Sustainability Science Sleuths

Day 8

DiscoveryCube

This guide accompanies *Sustainability Science Sleuths Day 8*

PRIOR TO TEACHING

Subject

Air Quality

Program Length

45 minutes – 1 hour

Program Objective

The air is made up of tiny molecules and particles too small for us to usually see, but these experiments will help you see the quality, speed, and power of the air around you.

Next Generation Science Standards

4-ESS3-1: Obtain and combine information to describe that energy and fuels are derived from natural resources and their uses affect the environment.

4-PS3-1: Use evidence to construct an explanation relating the speed of an object to the energy of that object.

4-PS3-2: Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.

4-PS3-4: Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.

5-ESS2-1: Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact.

5-PS1-1: Develop a model to describe that matter is made of particles too small to be seen.

What I Need Today

FROM SCIENCE KIT:

Per Student:

- [ ] air quality experiments from last time
- [ ] graph paper
- [ ] string or ribbon (about 12" long)
- [ ] 2-4 sheets of paper towels

Per Group of 3-4 Students:

- [ ] magnifying glass
- [ ] tape
- [ ] foil (about 12" in length per student)
- [ ] 2-4 index cards
- [ ] wooden skewer
- [ ] 2-3 beads
- [ ] disposable straw
- [ ] 5-10 toothpicks

SUPPLIED BY TEACHER/STUDENTS:

- [ ] pen
- [ ] fan or outside wind
- [ ] ruler
- [ ] scissors

Vocabulary

Pollution – The collection of contamination in air, water, or on land. Trash, chemicals, and other harmful substances can all contribute to pollution.

Molecule – Two or more atoms joined tightly together.

Particles – Tiny bits of matter – in fact, the smallest possible unit of matter. Atoms are made up of particles.

Greenhouse Gases – Various gases in the atmosphere that trap heat, but let sunlight pass through.

Asthma – A condition that causes breathing problems, such as coughing, wheezing, or shortness of breath.

Naked Eye – Looking at something without the help of a magnifying device, such as a microscope or magnifying glass.

Air Quality Index – A way of measuring and reporting on how clean and clear the air is; developed by the United States Environmental Protection Agency.

Particulates – Dust and soot so small that it floats in the air.

Turbine – A machine that is powered by the motion of a fluid (usually air or water).

Convection Currents – When different parts of a fluid (a liquid or a gas) are different temperatures, we get convection – or the moving and mixing of the warmer and cooler parts. The molecules that make up warmer fluids have more energy and spread out more, becoming less dense and rising upward, while cooler fluids become denser and fall downward. In the air, this natural pattern of convection causes wind.

Hub – The part of a turbine that rotates and connects the blades to the main shaft (or body).

Blade – A relatively flat, spinning part used on some machines (such as a turbine) to push a fluid (such as air or water). Turbine blades are not sharp like the blade of a knife.

Load – A weight – adding a load to a machine can test how well the machine performs its job.

Instructor Prep

☐ Students will be finishing the air quality experiment they started last time.

PROCEDURE

What We'll Learn

The quality of the air around you is constantly changing based on the temperature, humidity, direction and strength of the wind, and location of nearby fires or factories. Wind farms use turbines to harness the power of the wind and give us electrical energy.

What Will Happen?

Scientists ask questions and make predictions before they start investigating. Have your students hypothesize: how few blades can I use to make my wind turbine generate energy?

- ○ 1
- ○ 2
- ○ 3
- ○ 4
- ○ 5+

What to Do

REVIEW - DAY 7: WATERSHEDS

It's important to keep the quality of the water in your local watershed healthy and clean, but water isn't the only thing that can be contaminated, or dirty. Today, you're going to learn about air quality and why clean air is just as important as clean water.

VIDEO - SUSTAINABLE ENERGY SONG

To start learning about air quality, first watch *Sustainable Energy Song*, a musical science video:
https://vimeo.com/497104672/c4b40ed20c

EXPERIMENT - THE AIR I BREATHE

1) Review what you learned at the end of last time and reflect on the video:

Air is in constant motion around the Earth, absorbing water from lakes, rivers, and oceans, and picking up pollutants. Pollution can come from sources that are either natural (forest fires, volcanic eruptions) or manmade (vehicles, factories). As the wind blows, it moves these water molecules and pollutants around, constantly changing the quality of our air. When there are a lot of tiny particles or greenhouse gasses (such as carbon dioxide and sulfur) in the air, it can make it difficult for us to breathe, especially for someone with asthma. This experiment will help you visualize the quality of the air you breathe.

2) Collect your experiments from last time.

3) To record your data, use another sheet of graph paper to make matching 10x10 square grids. Label each data collection grid with the location where your experiment took place.

4) Use a magnifying glass to help you examine each of the squares on your experiment grids. On the corresponding square of the data collection grid, record how many particles you see in each square of the experiment. Then count how many total particles you have in your experiment. The more particles you find, the worse the air quality. Was the air quality better inside or outside?

Tips & Tricks: If you don't have a magnifying glass, you can use your "naked eye" – just make sure you look closely to see if you can find any particles inside a square.

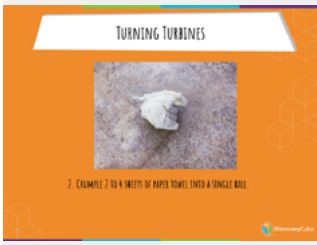
5) Visit https://www.airnow.gov/ to monitor the air quality around your home or school.

Fun Fact: Scientists check the quality of our air everyday using the Air Quality Index. When it is hot and sunny, pollutants can often get trapped close to the surface of the Earth. When there's a fire, the ash and carbon dioxide released from trees mix into the air we breathe. Wind and rain can both improve our air quality by helping particulates settle onto the ground (rain) or moving bad gases and tiny particulates higher into the air or further away from us (wind). And, when it is really windy, we can harness the power of the wind to give us clean, renewable energy that doesn't contribute to harmful greenhouse gasses.

EXPERIMENT - TURNING TURBINES: THE POWER OF THE WIND

1) To make a wind turbine, give each student 2-4 sheets of paper towel, about a 12" sheet of foil, 2-4 index cards, 5-10 toothpicks, tape, a skewer, a disposable straw, 2-3 beads, and about 12" of string.

Fun Fact: On Earth, air pressure and temperatures are mostly changed by convection currents. As the moving warm and cold air constantly circulate, wind is formed. We can capture the energy of the wind – and turn it into electricity – using a wind turbine.



2) Crumple 2 to 4 sheets of paper towel into a single ball.

3) Wrap foil around the ball to keep it together. To create the "hub" of the turbine (which will hold all the parts of your turbine together), shape one side of the ball into a pointed end. The pointed end will be the front, or face, of your turbine.

Tips & Tricks: If the face of the hub is too flat, the wind will press on the hub and the blades will not rotate.

4) How many blades do you want your turbine to have? Use index cards or thicker paper to cut blades for your turbine.

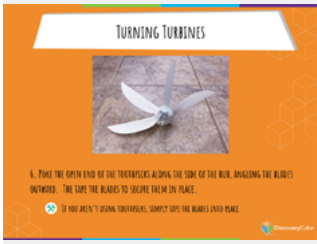
Fun Fact: Like the wing on an airplane, wind turbine blades are usually curved in order to generate the most electricity. Most wind turbines in use today have 3 blades because scientists and engineers have determined this is the best number to maximize energy yield while keeping the turbine balanced. But, historically, windmills often had 4 more blades.

5) Test your hub to make sure a toothpick will easily poke through it. If it does, place a toothpick so about ½ of it is over the blade and ½ of it is poking over a short end of the blade. Use tape to secure the toothpick in place. Repeat for all remaining blades.

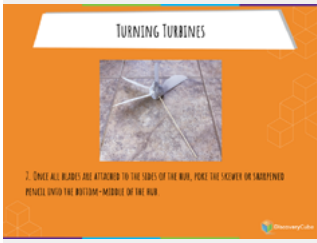
Tips & Tricks: If a toothpick does not easily poke through your hub, skip this step.

6) Poke the open end of the toothpicks along the side of the hub, angling the blades outward. Then tape the blades to secure them in place.

Tips & Tricks: If you aren't using toothpicks, simply tape the blades into place.

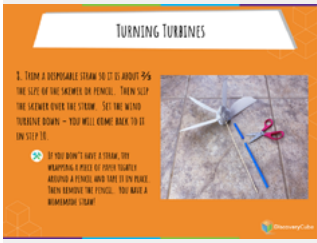


7) Once all blades are attached to the sides of the hub, poke the skewer or sharpened pencil into the bottom-middle of the hub.



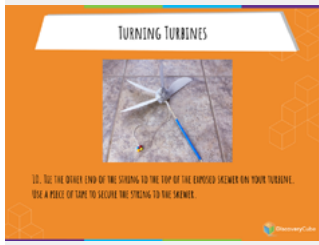
8) Trim a disposable straw so it is about ⍰ the size of the skewer or pencil. Then slip the skewer over the straw. Set the wind turbine down – you will come back to it in step 10.

Tips & Tricks: If you don't have a straw, try wrapping a piece of paper tightly around a pencil and tape it in place. Then remove the pencil. You have a homemade straw!



9) Tie some small weights, such as washers or beads, to the end of a string (about 12 inches long).

Fun Fact: Called a "load", this weighted string will help you see how well your turbine is working.



10) Tie the other end of the string to the top of the exposed skewer on your turbine. Use a piece of tape to secure the string to the skewer.

11) Holding the straw, place the turbine in front of a fan for consistent air flow. Be careful not to pinch the straw to the skewer so the hub, blades, and skewer can rotate together.

Tips & Tricks: If you don't have a fan, try doing this outside on a windy day, or take a couple big breaths and try blowing on it yourself. To see the direction and speed of the wind near you right now, visit https://www.windfinder.com/.

12) Watch your turbine rotate! If it's not rotating as well as you would like, think like an engineer: try experimenting with different blade shapes, blade angles, number of blades, and weight of your load.

Fun Fact: Energy is the ability to do work. If your turbine is working well, it will generate energy and pull the load all the way up to the skewer.

CONCLUSION

What I Discovered

To earn a portion of the Power Up badge, have your students use their journals to help them reflect on what they discovered. We would love to see pictures of their air quality experiments or their wind turbines. Please email pictures to educationemail@discoverycube.org.

Supplies for Next Time

FROM SCIENCE KIT:

Per Student:

- ☐ 1.5 volt light bulb
- ☐ AA battery
- ☐ foil (about a 6" length)
- ☐ Graham Crackers
- ☐ large marshmallow

Per Group of 3-4 Students:

- ☐ foil
- ☐ 8"x8" small aluminum baking dish
- ☐ masking tape
- ☐ black construction paper (3-4 sheets)
- ☐ chocolate bar
- ☐ plastic cling wrap

SUPPLIED BY TEACHER/STUDENTS:

- ☐ cardboard box – 1 per group
- ☐ ruler or stick – 1 per group
- ☐ scissors
- ☐ a sunny day
- ☐ hot mitt/pot holder (optional)
- ☐ box cutter (optional)

☐ **next time, your groups of students will be making solar ovens. Encourage the groups of students to bring a cardboard box with a lid (such as a pizza box or shoe box), but any medium sized cardboard box will work.