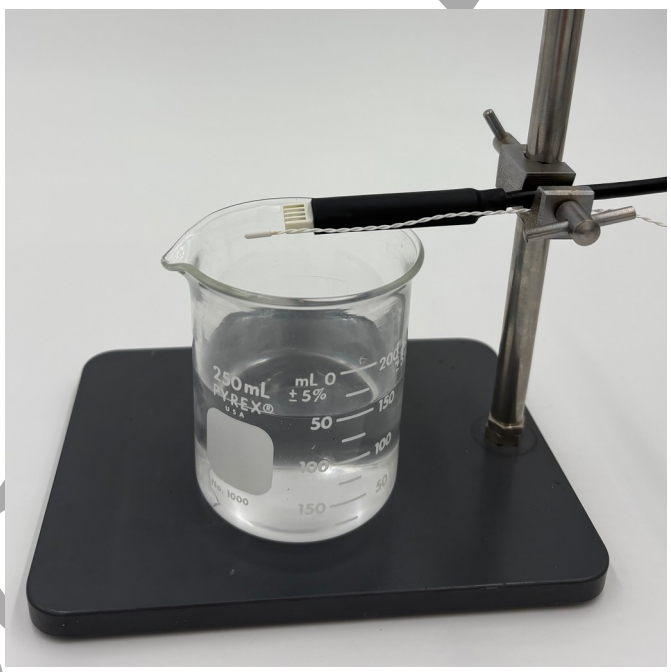
Exercise 1: Room Temperature Water

Aim: To determine the average air temperature and percentage relative humidity (% RH) above room temperature water.

Approximate Time: 40 minutes

Procedure

1. Place the humidity sensor and temperature sensor directly above the beaker. Ensure both sensors are level with the edge of the beaker. A stand clamp can be used to hold the sensors in place.
2. Prepare a beaker with 150 mL of room temperature water.
3. Immediately start the recording as the beaker is placed under the temperature and humidity sensors.
4. When the recording on both channels reach a relatively stable baseline, type **Room Temp Water** in the Mark box. Click the mark button to mark the recording.
5. Record 30 minutes of data.
6. Click Stop to halt the recording.
7. Select Save in the File menu.



Exercise 2: Ice Water

Aim: To determine the average % RH and air temperature above ice water.

Approximate Time: 40 minutes

Procedure

1. Repeat the procedure from Exercise 1. Substitute the room temperature water for ice water.
2. When the recording on both channels reach a stable baseline, type **Ice Water** in the Mark box. Click the mark button to mark the recording.
3. Record 30 minutes of data.

Figure ADS-CEK-3-S1: Recording of temperature and relative humidity after placing ice water beneath the sensors. A single cursor is positioned over the "Ice Water" mark to display the corresponding measurements on the right of each channel. The temperature reads 21.856 °C, and the relative humidity reads 40.5%.

Data Analysis

1. Scroll to the section of data for room temperature water recorded during Exercise 1.
2. Use the Display Time icons on the LabScribe toolbar to position this section of recording on the Main window. The required data can also be selected by:
    - Placing the cursors on either side of the section of data needed. Place one cursor on the stable temperature and humidity values recorded from Exercise 1. Place the second cursor on the stable values recorded at the end of the 30 minute mark.
    - Clicking the Zoom between Cursors button on the LabScribe toolbar to expand the segment of data to the width of the Main window.
3. Look at the Function Table that is above the uppermost channel displayed in the Analysis window. The mathematical functions that are listed should include Title, Value1, and Value2. The values for these parameters from each channel are seen in the table across the top margin of each channel.
4. Once the cursors are placed in the correct positions for determining the relative temperature and humidity, the values can be recorded in the on-line notebook of LabScribe by typing the names and values directly into the Journal.

5. The functions in the channel pull-down menus of the Analysis window can also be used to enter the names and values of the parameters from the recording to the Journal. To use these functions:
    - Place the cursors at the locations used to measure the mean temperature and % RH from both channels.
    - Transfer the name of the mathematical function used to the Journal using the Add Title to Journal function in the channel pull-down menu.
    - Transfer the values for the mean temperature and % RH to the Journal using the Add Ch. Data to Journal function in each channel's pull-down menu.

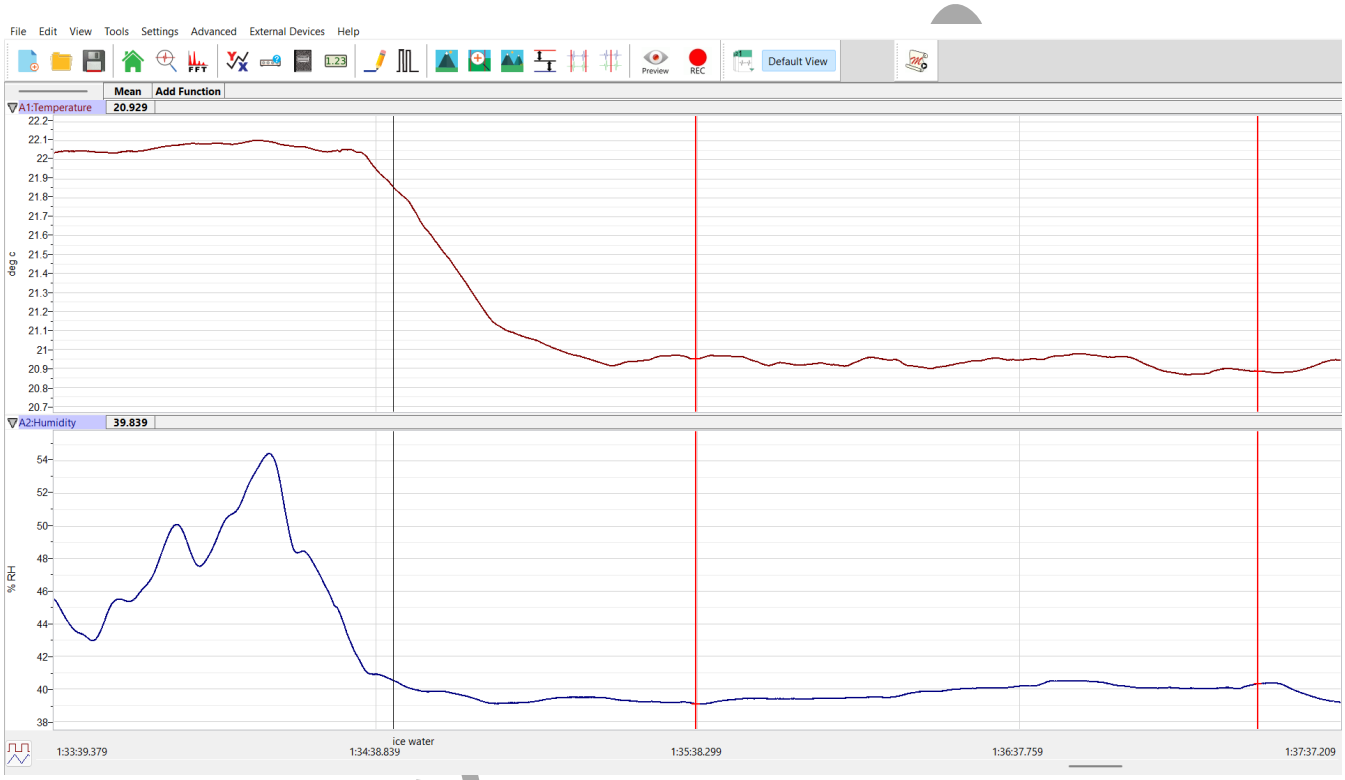


Figure ADS-CEK-3-S2: Temperature and relative humidity channels shown in the Analysis window. The red cursors are placed around the stable section of data to obtain the mean temperature and % RH.

Questions

1. Compare the values for % RH obtained from both room temperature water and ice water. Which water temperature yielded the highest % RH?
2. How might the position of the sensor (closer or farther from the water surface) influence the measurements of temperature and relative humidity?