



INVESTIGATING AIR POLLUTION

MEASURING AND ANALYZING AIRBORNE PARTICULATES

Student Investigation

In this lesson, students will investigate particulate matter in the air by constructing a particulate matter catcher to collect airborne particles from their local environment. Using magnifying glasses, students will observe and count the particles captured on their catchers, then organize and graph their data to examine the types and amounts of particulate matter present in the air around them.

As they analyze their results, students will compare particulate matter levels from different locations or conditions and consider how human activities and environmental factors influence air quality. They will interpret their findings to better understand the sources and impacts of airborne particulates on human health and the environment. Through this investigation, students will build skills in scientific observation, data collection, graphing, and data interpretation while gaining insight into the importance of monitoring air quality in their communities.



NGSS STANDARDS

MS-ESS3-3 – Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.

MS-ESS3-4 – Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.

HS-ESS3-1 – Construct an explanation based on evidence for how natural resources, hazards, and climate have influenced human activity.

This activity incorporates Science and Engineering Practices (SEPs) through data collection, analysis, graphing, evidence-based reasoning, and designing future investigations.

AP Environmental Science Topics

- 7.1 Introduction to Air Pollution
- 7.2 Photochemical Smog
- 7.3 Thermal Inversions
- 8.1 Sources of Pollution
- 8.3 Human Impacts on Ecosystems

Educator Instructions: Leading the Investigation

Introduction

At Headwaters Science Institute, students don't just learn about science, they become scientists. Through student-driven research, students make observations, ask questions, collect evidence, and use data to better understand the world around them. This investigation is designed to help students experience the scientific process firsthand while exploring an environmental issue that affects every community: air quality.

Students will begin by considering the driving question and using it to guide their investigation. After reading background information about particulate matter, they will select a location in their local environment where they can collect data. Their decisions about where to sample, along with the evidence they gather, will help them develop an evidence-based answer to the driving question.

Teacher Tips: Encourage students to choose different safe sampling locations around the school campus based on where they think particulate matter may vary (e.g., near parking lots, playgrounds, gardens, or other locations that may be affected by nearby traffic). After collecting their particulate catchers, have students combine and share their data with another group to create a larger, shared data set. Comparing results from multiple locations helps students identify patterns, evaluate possible sources of particulate matter, and develop stronger, evidence-based conclusions about air quality.

- After 24 hours, students will retrieve their particulate catchers and analyze what they have collected.
- As they compare observations and look for patterns, encourage them to revisit the driving question throughout the investigation.
- Students should use their data to support their claims, consider alternative explanations, and discuss how their findings relate to air quality in their community.
- Remind students that scientific investigations often lead to new questions, and that using evidence to explain their thinking is just as important as finding an answer.

Materials

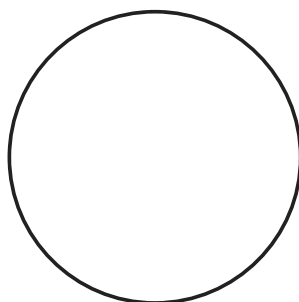
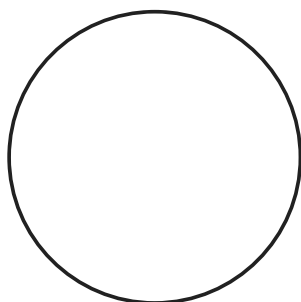
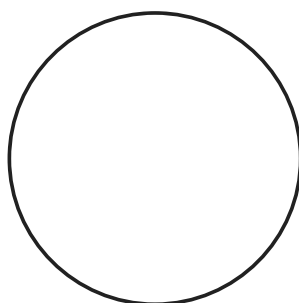
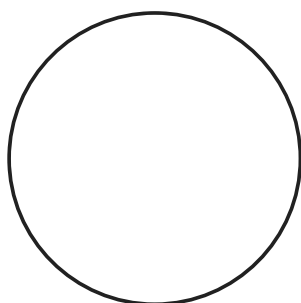
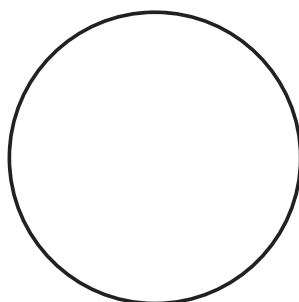
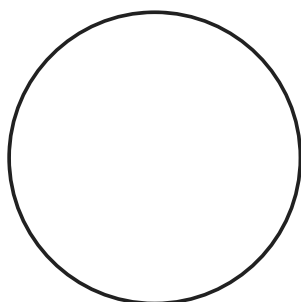
Educator preparation:

- Particulate catcher cards (next sheet)
 - *These work best printed on card stock for durability.*
 - *You may also laminate for reuse. Make sure to clean thoroughly after use by wiping off the petroleum jelly and use a small amount 70% isopropyl alcohol to clean. They can get wet but not submerged.*
 - *Cut out the cards (5 per group)*
 - *Punch a hole near the top of the card and attach a string or rubber band through the hole for hanging.*

Student supplies:

- Cotton Swabs
- Petroleum jelly
- Magnifying Glasses for Analysis
 - *Microscopes can be used, but will require more time for students to count*





Air Pollution: Causes, Impacts, and the Science Behind Monitoring Air Quality

Air pollution occurs when harmful substances enter the atmosphere from sources such as fossil fuels, transportation, industry, and wildfires. Particulate matter, made of tiny particles and droplets in the air, is a key pollutant scientists measure to understand air quality. By monitoring pollution levels, scientists study how air pollution affects human health, ecosystems, and the environment.



SOURCES AND CAUSES OF AIR POLLUTION

Air pollution occurs when harmful substances enter the atmosphere from human activities and natural sources. Major causes include burning fossil fuels, industrial processes, agriculture, wildfires, and dust. These activities release pollutants such as particulate matter, nitrogen oxides, sulfur dioxide, and chemicals that can react in the atmosphere to create additional pollutants like ozone and fine particles. Air pollution can harm human health, ecosystems, and climate by reducing air quality and exposing living things to harmful substances.



LASTING IMPACTS

Air pollution can have long-term effects on both human health and the environment. In humans, prolonged exposure to pollutants such as fine particulate matter, ozone, and toxic chemicals can increase the risk of respiratory diseases, heart problems, and other health issues. In the environment, air pollution can damage ecosystems, reduce biodiversity, contribute to acid rain, and affect climate patterns. Pollutants can also build up in the atmosphere and natural systems, creating lasting impacts that can continue even after emissions are reduced. Reducing air pollution through cleaner energy, improved technology, and sustainable practices can help protect human health and the environment.



PARTICULATE MATTER (PM)

Particulate matter (PM) is a mixture of tiny solid particles and liquid droplets suspended in the air. These particles can come from sources such as vehicle exhaust, wildfires, construction, industrial emissions, and natural processes like dust storms. Scientists measure particulate matter, especially fine particles, to evaluate air quality because these particles can affect human health and the environment. Air quality monitoring stations use instruments to measure the amount of particulate matter in the air, and this data is used to calculate air quality levels, identify pollution sources, and inform communities about potential health risks.



Student Investigation

In this investigation, you will collect and analyze real-world air quality data by creating particulate matter catchers and placing them in different environments. You will observe how many airborne particles are collected and compare results from different locations. Using your data, you will investigate patterns in particulate matter levels, explore how human activities and environmental conditions influence air quality, and better understand how scientists monitor pollution and its impacts on human health and the environment.

Create Particulate Catchers:

- 1. Apply a thin, even layer of petroleum jelly to the circles on the catchers to help capture airborne particles.
- 2. Select at least five different locations for testing and place one particulate catcher at each site.
- 3. Record the location and environmental conditions for each site in the chart below.
- 6. Leave the particulate catchers in place for 24 hours.
- 7. After 24 hours, retrieve each particulate catcher and prepare your samples for observation and data collection.

Location # and test site description	Environmental conditions (ex: cars present, near an air conditioner unit, etc.)

How does exposure to different environmental conditions affect the accumulation of particulate matter in the air?

Hypothesis:

The best scientific investigations often lead to new questions. Based on the reading, what is another question you could ask or investigate about particulate matter?



Student Investigation

Data Analysis

Retrieve your particulate matter samples and carefully count the number of particles collected from each study site. Record your results in the provided data chart to organize and compare your findings.

Location #	Tally the number of Particulates captured

Collect data from another group's particulate matter study and record their results in the provided data chart. Be sure to note their study site, particle counts, and environmental conditions so you can compare findings across different locations.

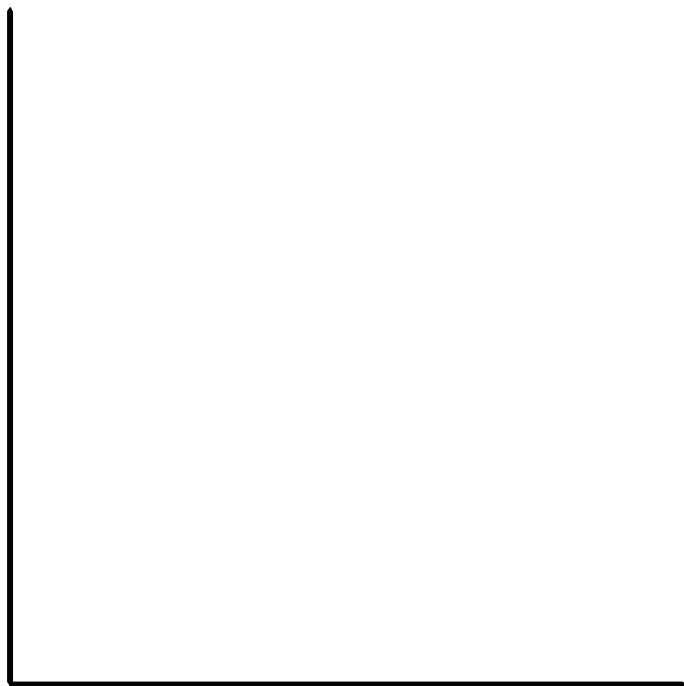
Location and total particulates	Environmental Conditions



Student Investigation

Data Analysis

Create a graph that includes your group's data and another group's results. Combine data from the same sites by labeling them as a range (for example, Site 6–10). Label the study site on the x-axis, particulate count on the y-axis, and include a clear title.



Use your graph and hypothesis to write a conclusion.

What patterns do you see in the particulate matter counts, and how do they support or challenge your hypothesis?

How did different environmental conditions influence the number of particulates captured?

A new power plant is being built in your local community, and scientists are studying how it could affect air quality. Predict how this power plant could influence particulate matter levels in nearby areas.

What potential impacts could changes in particulate matter levels from this new power plant have on the long-term health of people living in the surrounding community?

What future investigations could scientists conduct to better understand how human activities and environmental factors influence particulate matter levels in different environments?