Wonderings about Weather

Unit Overview

This 8th grade and Algebra unit uses weather concepts as the context for graph reading, analysis, and interpretation and analyzing the relationships in graphs. Students will conduct several investigations into concepts about weather (air pressure, temperature differences at various locations on the globe, weather maps, and extreme weather events), read and present information about weather concepts, and collect and analyze data related to weather events. Technological tools will be used to collect and analyze weather data and present information about readings. The recommended time frame for this unit is 11 instructional days.

Essential Questions	**Major Concepts**
What causes weather? How do extreme weather events change data sets? What types of relationships are found in weather data?	<u>Science</u> Weather <u>Technology</u> Sharing information <u>Engineering</u> No major concepts addressed <u>Math</u> Data collection and analysis Function relationships Writing graphs Graph interpretation

Suggested Lesson Sequence

<u>Prerequisites</u>

The lessons in this unit presume that students are familiar with basic data displays such as bar graphs and line graphs, as well as the features of data collection and representation (titles, axis labels, units, etc.). If your students are not proficient with these terms and/or concepts, a lesson teaching these is encouraged before beginning this unit.

This lesson is not intended to be a comprehensive study of weather and all of its related content. Instead, basic concepts of weather are used to learn data literacy and analyze relationships between sets of data.

Lesson 1 - Establishing Context, What Causes Weather?

Lesson Overview: Students will watch a video and teacher demonstrations to understand the basics causes of weather.

Lesson 2 - Air Pressure

Lesson Overview: Students will learn about qualitative and quantitative data and complete a lab to understand the effects of air pressure.

Lesson 3 - Angle of Light and Surface Temperature

Lesson Overview: Students will explore the relationship between the angle of light and surface temperature.

Lesson 4 - Interpreting Weather Maps
Lesson Overview: Students will learn about weather maps and compare them to more familiar types of graphs/charts.

Lesson 5 - Severe Weather
Lesson Overview: Students will track Hurricane Ike to issue weather warnings and graph weather variables to explore their mathematical relationships.

Lesson 6 - Flash! Bang!
Lesson Overview: Students will explore the inner workings of lightning and use data from a reading to solve problems.

Lesson 7 - Graphing Stories
Lesson Overview: Students will analyze three different graphs and determine their relationship to each other.

Materials, Tools, & Technology

- ☐ computer/Laptop/Tablet/Projector
- ☐ 100-watt light bulb
- ☐ six-inch paper circular disk
- ☐ small amount of talcum powder (about 1/2 teaspoon)
- ☐ burner or hot plate
- ☐ pie pan
- ☐ sponge
- ☐ ice cubes
- ☐ clear glass, large-mouth gallon jar
- ☐ copies of Lesson Handouts/Warm-ups/Etc.
- ☐ sturdy paper cup
- ☐ index card
- ☐ straight pin/partially straightened paper clip
- ☐ sink/bucket/catch basin
- ☐ thermometers
- ☐ reflector lamp with clamp and 60-watt bulb
- ☐ ring stand with iron ring
- ☐ utility clamp
- ☐ black construction paper
- ☐ stapler/tape
- ☐ scissors
- ☐ colored pencils
- ☐ graph paper

Vocabulary

atmosphere
evaporation
clouds
condense/condensation
air/atmospheric pressure
qualitative/quantitative data
forecast
station model
temperature
dew point
wind speed/direction
weather
hurricane
tornado
thunderstorm
weather warning/weather watch
storm surge
lightning
thunder
flash-to-bang method

☐ poster boards/butcher paper (optional)	

STEM Professional Involvement Ideas **(See Teacher Resources Appendix for talking point template)**

One or more of these STEM Professionals could be invited as a guest speaker at any appropriate point in the lesson sequence:

- NOAA/NWS Representative
  - NOAA stations employ community relations employees who are trained to give presentations to the public, schools, classes, etc. A NOAA employee could speak to students about weather, forecasting, technology, radar, and other weather-related concepts. Many NOAA stations also give tours and may be able to accommodate a field trip. To find a local NOAA station and contact information, visit the "NOAA In Your State/Territory" page at http://www.legislative.noaa.gov/NIYS/.
- Storm Chaser
  - A storm chaser pursues severe weather events to gather data. A local storm chaser, either professional or amateur, may be able to speak to the students about storm chasing, severe weather events, technology, data collection, etc.

Standards

Science

- **MS-ESS2-5. Collect data to provide evidence for how the motions and complex interactions of air masses results in changes in weather conditions.**

Technology

- **Locate, organize and use information ethically from a variety of sources and media.**
- **Evaluate and select information sources and digital tools based on the appropriateness to specific tasks.**
- **Analyze, evaluate, and summarize information or data and report results.**

Engineering

Mathematics

- **Math Practices 1, 3, 4, and 6**
- **S.ID.A Summarize, represent, and interpret data on a single count or measurement variable.**
- **S.ID.B Summarize, represent, and interpret data on two categorical and quantitative variables.**
- **S.ID.7 Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of the data.**
- **S.IC.6 Evaluate reports based on data.**

Notes

For math, this unit focuses on the application of data collection, representation, and analysis for 8th grade and High School data standards. If students are not familiar with basic types of graphs, coordinate graphing, and linear functions, some pre-teaching may be necessary to complete all of the lessons.

For a complete and comprehensive knowledge of the science standards, additional lessons may be necessary.

Appendix List

Appendix A: Teacher Resources
Appendix B: Student resources

Establishing Context, What Causes Weather? – Lesson 1

Grade Level: Middle School/ Algebra I	**Time Needed:** (1) 45-50 minute class period	**Subjects:** Science

Objective/ Learning Target: The students will understand that weather is caused by the sun heating the earth and its atmosphere.

Standards:
MS-ESS2-5. Collect data to provide evidence for how the motions and complex interactions of air masses results in changes in weather conditions.

Background Information:
Weather is the state of the atmosphere (hot, cold, wet, dry, cloudy, sunny, etc.) that we experience each day. The average weather conditions over an extended period of time make up the climate of a region.

But what causes weather? Why does it rain? What causes the wind? An exploration of the answers to these questions is a good context to explore data collection, representation, and analysis.

Materials:
- ☐ computer/tablet/projector for video
- ☐ 100-watt light bulb
- ☐ six-inch-circumference paper disk
- ☐ small amount of talcum powder (about 1/2 teaspoon)
- ☐ burner or hot plate
- ☐ pie pan
- ☐ sponge
- ☐ water
- ☐ clock
- ☐ ice cubes
- ☐ clear glass, large-mouth gallon jar
- ☐ copies of What is Weather Exit Ticket

Vocabulary:
atmosphere
air currents
evaporation
clouds
water vapor
condense/condensation

Resources:
- See Appendix B for What Is Weather Exit Ticket

Procedures:
1. <u>Warm-up:</u>
   a. Pose the question "What is Weather?" to students.
   b. The students will have private think time for one minute before sharing with an elbow partner or small group.
   c. The group should come up with an answer to write on the board or a large piece of paper.

2. <u>Introductory Video(s):</u>
   a. The students will watch one or more videos/video clips as an introduction to the concept of weather. The following videos are suggestions:
      i. *Earth: Climate and Weather* – National Geographic – 24hToday, https://www.youtube.com/watch?v=zz_CRzcIT-Q
      ii. *What is Weather?*

https://www.youtube.com/watch?v=G2e273LAcnE

iii. *Our World, What is Weather?*
https://www.youtube.com/watch?v=UtgFHHhm1xU

3. Teacher Demonstrations:
   a. Visible Air Currents
      i. Turn on the light bulb and allow it to get hot.
      ii. Allow students to feel the *air around the lightbulb* but not the bulb itself.
      iii. Sprinkle very small amounts of talcum powder over the bulb and several feet away from the bulb.
      iv. The students will watch the movement of the talcum powder swirling over the light bulb and the movement of the talcum powder farther away from the bulb.
      v. Cut the paper circle along the lines and attach a short length of string to the center.
      vi. Hold the paper circle over the light bulb.
      vii. The students will observe the motion of the paper circle over the light bulb.
      viii. Lead the students in a discussion about the demonstrations:
         - Is the bulb hot?
         - Is the air around the bulb hot?
         - What makes the talcum powder swirl in the air?
         - Why didn't the talcum powder farther away from the light bulb swirl in the air?
         - What causes the paper circle to move?

   b. Rain in the Classroom
      i. Place a pot of water on a burner or hot plate to boil.
      ii. Hold a pie pan with a wet sponge in it above the boiling water.
      iii. The students will watch the bottom of the pie pan to see where and when condensation forms.
      iv. The students will time and record the time it takes for the first raindrop to fall from the pan.
      v. Repeat the experiment with ice in the pan.
      vi. Lead the students in a brief discussion about the demonstration:
         - Compare the times it took for the first raindrop to fall.
         - What reasons can you think of for the difference in times?
         - What was different about the contents of the pan?
         - Why did the pan with the ice create raindrops more quickly?

   c. Clouds in the Classroom
      i. Place a pot of water on a burner or hot plate to boil.
      ii. Hold an inverted, large-mouth glass jar over the pot of water to collect hot air as it rises.
      iii. Cover several ice cubes with a wet paper towel and place them on top of the jar.
      iv. When the hot air reaches the cold at the top of the jar, clouds will begin to form.
      v. If the temperature difference is significant enough, raindrops may begin to fall.
      vi. Lead the students in a brief discussion about the demonstration:
         - What forms of water did you see in this demonstration?
         - How did these changes happen?
         - What can you tell about how clouds and rain form?

4. Exit Ticket
   a. The students will complete a brief exit ticket as a reflection of the demonstrations they viewed during the lesson.

Differentiation:

Supports	Extensions
Students with limited writing skills can be asked to write one answer to each question on the exit ticket.	

Assessment Opportunities:

This lesson is designed to provide an introduction to the concept of weather and what causes it. No assessment opportunities were designed in this lesson.

Citations:

Teacher demonstrations adapted from the Southwest Educational Development Laboratory (SEDL): http://www.sedl.org/scimath/pasopartners/pdfs/weather.pdf

The suggested videos were found on YouTube

Air Pressure – Lesson 2

Grade Level: Middle School/ Algebra I	**Time Needed:** (1) 45-50 minute class period	**Subjects:** Science, Math

Objective/ Learning Target: The students will understand that air exerts force on objects.
The students will understand that data can be qualitative or quantitative.

Standards:

MS-ESS2-5. Collect data to provide evidence for how the motions and complex interactions of air masses results in changes in weather conditions.

S.ID.A Summarize, represent, and interpret data on a single count or measurement variable.

S.ID.B Summarize, represent, and interpret data on two categorical and quantitative variables.

S.ID.7 Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of the data.

S.IC.6 Evaluate reports based on data.

Background Information:

We need air around us, or we wouldn't be able to breathe. Even though we do not usually feel the air, there are times when the force of the air around us is evident. Examples include the wind that tornados and hurricanes produce. Short of those extremes, though, air pressure can also be felt by holding a hand out of the window of a moving car.

The force of air has to do with differences in air pressure. Some people are more sensitive than others to those differences, resulting in ears popping during elevation changes and aching in joints. Differences in air pressure also influence wind and cloud formation, and help meteorologists predict weather patterns.

Materials:

- ☐ copies of Air Pressure Investigation Recording Sheet (see Appendix B)

For each group:

- ☐ sturdy paper cup
- ☐ index card
- ☐ straight pin/partially straightened paper clip
- ☐ water
- ☐ sink/bucket/catch basin

Vocabulary:

air pressure
qualitative data
quantitative data

Resources:

- See Appendix B for Air Pressure Investigation Recording Sheet

Procedures:

1. <u>Warm-up:</u>
   a. Pose the questions "Do you feel any air pressure right now?" and "How do you know there is air pressure?" to students.
   b. The students will write answers to the questions wherever they typically record warm-up answers.

2. <u>Qualitative and Quantitative Data:</u>
   a. Define qualitative data and quantitative data for students.
      Qualitative data: Data that deals with descriptions that can be observed but not measured with numbers. Examples include: colors, textures, tastes, smells, feelings, appearances, etc.
      Quantitative data: Data that can be measured with numbers; examples include: height, area, volume, weight, age, temperature, etc.

***The Regents Exam Prep website includes some good examples of qualitative data vs. quantitative data using the same examples: oil paintings, lattes, and a freshman class: http://regentsprep.org/regents/math/algebra/ad1/qualquant.htm

b. Practice differentiating qualitative and quantitative data. Read each example from the list below. If students think that it is an example of qualitative data, they will move to the left side of the classroom. If they think that it is an example of quantitative data, they will move to the right side of the classroom.

***Alternatively, you can use any method of voting that works in your classroom.

i. The age of students in this class (quantitative)
ii. The height of the teachers in the school (quantitative)
iii. The softness of your skin (qualitative)
iv. The number of pennies in your pocket (quantitative)
v. The color of the sky (qualitative)
vi. The number of hairs on your head (quantitative)
vii. The average grade of students in the class (quantitative)
viii. The hair colors of students on the football team (qualitative)
ix. The "coolness" of teachers in this school (qualitative)
x. The number of cars in each row of the parking lot (quantitative)

3. Air Pressure Investigation:

a. Test #1

ix. Working over a sink or catch basin, fill a cup with water until it is at the point of overflowing. It is important for the cup to be filled to overflowing so that there is no air in the cup. Place an index card over the top of the cup. Make sure the cup is touching the entire rim of the cup.
x. On your recording sheet, in the box labeled "Test #1 Prediction," write what you think will happen when you turn the cup and let go of the index card. Explain *why* you think that will happen.
xi. While holding the index card securely to the top of the cup, turn the cup over carefully. Hold the index card firmly to the cup so that no space is between the index card and the cup, but not so tightly that the cup bends. Remove the hand that is holding the index card. Record your observations of what happens in the box labeled "Test #1 Observation."

b. Test #2

vii. Repeat the Test #1 procedure, but only turn the cup sideways (not all the way upside down), holding the card to keep it in place.
viii. Remove the hand holding the index card.
ix. Record your observations of what happens in the box labeled "Test #2 Observation."

c. Test #3

vii. Repeat the Test #1 procedure. This time, after turning the cup upside down, carefully use the straight pin or paper clip to make a small hold in the bottom of the cup.
viii. Remove the pin.
ix. Record your observations of what happens in the box labeled "Test #3 Observation."

d. Test #4

i. Repeat the Test #1 procedure. This time, hold a finger securely over the hole in the bottom of the cup when you turn it over.
ii. Record your observation of what happens in the box labeled "Test #4 Observation."

4. Conclusions and Questions:
    a. On the back of the recording sheet, students answer the questions and then write a brief summary paragraph describing what they learned from the investigation they just completed.

Differentiation:

Supports

Some students may have trouble holding the upside down cup and may get overly frustrated if the water does not stay in the cup as intended. For these students, an activity with a syringe may be an acceptable substitute.

- Use a small plastic syringe and feel how much pressure it takes to depress the plunger.
- Hold a finger over the opening and try to depress the plunger.
- Hold a finger partially over the opening and try to depress the plunger.

The air inside the syringe will make it difficult to depress the plunger when the opening is covered.

An abbreviated number of questions can be assigned to students with below grade-level reading and/or writing ability.

Extensions

Challenge students who finish the activity early to determine a limit for the size of cup for which the phenomenon of unequal air pressure will still allow this investigation to work.

Assessment Opportunities:

The questions and summary paragraph will informally assess the student's understanding of the concepts addressed in this lesson.

Citations:

This lesson was adapted from "The Pressure's On" lesson in *Project Earth Science: Meteorology* from NSTA.

Angle of Light and Surface Temperature – Lesson 3

Grade Level: Middle School/ Algebra I	**Time Needed:** (2) 45-50 minute class period	**Subjects:** Science, Math

Objective/ Learning Target: The students will understand how the angle of sunlight affects heating of a surface.
The students will describe the relationship between angle of sunlight and surface temperature.
The students will be able to write an equation to represent the approximate relationship between angle of sunlight and surface temperature.

Standards:

MS-ESS2-5. Collect data to provide evidence for how the motions and complex interactions of air masses results in changes in weather conditions.

S.ID.A Summarize, represent, and interpret data on a single count or measurement variable.

S.ID.B Summarize, represent, and interpret data on two categorical and quantitative variables.

S.ID.7 Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of the data.

S.IC.6 Evaluate reports based on data.

Background Information:

Temperatures at the equator are not hotter because they are closer to the sun. While the equator *is* closer to the sun, the difference in distance (0.004% closer) is insignificant.

On any given day, the sun at the equator is almost directly overhead. At the poles, the sun never gets far above the horizon, or may not rise above the horizon at all. The angle at which the sun's rays strike the Earth's surface affects the temperature. More acute angles mean that the surface temperature will not increase as much.

Materials:

- ☐ copies of the Warm-up Sheet (see Appendix B)
- ☐ copies of Recording Sheet (see Appendix B)

For each group:

- ☐ three identical Celsius thermometers (glass or metal backed)
- ☐ reflector lamp with clamp and 60-watt bulb
- ☐ ring stand with iron ring
- ☐ utility clamp
- ☐ black construction paper
- ☐ stapler/tape
- ☐ several books or blocks to prop thermometers
- ☐ meter stick
- ☐ scissors

Vocabulary:

angle of sunlight
relationship
data
graph

Resources:

- See Appendix B for:
  Warm-up Sheet
  Angle of Sunlight vs Surface Temperature Prediction and Recording Sheet

Procedures:

Day One

1. Warm-up:
   a. The students will complete warm-up problems reviewing angles types and finding angle measures.
   b. The students will write answers to the questions wherever they typically record warm-up answers.

2. Angle of Sunlight Investigation:
   a. Use black construction paper to make a cover for the bulb of each thermometer. Cut a strip of paper approximately 5 cm x 10 cm. Fold the paper in half and staple four times, two on each side, to make a pocket. Slide a thermometer into the pocket.
   b. Prop the thermometers under the lamp set up by the teacher, using the books and/or blocks of wood. One thermometer should be vertical, one slanted at about 45 degrees, and the third horizontal. Be sure that you can easily read the thermometers without touching them during the investigation.
   c. Attach the lamp to a ring stand and make sure that it will be stable during your experiment. Adjust the lamp and stand so that the bulb is centered 40 cm above the bulbs of the thermometers.
   d. Before turning on the lamp, record the beginning temperature for each thermometer on your recording sheet and make a prediction about what will happen.
   e. Turn on the lamp and record the temperature of each thermometer every minute for 15 minutes. Be careful not to move the thermometers during the 15 minutes. Also, do not block the light going from the lamp to the thermometers.

Day Two

3. Warm-up:
   a. The students will reflect on their predictions made during the previous day.

4. Questions and Conclusions:
   a. The students will transfer their data from the predictions and recording chart to the graph.
      i. Use three different colored pencils or three different types of lines—one for each thermometer.
   b. The students will work individually or in pairs to answer the questions on the back of the recording sheet.

Differentiation:

Supports

Students who struggle with graphing and/or writing equations can be directed to graph/write an equation for only one of the thermometers in the investigation.

Many of the preparations/set-up for the investigation can be completed ahead of time for students who struggle with time management.

A tutorial in reading thermometers may be helpful to some/all students.

Extensions

Students can investigate why black construction paper was used. A second trial of the experiment can be conducted with all three thermometers lying horizontal (for maximum heat absorption) but with differently colored sleeves.

Have students tape a thermometer to the northern hemisphere and one to the southern hemisphere of a globe. Tilt the globe to 23.5° and shine a heat lamp on the globe, collecting data for 10 minutes. Have students compare the temperatures of the northern and southern hemispheres.

Assessment Opportunities: The questions and conclusions page will informally assess the student's understanding of the concepts addressed in this lesson.
Citations: This lesson was adapted from "Why Is It Hotter at the Equator Than at the Poles?" lesson in *Project Earth Science: Meteorology* from NSTA

Interpreting Weather Maps – Lesson 4

Grade Level: Middle School/ Algebra I	**Time Needed:** (1) 45-50 minute class period	**Subjects:** Science, Math

Objective/ Learning Target: The students will understand that there are many types of charts and graphs, some of which they may not typically see as charts or graphs.
The students will analyze information presented in a weather map to answer questions about collected data.

Standards:

MS-ESS2-5 Collect data to provide evidence for how the motions and complex interactions of air masses result in changes in weather conditions.

S.ID.A Summarize, represent, and interpret data on a single count or measurement variable.

S.ID.B Summarize, represent, and interpret data on two categorical and quantitative variables.

S.ID.7 Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of the data.

S.IC.6 Evaluate reports based on data.

Background Information:

Meteorologists collect weather data from all over the world using weather stations and instruments on the Earth's surface. They then use that data to make weather forecasts. Surface weather maps usually outline an interpretation of all of the data. These maps show a lot of information in a concise manner. If you combine information from many weather stations and maps, you will get a picture of the large weather systems across the nation. This is what most people are used to seeing when watching weather reports online or on TV news.

Materials:

- ☐ copies of Weather Map Foldable (see Appendix B)
- ☐ copies of BLM 17.1 Weather Map from *Project Earth Science: Meteorology*

--OR--

- ☐ copies of a weather map from a local newspaper (if using this option, the Questions and Conclusions page [see appendix B] will need to be altered)
- ☐ copies of Questions and Conclusions
- ☐ colored pencils
- ☐ pencil

Vocabulary:

weather
forecast
station model
weather map
temperature
dew point
atmospheric pressure
wind speed/direction

Resources:

- See Appendix A for: Weather Map Foldable (teacher version)
  See Appendix B for: Weather Map Foldable (student version) and Questions and Conclusions

Procedures:

1. <u>Warm-up:</u>
   a. The students will, individually, make a list of as many different types of charts and graphs as they can

in a set amount of time (1-3 minutes).
   b. The class will compile the warm-up answers into a class list.

2. Weather Map Foldable:
   a. Distribute copies of the foldable to each student and demonstrate folding techniques.
      i. Cut out on the bold, solid outer lines
      ii. Fold the paper in half vertically (on the solid line), crease, and then unfold.
      iii. Fold the left and right edges of the paper (on the solid lines), vertically, to the center line.
      iv. Cut on the dotted lines.
   b. Teach the different weather symbols to students, helping them to fill in the missing information in the foldables.

3. Questions and Conclusions:
   a. The students will work individually or in pairs to answer the interpretation questions using the weather map and their foldable as a reference.

Differentiation:

Supports

For students who struggle with reading/writing skills, giving them a completed copy of the foldable will allow them to focus on the instruction rather than writing the missing information.

A set of flashcards can be created for students who need help memorizing/learning the weather symbols.

Extensions

Students who complete the activity early can be encouraged to explore significant weather events such as winter storms, summer floods, hurricanes, freeze warnings, wind advisories, and/or tornadoes. Information is available at www.spc.noaa.gov.

Students can apply what they learn in this lesson to a weather map from a local newspaper and make predictions about weather events in the near future.

Have students investigate the meteorologist profession. What do these people do? What type of education do they need? And what type of math/data skills are necessary to be successful?

Assessment Opportunities:

The questions and conclusions page will informally assess the student's understanding of the concepts addressed in this lesson.

Citations:

This lesson was adapted from the "Interpreting Weather Maps" lesson in *Project Earth Science: Meteorology* from NSTA

Severe Weather – Lesson 5

Grade Level:	Middle School/ Algebra I	**Time Needed:**	(3) 45-50 minute class periods	**Subjects:**	Science, Math

Objective/ Learning Target:
The students will track the position of Hurricane Ike based on collected data.
The students will differentiate between a hurricane watch and a hurricane warning.
The students will analyze graphed hurricane data to determine relationships among data.

Standards:

MS-ESS2-5. Collect data to provide evidence for how the motions and complex interactions of air masses results in changes in weather conditions.

S.ID.A Summarize, represent, and interpret data on a single count or measurement variable.

S.ID.B Summarize, represent, and interpret data on two categorical and quantitative variables.

S.ID.7 Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of the data.

S.IC.6 Evaluate reports based on data.

Background Information:

Hurricanes are considered to be the most destructive storms on Earth. Hurricanes are very large storms that can reach 500 km in diameter. The strength, or intensity, and duration of these storms depend upon many meteorological variables such as mid-level wind speed, water temperature, humidity, position of fronts, and upper level wind speeds.

Hurricanes contain an immense amount of energy. They gather energy from warm ocean waters in the tropics and the heat is released after it rises, cools, and condenses. The heat warms the surrounding air, making it lighter and causing it to rise. As it rises, cooler air flows in to replace it, causing wind. The cycle continues until hurricanes diminish and die when they move inland or move into colder ocean waters.

A vital function of weather forecasting is to provide timely warnings about approaching dangerous storms. Accurately forecasting these events requires considerable information, much of which is collected using observer networks, weather balloons, radar, and satellites. These data points are collected by the National Weather Service (NWS), analyzed, and made available to the public in numerous ways. Accurately predicting these storm requires understanding the inner workings of complex weather systems. Knowing how severe weather works is crucial to anticipating when it will appear.

Materials:

- ☐ copies of the reading "Inner Workings of Severe Weather" from *Project Earth Science: Meteorology*
- ☐ copies of Severe Weather Reading Handout
- ☐ copies of Hurricane Ike Data Tables
- ☐ copies of Hurricane Ike Tracking Map
- ☐ copies of Hurricane Ike Tracking Handout
- ☐ graph paper

Vocabulary:

weather
forecast
hurricane
tornado
thunderstorm
weather warning
weather watch
storm surge

☐ copies of Air Pressure and Wind Speed Handout

Resources:

- See Appendix B for:
  Severe Weather Reading Handout
  Hurricane Ike Data Tables
  Hurricane Ike Tracking Map
  Hurricane Ike Tracking Handout
  Air Pressure and Wind Speed Handout

Procedures:

Day One

1. Warm-up:
   a. Present the following scenario to students:
      i. You have just heard on the radio that a hurricane warning has been issued for your city. This means that you have 36 hours for prepare and/or evacuate.
   b. The students will work in their Community Garden groups, pretending to be a family, to prepare a list of items they will take from their home when they evacuate. They are limited to the possessions that can fit in a large SUV with 5 people.
   c. The students will also make a plan for preparing their home for the hurricane.

2. Severe Weather Reading:
   a. Distribute copies of the reading "Inner Workings of Severe Weather" from *Project Earth Science: Meteorology* and the Severe Weather Reading Handout.
   b. The students, in their groups, will complete the reading, highlighting important information and taking notes as they read.
   c. The students, in their groups, will write summaries and answer the questions on the handout.

Day Two

1. Warm-up:
   a. Remind students of the hurricane warning scenario from Day 1. Have students, in their groups, read their list of items to be taken from their home.
   b. The students will make an estimate of the value of the possessions they are leaving behind in their homes. It is not possible to remember/list every item in their homes, so emphasize the need to estimate.
   c. The students will explain the method they used to arrive at their estimate.

2. Tracking Hurricane Ike:
   a. Read the following excerpt from *Project Earth Science: Meteorology* to the students:
   "In addition to the high winds—guests up to 172 kt (about 320 kmp or 192 mph)—and the torrential rains, hurricanes produce what is known as a storm surge. The circular winds, together with the low-pressure eye and high-pressure outer regions of a hurricane, create a mound of water in the center of a hurricane. The storm surge causes considerable flooding and is responsible for most hurricane damage and deaths.
   Weather satellites in orbit above Earth can easily detect hurricanes. Satellite data, along with data from radar and aircraft, are used to follow developing hurricanes. Through tracking, we can tell where a hurricane has been. We also can estimate where it will go in the near future. When it appears that a hurricane is moving toward land, the National Weather Service (NWS) issues hurricane watches and

warnings. A hurricane *watch* means that hurricane conditions are likely in the watch area within 36 hours. A hurricane *warning* means that hurricane conditions are likely in 24 hours. People living in low coastal areas that could be affected by a storm surge need to evacuate as soon as watches and warnings are issued."

b. Direct students to look at the Hurricane Ike Data Table 1. The first three types of data they will be using are:
   i. *Date/Time*: The data in this table was collected every six hours beginning on September 5, 2008 and ending on September 15, 2008. Time is given using a 24-hour clock; for example, 1200 is 12:00 noon and 18:00 is 6:00 pm.
   ii. *Position*: Longitude and latitude coordinates show the position of the eye of the storm. The storm is much larger than the eye and may extend out from the center as much as 250 km in all directions. That is about one-half of the area of one 5° longitude-latitude square on the map.
   iii. *Wind Speed*: This is the maximum speed of the winds in the storm, not the speed at which the hurricane is actually moving. Wind speed is given in knots (kt). 1 kt = 1.85 kph = 1.15 mph
c. The students will use the latitude and longitude coordinates to plot the position of the eye on the Hurricane Ike Tracking Map. A dot represents the new position of Hurricane Ike every six hours.
d. The students will draw a small star over the dot for each position at the beginning of a new day.
e. For each of the dates and times in the table, the students will issue hurricane watches and warnings for specific locations. They will base their decisions on how far, and in which direction, the storm traveled in the previous 24 hour period.
f. Table 2 contains storm surge data for Hurricane Ike in two different states. Students will use this to answer question(s) on the Hurricane Ike Tracking Handout.

Day Three

1. <u>Warm-up:</u>
   a. The students will make a prediction about the relationship between the air pressure of Hurricane Ike and the time since formation.
   b. The students will make a second prediction about the relationship between the wind speed of Hurricane Ike and the time since formation.

2. <u>Air Pressure and Wind Speed Graph:</u>
   a. The students will use Table 1 to create two graphs. First, they should graph Air Pressure vs. Time, plotting a point on the graph for each 6-hour period. Second, they should graph Wind Speed vs. Time, plotting a point on the graph for each 6-hour period.

3. <u>Questions and Conclusions:</u>
   a. The students will work individually, or in pairs, to answer the questions on the Air Pressure and Wind Speed Handout, using their graph as a reference.

Differentiation:

<u>Supports</u>

It is important that students transfer the numbers from the data and plot them accurately on the map. Students for whom this may be a concern can be paired with another student who has stronger skills in this area. It may be a good idea to create a scenario where one person is the scribe and one

<u>Extensions</u>

Students who finish their graphs at a fast pace can be directed to research a city that has been hit by a hurricane and locate a newspaper article from that time. The newspaper will contain many pictures of the damage from the storm. Have students research the effects of the storm surge and winds. They can develop

person is the auditor, checking for accuracy. Students who struggle with reading/writing skills can be assigned a shortened number of questions on any/all of the handouts.	a plan for how to build a house near the coast where a hurricane may hit. The history of any Eastern Pacific or Atlantic Basin hurricane can be found in a pdf file at www.nhc.noaa.gov/pastall.shtml. Students can track another hurricane and compare/contrast the path, wind speed, air pressure, temperature, etc. with that of Hurricane Ike.
Assessment Opportunities: The questions and conclusions pages will informally assess the student's understanding of the concepts addressed in this lesson.	
Citations: This lesson was adapted from "Riding the Wave of a Hurricane" lesson in *Project Earth Science: Meteorology* from NSTA	

Flash! Bang! – Lesson 6

Grade Level: Middle School/ Algebra I	**Time Needed:** (2) 45-50 minute class periods	**Subjects:** Science, Math

Objective/ Learning Target:
The students will understand the weather conditions that cause lightning.
The students will analyze data related to lightning and make inferences.
The students will understand precautionary measures to avoid the danger of lightning and calculate the approximate distance of lightning strikes.

Standards:

MS-ESS2-5. Collect data to provide evidence for how the motions and complex interactions of air masses results in changes in weather conditions.

S.ID.A Summarize, represent, and interpret data on a single count or measurement variable.

S.ID.B Summarize, represent, and interpret data on two categorical and quantitative variables.

S.ID.7 Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of the data.

S.IC.6 Evaluate reports based on data.

Background Information:

Lightning is caused when positive and negative charges collect on opposite sides of clouds. When static electricity arcs between the charges, lightning results. The vast majority (90%) of lightning strikes occur within clouds; only 1 in 10 lightning strikes arc to the ground.

While lightning is spectacular when viewed from a distance, it is also dangerous. It is one of the leading causes of weather-related deaths in the United States each year, as well as property damage. Being familiar with the properties of lightning, and its relationship to thunder, can guide the precautions necessary to minimize the risk of lightning strikes.

Materials:

- ☐ copies of the reading "Inner Workings of Severe Weather" from *Project Earth Science: Meteorology*
- ☐ copies of Flash! Bang! Reading Handouts A-C
- ☐ computer lab/laptops

--OR--

- ☐ poster boards/butcher paper

Vocabulary:

lightning
thunder
thunderstorm
flash-to-bang method
precautions

Resources:

- See Appendix B for Flash! Bang! Handouts A-C

Procedures:

Day One

1. Introductory Video(s):
   a. The students will watch one or more videos/video clips as an introduction to lightning. The following videos are suggestions:
      i. How lightning forms (a clip of a Discovery Channel documentary) https://www.youtube.com/watch?v=jM8h60S1GsM
      ii. Weather and Meteorology: What Causes Lightning? https://www.youtube.com/watch?v=BPDHCBqtPuo
      iii. What Causes Thunder and Lightning? By 60 Second Science

https://www.youtube.com/watch?v=0n6lwlTtz-4

iv. EXTREME Close Lightning in HD Compilation (video of real thunder/lightning) https://www.youtube.com/watch?v=Sp9bKDHRfsM

2. Flash to Bang Reading:
   a. The reading is divided into three sections. If there are more than three groups of students, assign the same section to multiple groups.
      i. Section A: Introduction, Deaths From Severe Weather, Lightning, Thunder, and Some Precautions
      ii. Section B: Lightning and People, Lightning and Property, and Some Precautions
      iii. Section C: The Lightning Flash, The Thunderstorm, and Some Precautions
   b. Distribute copies of the reading "Flash to Bang" from *Project Earth Science: Meteorology* and the Flash! Bang! Reading Handouts.
   c. The students, in their groups, will complete the reading, highlighting important information and taking notes as they read.
   d. The students, in their groups, will answer the questions on the handout.

Day Two

3. Jigsaw Presentations:
   a. The students, in their groups, will create a brief jigsaw presentation to share their learning from the reading with the other groups.
      i. If computers are available, students can create their jigsaw presentation using PowerPoint, Presi, or a similar/other suitable program.
      ii. If computer are not available, students can create their jigsaw presentation on poster board or butcher paper.
   b. Each group will share their presentation and answer clarifying questions from other students.

Differentiation:

Supports

Students with low reading skills may be paired with students of higher reading ability. Alternatively, students with lower reading ability may be paired together and assigned an abbreviated section of the reading, the questions, and the presentation.

Assessment Opportunities:

The questions on the handouts and the jigsaw presentation will informally assess the student's understanding of the concepts addressed in this lesson.

Citations:

The reading "Flash to Bang" can be found in *Project Earth Science: Meteorology* from the NSTA.

Graphing Stories – Lesson 7

Grade Level: Middle School/ Algebra I	**Time Needed:** (1) 45-50 minute class period	**Subjects:** Science, Math

Objective/ Learning Target:
The students will translate between video and graphical representations of a situation.
The students will analyze graphs and make inferences.
The students will compare and contrast graphs to find relationships.

Standards:

MS-ESS2-5. Collect data to provide evidence for how the motions and complex interactions of air masses result in changes in weather conditions.

S.ID.A Summarize, represent, and interpret data on a single count or measurement variable.

S.ID.B Summarize, represent, and interpret data on two categorical and quantitative variables.

S.ID.7 Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of the data.

S.IC.6 Evaluate reports based on data.

Background Information:

Graphing skills go beyond the physical skill of plotting points correctly on a coordinate plane. Students need to develop the tools necessary to discern units for quantities, choose appropriate levels of accuracy, and interpret graph features.

Materials:

- ☐ computer/laptop/tablet to show video clip
- ☐ copies of the Graphing Stories Handout

Vocabulary:

graph
elevation
time
axis
radiation
precipitation

Resources:

- See Appendix B for Graphing Stories Handout

Procedures:

Day One

1. Graphing Story:
   a. Show the first 1:08 minutes of the video below, telling students that their goal will be to describe the motion of the man in words. Note: It is important to stop the video at 1:08 because after that the answers to the graphing questions are given.
   http://www.mrmeyer.com/graphingstories1/graphingstories2.mov
   This is the second video under "Download Options" at the site http://blog.mrmeyer.com/?p=213 called "Elevation vs. Time #2."
   b. Help the students make statements that are relevant to the specified variable of elevation. Some prompting questions could include:
      i. How high do you think he was at the top of the stairs? How did you estimate that elevation?

ii. Were there intervals of time when his elevation wasn't changing? Was he still moving?
iii. Did his elevation ever increase? When?

c. If students do not naturally suggest making a graph, point them in the direction of representing the man's elevation on an elevation vs. time graph.
d. Distribute copies of the Graphing Stories Handout.
e. Give students time to draw the graph of the story individually or in pairs. Lead a discussion of formalizing the diagram:
   i. How should we label the horizontal axis? What unit of measurement would be appropriate?
   ii. How should the vertical axis be labeled? What unit of measurement would make the most sense?
   iii. Should we measure the man's elevation from his head? Or his feet?
   iv. The man starts at the top of the stairs. How do we represent that on our graph?
   v. NOTE: The graph shown at the end of the video is incorrect. It shows the man's elevation beginning at 30 feet which is clearly false. If you choose to show the last part of the video to the class, this would be a good time to work on Math Practice #3 by critiquing someone else's work and finding their error.

2. <u>La Honda, California:</u>
   a. Allow students to work, individually or in pairs, on the graphs about La Honda, California.
   b. After an appropriate amount of time, have students share their answers, focusing on logic, explaining reasoning, and proving ideas.

Differentiation:

<u>Supports</u>

A student who struggles with graphing can be paired with another student, allowing them to focus on the reasoning and conceptual understanding rather than graphing skills.

If the writing is prohibitive for some students, allow them the verbally answer the questions to the teacher, another adult, or a peer.

<u>Extensions</u>

Ask students to brainstorm other types of graphs/situations that might be related.

Assessment Opportunities:

The class discussions and students' answers to questions on the handouts will informally assess the student's understanding of the concepts addressed in this lesson.

Citations:

This lesson is adapted from Module 1, Topic A of the *Engage New York* curriculum.