Air Pollution: Particulates Matter![1]

Course Most Applicable: Environmental Science, Environmental Studies

Timing: 2+ Days (1 day introduction and set-up, 10 minute weather data collection for 3 consistent days, 1 day lab and analysis)

GLOBE CAP Framework Connection: Students will continue to collect, interpret, and create visualizations of data but also explore the links to public policy and apply their knowledge and skill in a service learning project or social enterprise.

California AP Environmental Science Content Area: Pollution: Pollution Types: Air Pollution Sources — primary and secondary; major air pollutants; measurement units; smog; acid deposition — causes and effects; heat islands and temperature inversions; indoor air pollution; remediation and reduction strategies; Clean Air Act and other relevant laws

NGSS Connection:
HS-ESS3-4: Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.

> **Science and Engineering Practices: Constructing Explanations and Designing Solution**
> Design or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-ESS3-4)
>
> **Disciplinary Core Ideas: Human Impacts on Earth Systems**
> Scientists and engineers can make major contributions by developing technologies that produce less pollution and waste and that preclude ecosystem degradation. (HS-ESS3-4)
>
> **Crosscutting Concepts: Stability and Change**
> Feedback (negative or positive) can stabilize or destabilize a system. (HS-ESS3-4)

Student Learning Outcomes:

- ✓ Successfully perform the GLOBE protocols for Wind direction & Speed, Max and Min Temperature, Precipitation, Relative Humidity, Cloud Cover & Percentage
- ✓ Be able to use Claim, Evidence and Reasoning (CER) to analyze particulate data and source(s)
- ✓ Know how to identify at least one particulate source and propose a remediation or mitigation measure associated with that pollutant source.

21st Century Skills:

- ✓ Collaboration
- ✓ Critical Thinking

[1] The procedures for this learning activity was adapted, in part, from Something's in the Air (SITA), a UC Berkeley Graduate Student Project.

This material is based upon work supported by the **National Science Foundation** under Grant No. 1139664

✓ Content Knowledge

Introduction: What are *particulates*? Where do particulates come from? What kinds of particulates are found in the air? What do they look like under magnification? Are particulates harmful to breathe? How do they impact human lungs? How can we capture particles in an area and analyze them? Particulates, or very small particles, become suspended in the air after release into the environment from various sources. Diesel buses and gasoline-powered vehicles emit exhaust gases that often contain heavy amounts of particulates. Trees, shrubs, grasses and other plants release pollen into the air. Dust and pollen are also particulates. Pollen grains can float for miles and cause many people to have difficulty breathing. Molds and fungi also can become airborne in the form of smaller particulates.

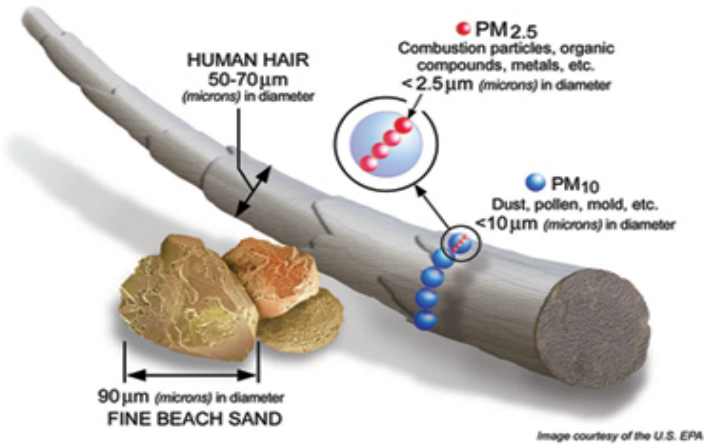
Background[2]: "Particulate matter," also known as particle pollution or PM, is a complex mixture of extremely small particles and liquid droplets. PM is the term for a mixture of solid particles and liquid droplets found in the air. Particle pollution is made up of a number of components, including acids (such as nitrates and sulfates), organic chemicals, metals, and soil or dust particles.

The size of particles is directly linked to their potential for causing health problems. EPA is concerned about particles that are 10 micrometers in diameter or smaller because those are the particles that generally pass through the throat and nose and enter the lungs. Once inhaled, these particles can affect the heart and lungs and cause serious health effects. EPA groups particle pollution into two categories:

- "*Inhalable coarse particles*," such as those found near roadways and dusty industries, are larger than 2.5 micrometers and smaller than 10 micrometers in diameter.
- "*Fine particles*," such as those found in smoke and haze, are 2.5 micrometers in diameter and smaller. These particles can be directly emitted from sources such as forest fires, or they can form when gases emitted from power plants, industries and automobiles react in the air.

How Big is a Particle Pollutant?

Some particles, such as dust, dirt, soot, or smoke, are large or dark enough to be seen with the naked eye. Others are so small they can only be detected using an electron microscope. Particle pollution includes "inhalable coarse particles," with diameters larger than 2.5 micrometers and smaller than 10 micrometers and "fine particles," with diameters that are 2.5 micrometers and smaller. How small is 2.5 micrometers? Think about a single hair from your head. The average human hair is about 70 micrometers in diameter – making it 30 times larger than the largest fine particle.



Particles come in many sizes and shapes and can be made up of hundreds of different chemicals. Some particles, known as primary particles are emitted directly from a source, such as construction sites, unpaved roads, fields, smokestacks or fires. Others

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form in complicated reactions in the atmosphere of chemicals such as sulfur dioxides and nitrogen oxides that are emitted from power plants, industries and automobiles. These particles, known as secondary particles, make up most of the fine particle pollution in the country

Anticipatory Set: Review Globe Protocols: Wind direction & Speed, Max and Min Temperature, Precipitation, Relative Humidity, Cloud Cover & Percentage. Review CER and its application to this learning activity.

Procedure: In Pairs

Day 1:

1. Obtain a Student Worksheet. Find the outdoor location in which you would like to hang your monitoring card. Measure the length of string necessary to suspend the card.
2. Back in the classroom, measure and cut a length of string.
3. Obtain one colored and one white index card.
4. Cut out a large square in the middle of the colored index card. (Refer to Student Worksheet for diagram).
5. Hole punch the center of the card and attach the length of string.
6. On the front of the card, write your name, location, and dates of exposure.
7. Cut strips of clear wide packing tape and place them on the card, so that the sticky side of the tape will show from the front of the card. Try not to touch the exposed sticky area.
8. Place your card in the location you identified earlier. Make sure that the card is hanging freely.

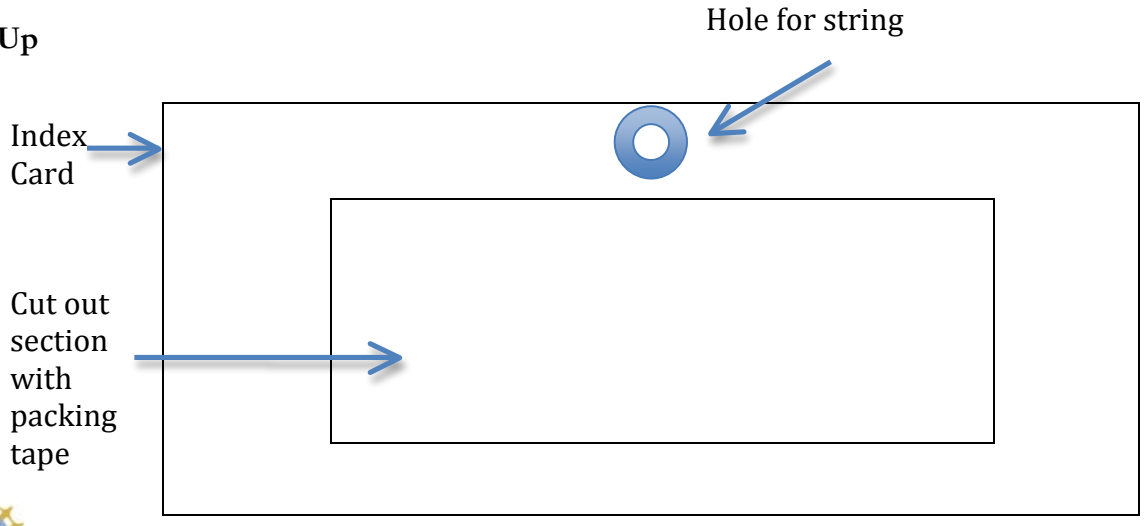
Days 3/4/5 (10 minutes per day):

9. Each day the card is exposed, obtain and record the wind speed and direction, temperature, relative humidity, cloud cover and any precipitation for the day. Use the GLOBE protocols to collect these data.

Last Day:

10. After three days, collect the cards and return them to the classroom for analysis.
11. Place a white index card behind the colored one to help see any particulates that may have been trapped by the tape.
12. Use a hand lens or microscope to evaluate the particulates that are present, determining the approximate size and amount on the card.
13. Sketch your results on the Student Worksheet and answer the analysis questions.

Card Set-Up



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Weather Conditions Summary (use GLOBE PROTOCOLS):

Weather Conditions	Initial Day	Day 2	Day 3
Wind Speed (km/hr) & Direction	**Speed:** **Direction:**	**Speed:** **Direction:**	**Speed:** **Direction:**
Temperature: Max & Min (°C)	**Max:** **Min:**	**Max:** **Min:**	**Max:** **Min:**
Precipitation (centimeters)			
Relative Humidity (%)	**%**	**%**	**%**
Cloud Cover % & Cloud Type	**%** **Type:**	**%** **Type:**	**%** **Type:**

Analysis:

Claim: How many particulates do you *think* are on your card? How many different sources of particulates do you *think* there will be? Identify the *sources of particulates* that you *think* will be present on the card, based on the relative location and weather conditions of the last 3 days.

Evidence:

1. Approximately what percentage of the exposed area had particulates on it? What percent of PM 2.5mm compared to PM 10mm do you see? Why do you think the percentages are this way?

2. What affected the ability of the tape to trap particulates? Explain why some particulates may not have been trapped.

3. Describe at least three types of particulates observed on the cards.

Reasoning: Based on your description of the particulates observed on the cards, isolate at least 3 particulates that you can identify. Now determine the probable source for each of these particulates. Keep in mind that particulates can travel for miles.

Action: Choose one particulate source and propose a remediation measure to eliminate or lessen this particulate in the atmosphere. And chose one particulate source and propose a mitigation measure to offset this pollutant in the atmosphere.

Self-Reflection:

1. If you were to repeat this experiment every season, describe 3 factors that would affect your results and explain why each of these 3 factors would affect your results.

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2. In your own words, explain the meaning of the term: "Particulates Matter!"

Particulates Matter

Name_____ **Date**_____

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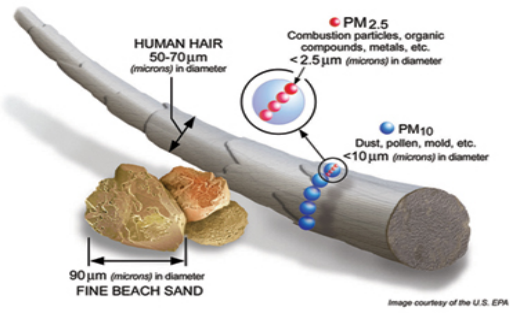

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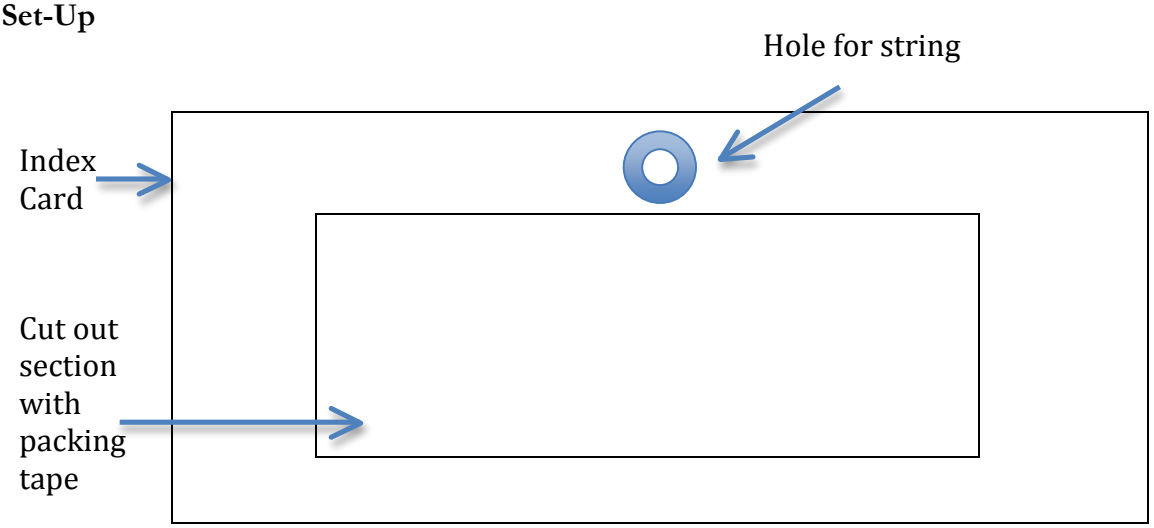

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