The Village Green Project

Lesson Plans for K-8 Educators

United States Environmental Protection Agency

Whitney Richardson, M.Ed.
reinert.whitney@epa.gov

Gayle Hagler, Ph.D.
hagler.gayle@epa.gov

The EPA has developed an exciting way to talk about air pollution with the public – the Village Green Project (VGP). This project is a solar-powered park bench (that yes, you can sit on), which has instruments built in that measures air quality and weather, and uploads the data to the internet every minute. Multiple park benches have been located in different cities in the United States, to test the technology and collect useful data. The best part? You can use that information to understand the science of air quality and weather – even if your nearest city does not have one of these science benches, you can access the data for all the locations on the project website (www.airnow.gov/villagegreen) to explore how air quality and weather changes from place to place.

The VGP Lessons for Educators provide a unique opportunity for students to learn about air quality as it relates to various topics of science appropriate to their grade level. The purpose of these lessons is to engage students of varying ability levels through hands-on and minds-on thinking. Each lesson is designed to focus around the topic of air quality; from issues of human health to career and 21st century skills.

Each VGP Lesson for Educators is intended to be learner-centered, using the levels of Bloom's Revised Taxonomy to foster instruction backed by research based methods, and differentiated for multiple ability levels. Teachers may use all of an individual lesson at once, or only use pieces they feel are appropriate at that time to break the learning objectives up into several days worth of material. Each lesson follows the United States Next Generation Science Standards for the designated grade level, but also incorporates real data and historical events in order to provide opportunities for cross curricular instruction.

The lessons in this guide are reproduceable and were created by the United States Environmental Protection Agency as a free educational tool for teachers.

Please contact Whitney Richardson (reinert.whitney@epa.gov) or Gayle Hagler (hagler.gayle@epa.gov) for any inquiries on the lesson plans.

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Lesson Plans for Teachers: Season's Greetings! (Kindergarten)

Teacher Notes:

This lesson has been designed by the United States Environmental Protection Agency (EPA) as a teaching aid on the topic of weather. The content follows Next Generation Science Standards (NGSS), and is designed to engage learners throughout the levels of Bloom's Taxonomy. Each section of the lesson is written in kid-friendly language and can be modified for differentiated instruction. This lesson discusses the four seasons and weather patterns that correspond to seasons; and is in alignment with NGSS Standard K.ESS2.D. This activity is designed to increase student awareness of the seasons, as well as encourage literacy skills through story writing. Since this is a lesson designed for kindergarten students, some children may need assistance with writing and reading, and explanations of unfamiliar words might be necessary. The Apply and Analyze section may be done as a whole group, small groups, or individually.

For story writing, assist students as necessary. Kindergarten standards encourage sentence writing, but depending on the time of school year, this could present a challenge. Stories can be told by students and transcribed by teachers if necessary.

Materials Needed: Weather shape cut outs (see attached), copies of (or a single class copy of) seasons chart.

Vocabulary:

Weather: What it's like outside. Examples: hot, cold, rainy, windy, snowy, etc.

Scientist: Someone who studies science.

Temperature: How hot or cold it is outside.

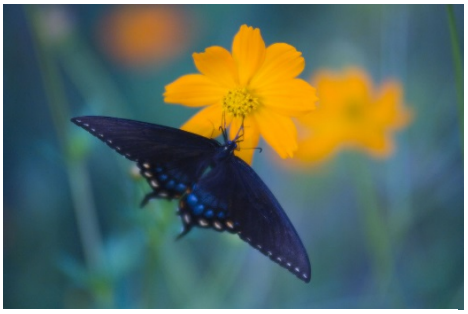
Introduction:

Weather is happening all the time. Weather happens when we're sleeping at night, when we're at school during the day, and when we're playing at home. No matter where you go on Earth, there is weather. Sometimes it's hot outside. Other times it's very cold! Sometimes it's raining or snowing; other times we might need a hat and sunblock to be safe outside. There are a lot of things that shape our weather, and some **scientists** even study weather as their job. Did you know there are special park benches across the country that measure how hot or how cold it is outside? These park benches are part of the Village Green Project and made by scientists! This special bench is one that people can sit on to relax, but also gives them information about the weather, including the **temperature**.

Turtles playing on a log on an autumn day. Photo Credit: Eric Vance, US EPA

Objectives: By the end of this lesson, you will be able to...

- Answer the question, "What is a pattern?"
- Discuss weather patterns.
- Create a weather story



Beautiful butterflies enjoy the spring! Photo Credit: Eric Vance, US EPA

Did You Know?

Our weather is shown in patterns that we call seasons. There are four seasons: spring, summer, autumn, and winter. Today, we know that weather follows a pattern of very cold weather in the beginning of the year to hot weather in the middle, and then cooler weather at the end! We have observed this pattern for a very long time.

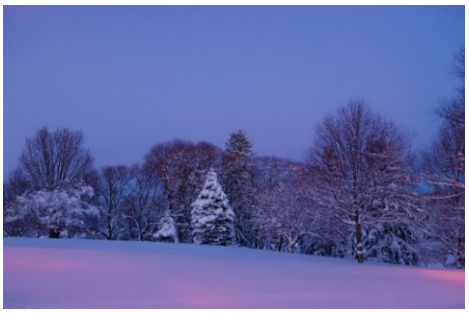
Keeping cool on a hot, summer day. Photo Credit: Eric Vance, US EPA

A) Recall

1) When does weather happen?
2) Is there weather everywhere on Earth or just where we are?
3) What are the four seasons?

B) Understand

4) What is the weather like today?
5) What was the weather like yesterday? Was it the same or different as today's weather?
6) What is a pattern? Is today's weather part of a pattern?



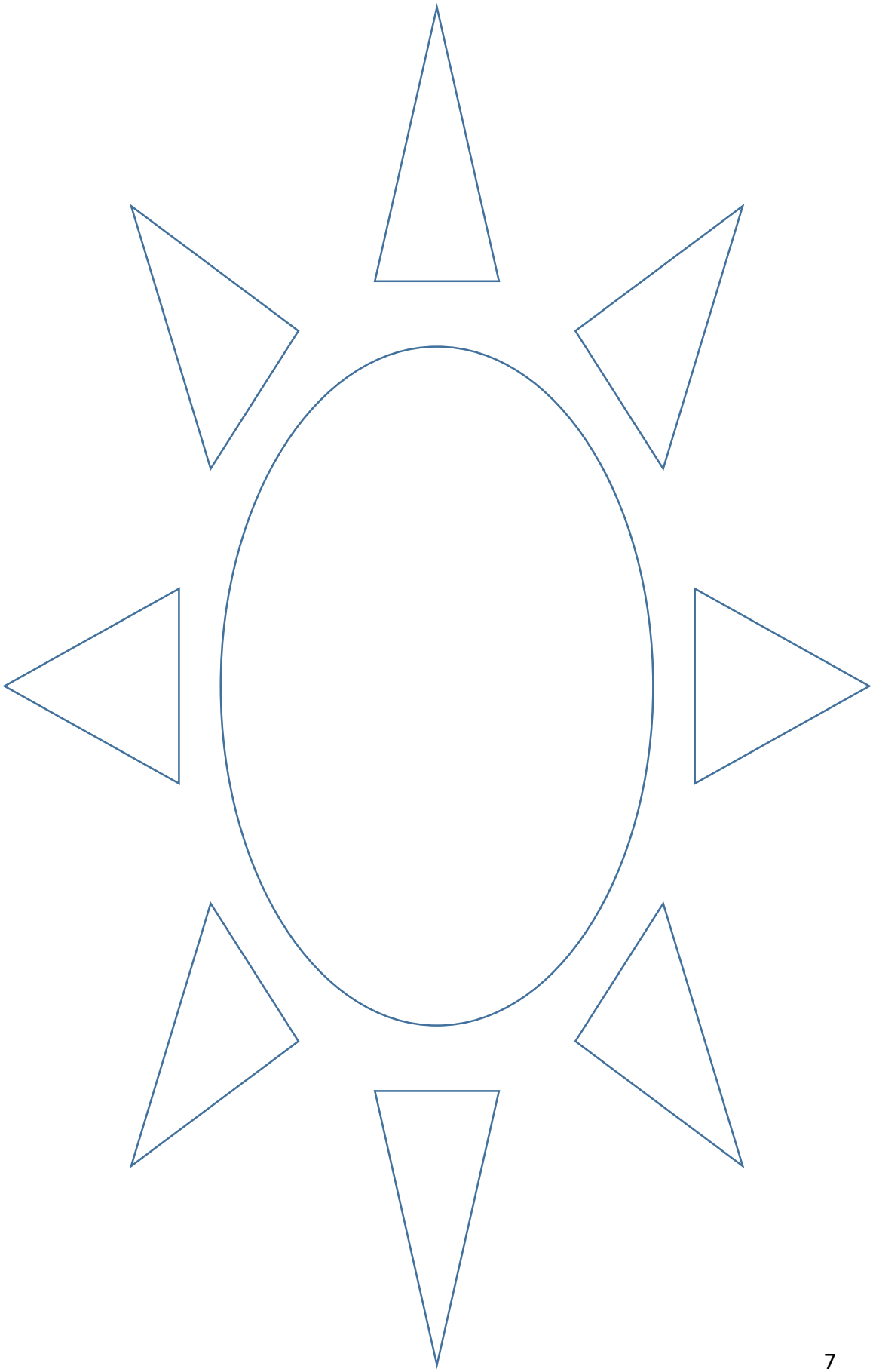
A snowy evening in winter. Photo Credit: Eric Vance, US EPA

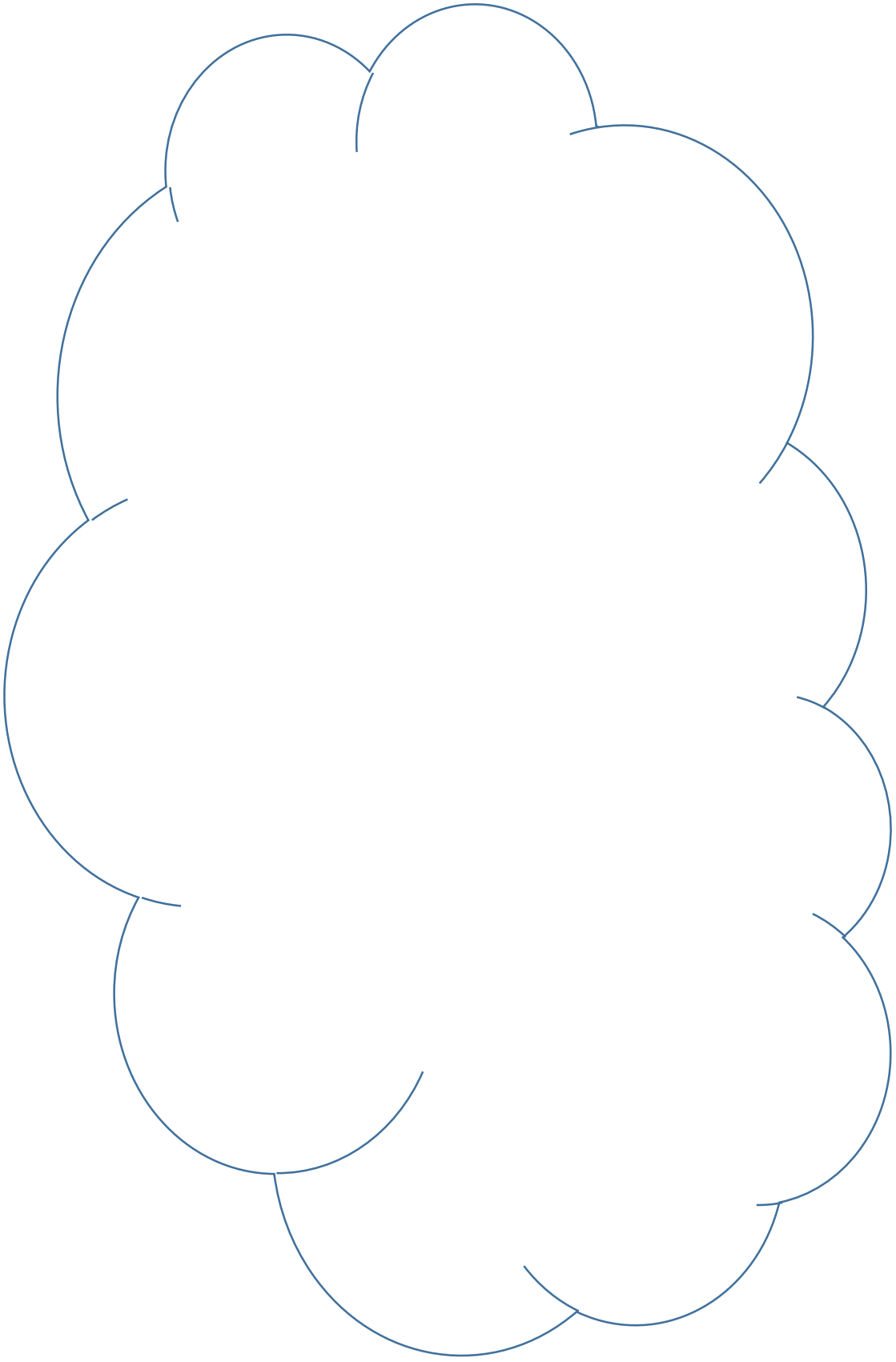
C) Apply & Analyze

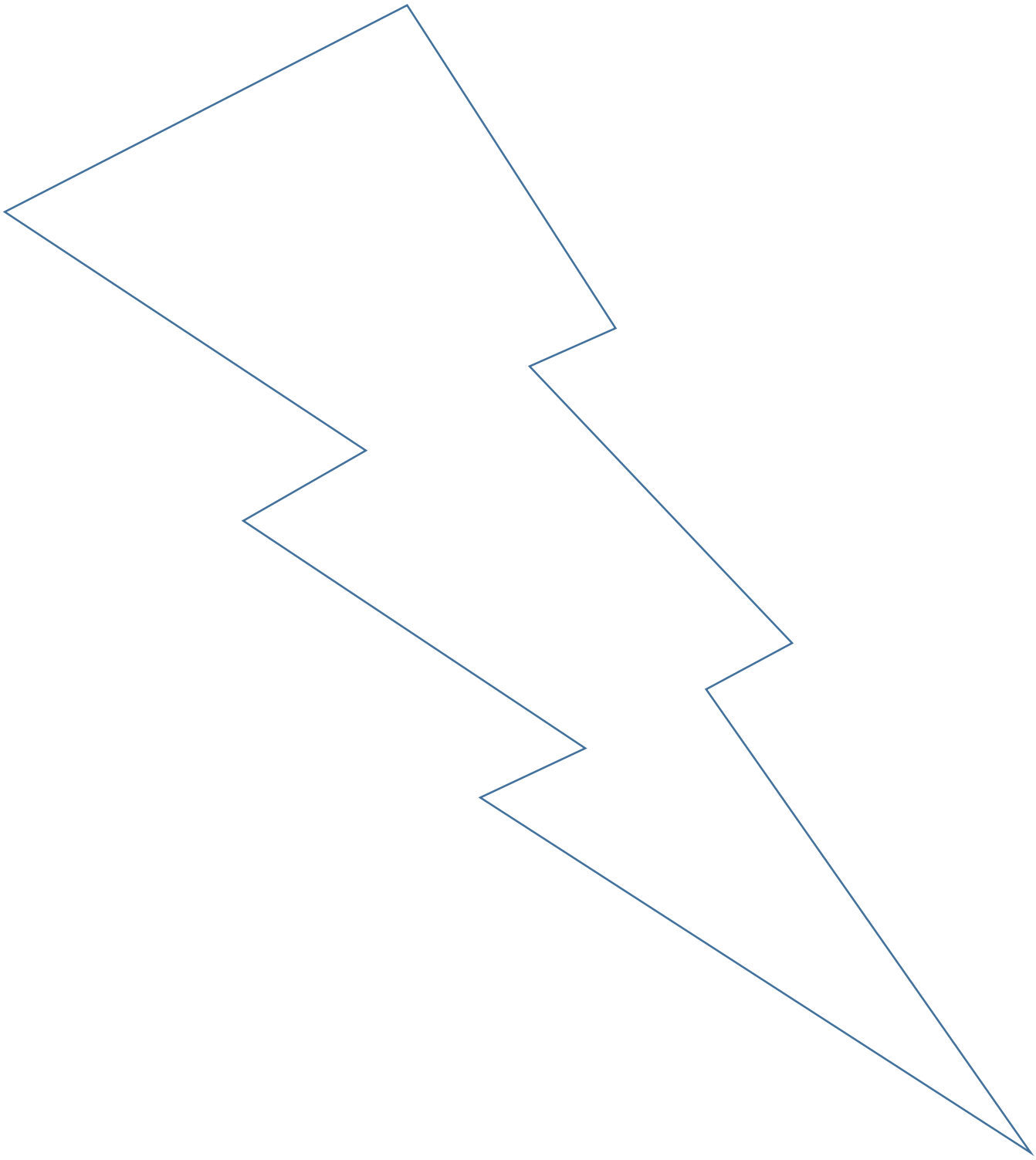
January	February	March
April	May	June
July	August	September
October	November	December
These months are in SPRING:		The weather in SPRING is…
These months are in SUMMER:		The weather in SUMMER is…
These months are in AUTUMN/FALL:		The weather in AUTUMN is…
These months are in WINTER:		The weather in WINTER is…

D) Extend & Create

Use the three pictures attached to this lesson to write a story about one day where you experienced ONE of the following: sunny weather, rainy weather, and stormy weather. How did you feel? What kinds of things did you do? Try to make your story three to four sentences long!







Lesson Plans for Teachers: Weather, Weather Everywhere! (Grade 1)

Teacher Notes:

This lesson has been designed by the United States Environmental Protection Agency (EPA) as a teaching aid on the topic of weather. The content follows Next Generation Science Standards (NGSS), and is designed to engage learners throughout the levels of Bloom's Taxonomy. Each section of the lesson is written in kid-friendly language and can be modified for differentiated instruction. This lesson discusses weather and temperature, as well as the role meteorologists play in weather forecasting. This lesson is in alignment with NGSS Standard 1.ESS.1.B. The activities in this lesson engage students in organization of numbers and brainstorming/sketching conceptual understanding of seasonal activities. Some students may need additional assistance in the organization of date's activity, as there are decimal numbers. Although the students are not asked to manipulate or organize the decimals, these numbers may look different than ones they have seen in the past. This section of the activity might best be done as a whole class, with emphasis on smaller and larger numbers by tens, ones, and tenths digits.

Materials Needed: Copies of the data tables/charts, questions for students, blank computer paper (or larger), colored pencils or crayons.

Vocabulary:

Temperature: How hot or cold it is outside.

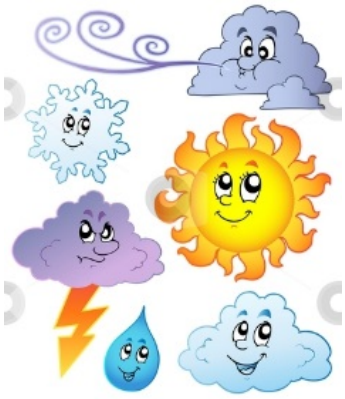
Meteorologist: A scientist who studies weather.

National Weather Service: Provides weather information for the United States.

Thermometer: Measures temperature.

Introduction:

What is weather? Weather is many things, including how hot or, cold it is; whether it is sunny or cloudy and if it is snowing or raining. Weather can be different depending on your location. It can be raining at your house, and sunny in the next town over! We describe weather by what we see and feel outside. We might say it's hot or cold depending on the **temperature**. If it's raining or if it's sunny outside will depend on whether we choose an umbrella or sunglasses when we leave the house. A **meteorologist** is a scientist who studies weather. Weather is something that impacts everyone, every day.



People are interested in weather because it is something everyone has to experience. Weather is not under any of our control—but it can be impacted by our small, daily actions.

Objectives: By the end of this lesson, you will be able to...

- Identify the type of scientist who studies weather.
- Create a model of activities for different seasons.

Did You Know?

Photo Credit: National Oceanic and Atmospheric Administration (NOAA)

Cleveland Abbe (born in New York, NY in 1938) was a famous **meteorologist**. A meteorologist is a scientist who studies weather. Cleveland was trustworthy and well educated about weather related topics. Thanks to his hard work, the National Weather Service was formed!

The **National Weather Service** is responsible for keeping the people of our country informed about weather conditions. They keep us safe by tracking storms, warning us about dangers, and giving helpful tips for times when bad weather strikes. They also keep track of good weather, and let us know what types of weather are ahead for us!

A) Recall

1) How do we know what the weather is like outside?

2) In what type of weather would you need…
    a. An umbrella?
    b. A pair of sunglasses?
    c. A pair of gloves?

3) What type of scientist studies weather?

B) Understanding

Date EST	Temp °F
1/31 12:00 AM	46.4
1/30 12:00 AM	39.0
1/29 12:00 AM	44.1
1/28 12:00 AM	39.6
1/27 12:00 AM	45.9
1/26 12:00 AM	43.5
1/25 12:00 AM	34.0

The table above shows **temperatures** in North Carolina at the end of January. We can measure temperature through a device called a **thermometer**. Using the table below, can you put the ***dates*** in order from coldest to warmest?

Order	Date	Temperature in °F
1) Coldest		34.0
2)		39.0
3)		39.6
4)		43.5
5)		44.1
6)		45.9
7) Warmest		46.4

C) Apply & Analyze

4) What month were these temperatures taken?
5) Were these temperatures taken in the spring, summer, fall, or winter?

D) Extend & Create

6) The temperatures in the chart you saw were cold! It might have been even colder where you live, or it could have been warmer. Warmer weather usually happens in the spring and hot weather in the summer; while cooler weather is more like to occur in the fall. Cold weather happens in the winter! Draw a picture of your favorite thing to do when it is cold outside! Then, draw another picture of you and your family doing something you love to do during your favorite season! (If your favorite season is winter, you get to draw two cold weather pictures)!

Lesson Plans for Teachers: Blown Away! (Grade 2)

Teacher Notes:

This lesson has been designed by the United States Environmental Protection Agency (EPA) as a teaching aid on the topic of weather. The content follows Next Generation Science Standards (NGSS), and is designed to engage learners throughout the levels of Bloom's Taxonomy. Each section of the lesson is written in kid-friendly language and can be modified for differentiated instruction. This lesson discusses the importance of wind, and is in alignment with NGSS Standard 2.ETS.1.2.This activity is designed to increase understanding of how and why wind is measured, as well as encourage engineering skills through building. Some students may need assistance analyzing graphs and creating their final products. All sections are designed so they could be completed as a whole group, small groups, or individually.

Vocabulary:

Wind: Air movement in from one place to another.

Renewable Energy: Energy that can be created naturally and quickly.

Pollution: When things are put into the environment that can cause harm to people, animals, and plants.

Anemometer: A device which measures wind speed.

Introduction:

Imagine visiting the beach on a beautiful, sunny day. Picture the waves crashing on the sandy shore and the happy people fishing on the pier. There are a lot of activities you can do at the beach: you can build a sandcastle, surf the waves, or search for seashells. Some beachgoers enjoy laying on the sand and reading a good book. There really is something for everyone. One of the most common, activities enjoyed by kids and adults alike is kite flying. Most people prefer to fly small kites for fun. Some people even participate in kite flying competitions! This activity has been around for thousands of

years; originating in China and spreading throughout the world. There is no known record of the very first kite, but folklore says that a farmer tied a string to his hat—because the wind kept blowing it away—and the kite was here to stay. Some people buy kites, some build their own…but regardless of how they get them, kite flying can be a fun activity for anyone.

Flying kites doesn't require a lot of practice, but it does require one very important thing—WIND! **Wind** is the movement of air from one direction to another. Scientists study wind for a lot of reasons. Wind can change the weather, change the land by moving dirt, sand and other ways, and can even be used to generate electricity we use to turn on the lights or TV. This energy is called **renewable energy**. Think about walking outside on a very, very windy day; even if the weather is perfect in all other ways, you can feel the power of the wind working against you! Since wind is so powerful, it is often used to provide electricity. Another benefit is that it is clean and can replace other ways we produce electricity, such as coal, which creates **pollution**.

The United States Environmental Protection Agency (EPA) helps protect us from air pollution that can make it hard to breathe, especially if you have asthma. The Village Green Project was developed by scientists at the EPA to give the public information about the air around them. You might even have a Village Green Project park bench in a city near you! If you don't, you can always look at the information on the website (with help from an adult) – www.airnow.gov/villagegreen. One of the things this park bench provides to the people in the area is how fast the wind is blowing. Why is this important? In this lesson, you'll discover interesting information about wind—and discuss how the Village Green Project could help people understand more about the air around them.

Objectives: By the end of this lesson, you will be able to...

- Describe what wind is and how it is useful.
- Analyze wind data from a chart.
- Build an anemometer.

Did You Know?

It's easy to tell when it's a windy day outside. Sometimes the trees are blowing, sometimes your hair may fly all around. Occasionally, you can even hear the wind whipping outside of your house. It can be challenging, however, to determine at just what direction and speed the wind is blowing. You might wonder, why does it matter which direction the wind is blowing? Or why should people care about wind speed? Wind, however, is a very important part of weather systems—and even impacts travel by boat, airplane, and car. If we didn't know wind measurements, planes might not be able to fly correctly, and sail boat captains could find themselves lost at sea! Knowing and understanding how winds work and how the wind affects us is an important part of understanding weather!

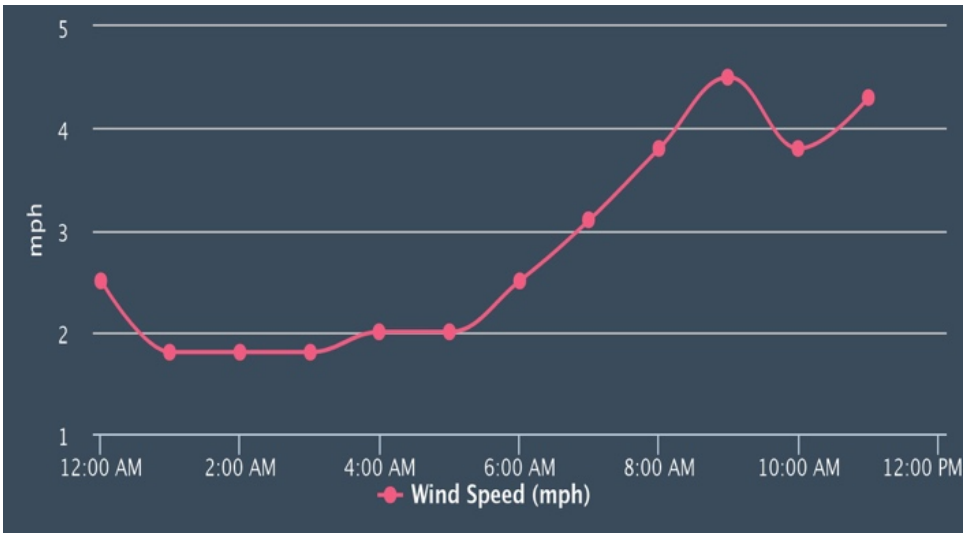
An **anemometer** is a device which measures wind speed. The first anemometer was developed in the 1400's by an Italian architect named Leon Battista Alberti. An anemometer has cup shaped devices attached to the base, and measures wind speed counting how many rotations the cup makes while the wind is blowing. The faster the wind blows, the more the cups rotate. It is important that we measure wind speed, because big changes can be a sign that something is going to happen to our weather. If the wind speed picks up and stays high for a while, a storm might be coming in. If we're experiencing very hot, dry weather, and there's almost no wind, we can expect not to see rain that day.

A) Recall

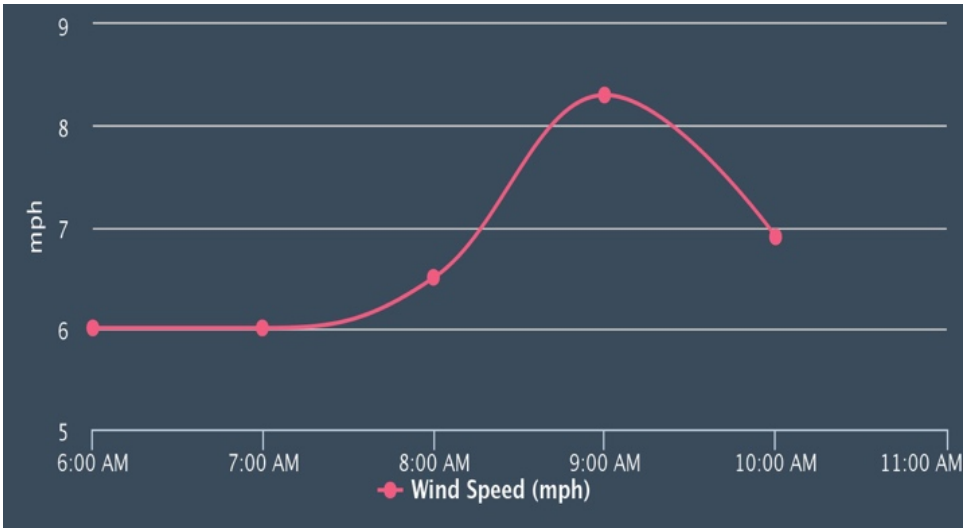
1) What device measures wind speed?
2) Where was the first kite invented?
3) What natural event must be happening in order for you to fly a kite?

B) Understand: Use the graphs and information below to answer questions 4-7

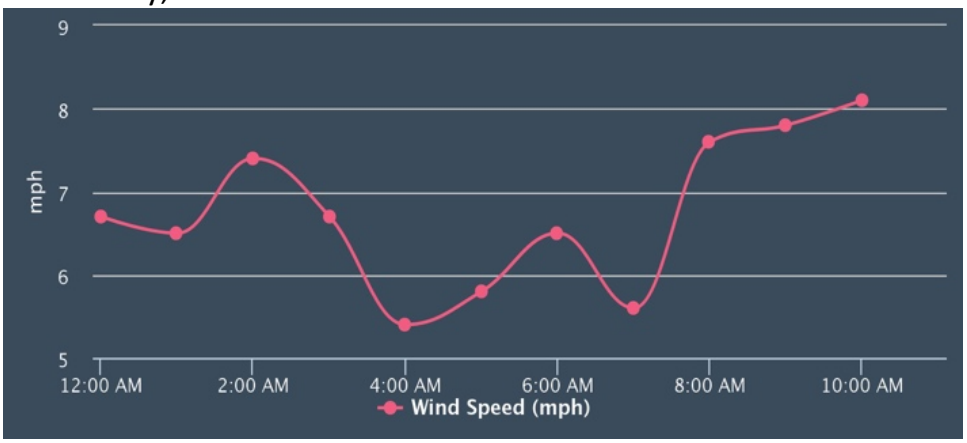
The data on these graphs were provided by the Village Green Project. Each graph shows wind speeds from the same date.



Philadelphia, PA



Kansas City, KS



Chicago, IL

4) Which city saw the lowest wind speed?

5) Which city saw the fastest wind speed?

6) What were the wind speeds for the three different cities at 8am?

C) Apply & Analyze

7) Using wind energy as an alternative to fossil fuels is a popular idea among scientist and citizens. Many wind energy supporters encourage wind turbines (the machine that would collect the wind energy) to be placed near coastal areas/beaches. These areas tend to be quite windy! Why do you think coastal/beach areas are windier?

8) Visit the Village Green Project webpage at www.airnow.gov/villagegreen (with help from your teacher) and look at some of the wind speeds in the area closest to you, today! Now think about the weather outside. Does it feel like your wind speed matches with the type of weather you are experiencing? Why or why not?

D) Extend & Create

9) You're going to create and test your own wind speed measurement device, called an anemometer. This device will require certain materials, and you need to listen very carefully for your instructions! (Teacher: See attached anemometer design instructions)

Build Your Own Anemometer Activity (Teacher Instructions, Grade 2)

Materials Needed Per Anemometer:

- 5 small cups (3-5 oz)
    - Can be plastic or paper
- Thin, straight device for attaching cups
    - Best picks: Plastic straws (straight, not "bendy"), small dowel rods, or plastic rods (like the ones found in toy building kits)
- Medium length dowel rod or unsharpened pencil (with eraser) for post.
- One-hole punch (can be shared by multiple students or may best be used by teacher).
- Tape (masking, scotch, or duct—whichever works best for your cup/attachment device)
- Scissors
- Push Pin (may best be used by teacher)

Instructions:

Step One: Using the hole punch, make one hole on one side of four of the cups. Make sure the holes are in the same location on each cup ***(Teacher Note: You can premeasure the cups and draw a line approximately ½ inch below the rim).***

Step Two: ***Teacher Note: It would be best for the teacher to do this prior to passing out materials.*** Using the hole punch, make four holes in the remaining cup. Two of the holes (on opposite sides of the cup) should be approximately ½ inch below the rim. On the other two opposite sides of the cup, punch the holes approximately ¼ inch below the rim. This will allow the dowels/straws to fit more comfortably in the cup. Then,

using the push pin puncture the bottom of the cup. Use the scissors to make the hole large enough to snugly fit the post dowel into the bottom of the cup.

Step Three: Place the dowels/straws through the base of the cup onto the post. Use tape to secure the cup to the post.

Step Four: Attach the four remaining cups to the ends of the dowels/straws with the base of the cups facing inward (so that the opening of the cups face outward). Use tape to secure the cups to the dowels/straws.
***NOTE:** Use tape to secure any of the cups if necessary EXCEPT where the cup attaches to the post (pencil in pictures). This needs to fit snugly, but cannot be secured with tape or the device will not spin.

Testing Your Anemometer:
The anemometer can be tested by placing it securely in the ground, or by placing the post in a tall container (like a water/soda bottle) to keep it upright.

Count the number of times the anemometer makes a complete revolution when it spins for ten seconds (in order to make this easier for small kids—and adults—you can use tape, a marker, or some other device to mark one of the cups). ***Every four revolutions is approximately one mile per hour.*** Have your students calculate the approximate wind speed on different days throughout the week.

Lesson Plans for Teachers: Oh No! Ozone! (Grade 3)

Teacher Notes:

This lesson has been designed by the United States Environmental Protection Agency (EPA) as a teaching aid on the topic of weather. The content follows Next Generation Science Standards (NGSS), and is designed to engage learners throughout the levels of Bloom's Taxonomy. Each section of the lesson is written in kid- friendly language and can be modified for differentiated instruction. This lesson discusses the layers of the atmosphere and ozone; and is in alignment with NGSS Standard 3.ESS.2.D. This activity is designed to increase student understanding of atmospheric organization and how ozone behaves in the stratosphere versus the troposphere. Some students may need assistance while interpreting graphs and analyzing data; others may need assistance in creating models/diagrams. This lesson is designed so that all sections may be done as a whole group, small groups, or individually.

Materials Needed: Project materials (tri-folds, poster boards, markers, paper, etc). Materials can be requested from home or school materials could be used. This could also be a good time to teach students about upcycling; encouraging them to bring in recyclable materials from home to be used by the whole class. This would cut down on expenses when developing models.

Vocabulary:

Atmospheric Layers: The five layers of gas which surround earth.

Troposphere: The layer of atmosphere closest to the earth. This is the air we breathe and where birds and planes fly!

Stratosphere: The second layer of the atmosphere (from Earth), going up about 32 miles above earth's surface.

Mesosphere: The third layer of the atmosphere (from Earth), between about 30-50 miles above earth's surface, where meteors burn when they enter from space!

Thermosphere: The fourth layer of the atmosphere (from Earth). The thermosphere gets very, very hot! This is where shuttles fly.

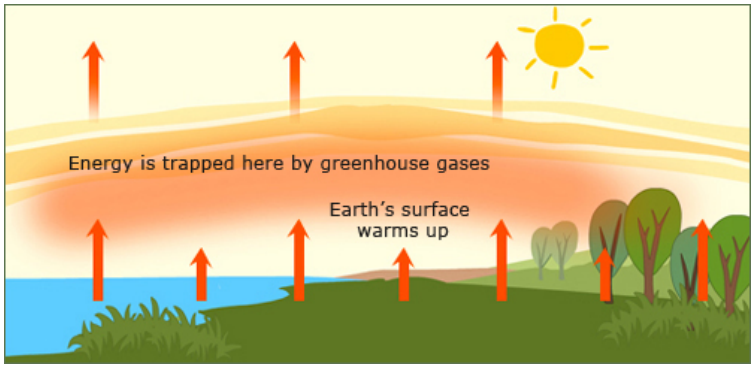
Exosphere: The last layer of the atmosphere. The air here is very, very thin.

Ozone: A gas found in the atmosphere. Ozone protects people from intense sunlight when present up high in the stratosphere, but dangerous for people to breath when close to the Earth's surface.

UV Radiation: Energy from ultraviolet (UV) light, which is produced by the sun but not visible to your eye. UV radiation but can cause sunburns and affect human health.

Introduction:

Did you know that there are many different sections of our atmosphere? The air you breathe does not act like the air that surrounds Earth. We call these divisions the **atmospheric layers**.



Scientists noticed that at different heights above Earth's surface, gases behaved differently; because gases have certain behaviors at certain temperatures. The **troposphere**, which is the only place that has weather, is the layer closest to Earth. This is the location of the air we breathe and where birds fly. Above the troposphere is the **stratosphere**. This is where the ozone layer is located, which is our protection against solar radiation (dangerous rays from the sun). This is also where you will find airplanes; they can't fly too close to the Earth's surface, but also don't want to get too high, either. The **mesosphere** is in the middle—and as you climb higher, it gets really cold! The mesosphere is in an interesting location. It's too high for planes and too low for spacecraft. Above the mesosphere, however, is the largest part of our atmosphere—the **thermosphere**. The thermosphere can get very hot, but the temperature changes based on the amount of solar radiation it receives. This is the part of our atmosphere where a lot of research is conducted; astronauts in spacecraft and satellites spend a lot of their time in the thermosphere.

Lastly, is the **exosphere**, the outermost layer of the atmosphere. In fact, some scientists argue about how far the exosphere actually goes; describing the boundary as where the Earth's atmosphere would end, and outer space would begin. This is the first part of the atmosphere which is exposed to the sun's rays, so it's the first thing to protect us against harmful radiation.

The EPA measures a gas called **ozone**. Ozone is created in the upper atmosphere when sunlight (solar radiation) interacts with oxygen molecules in the air; in the lower atmosphere, ozone is created when sunlight and two air pollutants interact. Ozone is beneficial in our stratosphere; when it's high above the earth, it helps protect us from solar radiation.

When ozone is close to earth, however, it can be dangerous to humans, animals, plants, and entire ecosystems. The EPA measures ozone and other air pollutants through a park bench device called the Village Green Project. This project allows people to see what conditions are like in their area and in other places around the country. You can check out the ozone levels (as well as other interesting data) by visiting their website at www.airnow.gov/villagegreen or searching for EPA Village Green Project!

Ozone in the atmosphere is good when it's located in the stratosphere. It acts like a shield, helping to protect us against harmful **UV radiation**. Unfortunately, a lot of ozone is being produced in the troposphere; due to the large amounts of pollution humans are putting into our air. When it comes to the levels of the atmosphere and ozone, the EPA has a saying: "Good Up High! Bad Nearby!"

You may occasionally hear people talk about the differences in "good ozone" and "bad ozone;" and the fact that it all depends on where that ozone is located. This may seem confusing—since we know that we're talking about the air above us. But, it all depends on where the ozone is.

Objectives: By the end of this case study, you will be able to...

- Describe the how ozone in the stratosphere helps us.
- Make inferences about ozone levels in the troposphere and atmospheric conditions.
- Create a graph showing patterns in ozone levels from real data.

A) Recall

1. What are three of the atmospheric layers? Which one includes the air we breathe?
2. How can ozone hurt us?
3. How can ozone help us? Where does it need to be located in order to be helpful?

B) Understand

The following table from the Village Green Project shows ozone measurements (in parts per billion) for Oklahoma City, Oklahoma on March 6, 2016. The measurements are from noon (12:00 pm) until 10:00 pm, and are shown in with the latest readings first. Use the data in the table to answer questions 4-6.

3/6 10:00 PM	34
3/6 9:00 PM	37
3/6 8:00 PM	42
3/6 7:00 PM	45
3/6 6:00 PM	43
3/6 5:00 PM	41
3/6 4:00 PM	42
3/6 3:00 PM	44
3/6 2:00 PM	48
3/6 1:00 PM	50
3/6 12:00 PM	55

4. At which hour was the ozone level the highest? Lowest?
5. What do you think time of day has to do with ozone levels?
6. Create a bar graph showing the difference in ozone measurements. What is the difference between the highest and lowest measurements for this time period?

C) Apply and Analyze

7. If some ozone is natural, why is it dangerous to the environment? Describe how surface ozone if formed, and why we should be concerned about too much of it.
8. Explain what the EPA slogan, “Good up high, bad nearby” means.
9. Understanding how surface ozone is formed, do you think a particular season would have higher ozone levels than others? Or do you feel the levels would be similar? Defend your answer.

D) Extend/Create

10. Imagine the principal of your school asked your third grade class to create a display for informing visitors about ozone. To create your display, you can be as creative as you'd like. You may use a tri-fold, poster board, or even design a model to demonstrate your understanding. You might consider creating a diagram of the layers of the atmosphere, discussing man made pollution, or even talking about the ways ozone can be both good and bad. The final product must include information about the different ways that ozone impacts the planet and our health, and why it's important.

Lesson Plans for Teachers: The Air Out There (Grade 4)

Teacher Notes:

This lesson has been designed by the United States Environmental Protection Agency (EPA) as a teaching aid on the topic of weather. The content follows Next Generation Science Standards (NGSS), and is designed to engage learners throughout the levels of Bloom's Taxonomy. Each section of the lesson is written in kid friendly language and can be modified for differentiated instruction. This lesson discusses the air pollution, and is in alignment with NGSS Standard 4.EES3. This activity is designed to increase student understanding of air pollutants and their sources, as well as encourage engineering skills through modeling and design. Some students may need assistance while interpreting graphs and analyzing data. This lesson is designed so that all sections may be done as a whole group, small groups, or individually.

Materials Needed: Blank paper for sketches, Art supplies (for brochure), Access to a computer with an internet connection.

Vocabulary Suggestion: Have students read the passage individually, underlining any words with which they are not familiar. Have students find definitions using dictionaries or online resources. Define any words about which they still have questions before completing Part D of the assignment.

Introduction:

Air pollution is a serious issue which our planet faces every day. Air pollution comes in many forms and from many places. Sometimes air pollution comes from natural sources, such as volcanoes. Much of our air pollution can be controlled, however — because it's us who are putting it there. Humans impact air pollution levels through every day actions: driving cars, producing goods at factories—even farming—can contribute to air pollution. Will there ever not be pollutants in the air? No! Since some occur in nature, there will always be particles in the air we breathe. The challenge we face as citizens of the planet is to try to leave as little pollution behind as necessary.

Air pollution from a construction site. Photo Credit: Eric Vance, US EPA

What kinds of things are in our air? There are many pollutants in the air we breathe. The Environmental Protection Agency (EPA) sets National Ambient Air Quality Standards for specific pollutants. What that means is that these levels must be monitored by scientists because they could potentially be harmful to human health as well as plants, animals, and other living things. These pollutants are: Ozone (O_3), Particulate Matter (PM), Carbon Monoxide (CO), Nitrogen Oxides (NO_x), Sulfur Dioxide (SO_2) and Lead (Pb).

Scientists who study air pollution not only look for types of pollution, but also research interesting and innovative ways to educate other people about pollution and what they can do to help. The EPA has developed an exciting way to talk about air pollution with the public, the Village Green Project. This project is a solar-powered park bench (that yes, you can sit on) that is located in a number of cities across the country, which collects information from the surrounding air and uploads it to an internet server every minute. The best part? You can use that information to help yourself and your loved ones make good decisions for our environment.

The Village Green Project park bench in Durham, NC. Photo Credit: US EPA

Objectives: By the end of this lesson, you will be able to...

- Identify types of air pollutants and where they originate.
- Read, analyze and interpret data from the Village Green Project.
- Design a model of an air monitoring station which you think would benefit the public.

Did You Know? The city of London, England is known for many things: Big Ben, Buckingham Palace, and being a city often covered in fog. December 5, 1952, however, a different kind of fog rolled in to town—and caused a lot of destruction. For five days, a dense smog covered the city. The smog, which was much heavier and more toxic than usual, was caused by massive amounts of coal being burned by residents of London. The winter of 1952 proved to be colder than usual; and when a high pressure system came through (which pushed air downward) the cold air got pushed toward the ground. This essentially captured the smoke from the chimneys; trapping it so that it could not rise into the atmosphere.

The smoke lingered in the city for five days. Life in London was impacted greatly; farmers lost livestock, visibility was so low that people could not travel, and thousands of people ended up not being able to physically handle the heavy pollution. Thousands of people became very sick and lost their lives.

There is a silver lining to The Great Smog of London. The terrible circumstances the people of London faced that winter made room for a great environmental breakthrough. Law makers decided there needed to be regulations to what types of things could be put in the atmosphere, and thus began the development of The Clean Air Acts (1956 & 1968). These acts focused on decreasing dangerous black smoke, and also making certain that factories were better regulating the types of fuel they were using. Policy makers saw a problem and took swift actions to protect the people, animals, and environment.

A) Recall

1. What types of human activities can cause air pollution?
2. What are some of the dangers of air pollution?
3. What laws were passed to make sure another smog incident like that which occurred in London wouldn't happen again?

B) Understand

Use the table below to interpret data from the Village Green Project in the Philadelphia, PA location in March, 2016.

Date EDT	O_3 ppb	$PM_{2.5}$ $\mu g/m^3$	Temp °F	RH %	W Spd mph
3/28 7:00 PM	34	4.4	62.1	41.6	1.4
3/28 6:00 PM	34	4.3	63.9	38.1	2.0
3/28 5:00 PM	38	3.9	66.2	33.9	2.2
3/28 4:00 PM	40	4.6	68.4	31.9	3.0
3/28 3:00 PM	36	6.7	71.1	39.6	1.8
3/28 2:00 PM	37	5.8	69.3	46.3	1.5
3/28 1:00 PM	30	12.0	64.4	67.2	1.6
3/28 12:00 PM	24	22.2	60.3	80.6	0.8
3/28 11:00 AM	26	11.5	55.2	90.2	0.4

4. Based on the observation data, why do you believe the ozone (O_3) levels were at their highest in the late afternoon?
5. What other piece/pieces of data could you use to help you come to this conclusion?
6. What data did you understand from this table? Which parts of this table would you like to know more about?

C) Apply/Analyze

7. How do you think projects like Village Green can benefit the general public?
8. Air pollution has become a major problem all over the world. Give examples of locations where you might find heavy air pollution; and why those areas might have greater cause for environmental concerns.
9. Describe a situation where you might be able to lessen the amount of pollutants in the atmosphere. What types of struggles might you face in doing this?

D) Extend/Create

10. Think of the community in which you live. Consider your family, friends, and neighbors. Are there businesses on your street? Is there a lot of traffic flowing through your community? Are you surrounded by trees, water systems, or wildlife? Now, think about the quality of the air you, your family, and even the local animals are breathing.

Your task is to create an air monitoring device that can be used by the people of your neighborhood. What type of air quality measurement device would be most useful in your specific community? What would it need to be made out of? Would it be large or small? What type of data would the people in your community most want to see?

In order to brainstorm ideas and get the most information about the various prototypes you could make, visit www.epa.gov/villagegreen to find out more information about what the Village Green Project offers. Additionally, if there is a VGP location in your area, visit the site to see what it's like.

Your task includes:

- Identify the type of community in which you live; and the needs of the individuals around you.
- Create a sketch/diagram of your new air quality monitor system.
- Describe how this new product would meet the needs of the community (what would it measure, how much space would it take up, how could the public use it, etc.)
- Create an advertisement (brochure, commercial, music video, etc.) convincing a company to provide you funding to begin your project.

Lesson Plans for Teachers: Caught in the Storm (Grade 5)

Teacher Notes:

This lesson has been designed by the United States Environmental Protection Agency (EPA) as a teaching aid on the topic of weather. The content follows Next Generation Science Standards (NGSS), and is designed to engage learners throughout the levels of Bloom's Taxonomy. Each section of the lesson is written in kid friendly language and can be modified for differentiated instruction. This lesson discusses wind and hurricanes, and is in alignment with NGSS Standard 5.ESS2.1. This activity is designed to increase student understanding of wind's role in weather, including during major storms such as hurricanes. This lesson also encourages data collection and analysis, and will require students to conduct research. Some students may need assistance while collecting, organizing, and interpreting data. This lesson is designed so that all sections may be done as a whole group, small groups, or individually.

Materials Needed: Computer with internet access.

Vocabulary Suggestion: Have students read the passage individually, underlining any words with which they are not familiar. Have students find definitions using dictionaries or online resources. Define any words about which they still have questions before completing Part D of the assignment.

Introduction:

Wind is a little thing that makes a big difference. When it comes to wind, there's a lot to be thankful for. Without wind, we would not have the types of weather we do. Wind is responsible for movement of fronts, which bring frontal systems. Fronts, including warm, cold, occluded, and stationary, are the cause of beautiful days and major storms. Wind is also responsible for movement of clouds, which provide precipitation like rain and snow. Some places receive more winds than others; coastal areas and beaches tend to be windier than flat lands. Contrary to popular belief, Chicago IL is not the windiest city in the United States (although it does have the nickname "The Windy City"). Brockton, MA holds the title of windiest city!

Wind farms create energy without using valuable resources. Photo Credit: Eric Vance, US EPA

Wind speed and pressure are measured by a device called an anemometer. It is important to monitor wind speeds and directions in order to inform people of atmospheric conditions, especially in the event that storm systems are moving toward them. The United States Environmental Protection Agency (EPA) has a special device which measure wind speed, as well as other atmospheric conditions, through a data collection device called the Village Green Project. The Village Green Project park benches contain special equipment designed to measure changes in the atmospheric conditions and send updates to a computer database. This database is available to the public, and can be used to monitor how the air quality and meteorological events have changed over the course of the day, week, months, or even year. Currently, there are several of these park benches across the United States; there might even be one near you. Even if there isn't a Village Green Project location in your area, you can access the information to see what's happening in locations all over.
One of the reasons studying wind is such an important part of understanding weather is because of the impact weather systems can have on our daily lives. Hurricanes are a fascinating and highly studied topic in regards to wind.

Objectives: By the end of this lesson, you will be able to...

A hurricane off the coast of the South Eastern United States. Photo Credit: US EPA

- Explain how weather is influenced by wind.
- Analyze wind data from the Village Green Project.
- Describe how hurricanes are categorized.

Did You Know?

Hurricanes are one of Mother Nature's most powerful and dangerous storm systems. Hurricanes not only produce unsafe seas and rip currents, but bring with them the potential for flooding, heavy winds, and even tornadoes. Hurricanes can pack winds nearing or over 200 miles per hour, and can impact several different areas in the course of their life cycle. The most dangerous issue those in the path of a hurricane face is the storm surge, or flooding, which can contribute to property damages, geologic issues (such as uprooted trees), and even loss of life.

Winds, although not the primary concern, are also an incredibly dangerous part of hurricane anatomy. Winds from hurricanes have been known to destroy homes, blow over trees, and even turn all kinds of debris into dangerous projectiles. Winds in hurricanes are measured through a scale called the Saffir-Simpson Hurricane Wind Scale (Figure 1). The scale ranges from 1 to 5, with 5 being characterized by potentially catastrophic wind speeds. The scale was designed by scientists Herb Saffir and Bob Simpson as a way to categorize wind speeds in a way that would warn the public about the potential risks of approaching storms. The hurricane is placed in a category based on its maximum sustained wind speed. This is determined by taking the average of wind speeds over a period of one to two minutes. Hurricane Patricia, which hit Mexico in October 2015, had maximum sustained winds of 215 mph!

Two buildings collide after Hurricane Katrina
Photo Credit: Eric Vance, US EPA

Fortunately, the massive Category 5 storm hit in an area that was not heavily populated; the damage caused by Hurricane Patricia could have been much worse if landfall was made in a more populated area. Hurricane Patricia only claimed the lives of 13 people total—and although that is a devastating loss of life, there have been many smaller hurricanes in history that have taken the lives of thousands. Being well prepared and following evacuation/safety orders from government officials, especially for people living in coastal communities, is the key to staying safe in the face of such an unstoppable force.

Figure 1: Saffir Simpson Scale

Storm Category	Wind Speed	Destruction Level
Tropical Depression	0-38 mph	Minimal to no damage
Tropical Storm	39-73 mph	Minimal Damage
Category 1 Hurricane	75-95 mph	Very Low Levels of Damage
Category 2 Hurricane	96-110 mph	Changes made to trees, some serious damage to structures possible.
Category 3 Hurricane	111-129 mph	Likely to cause serious damage to structures, especially homes. Possible uprooted trees. Debris.
Category 4 Hurricane	130-156 mph	Extreme risks for structures, flying debris and surges/flooding.
Category 5 Hurricane	157+ mph	Catastrophic damage will occur.

A) Recall

1. How does wind influence weather?
2. How do scientists categorize hurricanes?
3. Why do some hurricanes shift directions from their projected paths?

B) Understand

4. To familiarize yourself with wind speed data, visit the EPA's Village Green Project website and search for the closest VGP station to you. What is the current wind speed in your area? How does that compare to the wind speed in the VGP location farthest away from you? Based on the Saffir-Simpson scale, should you be alarmed by these wind speeds? Why or why not?

5. Choose a year between 1990 and 2016 to research the number of tropical systems (hurricanes or cyclones) which impacted the United States of America. Gather information on that year, including the number and names of the storms, their category, wind speeds, dates they made impact, where they struck, and the damages reported. Create graphs for each of the categories of the storms. You may use line graphs, bar graphs, histograms, or whichever graphs you feel make sense with your data. Do you notice a trend for that year? Does any of the data match? How do you think this data could be used to describe the hurricane season for the year you chose?

C) Apply & Analyze

6. Many people are impacted by hurricanes when they strike, not just those who live on the coast. Consider what you know about hurricanes and the damages they cause. Why do you believe hurricanes pose a threat to people so far away from the zone of impact?
7. One side effect of climate change is that winds will, for the most part, slow down. However, another effect of climate change is increased intensity of storms, especially hurricanes. How will these things impact one another?
8. What are some ways to stay safe during a hurricane?

D) Extend & Create

9. Create a presentation for your class (in any multimedia or traditional format you choose) to describe the hurricane season of the year you chose in Part B.

10. Using the data you gathered in Part B, compare that information to the projected hurricane season for the current year. Do you notice any similarities or differences? Use this data to create a brochure explaining how these storms have/will change over time. According to your data, should people be preparing for bigger, more destructive storms; or does your information show that we need to maintain our current tracking and preparation plans? There is no right or wrong answer—it's all in your data. Be sure to include graphs or tables, images, and explanations of what hurricanes are, how they form, and what types of damages they cause. Your target audience for this activity is the general public, so it should be written so that anyone could pick it up and read it.

Lesson Plans for Teachers: The New Vesuvius (Middle Grades)

Teacher Notes:

This lesson has been designed by the United States EPA as a teaching aid on the topic of weather. The content follows Next Generation Science Standards (NGSS), and is designed to engage learners throughout the levels of Bloom's Taxonomy. Each section of the lesson is written in kid friendly language and can be modified for differentiated instruction. This lesson discusses air pollution and volcanoes; and is in alignment with NGSS Standard MS.ESS2.2. This activity is designed to increase student understanding of natural versus man-made pollutants, including pollution from volcanoes as a natural source. This lesson also encourages data collection and analysis, and will require students to conduct research. Some students may need assistance while collecting, organizing, and interpreting data. This lesson is designed so that all sections may be done as a whole group, small groups, or individually.

Materials: Computer with internet access, multimedia software (for video editing, such as Movie Maker or iMovies), video cameras (students may use phones for videos).

Vocabulary Suggestion: Have students read the passage individually, underlining any words with which they are not familiar. Have students find definitions using dictionaries or online resources. Define any words about which they still have questions before completing Part D of the assignment.

Introduction:

There are many aspects of our natural world which captivate scientists and the general public alike. Geologists study Earth's physical topographies and provide us with information about how the Earth has formed, why it looks and acts as it does, and what could become of particular features in the future. For many, volcanoes are considered one of the more fascinating geologic structures. There are about 1900 active volcanoes on Earth, and many more which lie dormant. For a volcano to be considered "active," it must have an indicator which suggests that they might explode again in the near future. Dormant volcanoes are not necessarily incapable of an eruption—they're just less likely due to their lack of activity over extended periods of time.

Volcanic eruptions are not all the same. Some volcanoes erupt continually; like Mount Yasur in the country of Vanuatu, which has been erupting for hundreds of years. These eruptions can vary in intensity. Some volcanoes vent slowly with little to no interruption to people's lives; but sometimes volcanic eruptions are explosive!

When we think of volcanic eruptions, we often picture large plumes of smoke and hot, flowing lava. That smoke cloud that we see is actually water vapor, gases, and solid particles. We call the solid particles, along with liquid droplets in the air, particulate matter (PM). Particulate matter can come in various shapes and sizes; and can even be small enough to enter into the lungs when inhaled. When the ash cloud escapes the volcano during eruption, particle pollutants enter the atmosphere in large amounts; immediately impacting visibility and breathing conditions in areas surrounding the volcano. Due to its size, however, particle pollution can also be carried in a several mile radius.

Particulate matter is categorized by size into two categories. Coarse PM includes inhalable particles which have a diameter less than 10 micrometers long, but larger than 2.5 micrometers. Fine PM is anything 2.5 micrometers in diameter or smaller.

Particle pollution can be hazardous to lung and heart health; particularly for young people, the elderly, and those susceptible to breathing issues such as those living with asthma, emphysema, and chronic obstructive pulmonary disease (COPD). In addition to health concerns, particle pollution also impacts water systems, soil, and vegetation. Fine PM ($PM_{2.5}$) can cause issues with visibility; this is the same pollution that causes busy city skylines to look "hazy."

The United States Environmental Protection Agency (EPA) monitors particle pollution in the atmosphere. One outlet through which they monitor this pollutant is the Village Green Project. This initiative was developed in order to educate the public about important air quality issues while providing them with real time data relevant to their local area. The Village Green Project uses a park bench monitoring station to collect data on particle pollution as well as ozone levels, temperature, humidity, and wind direction/speed. This information is essential in understanding the basics of air quality in one's area. The information is then sent to a database at the EPA and provided to the public through the Village Green Project website (www.airnow.gov/villagegreen). In this lesson, you will view the Village Green Project website and gain a greater understanding of particle pollution in an area close to you.

Objectives: By the end of this lesson, you will be able to...

- Analyze data provided by the Village Green Project.
- Make predictions about future events when given information about air quality.
- Research potential volcanic threats to modern societies, and determine how those eruptions might impact quality of life for different populations.

Did You Know?

Volcanic eruptions can destroy homes and habitats; they can potentially hurt (or sometimes kill) plants, animals, and people. On August 24 in the year 79 AD, Mt. Vesuvius, located in Naples, Italy, secured its position as the most famous and catastrophic volcanic eruption of all time. The story of this stratovolcano's famous eruption sounds like something straight out of a horror movie; the blast completely destroyed the nearby city of Pompeii—and took thousands of the city's residents with it. When the eruption occurred, people were less than unprepared; they were caught violently off guard. Scientists now believe that the extreme heat surge from the volcano is to be held responsible for the death of the community; with many people entombed

in an ash cast, eternally preserved in whatever action position they were in at the time of their death. The entire city was covered in nearly 17 feet of ash and stone, burying the men, women, and children who perished during the 18 hour eruption. The ash and smoke that covered the area was, undoubtedly, hazardous to anyone or anything that could have survived the catastrophic events of that day.

While scientists of the time weren't monitoring air quality as we do today, we do know that the blast of the volcano had temperature surges of over 500°F! The incredibly hot air, mixed with volcanic ash, smoke, and other pollutants, had environmental effects that were likely unheard of. The likelihood of another great eruption such as the one experienced by people of Pompeii is unknown. Scientists believe Mt Vesuvius will undoubtedly erupt again; the question is at what magnitude the event will occur. What we also do not know is the dangers of large scale volcanic eruptions and our air quality—because the atmosphere is much more polluted today than it was two thousand years ago. Could another cataclysmic volcanic eruption change the world as we know it?

A) Recall

1) Where is Mt. Vesuvius located?
2) What is particulate matter?
3) Why is particulate matter dangerous?

B) *Understanding*

4) Logon to the Village Green Project website at http://www.epa.gov/air-research/village-green-project-fact-sheet and explore the information provided. Then, click on "Explore the Data" to view information about several Village Green park bench locations throughout the country. Find the location closest to you. How has the PM level changed over time this week? This month? What things do you think have influenced the levels of particle pollution in your area?

C) Apply & Analyze

5) Visit http://volcano.si.edu/ to view the Smithsonian Institution National Museum of Natural History Global Volcanism Program website. Under the "Reports" tab, click the link that says, "Smithsonian/USGS Weekly Volcanic Activity Report." From here,

explore the places on the map with the red balloons. Clicking on these will provide you with information regarding recent volcanic activity reports.

6) After reviewing the different volcanoes, choose two of them to study in more depth. Perform searches within (and outside of) this website in order to find out the history of these volcanoes, any significant past eruptions, the surrounding population, potential devastations if the volcano were to erupt again, etc. Collect your facts and brainstorm information on a separate sheet of paper, in a computer document, or in a graphic organizer.

D) Extend & Create

7) In Section C, you narrowed your search of recently active volcanoes to two. Choose one of these volcanoes to complete this activity: Imagine volcanologists in the area believe there will soon be an eruption. The local government in the area needed to provide the public with information regarding the volcano's activity and potential destructiveness. They have asked you to create a 3-5 minute video explaining this information; including potential threats to air quality and human health. Use real documented data from that particular volcano, and be sure to cite your sources of information. You will need to include graphics (visual aids) in your video. You can be a part of your video, or use computer software to narrate over your images.

Lesson Plans for Teachers: Green Design (Middle School)

Teacher Notes:

This lesson has been designed by the United States Environmental Protection Agency (EPA) as a teaching aid on the topic of weather. The content follows Next Generation Science Standards (NGSS), and is designed to engage learners throughout the levels of Bloom's Taxonomy. Each section of the lesson is written in kid friendly language and can be modified for differentiated instruction. This lesson discusses the role of engineers in developing technologies, and is in alignment with NGSS Standard MS.ESS3.5.D. This activity is designed to engage students in considering real life applications to science and engineering, as well as increase their ability to read, analyze, and apply real data to fictional scenarios. Some students may need assistance while collecting, organizing, and interpreting data. This lesson is designed so that all sections may be done as a whole group, small groups, or individually.

Materials Needed: Computer with internet access and presentation software.

Vocabulary Suggestion: Have students read the passage individually, underlining any words with which they are not familiar. Have students find definitions using dictionaries or online resources. Define any words about which they still have questions before completing Part D of the assignment.

Introduction:

What do you see when you picture a scientist? A man with crazy hair, glasses, and a lab coat? The outdated perception of what it takes to be a scientist is quickly being replaced with the reality of science, technology, engineering, and mathematics (STEM) careers—scientists and engineers come from all backgrounds of life. They might be young or old, male or female, and come from a vast array of racial, ethnic, and religious backgrounds. Engineering is a special branch of science that not only studies theory, but brings concepts to life by applying processes, building models, creating technologies, developing maps and diagrams, and so much more.

Engineers and other scientists have many fascinating aspects of their jobs. Photo Credit: Eric Vance, US EPA

Engineers work in many arenas, and there are new needs for engineers every day. There are numerous branches of engineering, including: Aerospace, Biological, Biomedical, Chemical, Civil, Computer, Electrical, Environmental, Industrial, Mechanical, Nuclear, and Textile. This is a short list of the types of engineering opportunities and programs available at universities; with many places specializing in other branches unique to their location. Engineers have an interesting career because they can help plan, develop, and carry out projects in so many fields of work. The primary function of an engineer depends on their particular field, but their primary goal is to find solutions to problems through scientific and mathematical understanding; as well as testing for solutions and using data to draw conclusions.

Engineers have worked hard to help develop a special air quality monitoring device called The Village Green Project. This project is run by the United States Environmental Protection Agency and focuses on providing the general population with information regarding air quality in their area. Teams of engineers have worked together at the EPA to plan, develop, test, and build these unique structures which serve a practical use to their community (the devices are located within a park bench), as well as a source of information about important environmental health issues.

The Village Green Project Bench in Durham, NC. Photo Credit: US EPA

In order to provide accurate, up to date information, The Village Green Project park benches include:

- Particulate Monitor
- Ozone Monitor
- Wind Sensor
- Humidity/Temperature Sensor
- Power Controller
- Absorbed Glass Mat Battery
- Solar Panel
- Microprocessor
- Cellular Router

Engineers on the project not only build the benches with these materials; but test the stations to ensure

all of the sensors are working properly and are ready for the public. In addition to creating the devices, they then follow up with the monitoring which is occurring at the park benches all over the nation; and travel to make corrections to the equipment if something isn't working properly, If not for the engineers on projects such as these, none of this would be possible.

Objectives: By the end of this lesson, you will be able to...

- Identify the role of engineers in developing technologies to monitor environmental conditions.
- Analyze actual data from the Village Green Project
- Develop a model of a monitoring device for an environmental issue of your choice.

Did You Know?

Scientists have been measuring air quality and other issues surrounding pollution for decades. Unfortunately, it sometimes takes bad things happening for people to see the importance of taking care of the environment. In 1948, the town of Donora, PA experienced a deadly smog caused by industrial air pollution. The smog lingered in the area for five days, killing nearly forty and leaving over 7,000 people sick! The smog was most likely caused by heavy emissions from local steel and zinc plants, mixed with a pocket of warm air which trapped the cooler air (and pollutants) at the surface level. Just a few short years after this event, the people of London, England experienced something similar with the Great Smog of London. During this event, however, thousands of deaths were attributed to the toxic air exposure.

Factories are a major source of man-made air pollution. Photo Credit: Eric Vance, US EPA

There is a silver lining to these events, though, as they demanded public attention. These types of events have increased public awareness of air quality, pollution, and the types of health risks associated with irresponsible burning of fossil fuels and dangerous chemicals. While we're still not facing an ideal world in terms of air quality, policy makers have made drastic improvements to monitoring systems. If it were not for disasters such as these smog events, The Clean Air Act would not have been passed when it was (in 1970); and the air quality monitoring technologies and information may have been drastically different. We have the opportunity to not only monitor what

we're doing, but make big changes as we move forward with information on pollution and clean air. Today, thanks to scientific advancements in research and engineering—as well as public interest and knowledge—we're getting closer to breathing a little easier.

A) Recall

1. What is the primary role of an engineer?
2. Why is it important to include engineers in the monitoring of environmental conditions?
3. What types of monitoring devices are present in the Village Green Project park benches?

B) Understand

4. Visit the Village Green website at www.epa.gov/villagegreen to view the current conditions report in the VGP location closest to you. Then, review the measurements for ozone, PM 2.5, and temperature for the past month. Create a triple line graph showing these measurements. Is there any correlation between the measurements? What trends do you notice? Why do you think this is the case?

C) Apply & Analyze

5. There has been a lot of discussion surrounding current environmental conditions, especially with issues of climate change. Visit the EPA climate change website at http://www3.epa.gov/climatechange/ and thoroughly look at the information available surrounding climate change issues and initiatives. Create a graphic organizer describing one of the topics which you found to be most interesting (or urgent). What type of research is being done on this topic? Are there technologies being used to study the topic? What type of information is being made available to the public?

D) Extend & Create

6. There are many areas of concern surrounding our climate and the impact humans are having for future generations. The EPA, along with other government and private organizations, are driven to find better ways to treat our planet! One of the most valuable tools for understanding climate change is that the public must be accurately informed. There is a lot of information available that just isn't accurate. Providing the general public with accurate, real time, and relevant information is why projects such as Village Green started. Imagine you have been

hired by the EPA to create a new device designed to gather information and educate the public about the topic you chose in Part C. What would you design? Where would it be located? How would you get the information to the public? Why would this be beneficial? Individually or in groups, create a model of your device and develop a business pitch to present to your classmates. Your model can be 2-D (like a sketch) or 3-D (like a small prototype), but must be detailed. Your business pitch should use multimedia, be appealing and relevant to the audience, and provide information about why your device is important.

Lesson Plans for Teachers: Planet X (Middle School)

Teacher Notes:

This lesson has been designed by the United States Environmental Protection Agency (EPA) as a teaching aid on the topic of weather. The content follows Next Generation Science Standards (NGSS), and is designed to engage learners throughout the levels of Bloom's Taxonomy. Each section of the lesson is written in kid friendly language and can be modified for differentiated instruction. This lesson reviews air quality data from around the world; focusing on the implications of air quality issues on human health and well-being. This activity is designed to engage students in analyzing real data, and drawing conclusions on AQI impact based on scientific findings. Some students may need assistance while collecting, organizing, and interpreting data. This lesson is designed so that all sections may be done as a whole group, small groups, or individually.

Materials Needed: Computer with internet access and presentation software.

Vocabulary Suggestion: Have students read the passage individually, underlining any words with which they are not familiar. Have students find definitions using dictionaries or online resources. Define any words about which they still have questions before completing Part D of the assignment.

Introduction:

Photo Credit: Eric Vance, US EPA

Air pollution is a serious topic of concern for many people around the world. Air pollution is not only damaging to the physical environment, but can cause long term (and sometimes irreversible) damage to the health of human beings. In the United States, the Environmental Protection Agency (EPA) monitors six major air pollutants: Ozone, Particulate Matter, Carbon Monoxide, Nitrogen Oxides, Sulfur Dioxide, and Lead. Scientists at the EPA look for ways to control these pollutants and their causes; and

investigate the numerous ways increased pollution rates can impact our health and well-being. Unfortunately, air quality in other parts of the word is not as closely monitored as it is in the United States; and some countries are facing a lot of trouble because of it.

The EPA also set a goal to inform the public about air quality; engaging the general population about concerns with our air is a great way to start important conversations such concerning climate, human health, and the future of our environment. Through programs like The Village Green Project, the EPA is putting environmental information at the fingertips of people all over the world—and data collecting park benches across the country. The Village Green Project is an education initiative which provides a resource for the public to learn about their local air quality in real time, in ways that are easy to read and understand. The monitoring devices are located inside a park bench, where people can lean while they enjoy the outdoors or wait on the bus to arrive.
Before continuing with this activity, visit www.epa.gov/villagegreen to explore the data and learn more about this important air quality initiative.

Objectives: By the end of this lesson, you will be able to...

- Identify issues of air quality around the world.
- Describe impacts around the world if air quality continues to decrease.
- Relate air quality to issues in public health.

Did You Know?

Research scientists study air quality data from around the world, not just here in the United States. Scientists, law makers, and citizens worldwide share a growing concern regarding what steps should be taken in order to ensure we're breathing cleaner, safer air. You might wonder: if this topic is so important, why are there so many places in the world experiencing dangerous levels of pollution? Unfortunately, there is not a simple answer to this question; there are many factors which contribute to global air quality. One of the major contributors, however, is human emissions from cars, factories, and other byproducts of our industrialized societies.

Canadian and American scientists and researchers from Dalhousie University in Nova Scotia used satellite observations to monitor and estimate $PM_{2.5}$ concentration levels

around the world. One of the images they created shows the average levels of $PM_{2.5}$ from 2001-2006 on a global scale. This image (Fig. 1) provides insight into the locations with the greatest and least amounts of particle pollution. The reality is that many people in some of the most populated areas of Earth are living in areas of poor air quality; even here in the United States.

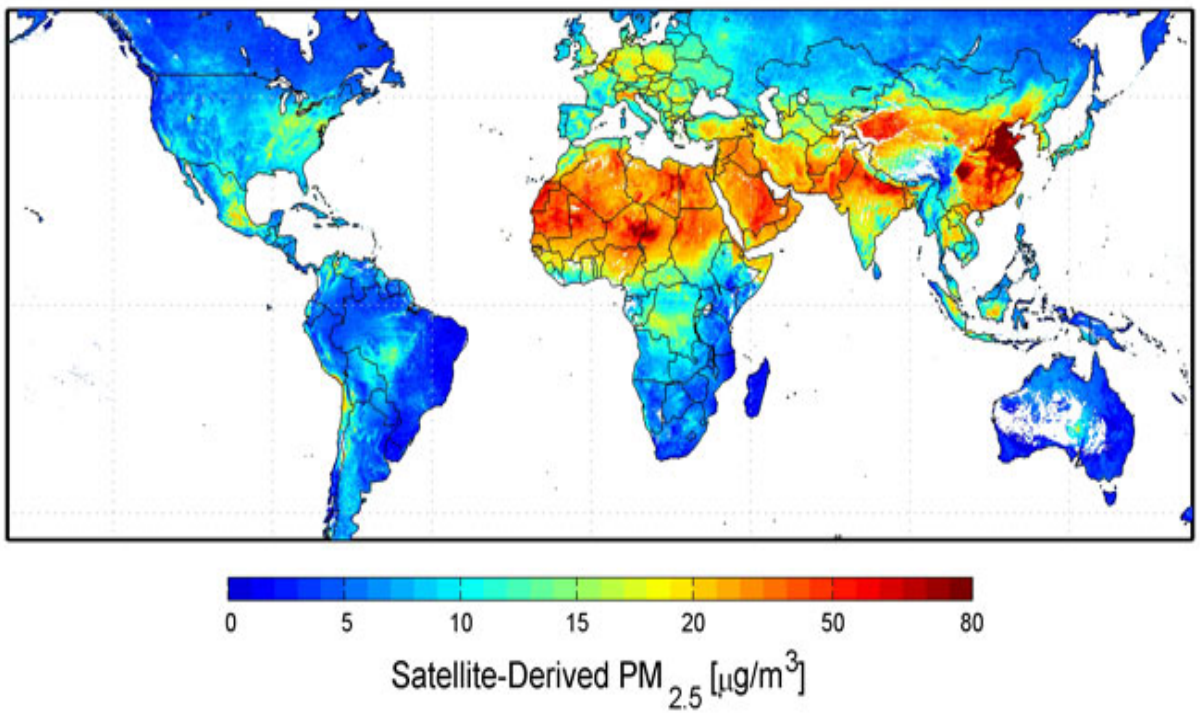


Figure 1: Satellite image showing average $PM_{2.5}$ levels from 2001-2006. Photo Credit: Donkelaar et al, 2010.

A) ***Recall***

1. What six pollutants are monitored by the EPA?
2. From the information on the Village Green Project website, in what cities and states are the air monitor park benches located?

B) ***Understand***

View the Air Quality Index (AQI) at https://www.airnow.gov/ Explore the data, then fill in the following table and answer the questions below.

3.

AQI Value	Public Health Concern	Color Code
0-50		

	Moderate	
		Orange
	Unhealthy	
201-300		
		Maroon

4. Using the map on the main page of the AQI, look at today's forecast. What is the AQI measurement for your area?
5. Which areas are in the Highest 5?
6. Notice the parts of the country in green. What factors do you feel contribute to the air quality being better in these areas?
7. Click on your state. What is the air quality like in the city closest to you?

C) Apply & Analyze

8. Visit www.epa.gov/villagegreen and review the Village Green Project data and background information. Where in the United States do you feel the next park bench should be located? Why would you choose this location? What interesting/beneficial information would it show?

9. Consider the dangers associated with increased AQI ranges. Public health is a huge factor in air quality, as the effects of this are seen immediately for some (with issues like asthma), and for others over a range of time in the form of diseases such as cancer, emphysema, and COPD. You have just researched the air quality measurements in your area (or a surrounding city). What types of factors may contribute to your current AQI status? What types of changes in your community might change your AQI for the better? For worse? Think about the demographics of the area in which you live—what groups might be most at risk if air quality conditions worsened, and why would they be more at risk? Write your summary in paragraph form.

D) Extend & Create

10. "It could never happen here!" You might think this to be true when you hear the stories about and see the pictures of heavily polluted locations around the world. Unfortunately, the city of Los Angeles was once considered one of the most polluted places on the planet. The United States and other industrial nations are not immune to these issues. Air pollution is not just a concern in areas with a dangerously high AQI—although there is a greater sense of urgency in these locations. Air quality is a matter all areas experience and must consider when thinking about the health of the people, animals, and environment in their areas.

Industry impacts air quality. Photo Credit: Natural Resources Defense Council

Imagine the hazardous air quality conditions such as the ones you've viewed around the world became the norm; instead of a planet with primarily clean air and pockets of heavy pollution, the planet became overcome with industrialized pollution. What other systems would this impact? How would life on earth change? How would you anticipate, based on scientific reasoning, the new planet (Planet X) would function? Would there still be human life? If so, how would they have to adapt? What types of issues would plants and animals experience? Would the water systems be damaged or stay the same? Would there be an increase or decrease in rain, storms, temperature, or other weather related issues? Now, imagine you are a travel agent trying to get visitors to come to your planet (Planet X). Describe the living conditions of the new Earth—and what visitors can expect on their trip. Be creative, but be sure to provide scientifically accurate information in your predictions!