Extension Activity – Air and Soil

Title of Activity – Make Your Own Hygrometer

Concepts/Principles Covered -

A hygrometer measures the amount of water vapor in air or soil. A simple hygrometer was invented by da Vinci in 1480. Others later developed more practical versions. In 1783, Swiss physicist and geologist de Saussure invented the first hygrometer using human hair to measure humidity. (Wikipedia)

Early measures of the moisture in the air were based on how much moisture paper can collect. A simple version can be made from a pile of paper discs suspended on one arm of a balance. The other arm moves over a scale. The paper absorbs water in the atmosphere and so gets heavier in humid conditions, tipping the scale as an indication of humidity. A version including hair can also be made fairly easily.

The maximum amount of water vapor that can be held in a given volume of air (saturation) varies greatly by temperature; cold air can hold less mass of water per unit volume than hot air. Temperature can change humidity.

Short Description –

Demonstrate how a hygrometer can reflect the moisture content in the air. Use the engineering design process to optimize the hygrometer design.

Standards Covered -

MS-ETS1-1: Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.

MS-ETS1-2: Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

MS-ETS1-3: Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.

MS-ETS1-4: Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.

HS-ESS2-5: Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.

Length - 45 minutes

Age Group – Grades 5-9

Materials and Supplies (Simple version) -

- Cardboard or cardstock
- Plastic cup
- Straws, dowel or long, round pencil
- Paper towels

Step-by-step Instructions -

Construction Phase

- Use cups, straws, long pencils, dowels to create your balance. Create a means of registering change in moisture (a scale). Determine materials to trap moisture effectively.
- Build your simple hygrometer. Modification during construction can be done via the engineering design process.

Testing Phase

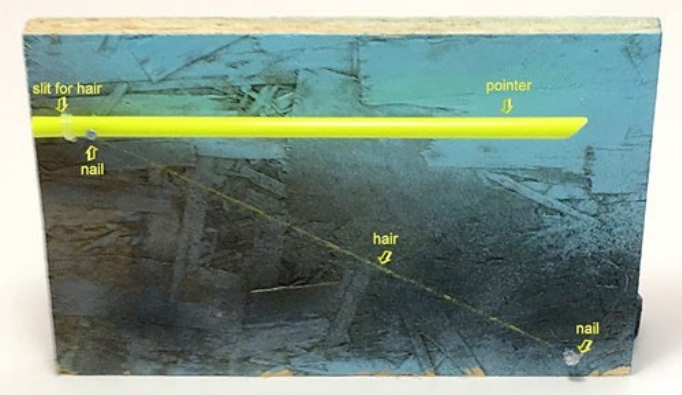
- Leave your hygrometer overnight to generate a base "reading" of humidity.
- The next day, record the "normal" humidity measurement.
- Expose your hygrometer to humidity by a series of sprays of mist/water.
- Mark your hygrometer's "readings" after each spray. Record each value.

DATE AND TIME	NUMBER OF SPRAYS	READING

Materials and Supplies (Hair version) -

- Rubbing alcohol (70% isopropyl alcohol works well)
- Three long strands of human hair (about 20 centimeters long)
- Cotton swab
- Wide, non-bendable straw
- Scissors

- Metric ruler
- Glue (fast drying glue or a glue gun works best)
- Piece of wood, about 25 cm long and 15 cm wide
- Two small nails
- Hammer
- Marker
- Hair dryer
- Ziplock bag, large enough to fit the wood inside and have a little room to spare
- Wet sponge or paper towel



Step-by-step Instructions -

- Make a solution of 25% rubbing alcohol and 75% water.
- Dab a cotton swab in the diluted rubbing alcohol solution and wipe down each strand of hair to remove residual oils and allow water to permeate the hair more readily.
- Cut a triangle on one end of the drinking straw so it becomes a pointer. Cut a slit about 1 cm away from the other end of the straw about halfway through from the top.
- Take a clean strand of hair and slip one end through the slit you just cut. Glue hair in place.
- Wrap the other end of the hair twice around a nail. Glue in place.
- Place wood in landscape orientation. Place straw on the wooden panel so it points to the right, about 5 cm below and parallel to the top of the wood. Align the left side of the straw with or near the left side of the wood. Check that the strand of hair is not wrapped around the straw but hangs down from it.
- Poke the second nail through the center of the straw, about 2 cm from the left side and secure to the wood.
- Gently move the straw up and down until the pointer moves snugly, but without friction around the nail.
- Take the nail with the hair strand attached and move it towards the lower right corner of the wooden panel until the hair is taut. Hammer the nail in the wood at that spot. The hair needs to be stretched taut when the straw is approximately horizontal.
- Calibrate your hydrometer by indicating two humidity extremes: dry air and very humid air. Dry the area around the hair gently with a hair dryer. Do not touch the pointer or blow it upwards.
- When the pointer stops moving, mark the pointer location on the wood. The hair dryer removed moisture from the air. Label the point you just marked "Dry."
- To place your hygrometer in humid conditions, enclose it in the plastic bag with a small wet (not dripping) sponge or towel. Close the bag tightly. Make sure there is room for the pointer to move inside the bag. Wait 10 minutes.
- Observe the bag and the hygrometer inside. After the 10 minutes are up, open the bag, mark the pointer location lightly, and reseal the bag. Wait another 10 minutes before repeating this step. Keep doing this until the pointer location stops changing. Clearly mark the final pointer location and label it "Very Humid."

Modified from https://www.sciencebuddies.org/stem-activities/humidity-meter-hygrometer