OVERVIEW	
Unit Title: Weather, Climate, Climate Change **Lesson Title:** Will It Rain Tomorrow?	**Length of Lesson in # of Hours:** 3 **# of Classes:** 2

How does this lesson connect to previous or future work as exemplified by the Standards in your scope and sequence?

This lesson is part of an earth science unit on weather, climate, and climate change. The unit begins by building a foundation of weather-related vocabulary and ideas and introducing basic data and probability concepts that will then be used to make sense of the long term, probabilistic concepts of climate and climate change.

LESSON OBJECTIVES

At the end of this lesson, students will be able to:

- understand probability as the long run frequency of an event occurring
- identify general probabilities along a spectrum from "impossible" to "certain"
- connect probabilities with benchmark fractions and percentages from 0% to 100%, multiples of 10% only
- identify different terms, symbols, and numbers common to weather reports
- interpret a weather report to make decisions

STANDARDS

Citation	
7.SP.5	Understand that the probability of a chance event is a number between 0 and 1 that expresses the likelihood of the event occurring.
RST.7	Integrate and evaluate content presented in diverse media and formats, including visually and quantitatively, as well as in words.

1 - 3 MATHEMATICAL PRACTICE(S) ADDRESSED IN THIS LESSON	ELEMENTS OF RIGOR
MP 4: Model with mathematics.	*Which aspect(s) of Rigor do the targeted Standard(s) require?* ☒ Conceptual understanding of key concepts ☐ Procedural skill and fluency ☒ Rigorous application of mathematics in real-world contexts

ESSENTIAL QUESTIONS

How can I interpret a weather report to make decisions?

What does it mean to say there is an x percent chance of something occurring?

EVIDENCE OF LEARNING

Ways I and my students will know the extent to which the objectives have been met.

Students will complete an exit ticket in which they reconsider the three questions they answered as they came in, and to write a sentence for each one explaining their thinking.

LEARNING PLAN - Vocabulary

Weather/Climate vocabulary that may come up when examining weather reports:

Temperature (temp)

High/low (hi/lo)

Precipitation (precip.)

humidity

Pollen count

Radar

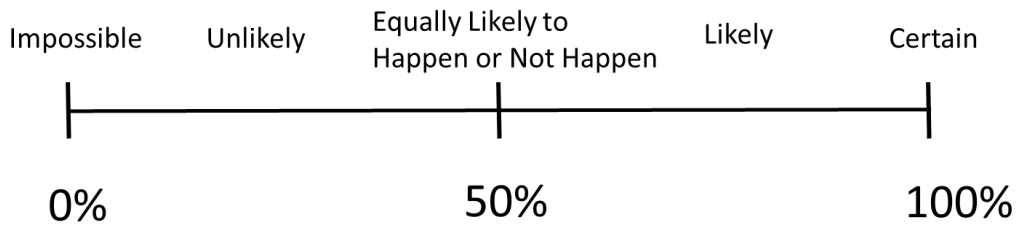
Wind (along with cardinal directions N/S/E/W etc., and mph)
sunny / cloudy / showers / fog / snow / frost / thunderstorms / hail / lightning
Partly / mostly / occasional / scattered / frequent / AM / PM
Extreme (cold / heat)
Emergency
Air Quality
UV index

Math vocabulary:
Probability / chance / likelihood
Likely / unlikely
Impossible / certain

LEARNING PLAN - Introduction	MATERIALS	TIME
Write the following questions on the board. Have students vote (verbally or on board with an X, magnet, or sticky note). 1. **For the last two days, the weather forecast has said there is a 30% chance of rain, but it hasn't rained. Good forecast or bad forecast?** 2. **Yesterday, the weather forecast said there was a 90% of rain, but it didn't rain. Good forecast or bad forecast?** 3. **For the last week, the forecast has predicted an 80% chance of rain every day, but it hasn't rained once. Good forecast or bad forecast?** Spend a few minutes asking students why they chose what they did, but don't go into too much detail now. This is just to get them thinking.		5-10 mins

LEARNING PLAN – Body of the Lesson	MATERIALS	TIME
Looking at Weather Forecasts		
1. Display an online weather report for the current day and location. Some options: • Weather Underground (wunderground.com) • The Weather Channel (weather.com) • Accuweather (accuweather.com) Ask students what they notice about the report. Ask them to write three observations, and then make a class list. Note especially weather-related terms that come up (see list above), and where they see numbers or measurements. Make a list of these on chart paper. Next, ask students what they wonder about the report. Have them write at least two questions, then share out. Show a week or ten-day forecast and repeat the notice/wonder activity. **Numbers or measurements that might appear:** High or low temperatures, usually in °F (can be positive or negative whole numbers) Percent humidity Chance of precipitation (as a percent) Wind speed (usually in mph, often with cardinal direction given)	Laptop and projector or printouts of weather reports	20 mins
2. Assign each small group of students a few of the weather terms from the list to look up (they can use their phones or computers, or just write a definition in their own words if they know what they mean.) Come back together and fill out the definitions on the easel paper while students take notes. Ask, why would someone want to know this data? What kind of decisions could it help them make?	Easel paper and markers	

Probability in Weather Forecasting		
1. Poll students about their impressions of weather forecasts. This can be done verbally with a raise of hands, or you can create a simple visual on the board by writing the question and possible answers and having each student vote with an X or a magnet or sticky note above their answer. **How often do you check the weather forecast?** Never Rarely At least once a week Several times a week Every day **How accurate or reliable do you think weather forecasts are?** Not accurate at all / totally useless Somewhat accurate Mostly accurate Always accurate / never wrong	Easel paper and markers or white board and magnets/sticky notes	30 mins
2. Some people are very critical of weather forecasts and the *meteorologists* that create them. Show clip of Patriots Coach Bill Belichick criticizing meteorologists. https://www.wcvb.com/article/patriots-head-coach-bill-belichick-goes-on-rant-about-meteorologists/8048553 3. Draw students' attention to the fact that both the clip from Belichick and the weather reports they just looked at predicted precipitation with percentages. Ask students if they know what that means and why percentages are used. 4. Ask students if they can define what we mean by the likelihood or chances of something occurring. Create a class definition. The definition should mention something about what we expect to happen, or how confident we are that something will happen or not happen. 5. Draw a probability spectrum on the board, like the one below.	Laptop and projector	



Discuss the terms that go at each point (impossible, unlikely, equally likely or unlikely, likely, certain) and generate examples of events that (subjectively) match these different probabilities. Some ideas:

Impossible:
A horse will give birth to a goat.
A person will grow younger instead of older.

Unlikely:
I will win the lottery jackpot.
I will win an Olympic sporting event.

Equally Likely or Unlikely:
The new baby will be a girl.
I will flip a heads on a coin toss.

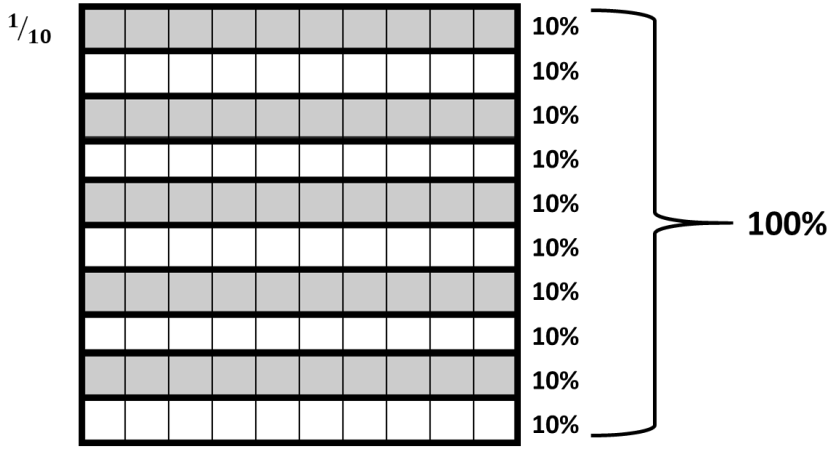
Likely:
The temperature will be above 60 on a summer day in Boston.
I will drive my car to work tomorrow.

Certain:
I will breathe oxygen tomorrow.
Time will keep moving forward.

6. Explain that we can put numbers to probabilities between 0 and 1 (or 0% and 100%) and add numbers (with percent and fraction/decimal equivalents) to the spectrum for 0%, 50%, and 100%. (If students are unfamiliar with percents, define percent as "per hundred" and give examples.) 7. Discuss the fact that there are a lot of things that are *almost* impossible (like travelling to Mars…maybe it can be done, but we don't have the technology yet) or *almost* certain (my name will be the same tomorrow, unless something happens that I never could have predicted). These events might have a probability very close to 0%, or very close to 100%, so we sometimes say they are impossible or certain, even when there is a very, very small chance that we are wrong. Generate some examples of things that are almost impossible (but not quite), and almost certain (but not quite).		
Modeling the Probability of Precipitation		
1. Show students the glass jars and blocks. Explain that you will be modeling a probability situation in which there are ten blocks in a jar. The blocks can be red or blue (or whatever two colors you have), and will be pulled out without looking. (The reason for using glass jars for the whole class demo instead of opaque bags is so that the rest of the class can visually see the ratios of red and blue blocks in the jar.) The jar has to hold ten blocks. Ask students what they would put in to be certain of pulling out a blue. What could they put in to make it impossible to pull out a blue? Equally likely or unlikely? Likely? Unlikely? If there are nine blue blocks and one red block in a jar, what would you predict will happen? Is it possible to pull out a red block? If you did pull out a red block, does that mean that your prediction is bad? 2. Give students a handout, Probability of Rain. Ask them how they would label the extra jumps on the spectrum. Connect this to the blocks in jars, and discuss why each block represents 10%. Make sure to connect to the fraction 1/10 and the idea of one out of ten.	3-4 clear jars (glass or plastic) Blocks, snap cubes, or tiles in two contrasting colors Copies of handout Probability of Rain	60-90 mins

Note: If students struggle with this equivalence (1/10 = 10%) use a visual like the following to show how 100 parts can be broken up into ten groups of ten:

Large grid paper or grid on board



3. Give each pair of students a paper bag and their own blue and red blocks. Explain that a blue block represents rain. Have each pair set up their paper bag so that there is a 50% chance of rain. After checking that each group has 5 red and 5 blue in their bags, ask them to predict what they think will happen if they all draw one block out of their own bag at random.

   Have each group draw out one block. Record the results. Did it match the prediction?

   Repeat several times. Each time record the number of groups that got rain and the number of groups that did not.

   Add up the total number of pulls and the total number of times rain was pulled. How close is it to 50%?

Paper bags, 1 per pair of students

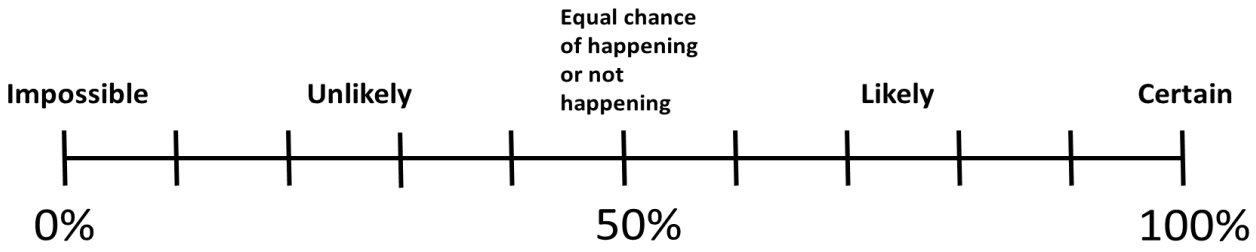
Blocks, snap cubes, or tiles in two contrasting colors

4. Give each pair a weather forecast card. (There should be two groups with each type of forecast, so that they can combine their data to get 100 trials.) Ask them to put the blocks in their bag to model the percent chance of precipitation in their forecast (blue represents precipitation). Check that the groups have done this correctly before they start collecting data. Each pair should follow the instructions on the Probability of Rain worksheet and record their data. 5. Have students record their results on a chart on the board. Have students combine their data with the other pair who had the same forecast, and have them record the total number of "rains" out of 100 trials.	Weather Forecast Cards handout, cut up	
Wrap Up Discussion		
1. Questions for discussion: • **How did your results compare to the probability in the forecast?** • **Did you have any runs of ten with unusual results?** • **Which was closer to the forecast probability: your groups of ten trials, or the larger group of 100 trials? Why do you think this is so?** 2. Explain that when we discuss the probability of the event occurring, it might happen or not happen with only one trial. The probability is what we expect to happen over the long run (many trials). The more trials, the more we expect to get closer and closer to what is predicted (if the prediction is good). 3. Connect this to weather forecasts. When a forecast predicts a percent chance of precipitation, it doesn't tell us whether or not it is going to rain tomorrow. Instead, it tells us what the jar of blocks looks like that we are pulling from. (Reference the clear jars at the front of the room for a visual.)		15-20 mins

LEARNING PLAN – Closure / Conclusion	MATERIALS	TIME
Exit ticket prompt: Ask students to reconsider the three questions they answered as they came in, and to write a sentence for each one explaining their thinking.		10 mins

Suggestions for Differentiation	MATERIALS
More accessible: Reference only likely/unlikely and comparing to the benchmark of ½ (50%). When students are completing the Probability of Rain worksheet, help them set up their bags, then ask them for each set of ten trials (and the later set of 100 trials) whether rain happened more than half the time or less than half the time. **More challenging:** Give students the worksheet Good Forecast or Bad Forecast? This asks them to think informally about when the results we get can seem to have reasonably happened by chance, and when we start to question the underlying models.	Copies of Good Forecast or Bad Forecast?

Probability of Rain



Testing the Forecast

1. Your teacher will give you a weather forecast card. You will need to set up your bag to represent the probability of rain in your weather forecast.

   A blue block means rain, a red block means no rain. Your bag should contain 10 blocks in total.

   Have the teacher check your bag before you start collecting data.

Probability of Rain	Number of blue blocks in our bag	Number of red blocks in our bag

2. Take turns drawing one block out of the bag. **Replace the block after each draw.** Each draw represents one day in which it either rains or does not rain. Draw ten times, and record your results below.

Trial 1: Ten Days	
Rain (Blue)	**No Rain (Red)**

Did the results surprise you? Why or why not?

Since you drew ten times in total, what percentage does each draw represent?

What percent of the time did you draw rain (blue)? How does this compare to your weather forecast?

3. Repeat Step 2 four more times. For each group of ten "days," write the percent of the time it rained (when you drew a blue block).

Trial	Days of Rain (Blue)	Days of No Rain (Red)	Percent of days with rain
2			
3			
4			
5			

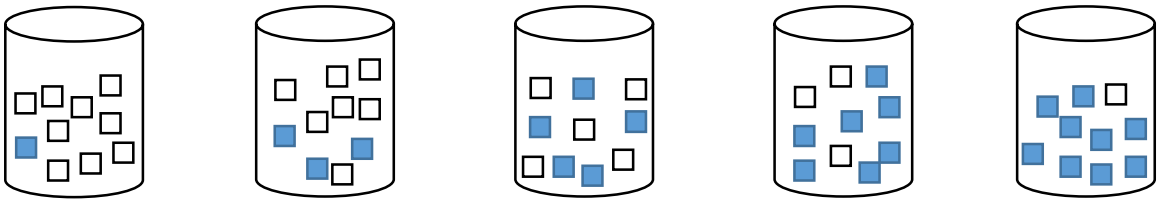
Weather Forecast Cards

Weather Forecast for Boston, MA August 18  72° 30% chance of rain	Weather Forecast for Boston, MA August 18  72° 30% chance of rain
Weather Forecast for Springfield, MA August 18  65° 60% chance of rain	Weather Forecast for Springfield, MA August 18  65° 60% chance of rain
Weather Forecast for Danvers, MA August 18  85° 10% chance of rain	Weather Forecast for Danvers, MA August 18  85° 10% chance of rain
Weather Forecast for Chicopee, MA August 18  80° 40% chance of rain	Weather Forecast for Chicopee, MA August 18  80° 40% chance of rain

Weather Forecast for Plymouth, MA August 18  71° 90% chance of rain	Weather Forecast for Plymouth, MA August 18  71° 90% chance of rain
Weather Forecast for Lenox, MA August 18  63° 20% chance of rain	Weather Forecast for Lenox, MA August 18  63° 20% chance of rain
Weather Forecast for Lowell, MA August 18  61° 50% chance of rain	Weather Forecast for Lowell, MA August 18  61° 50% chance of rain
Weather Forecast for Fall River, MA August 18  78° 80% chance of rain	Weather Forecast for Fall River, MA August 18  78° 80% chance of rain

Good Forecast or Bad Forecast?

When a forecast predicts a percent chance of rain, it doesn't tell us whether or not it is going to rain tomorrow. Instead, it tells us *how likely* it is to rain or not rain. In other words, what does the jar of blocks look like that we are pulling from?



How can we tell if we are getting good or bad forecasts? Based on the lesson activity you just completed, decide if each of these forecasts seems good or bad, based on what actually happened. Then write one sentence explaining your thinking.

Forecast 1: There is a 50% chance of rain every day this week.

What actually happened:

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
No rain	No rain	**Rain**	**Rain**	**Rain**	No rain	No rain

Good forecast or bad forecast? Explain your thinking.

Forecast 2: There is a 20% chance of rain every day this week.

What actually happened:

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
No rain	No rain	No rain	No rain	No rain	No rain	No rain

Good forecast or bad forecast? Explain your thinking.

Forecast 3: There is a 90% chance of rain every day this week.

What actually happened:

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
No rain	No rain	No rain	No rain	No rain	**Rain**	No rain

Good forecast or bad forecast? Explain your thinking.

Forecast 3: There is an 80% chance of rain every day this week.

What actually happened:

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Rain	No rain	**Rain**	**Rain**	No rain	**Rain**	No rain

Good forecast or bad forecast? Explain your thinking.