

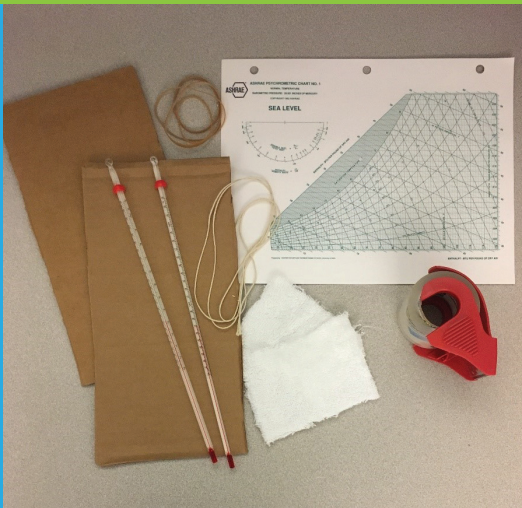
# ASHRAE Student Activities: Sling Psychrometer STEM Kit



## INTRODUCTION

Psychrometrics is the study of air-water mixtures. Meteorologists use psychrometrics to determine the relative humidity and dew point temperature for the weather broadcast. Engineers who work in the air conditioning field use psychrometrics to determine how much moisture is being held within a quantity of air to assist them in making our buildings comfortable. Sling psychrometers are an instrument used to measure how much moisture is in the air.

In using this kit, students will learn how to build a sling psychrometer and directly measure two properties of air: dry bulb temperature and wet bulb temperature. Using these measurements, students can determine other properties of air on a psychrometric chart, e.g., dew point, relative humidity and more. This kit is intended for students aged 12 to 17.



## CONTENTS

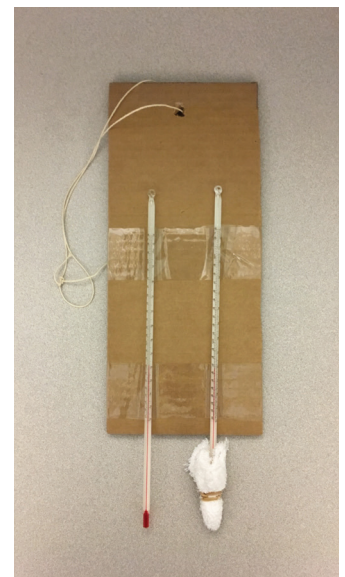
- Alcohol-based dual-unit thermometers (2)
- Transparent packing tape
- Rubber bands (4)
- Small pieces of cloth (2)
- String
- Psychrometric charts

## ON-SITE

- Robust cardboard (possibly sourced from this STEM kit's box)
- Water
- Scissors or hole punch

## INSTRUCTIONS

1. Divide the students into small groups if multiple kits are available. One kit contains enough materials to create one sling psychrometer.
2. Cut two long box flaps and align them together. Secure with transparent packing tape. Designate one side "top" and the other "bottom." On the top side, use a pair of scissors (or hole punch) to carefully puncture the cardboard for the string to pass through. Ensure there is enough cardboard to prevent it from being torn while being swung around (approximately 1-1.5 inches [2-3 cm]).
3. Using transparent packing tape, affix the thermometers to the cardboard lengthwise, as shown in the picture. Removing the thermometer roll-guards is optional. Consider using tape on the top and bottom of the thermometers to create two secure points. Be sure to press the tape down to ensure good adhesion. Align them so that their temperature scales are easy to read. The thermometers should be parallel to one another and the bulbs should hang off the bottom edge. Be generous with the tape to ensure that the thermometers do not fly off the cardboard when the assembly is swung around. Use additional cardboard to ensure a rigid structure, if needed.
4. Wrap one thermometer bulb with a small piece of cloth and secure with a rubber band and transparent packing tape. This will become the "wet" bulb thermometer.



5. Place the string through the hole at the top and fasten in a loop with a square knot.
6. Dip the cloth-covered thermometer bulb in water to ensure it is wet.
7. Being mindful of other people, carefully swing the sling psychrometer in a circle for at least two minutes. Students should be advised not to stand in the path of the swinging. Alternatively, use a fan to blow air across both thermometer bulbs.
8. Record the temperatures of both thermometers (wet bulb first and then the dry bulb) being careful to hold the unit by the cardboard so that the temperatures don't change from the warmth of your hands.
9. Consider taking measurements in other areas where air conditions may be different, including:
  - a. Outside, especially if it's a hot and humid day (compare your readings with the current weather report on your phone)
  - b. A walk-in cooler/freezer
  - c. The airstream coming from the air conditioning system diffuser or classroom unit ventilator
10. Plot the conditions on a psychrometric chart to determine the other properties of air. Dry bulb temperature is shown along the horizontal axis and wet bulb temperature is displayed on this chart as Saturation Temperature on the left side.

## DISCUSSION

- How did the relative humidity and dew point temperatures vary between the outside, and the inside? How can the psychrometric chart be used to show these conditions? Did the air feel different to you? (Dew point temperature is discussed in the conclusion, below.)
- How did the air properties in the classroom compare to the air conditioning diffuser or unit ventilator? Was the supply air drier coming from the air conditioning system?
- How did the air conditions inside the walk-in cooler compare to the classroom/gymnasium? How did they compare to the air conditioning system?
- What can you say about the relative humidity of air if its dry bulb temperature and wet bulb temperature are equal?

## CONCLUSION

The dew point temperature of any state point (defined by plotting the dry bulb and wet bulb temperatures on the psychrometric chart) can be found by drawing a line from the state point horizontally along a specific humidity line to the left until the 100% relative humidity line is reached. When air at this state point is cooled (without adding nor subtracting moisture) to its dew point, water condenses out of the air.

Example: When a surface is at or colder than the dew point temperature, the surrounding air is cooled and moisture droplets form upon the cold surface. This can be seen when a cold beverage container sits and condensation forms on the outside. This also happens in nature and is observed as dew forming on plant leaves.

Ask the students why they believe there is a difference between the dry bulb and wet bulb temperatures. They should conclude that the wet bulb temperature decreases due to the cooling effect produced by evaporation, i.e., heat is needed to evaporate the water so it is taken from the air around the wet bulb thermometer. When the relative humidity of the air is 100%, no more water can be evaporated so the dry bulb and wet bulb temperatures are equal. Note that this is consistent with the psychrometric chart.

Optional: Explain to students how one can use psychrometrics to show air conditioning processes, e.g., cooling, heating, dehumidification, humidification, and combining air streams. This can be as simple as showing sets of two state points and how processing air from one state point to another demonstrates one of the basic air conditioning processes.

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