

Design and Build an Particulate Matter Collector

Grade Level: 3-5

In this lesson, students explore the topic of air pollution by designing and constructing a model particulate matter collector.

Cross-cutting Concepts

Scale, proportion, and quantity

- Natural objects and/or observable phenomena exist from the very small to the immensely large or from very short to very long time periods.

Structure and Function

- Different materials have different substructures, which can sometimes be observed.

Disciplinary Core Ideas

Earth and human activity

- **ESS3.C:** Human activities in agriculture, industry and everyday life have had major effects on the land, vegetation, streams, ocean, air and even outer space. But individuals and communities are doing things to help protect Earth's resources and environments.
- **PS1.A:** Matter of any type can be subdivided into particles that are too small to see, but even then the matter still exists and can be detected by other means. A model showing that gases are made from matter particles that are too small to see and are moving freely around in space can explain many observations, including the inflation and shape of a balloon and the effects of air on larger particles and objects.

Science and Engineering Practices

Asking questions and defining problems

- Define a simple design problem that can be solved through the development of an object, tool, process, or system and includes criteria for success and constraints on materials, time, or cost.

Developing and using models

- Develop a diagram or simple physical prototype to convey a proposed object, tool, or process.

Constructing explanations and designing solutions

- Apply scientific ideas to solve design problems.

Obtaining, evaluating, and communicating information

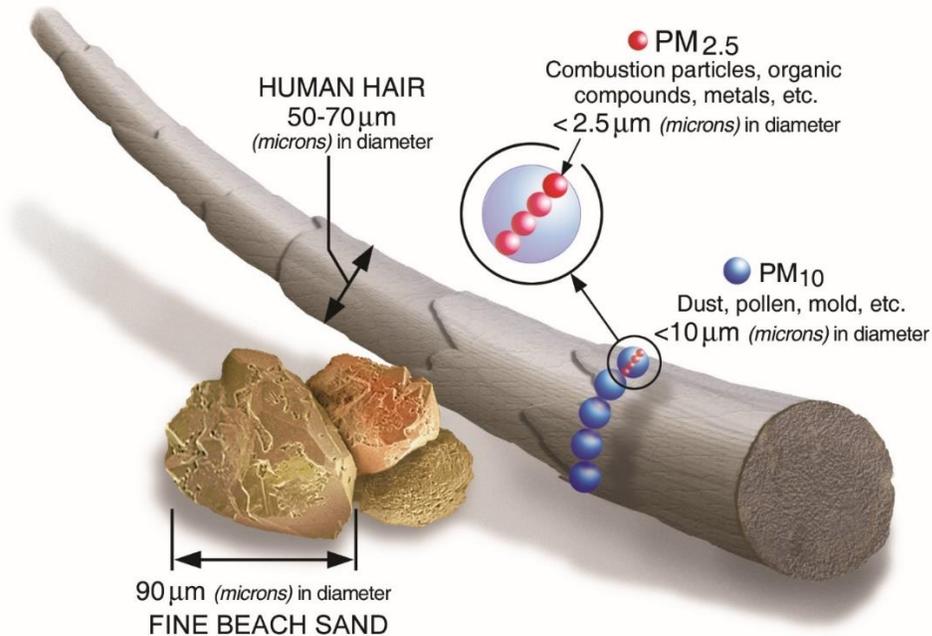
- Obtain and combine information from books and/or other reliable media to explain phenomena or solutions to a design problem.
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Opening questions:

- What is particulate matter?
- Where does it come from?
- How does it affect human health?

Background

Particulate matter is a type of air pollution that can be created by natural processes and human activities. The most harmful particulate matter is composed of extremely small particles, liquid droplets, or aerosols measuring less than 2.5 microns in diameter. This type of pollution is often called “PM_{2.5}” (pronounced “PM two point five”). The illustration below compares the relative size of particulate matter to beach sand and human hair.



Natural sources of particulate matter include:

- Volcanic eruptions
- Forest fires
- Dust storms

Human sources of particulate matter include:

- Combustion of fossil fuels
- Burning trash
- Cigarette smoking

Particulate matter is harmful to human health because it can be inhaled deep into lungs, where it can cause damage to lung tissue and may even cross into the bloodstream. Particulate matter affects all people, but certain groups are especially vulnerable to its health effects including:

- Children
- Elderly
- People with lung problems such as asthma, emphysema, and COPD
- People with heart problems

Because it is so small, particulate matter is invisible to the unaided eye. How do we know if particulate matter is in the air?

Students Generate Questions

Students should spend some time generating questions that will help them design a particulate matter collector. Examples of questions could include:

- How do I catch particulate matter?
- Should I design an active or passive collector?
 - o An active collector is one that uses a pump to actively pull air through it, while a passive collector relies only on natural air currents to carry pollutants onto or through it.
- How could I get air to move through my collector (if active)?
- Is my collector a prototype model or a working collector?
- Where would I place my collector?
- How will I measure what I collect?

Students Design Solutions

Thinking of the questions they generated, students should brainstorm ideas for designing a collector for particulate matter. Students should sketch one or more ideas for their design.

Students Construct Collectors

Students must now turn their chosen design into either a prototype model or a real working collector, using simple materials found around the house. Materials can include:

- Various kinds of filter materials (coffee filters, white knee-hi stockings, tissue, scrubber sponges, cotton balls)
- Paper or plastic plates & cups
- Tape, glue
- Various kinds of clips
- Soda straws
- Chenille stems
- Brass fasteners
- Cardstock, index cards, small boxes
- Construction paper
- Plastic bottles (1- and 2-liter)
- Vaseline
- Scissors

Share-a-thon

- Students write a description of their model, highlighting how it works and how they would measure the results. How would they answer the questions they generated?
- Video option: Students record a short video describing their completed model and how it works.

Explore More

How does a real particulate matter collector work? Students can research this question and explore how and where their state air quality agency monitors particulate matter and other pollutants. "[How Clean is Our Air?](#)" is a story map for students that explores how the Kentucky Division for Air Quality monitors air pollution across the state.

Resources

<https://landairwater.me/2017/05/26/students-design-air-quality-solutions/> Read an article about this activity and how it was used with a Frankfort homeschool group.

<https://eec.ky.gov/Environmental-Protection/Air/Air-Monitoring/Pages/default.aspx> -- This website describes how and where the Kentucky Division for Air Quality monitors for various pollutants across the Commonwealth.

<https://www.epa.gov/sites/production/files/2015-08/documents/peg.pdf> -- The U.S. Environmental Protection Agency's *Plain English Guide to the Clean Air Act* offers a good introduction to how air pollution is regulated to protect public health and the environment.

<https://eec.ky.gov/Environmental-Protection/Air/Pages/Division-Reports.aspx> -- The Division for Air Quality annual reports contain real air monitoring data from Kentucky's air monitoring network.

<https://www.airnow.gov/education/teachers/> EPA's teacher resource site has links to curriculum resources and presentations about air quality and climate change.

Contact the Division for Air Quality for more information or to schedule a classroom visit to your school.

Roberta Burnes
Kentucky Division for Air Quality
300 Sower Blvd.
Frankfort, KY 40601
502-782-6571
roberta.burnes@ky.gov