Unit 3

Weather, Climate, and Water Cycling:

Why does a lot of hail, rain, or snow fall at some times and not others?

Student Work Pages

GRADE 6 Core Knowledge Science®

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Weather, Climate, and Water Cycling:

Why does a lot of hail, rain, or snow fall at some times and not others?

Table of Contents

Science Literacy Exercise Pages

Name: ____________________ Date: ____________________

Initial Model

Develop an initial model to explain "**What causes this kind of precipitation event to occur?**"

- Show what you think was happening above and around the area where the precipitation fell, at 3 different points in time.
- Use *pictures, symbols, and words* to help explain **what caused these changes** to happen over time.

Over the hour before the precipitation started falling where it did	*When the precipitation started falling where it did*	*Over the hour after the precipitation stopped falling where it did*

What do you think happened in this system that would help explain what caused this kind of precipitation event?

Name: ____________________ Date: ____________

Representing Particle-Level Changes in the System

Look back at your model for explaining **"What causes this kind of precipitation event to occur?"**

1. What do you think was happening at the particle level that might help us explain what was happening in this event?
   a. Identify 3 places in the middle frame of your initial model where you think important changes were happening at the particle level in the air or water above.
   b. Add a small circle and a letter (A, B, and C) to those parts of the model.
   c. Use the zoom-in bubbles below to represent what was happening at the particle level in those locations (A, B, and C). Include labels or a key for these representations.

A **B** **C**

2. Go back to your large-scale model on your other handout and use a different color to show and label places where you think energy was getting transferred into, through, or out of the system.

Name: ______________________ Date: ______________

Sunlight and Temperature Investigation

The Question We Want to Answer:

____

____

____

Planning for the Investigation

What data should we collect and why?	
What tools can we use to collect the data? How will we do it?	
How will we choose our sites? **Identify potential sites.**	

Make Predictions

Draw and write about what you think we will see when we collect temperature and sunlight data outside. Use the image below to make notes about different ground and air temperatures.

What do you think we will see in the data?

Collect Data

Choose up to **3 different ground surfaces** that are relatively flat and facing upward and in similar amounts of sunlight (none of them should be in the shade). First, use your light meter to check that all the surfaces have similar amounts of light reaching them. Once you have made sure of this, go from one surface to another and record the following measurements:

Data source: Describe the surface.	Incoming light to the surface (lux)	Reflected light from the surface (lux)	Temperature of the surface (°F)	Temperature of the air 4 ft above the surface (°F)

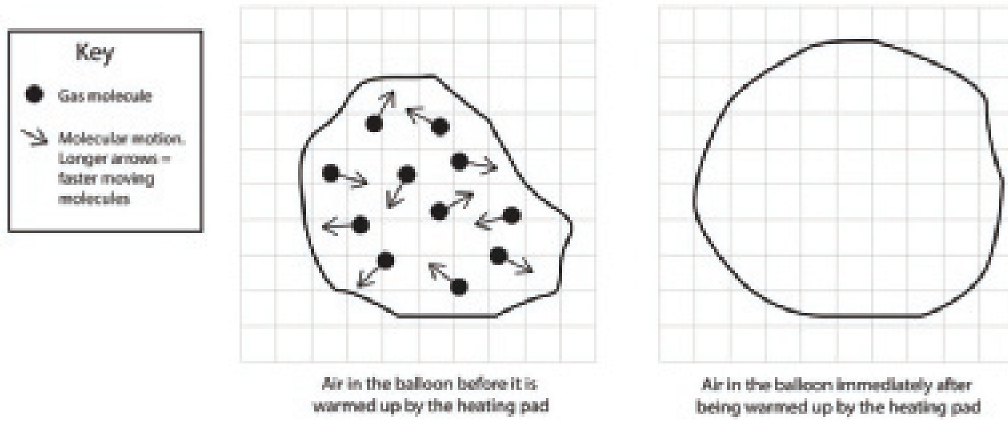
As you collect data, think about these questions...

- Do all the surfaces receive a similar amount of incoming light?
- Do all the surfaces reflect a similar amount of light?
- Are all the surfaces similar temperatures?
- What is the air temperature above the ground compared to the temperature right at the ground?

Jot your notes below as you collect your data.

Heated Balloon Investigation

1. If neither the number nor the size of the gas molecules increased in the balloon after we heated it, what happened that caused the balloon to increase in volume? Draw and label what happened to the gas molecules that can explain this.



2. In which of the models (question 1) were the gas particles inside the balloon more densely packed together? How do you know?

3. In which of the models (question 1) were the gas particles inside the balloon less densely packed together? How do you know?

4. Draw a time series model that shows the balloon's journey at 3 positions over time:
   a. The balloon was first placed on the heating pad.
   b. The balloon was at its highest point in the air.
   c. The balloon fell back to the ground.

5. At each of these 3 positions (a, b, c), describe the following:

- temperature changes of the gas in the balloon
- the temperature of the gas in the balloon compared to the temperature of the air outside the balloon
- volume changes of the balloon
- the density of the gas in the balloon compared to the density of the air outside the balloon (less dense, as dense, or more dense)

***Heated Balloon Investigation*—Time Series Model**

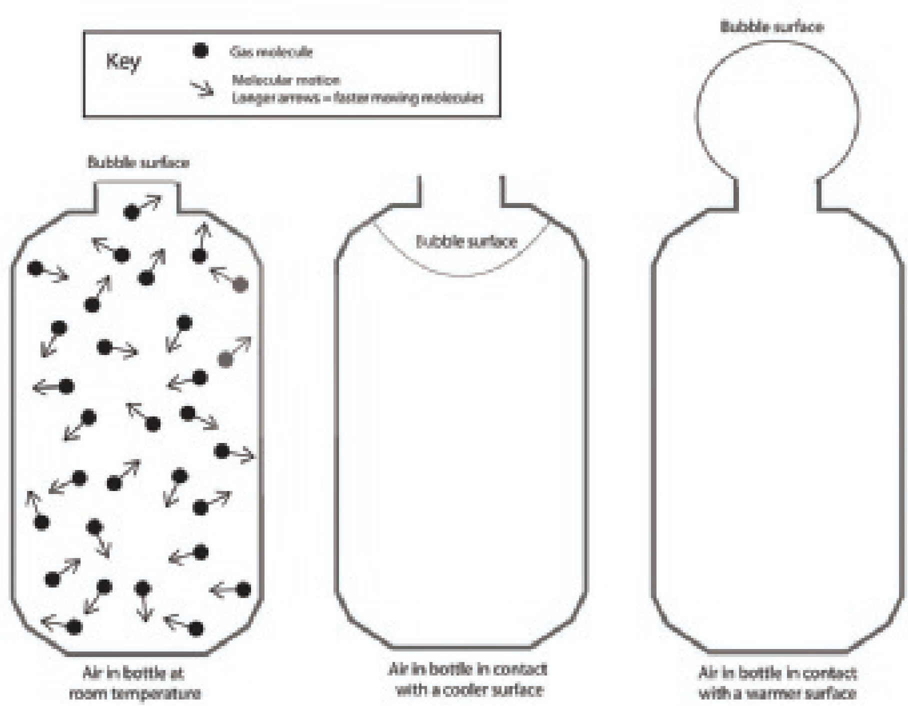
Soap Bubble and Bottle Investigation

1. When representing the molecules that make up the air in the closed bottle system after cooling and after warming, how many dots should you draw? Why?

2. How did changing the temperature of the air in the closed bottle system affect the molecules that made up the air?

3. Use the above ideas to represent changes in the behavior of the molecules that made up the air in the closed bottle system when you cooled and warmed it. As you work on your models, consider the following elements:

- the number of molecules that make up the air in each bottle system
- the length of the arrows to represent the speed of the molecules that make up the air in each bottle system
- the amount of space between the molecules that make up the air in each bottle system



Tracking Air Movement in Cloud Formation

Keep track of any patterns you see in the motion of the air as the hail (cumulonimbus) cloud forms at the six time points shown below.

- Use arrows pointing up to label spots in the hail cloud where you see air moving upward.
- Use an "x" to label spots in the hail cloud where you see air that had been rising stop moving upward.
- Use arrows pointing down to label spots in the hail cloud where you see air moving downward.

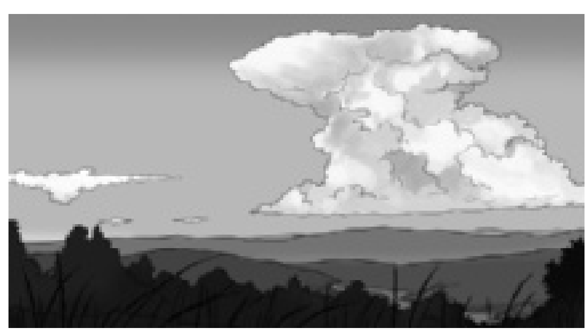
0:32 seconds

0:38 seconds

0:41 seconds

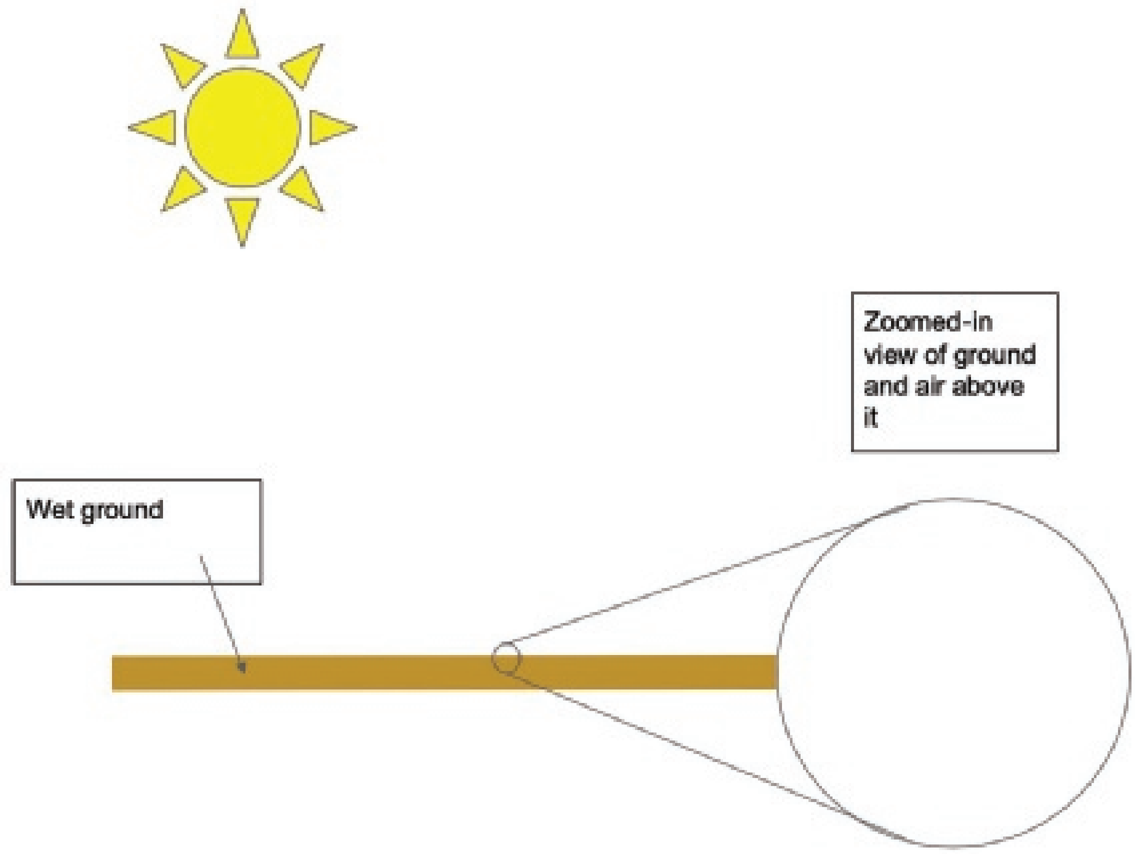
0:45 seconds

0:46 seconds



0:50 seconds

Model for How Water Gets into the Air



Based on the ideas we have developed so far about how light interacts with matter, draw a model in the zoomed-in circle above to show how some of the water in or on the ground gets into the air.

Name: ______________________ Date: ______________

Self-Assessment

Self-Assessment: Giving Feedback

How well did you give feedback today?

Today, I . . .	YES	NO
Gave feedback that was specific and about science ideas.		
Shared a suggestion to help improve my peer's work.		
Used evidence from investigations, observations, activities, or readings to support the feedback or suggestions I gave.		

One thing I can do better the next time I give feedback is:

____

____

Self-Assessment: Receiving Feedback

How well did you receive feedback today?

Today, I . . .	YES	NO
Read the feedback I received carefully.		
Asked follow-up questions to better understand the feedback I received.		
Said or wrote why I agreed or disagreed with the feedback.		
Revised my work based on the feedback.		

What is one piece of feedback you received?

____

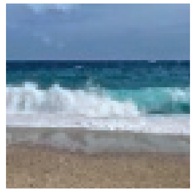
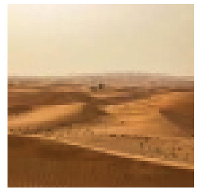
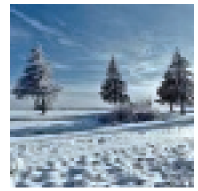
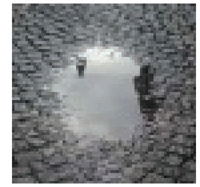
____

What did you add or change to address this feedback?

____

____

Sources of Water in the Air

Environments of the World	 **Beach**	 **Desert**	 **Snow-covered ground**	 **Puddle on the sidewalk**	 **Lawn**	*Control Condition* **Empty container**
Prediction: Is this a place where water in the air could come from?						
Data we recorded						

Making-Sense Questions

1. Which bottles provided evidence that water went into the air?

2. What claim can you make in response to the question, "Where did all the water in the air come from?"

Name: ______________________ Date: ______________

Elements Map and Results for Investigation C

This element in our investigation . . .	*is like this feature in the real world . . .*	*because . . .*
each magnetic marble		
faster vs. slower movement of the marbles		

Real-World Interactions	Investigation Question	Results
C1. Water molecules and water droplets are attracted to one another.	How did the behavior of the marbles compare to the behavior of the water droplets when they made contact with each other in *Investigation B*?	
C2. In a liquid, molecules slide past one another, and in a solid they vibrate back and forth in place.	How did the motion of the marbles change as you simulated an increase in temperature? Was it more like what you picture molecules doing in a liquid or in a solid?	
C3. In a gas, molecules are spread far apart and bounce off other molecules they collide with.	Why are the marbles behaving more like molecules in a gas now? Why would raising the temperature of water high enough cause this to happen?	
C4. Water vapor in the air will condense to form droplets if that air is cooled down enough.	How did the result of a collision change as you slowed down the speed at which the marbles collided? How does this help explain why cooling water vapor can cause condensation?	

Name: ______________________ Date: ______________________

Explaining a Related Phenomenon

A white solid appeared on the surface of the gel pack that wasn't there at the start of the demonstration.

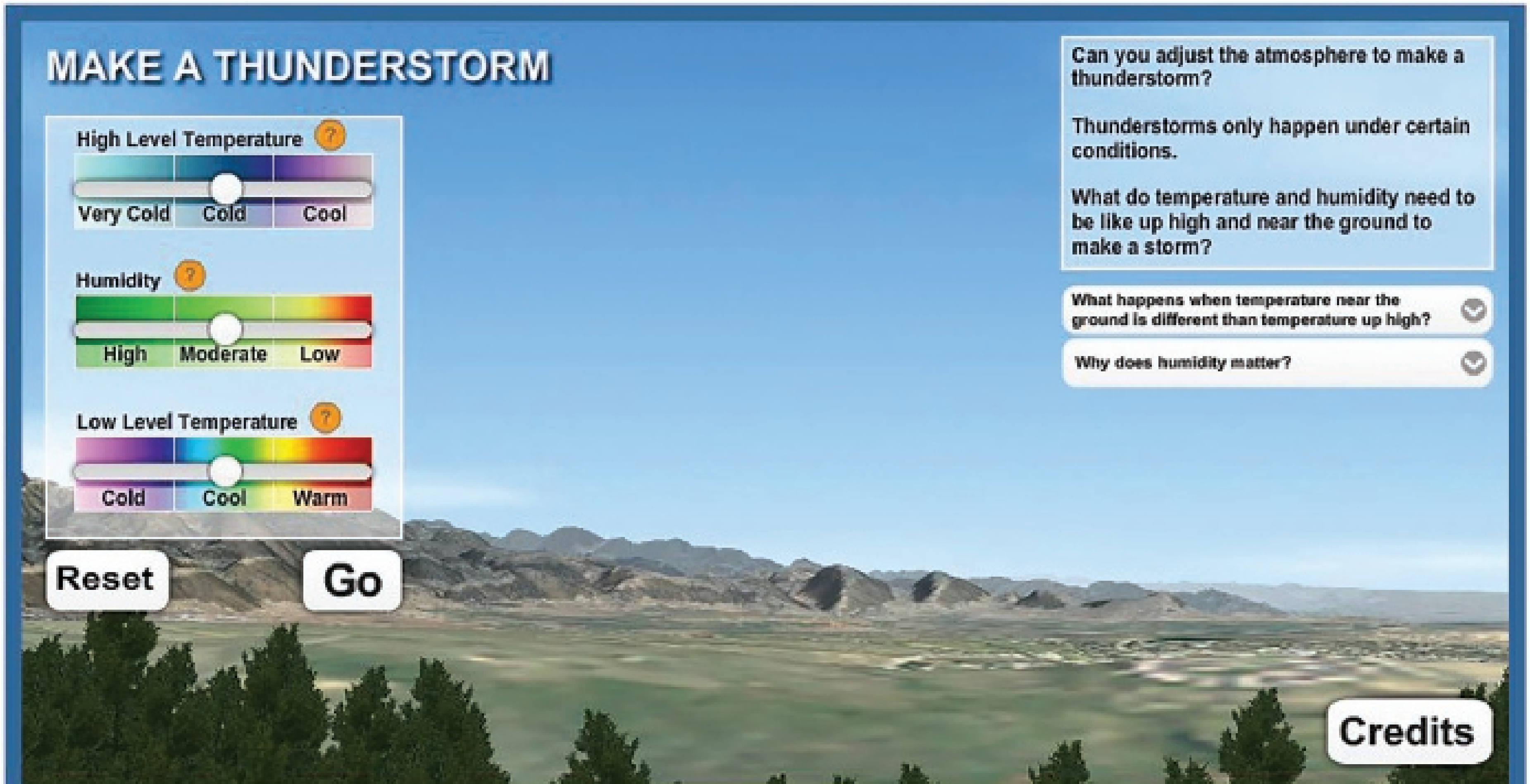
1. What happened to the amount of liquid water in the container (or cup) as the white solid appeared on the gel pack? Why?

2. What happened to some of the molecules of liquid water at the surface that helps explain this phenomenon?

3. What happened to the molecules of water near the gel pack that helps explain this phenomenon?

4. What sorts of things in a cloud serve a similar function as the surface of the gel pack when ice crystals form on it? How do those things help ice crystals form in the cloud?

Name: ______________________ Date: ________________



Credit: UCAR/NCAR

University Corporation for Atmospheric Research (UCAR)

Name: ______________________ Date: ______________

Data Table for Making a Thunderstorm

Input conditions	Output	Why did this happen?
High-level temp [ ] Humidity [ ] Low-level temp [ ]	• no storm • small storm • medium storm • big storm	
High-level temp [ ] Humidity [ ] Low-level temp [ ]	• no storm • small storm • medium storm • big storm	
High-level temp [ ] Humidity [ ] Low-level temp [ ]	• no storm • small storm • medium storm • big storm	
High-level temp [ ] Humidity [ ] Low-level temp [ ]	• no storm • small storm • medium storm • big storm	
High-level temp [ ] Humidity [ ] Low-level temp [ ]	• no storm • small storm • medium storm • big storm	

Name: ______________________ Date: ______________

Explaining Relationships in Storm Development

Using words, symbols, and pictures, construct an explanation that explains the *relationship* between air temperatures close to the ground, air temperatures high in the atmosphere, humidity levels, and storm formation.

- Be sure to account for what these inputs (temperatures and humidity) need to be to form a strong storm versus a weak storm.

Greater differences in temperatures seem to be associated with stronger storms. Does temperature difference cause storms? Why or why not? Are there other things to account for?

Name: ______________________ Date: ______________

Gotta-Have-It Checklist

Instructions: Use information in your science notebook to make a checklist of the most important ideas you need to explain why clouds or storms form at some times but not others.

What our model needs to have to answer the question, "Why do clouds or storms form at some times but not others?"	***Check off pieces of the model as you use them.***	
	Used	***Did not use***
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		
9.		
10.		

Use your checklist to guide your revisions to the Make a Thunderstorm simulation. As you use ideas from your checklist, put a check in the "Used" column for the idea and label the concept in your revisions with its row number from the checklist. If you do not use an idea after all, place a check in the "Did not use" column.

Name: ______________________ Date: ______________

Predicting and Explaining the Effects of Opposing Forces

Make a Prediction. What would different objects do if they were released in clouds where the updraft forces on them were different (Case A versus Case B): *Would the object start to rise, would it start to sink, or would it remain floating at the height it was released?*

Object	Weight of this object (in oz)	Case A	Case B
		Updrafts apply 0.01 oz of force on this object.	Updrafts apply 0.1 oz of force on this object.
Small snowflake	0.0001 oz		
Small water droplet	0.001 oz		
Larger water droplet	0.01 oz		
Small hailstone	0.1 oz		
Larger hailstone	1.0 oz		

The data above can help you argue for why water droplets or ice crystals might remain at a stable height in the clouds in some cases, and might start to rise or fall (change motion) in other cases.

Argue from Evidence. How would you answer our lesson question now: *Why don't water droplets or ice crystals fall from the clouds all the time?*

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Name: ______________________ Date: ______________

Weather Log

Predictions

- What changes do you predict you would see in the cloud cover when the air pressure outside increases?

- What changes do you predict you would see in the cloud cover when the air pressure outside decreases?

Observations

Date	Pressure reading on the barometer	How does this pressure reading compare to the previous one: Is it the same, did it increase, or did it decrease?	Observations of current cloud cover and precipitation
		N/A	

New Wonderings: What new questions are raised by the data you collected?

Air Movement in Different Conditions

Use observations from our investigation with water as the fluid to show how our results apply to what would happen to air in different conditions. Use arrows and words to show the speed and direction of the movement in the different conditions.

Key	Based on your observations of movement in water, use words and pictures to illustrate the relationship between the movement of air and how high a cloud might grow. 
Describe the test condition and observations of movement:	

Name: ______________________ Date: ______________

Convection in Fluids

Complete the table to describe how the elements in the liquid and cup system map back to the cloud and storm systems outside.

This part of the experimental setup. . .	is like. . .	this part of the phenomenon.	How are they the same?
A. Liquid water in a tub	--->		
B. Cup with water at a temperature higher than A	--->		
C. Movement of dye	--->		

Initial Observations

1. Describe the movement of the dye after it was added to the water in both tubs.

Predictions

2. What are some things we could change about what is in the cup below the tub that might increase the amount or rate of thermal energy transfer from the cup to the fluid above?

3. What effect do you think those changes would have on the motion of the fluid above the cup and along the bottom of the tub?

Name: ______________________ Date: ______________

Convection Investigation Plan

Plan your investigation. As you design and conduct your investigation, complete the following data table:

Variable	Condition 1	Condition 2	Will this be your independent variable or a controlled variable?
Initial temperature of the thermal energy source			
Initial temperature of the fluid in the tub			
Amount of matter in the thermal energy source			
Other things that are important to control			
Dependent variables	The amount and direction of movement in the fluid		

Record observations of the dependent variables for each condition.

Condition 1	Condition 2

Name: ____________________ Date: ____________________

Explaining Convection in the Air Outside

1A) A group of scientists measures the temperature of the ground and the air above it at 3 locations. Which location would you expect to have the strongest updrafts?

a. an area where the ground temperature is much greater than the air above it

b. an area where the ground temperature is slightly higher than the air above it

c. an area where the ground temperature is the same as the air above it

1B) Why would this location have the strongest updrafts? What evidence do you have from the investigation we conducted to support the claim you chose?

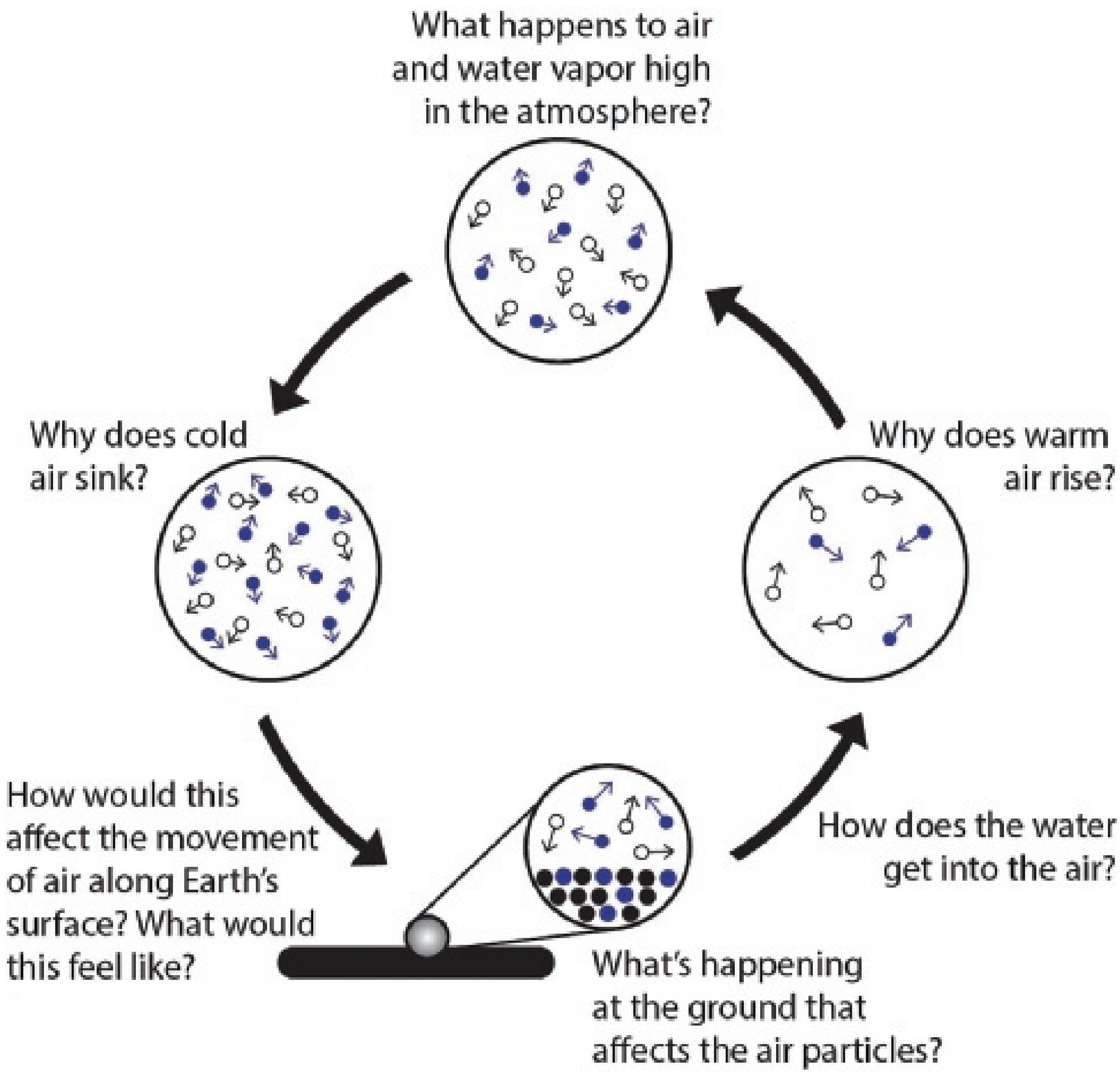
2A) Which location would you expect to have the strongest updrafts?

a. a small amount of land that is 20 degrees warmer than the air above it

b. a large amount of land that is 20 degrees warmer than the air above it

2B) Why would this location have the strongest updrafts? What evidence do you have from the investigation we conducted to support the claim you chose?

Final Hail Model



Name: ______________________ Date: ______________

Lesson 13: Gotta-Have-It Checklist

Instructions: Use your Progress Tracker and your science notebook to add to your checklist the ideas you figured out in the last 2 lessons that you think are important to answer our question.

What our model needs to have to answer the question, "Why do some storms produce hail?"	***Check off pieces of the model as you use them.***	
	Used	***Did not use***
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		
9.		
10.		

Use your checklist to make a new model for answering the question. As you use ideas from your checklist, put a check in the "Used" column for the idea and label the concept on your model with its row number from the checklist. If you do not use an idea after all, place a check in the "Did not use" column.

Name: ______________________ Date: ________________

Revisiting Our Driving Question Board

Instructions: Below is a list of questions from our Driving Question Board. Put the appropriate symbol next to each question to indicate whether you think the class has answered it:

- We did not answer this question or any parts of it, yet: **O**
- Our class answered some parts of this question, or the ideas we developed help me see how I could now answer some parts of this question: ✓
- Our class answered this question, or the ideas we developed help me see how I could now answer this question: ✓+

Questions from the DQB:

Questions from Driving Question Board	Mark

Name: ______________________ Date: ______________

Evaluating Connections to Our Previous Model

The mechanisms listed in the table below were some of the ones we used to explain the question, "Why do some storms produce (really large) hail and others don't?"

Review these mechanisms. Then add the following to column A:

- Put a ✓ next to each mechanism that you predict would also help explain what is causing this large-scale rain, ice, and snowstorm.
- Put a – next to each mechanism that you predict would not also help explain what is causing this large-scale rain, ice, and snowstorm.
- Put a ? next to each mechanism that you aren't sure about.

If there are new mechanism(s) that you think could also help explain what is causing this large-scale rain, ice, and snowstorm, add them to the + section below.

Previous mechanisms	A. My initial ideas	B. My revised ideas
1. Air temperature tends to decrease the higher up you go.		
2. Sunlight absorbed at Earth's surface is the source of thermal energy that warms the air directly above it.		
3. Parcels of air that are less dense than the surrounding air rise, and those that are more dense sink.		
4. Cooling humid air can cause water vapor in it to condense and/or solidify out of it.		
5. Rising air pushes up on water droplets or crystals, holding these aloft until they grow heavy enough to fall.		

+ Additional mechanisms:

____

____

____

How do your ideas compare to others in your class?

____

____

Initial Model

Develop a model and explanation to show what you think will happen in the air over the United States at three points in time that could answer the following questions related to the claims that the forecaster made.

One set of *claims* the forecaster made: *"There are two parts to this storm. We have the cold part and the warm part. . ."*

Annotate your maps to show: Where are these parts located at different points in time?

At the time of the forecast

8:00 am EST Saturday, Jan. 19th, 2019

Sunday morning (24 hours later)

8:00 am EST Sunday, Jan. 20th, 2019

End of Sunday night (40 hours later)

11:59 pm EST Sunday, Jan. 20th, 2019

Another set of claims the forecaster made: *"We are looking for about 4 to 8 inches (of snow) back through Ohio, closer to a foot to a foot and a half across the northeast . . . This is going to be a huge area of concern . . . down east, Maine, most of Massachusetts. This is ice half an inch to three-quarters of an inch."*

Annotate your maps and explain your thinking on a separate piece of notebook paper to help answer this question:
How is what is happening at the time of the forecast (8:00 a.m. Saturday) connected to what is predicted will happen by the end of the weekend (11:59 p.m. Sunday) in the northeastern part of the country?

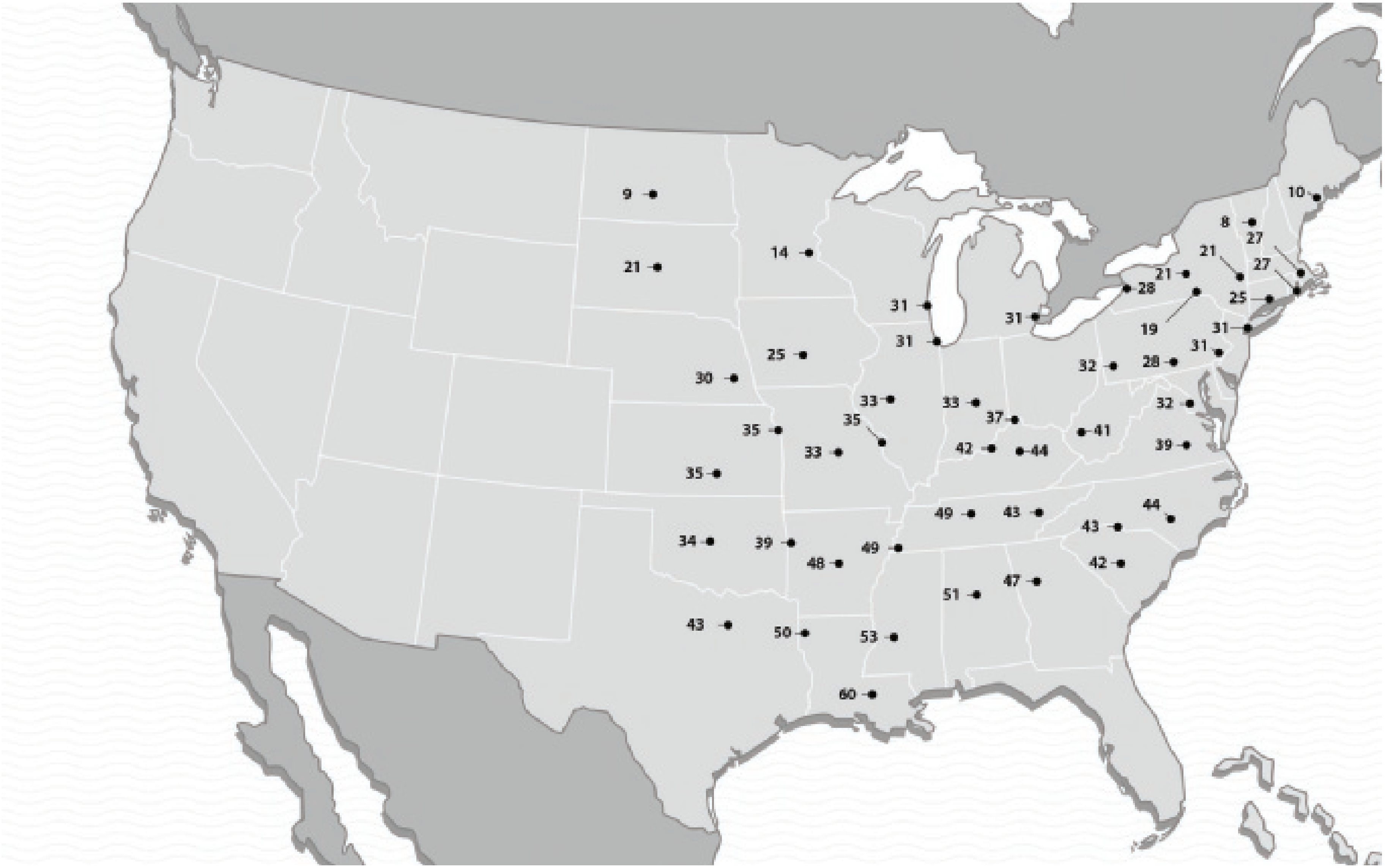
Time Point 1

Air Temperature, Thursday, January 17, 2019, 4:00 p.m.

Data Source: NOAA

Time Point 2

Air Temperature, Friday, January 18, 2019, 12:00 a.m.



Data Source: NOAA

Time Point 3

Air Temperature, Friday, January 18, 2019, 8:00 a.m.

Data Source: NOAA

Time Point 4

Air Temperature, Friday, January 18, 2019, 4:00 p.m.

Data Source: NOAA

Time Point 5

Air Temperature, Saturday, January 19, 2019, 12:00 a.m.

Data Source: NOAA

Time Point 6

Air Temperature, Saturday, January 19, 2019, 8:00 a.m.

Data Source: NOAA

Time Point 7

Air Temperature, Saturday, January 19, 2019, 4:00 p.m.

Data Source: NOAA

Time Point 8

Air Temperature, Sunday, January 20, 2019, 12:00 a.m.

Data Source: NOAA

Time Point 9

Air Temperature, Sunday, January 20, 2019, 8:00 a.m.

Data Source: NOAA

Time Point 10

Air Temperature, Sunday, January 20, 2019, 4:00 p.m.

Data Source: NOAA

Time Point 11

Air Temperature, Monday, January 21, 2019, 12:00 a.m.

Data Source: NOAA

Time Point 1

Relative Humidity, Thursday, January 17, 2019, 4:00 p.m.

Data Source: NOAA

Time Point 2

Relative Humidity, Friday, January 18, 2019, 12:00 a.m.

Data Source: NOAA

Time Point 3

Relative Humidity, Friday, January 18, 2019, 8:00 a.m.

Data Source: NOAA

Time Point 4

Relative Humidity, Friday, January 18, 2019, 4:00 p.m.

Data Source: NOAA

Time Point 5

Relative Humidity, Saturday, January 19, 2019, 12:00 a.m.

Data Source: NOAA

Time Point 6

Relative Humidity, Saturday, January 19, 2019, 8:00 a.m.

Data Source: NOAA

Time Point 7

Relative Humidity, Saturday, January 19, 2019, 4:00 p.m.

Data Source: NOAA

Time Point 8

Relative Humidity, Sunday, January 20, 2019, 12:00 a.m.

Data Source: NOAA

Time Point 9

Relative Humidity, Sunday, January 20, 2019, 8:00 a.m.

Data Source: NOAA

Time Point 10

Relative Humidity, Sunday, January 20, 2019, 4:00 p.m.

Data Source: NOAA

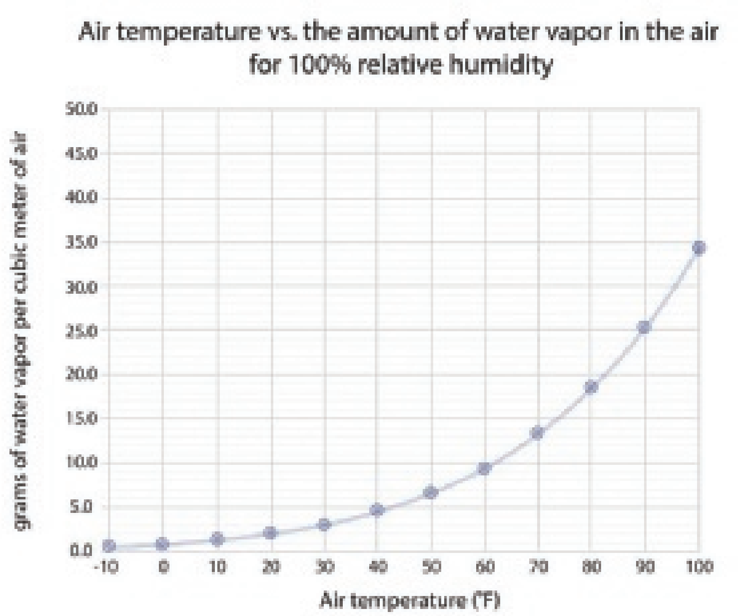
Time Point 11

Relative Humidity, Monday, January 21, 2019, 12:00 a.m.

Data Source: NOAA

Name: ______________________ Date: ______________

Relative Humidity Data



Part A: Use the graph above to answer the following questions:

1. What do the points along the graphed line represent?

____

____

a. How much water vapor is in air at 80°F and 100% relative humidity? ______

b. How much water vapor is in air at 60°F and 100% relative humidity? ______

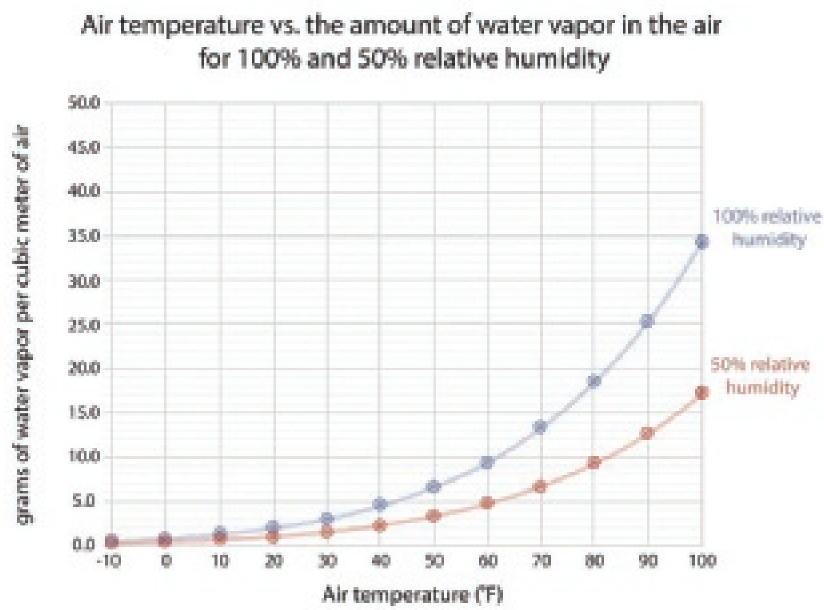
c. How much water vapor is in air at 40°F and 100% relative humidity? ______

2. Based on the information in the graph, what is the relationship between air temperature and the amount of water vapor that the air can hold?

____

____

____



Part B: Use the graph above to answer the following questions:

3. What do the points along the lower line represent?

____

____

d. How much water vapor is in air at 80°F and 50% relative humidity? ______

e. How much water vapor is in air at 60°F and 50% relative humidity? ______

4. Do we still see the same relationship between air temperature and the amount of water vapor that air can hold? How do you know?

____

____

____

Part C

5. What can hold more water vapor in it, warmer air or cooler air? How did the graphs you analyzed help you figure this out?

6. What will happen to some of the water vapor in the air if you cool air that is at 100% relative humidity?

7. If you cool air that is at 60°F and 100% relative humidity, some water vapor will condense out of it. Would any more water vapor condense out of the air if it cooled further? How do you know?

Name: ____________________ Date: ____________

Warm and Cold Water Interactions

Part A: Complete the table to describe how the components of our experimental setup map back to components in the atmosphere.

This component of the experimental setup. . .	. . . is like. . .	. . . this part of the atmosphere.	How are they the same?	How are they different?
Warm water	⇨			
Cold water	⇨			
Aquarium	⇨			
Foam barrier	⇨			

Part B: Use pictures and words to record your observations for each setup.

Air Masses Meeting Along a Vertical Boundary	
Warm water to the left of cold water	**Warm water to the right of cold water**
Prediction:	**Prediction:**
Observations:	**Observations:**

How does warm water interact with cold water after we remove the vertical boundary?

Why do you think this happened?

Air Pressure Maps

<u>Map 1:</u> The air pressures shown on the map below were recorded on Thursday, Jan. 17, 2019 at 4:00 pm (EST).

Data Source: NOAA

Map 2: The air pressures shown on the map below were recorded on Friday, Jan. 18, 2019 at 12:00 am (EST).

Data Source: NOAA

Map 3: The air pressures shown on the map below were recorded on Friday, Jan. 18, 2019 at 8:00 am (EST).

Data Source: NOAA

Map 4: The air pressures shown on the map below were recorded on Friday, Jan. 18, 2019 at 4:00 pm (EST).

Data Source: NOAA

Map 5: The air pressures shown on the map below were recorded on Saturday, Jan. 19, 2019 at 12:00 am (EST).

Data Source: NOAA

Map 6: The air pressures shown on the map below were recorded on Saturday, Jan. 19, 2019 at 8:00 am (EST).

Data Source: NOAA

Map 7: The air pressures shown on the map below were recorded on Saturday, Jan. 19, 2019 at 4:00 pm (EST).

Data Source: NOAA

Map 8: The air pressures shown on the map below were recorded on Sunday, Jan. 20, 2019 at 12:00 am (EST).

Data Source: NOAA

Map 9: The air pressures shown on the map below were recorded on Sunday, Jan. 20, 2019 at 8:00 am (EST).

Data Source: NOAA

Map 10: The air pressures shown on the map below were recorded on Sunday, Jan. 20, 2019 at 4:00 pm (EST).

Data Source: NOAA

Map 11: The air pressures shown on the map below were recorded on Monday, Jan. 21, 2019 at 12:00 am (EST).

Data Source: NOAA

Name: ______________________ Date: ______________________

Air Pressure Prediction and Map Analysis

Predictions

Where do you think the lowest pressure air will be located over the United States from the afternoon of Jan. 17, 2019 to the end of the day on Jan. 20, 2019?

Why do you think you will see this pattern?

Analyze and Interpret the Maps

Review all 11 maps. What patterns do you notice in where the lowest pressure air was located from the afternoon of Jan. 17, 2019 to the end of the day on Jan. 20, 2019?

Name: ______________________ Date: ______________________

Explaining Patterns and Predictions in the Forecast

1. Compare where the area of lowest pressure was in the forecast to what you saw in the actual data from your Gallery Walk. How did the pattern of where the lowest air pressure was located over time compare?

2. How was the forecasted location of lowest air pressure related to the forecasted location of the fronts and precipitation?

3. How could the movement of different air masses and the interaction between them be causing the patterns you noticed in the previous two questions?

Name: ______________________ Date: ______________

Comparing Ideas Used Between Explanations

Previous mechanisms	A. Ideas that others used in their explanations	B. Ideas that I think should be part of my explanation
1. Air temperature tends to decrease the higher up you go.		
2. Sunlight absorbed at Earth's surface is the source of thermal energy that warms the air directly above it.		
3. Parcels of air that are less dense than the surrounding air rise, and those that more dense sink.		
4. Cooling, humid air can cause water vapor in it to condense and/or solidify out of it.		
5. Rising air pushes up on water droplets or crystals, holding these aloft until they grow heavy enough to fall.		
Additional mechanisms		
+		
+		
+		
+		

Name: ______________________ Date: ______________

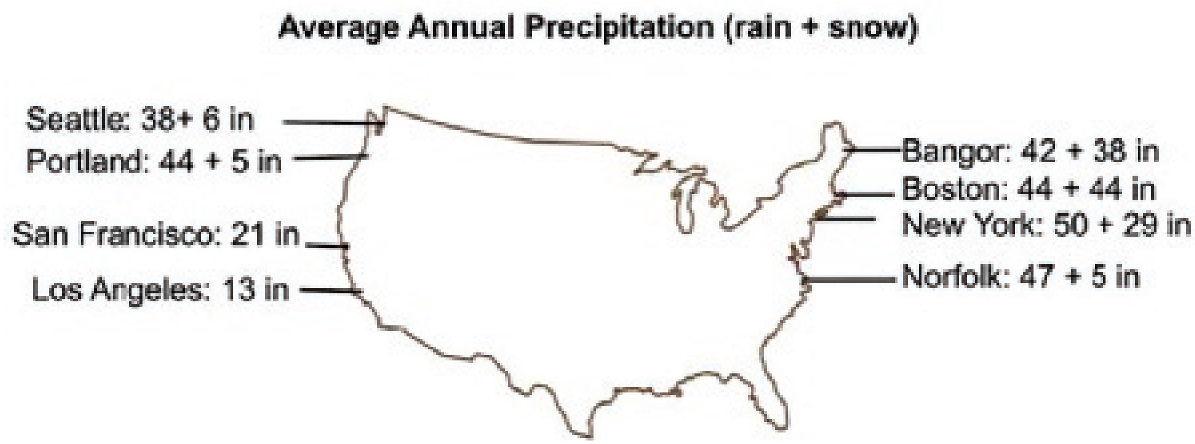
Progress Tracker: Ideas Needed in Our Consensus Explanation

Which previous mechanisms (1-5) and/or which new mechanisms are needed to explain this question:

- How could the movement of different air masses and the interaction between them **cause** the patterns in (a) the area of lowest air pressure, (b) the locations of the fronts, and (c) where precipitation fell over time?

Previous mechanisms	Needed?
1. Air temperature tends to decrease the higher up you go.	
2. Sunlight absorbed at Earth's surface is the source of thermal energy that warms the air directly above it.	
3. Parcels of air that are less dense than the surrounding air rise, and those that are more dense sink.	
4. Cooling, humid air can cause water vapor in it to condense and/or solidify out of it.	
5. Rising air pushes up on water droplets or crystals, holding these aloft until they grow heavy enough to fall.	

Additional mechanisms	
+	
+	
+	
+	



north ↕ south

West coast cities	Days with precipitation	Yearly precipitation (inches)
Seattle, Washington	**149**	**38 rain 6 snow**
Portland, Oregon	**164**	**44 rain 5 snow**
San Francisco, California	**68**	**21 rain 0 snow**
Los Angeles, California	**36**	**13 rain 0 snow**

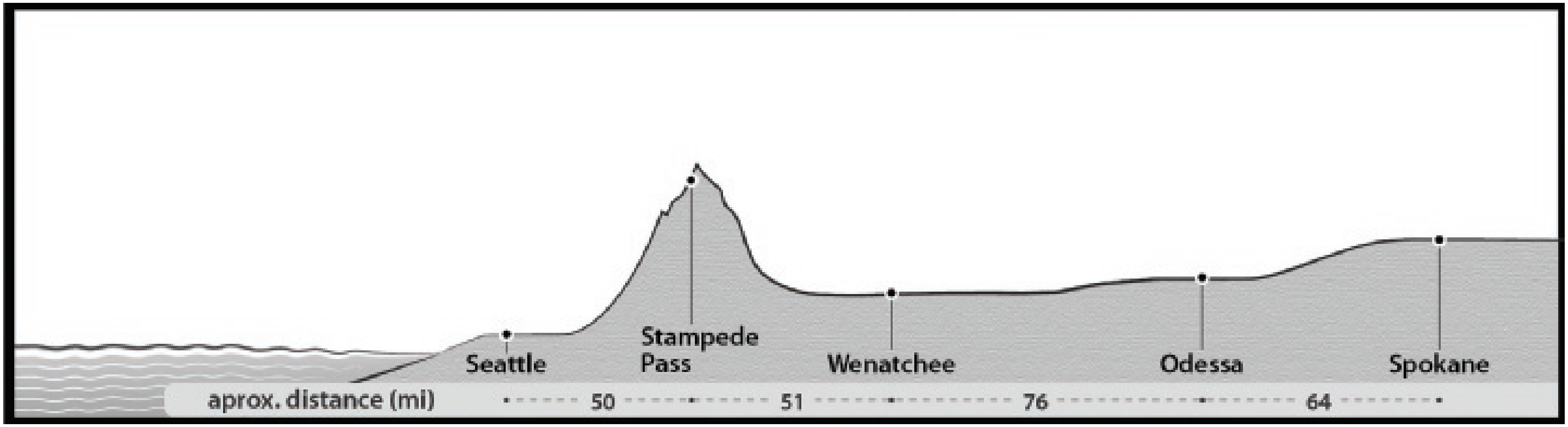
East coast cities	Days with precipitation	Yearly precipitation (inches)
Bangor, Maine	**128**	**42 rain 38 snow**
Boston, Massachusetts	**126**	**44 rain 44 snow**
New York, New York	**122**	**50 rain 29 snow**
Norfolk, Virginia	**114**	**47 rain 5 snow**

Analysis Questions

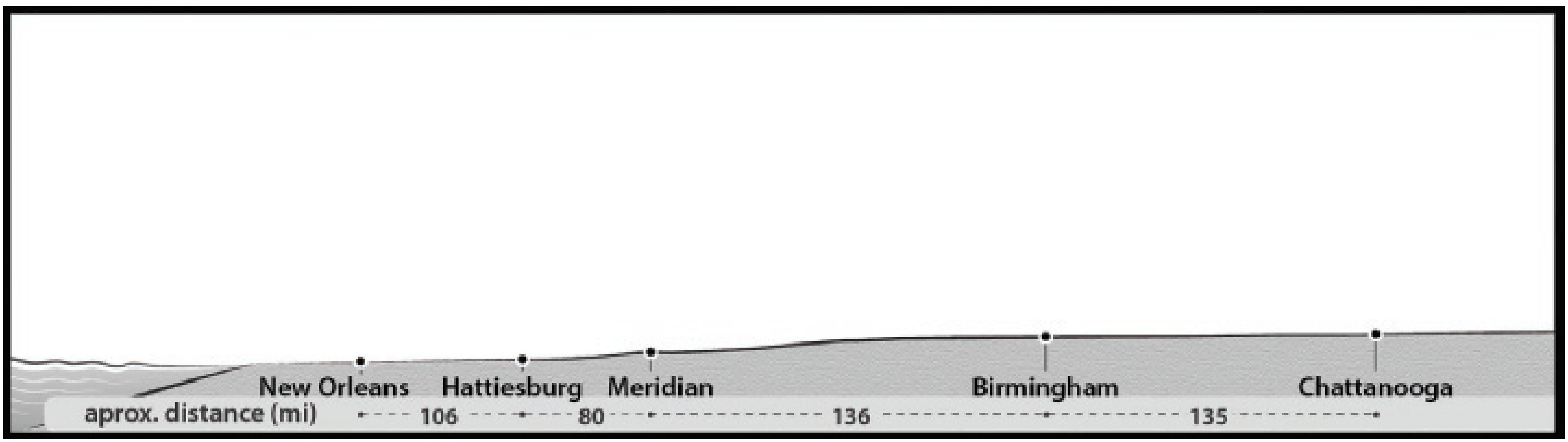
- What patterns do you notice in the data?
- How could the ocean be part of explaining these patterns?
- What could explain the precipitation that happens all along the east coast?
- Why is there such a difference between Portland, Oregon, and Los Angeles, California, even though they are both on the west coast?

Profile Views: Pacific Northwest and Gulf Coast

Pathway 1: Pacific Northwest



Pathway 2: Gulf Coast



Name: ______________________ Date: ______________

Revisiting Our Driving Question Board

Instructions: Below is a list of questions from our Driving Question Board. Put the appropriate symbol next to each question to indicate whether you think the class has answered it:

- We did not answer this question, or any parts of it, yet: ✓
- Our class answered some parts of this question, or the ideas we developed help me see how I could now answer some parts of this question: ✓✓
- Our class answered this question, or the ideas we developed help me see how I could now answer this question: ✓✓✓

Questions from the DQB:

Question from Driving Question Board	Mark

Name: ______________________ Date: ______________

Science Literacy Exercise Page 1 Use with Reading Collection 1

Roadmap for Reading

This week's reading collection focuses on visualizing weather, climate, and the atmosphere. The selections include several maps to interpret.

"Collection 1: Weather Concepts" consists of 4 selections.

1 Rain, Snow, and Hail Capitals
2 A History of Mapping Weather
3 Modern Weather Data Visualizations
4 The Atmosphere as a Fluid

As you read:

- Consider the general purpose of each part: is it a description, an explanation, a procedure, or an attempt to persuade?
- Consider how data and graphics support the narrative text and how narrative text clarifies the data and graphics.
- Jot down words or ideas that you want to better understand, and share them with your teacher.

Written Response

It's career day at school next week, and your challenge is to design a poster to explain what kinds of interests and abilities are needed to become a meteorologist—a weather scientist. You'll have to make some inferences based on what you've read in this collection and arrange them in an appealing design.

- Compose your career day poster on a separate sheet of paper; attach this page to the front of it when you turn it in.
- Include the following points for readers of the poster:
    - *parts of Earth about which they need to become experts*
    - *school subjects they will enjoy*
    - *what types of measurements they would make in this career*
    - *how the work involves computers or not*
    - *how maps and mapping are involved*
- Before you begin, review the criteria in the Evaluation Guidelines that follow to help you clearly understand the expectations of the exercise.

Evaluation Guidelines

Element	1	2	3	Feedback
Content	The job title is missing or inaccurate, and the requirements cannot be inferred from the readings.	The job title is accurate, but there are fewer than five requirements that can be inferred from the readings.	The job title is accurate, and there are five major requirements that can be inferred from the readings.	
Visuals and delivery	The visual elements are absent or unappealing, and the text lacks reader engagement.	The visual elements are appealing but do not support the topic. The text is somewhat engaging.	The visual elements are appealing and support the topic, and the text is engaging.	
Grammar and mechanics	There are six or more errors in punctuation, capitalization, or spelling.	There are three to five errors in punctuation, capitalization, or spelling.	There are fewer than three errors in punctuation, capitalization, or spelling.	

Additional Feedback Notes:

Name: ______________________________ Date: ______________________

Science Literacy Exercise Page 2 Use with Reading Collection 2

Roadmap for Reading

This week's reading collection focuses on how solar energy, Earth's surface, and the atmosphere interact. The selections describe many cause-and-effect relationships that help explain weather and climate patterns.

"Collection 2: Energy and Surfaces" consists of 4 selections.

1 Uneven Heating of Earth
2 Solar Irradiance
3 The Atmosphere and Pressure
4 Earth's Diverse Surfaces

As you read:

- Consider how data and graphics support the narrative text and how narrative text clarifies the data and graphics.
- Consider how each part of the reading relates to knowledge you gained from the previous part and from a previous unit.
- Consider how each part relates to your classroom discussions and investigations.

Written Response

Your writing exercise is to draw a four-panel science comic that will identify one important science idea from each of the four Collection 2 readings.

- Copy the template that follows on a separate sheet of paper and draw your comic in it; attach this page to the front of it when you turn it in.
- Include one character or avatar—human or nonhuman. For example, it can be an expert (a scientist) or a nonexpert (you).
- In each panel, have your character communicate an interesting, challenging, or important idea about weather, climate, or water cycling from one of the four readings.
- Before you begin, review the criteria in the Evaluation Guidelines that follow to help you clearly understand the expectations of the exercise.

Evaluation Guidelines

Element	1	2	3	Feedback
Content	The narrative about solar energy, Earth's surface, and the atmosphere has three or more errors and represents only one or two of the readings.	The narrative about solar energy, Earth's surface, and the atmosphere represents three of the four readings and has only one or two minor errors.	The narrative about solar energy, Earth's surface, and the atmosphere is accurate and represents each of the four readings.	
Character or avatar	The character or avatar is missing or lacks a point of view or personality.	There is one character or avatar, but its point of view or personality is inconsistent across all four panels. Its contribution to reader engagement is minimal.	There is one character or avatar who narrates the comic with a point of view or personality that is consistent across all four panels and contributes to reader engagement.	
Creativity	The comic is lacking in creative details that could have contributed to reader enjoyment.	At least one creative detail contributes to reader enjoyment.	Many creative details contribute to reader enjoyment.	
Organization and illustrations	Fewer than four panels are used. Connections to the readings are not apparent. Drawings and text are difficult to interpret.	Each of the four panels conveys an important idea, but it is not quite clear how they match up with the four readings. Drawings and text are mostly easy to interpret.	Each of four panels conveys an important idea from a different reading. The drawings are easy to interpret, and the text is easy to read.	
Grammar and mechanics	There are more than three errors in punctuation, capitalization, or spelling.	There are one to three errors in punctuation, capitalization, or spelling.	There are no errors in punctuation, capitalization, or spelling.	

Additional Feedback Notes:

Name: ______________________ Date: ______________________

Science Literacy Exercise Page 3 Use with Reading Collection 3

Roadmap for Reading

This week's reading collection focuses on how water on Earth behaves at the particle level and how it is affected by changes in temperature. The selections include four visual displays of data in the form of graphs and maps.

"Collection 3: Water in and out of the Air" consists of 5 selections.

1. Lake Mead
2. Sticky Water
3. Science Fiction, Science Fact
4. A Minute to a Million Years
5. Heat and Drought

As you read:

- Consider how data and graphics support the narrative text and how narrative text clarifies the data and graphics.
- Consider how each part of the reading relates to knowledge you gained from the previous part and from a previous unit.
- Consider how your classroom discussions and investigations about changes to water vapor prepare you to interpret the readings.

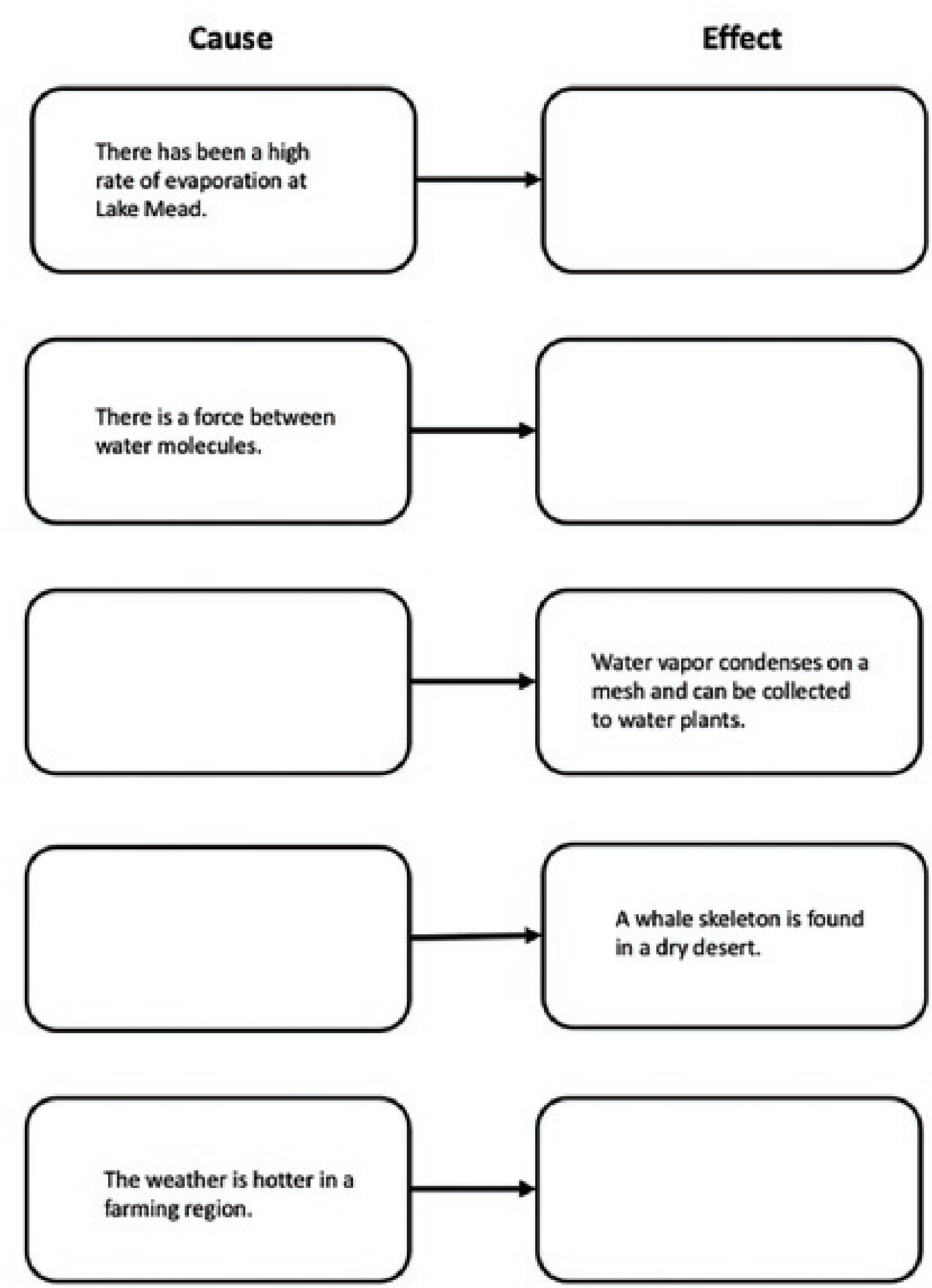
Written Response

Your writing exercise is to complete a cause-and-effect graphic organizer that describes some interactions of water, air, weather, and climate.

- Fill in the blank bubbles on the graphic organizer on page 116.
- Notice that you will write both cause and effect statements. Follow the style provided, and use complete sentences.
- Each of the five readings has a cause-and-effect relationship.

Evaluation Guidelines

- Follow the style provided, and write complete sentences.
- Use terms from the Vocabulary and Word to Know boxes as appropriate.


Cause
Effect
There has been a high rate of evaporation at Lake Mead.
There is a force between water molecules.
Water vapor condenses on a mesh and can be collected to water plants.
A whale skeleton is found in a dry desert.
The weather is hotter in a farming region.

Name: ______________________ Date: ______________

Science Literacy Exercise Page 4 Use with Reading Collection 4

Roadmap for Reading

This week's reading collection focuses on clouds. The selections include many images of a wide variety of clouds for you to compare.

"Collection 4: All About Clouds" consists of 4 selections.

1. Cloud Types
2. Cloud Seeding
3. Cloudy Understanding
4. Clouds and Cities

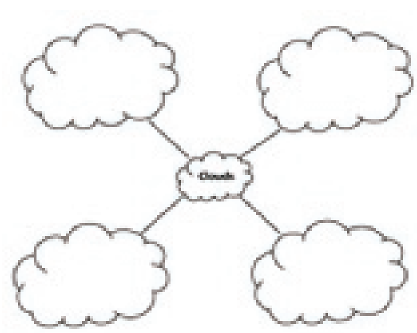
As you read:

- Consider the general purpose of each part: is it a description, an explanation, a procedure, or an attempt to persuade?
- Consider how graphics and images support the narrative text and how narrative text clarifies the graphics and images.
- Look for cause-and-effect relationships that explain why clouds appear as they do.
- Use what you learned in class discussions and context clues to figure out the meanings of science terms in the text.

Written Response

Your writing exercise is to draw a concept map summarizing main ideas about clouds in this collection.

- Compose your concept map on a separate sheet of paper; attach this page to the front of it when you turn it in.
- Use the drawing below as a model for your concept map, but you may change the layout and add more clouds for details.
- Make sure there is a main idea for each of the four readings expressed as a complete sentence.



- Before you begin, review the criteria in the Evaluation Guidelines that follow to help you clearly understand the expectations of the exercise.

Evaluation Guidelines

Element	1	2	3	Feedback
Content	One or more readings is not represented by a main idea cloud. There are two or more scientific inaccuracies. Cause-and-effect thinking is difficult to identify.	There are four main ideas, but it is difficult to identify which represents which reading. At least one main idea has minor scientific inaccuracies. Cause-and-effect thinking is apparent in at least one of the main ideas.	Each of the four readings is summarized by a scientifically accurate main idea. The main ideas make it easy to identify which reading is which. Cause-and-effect thinking is evident in the wording.	
Relationships of concepts	The organization of topic title and main ideas is confusing.	The organization is mostly easy to follow. If details are present, they are linked to the correct main ideas.	The organization, including linking lines, clearly distinguishes main ideas from the topic title. If details are present, they are linked to the correct main ideas.	
Design and graphic elements	Drawing is messy; text is difficult to read in several places.	Drawing is mostly neat and legible design; text is somewhat easy to read.	Drawing is a neat, legible design; text is easy to read.	
Grammar and mechanics	There are five or more errors in punctuation, capitalization, or spelling.	There are one to four errors in punctuation, capitalization, or spelling.	There are no errors in punctuation, capitalization, or spelling.	

Additional Feedback Notes:

Name: ______________________ Date: ______________________

Science Literacy Exercise Page 5 Use with Reading Collection 5

Roadmap for Reading

This week's reading collection focuses on how storms and other extreme weather develop. The selections reveal that some of these changes are sudden and others, such as changes in climate, are gradual.

"Collection 5: Convection, Hail, and Other Events" consists of 5 selections.

1 Hailstorms
2 Severe Weather Hot Spots
3 Perspectives on Climate Change
4 Jet Streams and Weather
5 Convection and Storms

As you read:

- Consider the general purpose of each part: is it a description, an explanation, a procedure, or an attempt to persuade?
- Consider how data and graphics support the narrative text and how narrative text clarifies the data and graphics.
- Consider how each part of the reading relates to knowledge you gained from the previous part.

Written Response

After reading this week's collection, your writing exercise is to complete an outline that summarizes the science in each of the selections.

- Copy the partially written outline on a separate sheet of paper; attach this page to the front of it when you turn it in.
- Go back and review the readings, looking for statements that describe important cause-and-effect relationships. Write additional main ideas needed to complete the summary of each reading in the outline.
- Write your own title above the outline, summarizing the entire collection of readings, while including wording that signifies cause and effect.
- Before you begin, review the criteria in the Evaluation Guidelines that follow to help you clearly understand the expectations of the exercise.

Science Literacy Exercise Page 5 continued

Title: ______________________________

I. Hailstorms

A. Hailstones vary from pea-sized to grapefruit-sized.

B. Hail forms in thunderstorms when updrafts lift rain to where the air is colder and the water freezes.

C. ______________________________

II. Severe Weather Hot Spots

A. The probability of severe weather depends on the month of the year.

B. ______________________________

C. ______________________________

III. Perspectives on Climate Change

A. Scientists think a warming climate may cause more hailstorms.

B. ______________________________

C. ______________________________

IV. Jet Streams and Weather

A. When the polar jet stream moves north and south, it causes colder or warmer weather.

B. ______________________________

V. Convection and Storms

A. ______________________________

B. ______________________________

C. A large, steady updraft can produce a tornado.

Evaluation Guidelines

Element	1	2	3	Feedback
Outline title	Inadequately summarizes the collection of readings or signifies cause-and-effect relationships	Clearly summarizes either the entire collection of readings or signifies cause-and-effect relationships	Clearly summarizes the entire collection of readings and signifies cause-and-effect relationships	
Main ideas	Incomplete or inaccurate statements, or too detailed to be considered main ideas	Complete or accurate main ideas, but unclear relationship to cause and effect	Appropriate and accurate main idea sentences for each lettered line in the outline that include cause-and-effect language	
Grammar and mechanics	There are six or more errors in punctuation, capitalization, or spelling.	There are three to five errors in punctuation, capitalization, or spelling.	There are fewer than three errors in punctuation, capitalization, or spelling.	

Additional Feedback Notes:

Name: ______________________ Date: ______________

Roadmap for Reading

This week's reading collection is wide-ranging in topics—but all have something to do with weather. The selections include a travel ad, tips on how to interpret weather maps, and diagrams.

"Collection 6: A Closer Look at Weather" consists of 4 selections.

1 Destination: Florida

2 Barometers: Then and Now

3 How Air Masses Behave

4 Hailstone Factory

As you read:

- Consider the general purpose of each part: is it a description, an explanation, a procedure, an argument of a point, or an attempt to persuade?
- Consider how images and data support the narrative text and how narrative text clarifies the images and data.
- Consider how knowledge you gained from the activities and discussions in Lessons 15–18 prepares you to interpret what you are reading.

Written Response

Your writing exercise is to draft some rap song lyrics that use a weather idea as a metaphor.

- Compose your lyrics on a separate sheet of paper; attach this page to the front of it when you turn it in.
- Write four lines. You can think of them as the beginning of a much longer song or as the reprise (the part of the song that gets repeated).
- Choose a weather concept from Collection 6 as a metaphor for something else you want to communicate.
    - *climates with warm air temperatures*
    - *how a barometer works or what causes various atmospheric pressures*
    - *air masses, the fronts where they meet, and weather maps*
- Choose words that will rhyme or create a strong beat when performed.
- Before you begin, review the criteria in the Evaluation Guidelines that follow to help you clearly understand the expectations of the exercise.

Evaluation Guidelines

Element	1	2	3	Feedback
Content	It is hard to tell what weather topics or concepts were intended.	References are made to weather in general but not the specific topics or concepts from Collection 6 readings.	References are clearly focused on one topic or concept from Collection 6 readings; all science references are accurate.	
Originality and use of metaphor	There is little evidence of originality that adds to the listener's enjoyment; there is no weather metaphor evident.	There is some evidence of originality that adds to the listener's enjoyment; the weather metaphor is a bit hard to grasp.	There is clear evidence of originality that adds to the listener's enjoyment; it is clear what the weather metaphor represents.	
Rhyming or beat	There is little evidence in the word choice to attempt to rhyme or establish a beat.	Though not entirely successful, there is clear evidence that an attempt was made to rhyme or have a strong beat.	The last words of some lines rhyme, or there is a strong beat pattern when read aloud.	
Mechanics	Capitalization is lacking; there are three or more unintended spelling errors.	There are one or two errors in capitalization; there are one or two unintended spelling errors.	There are no errors in capitalization; any spelling errors are intentional to make rhymes, repetition, or a beat.	

Additional Feedback Notes:

Name: ____________________ Date: ____________________

Science Literacy Exercise Page 7 Use with Reading Collection 7

Roadmap for Reading

This week's reading collection focuses on instruments used to collect weather data, climate patterns, and understanding weather forecasts. Two mathematical themes of this collection are exploring probability and understanding data sets.

"Collection 7: Weather and Climate" consists of 5 selections.

1 Inventions in Weather
2 El Niño and La Niña
3 Science Interviews Podcast
4 Fall Camping in Death Valley
5 Dear Weather Detective

As you read:

- Consider the general purpose of each part: is it a description, an explanation, a procedure, or an attempt to persuade?
- Consider how graphics support the narrative text and how narrative text clarifies the graphics.
- Consider how each reading relates to knowledge you gained from Lessons 19–22.

Written Response

Your writing exercise is to complete a thoughtful paragraph that argues the usefulness of the concept of probability when explaining weather events and climate.

- Compose your paragraph on a separate sheet of paper; attach this page to the front of it when you turn it in.
- Choose one of the following topic sentences, making a claim.
    - *There IS a probability of rain when playing basketball in Death Valley.*
    - *The words* complex *and* dynamic *are useful to use when trying to understand, describe, and predict weather.*
    - *Weather is at the same time both predictable and not fully predictable.*
    - *When a weather app shows a graphic of rain falling and it doesn't rain, nothing is wrong with the app.*
- Complete a well-constructed paragraph that supports the claim in the topic sentence. In your supporting sentences, construct an argument that uses details from the Collection 7 readings in your supporting.
- End your paragraph with a conclusion sentence that refers to the claim and explains why the reader should care.
- Before you begin, review the criteria in the Evaluation Guidelines that follow to help you clearly understand the expectations of the exercise.

Evaluation Guidelines

Element	1	2	3	Feedback
Content	Inadequate alignment with the claim in the topic sentence	Adequate completion of a paragraph about weather and climate, but weak in alignment with the claim in the topic sentence	Thorough support of the topic sentence claim, citing specific, relevant details from the reading selections	
Supporting sentences (details)	Incomplete sentences, or details irrelevant to the claim in the topic sentence	Complete sentences, but too few, lacking in support from the readings, or having an unclear relationship with the topic sentence claim	At least six complete sentences, encompassing three major points from the reading that support the topic sentence claim	
Conclusion sentence	Conclusion sentence is missing or contradicts the claim in the topic sentence; statement of why the reader should care is missing.	Restates the claim using some of the same wording in the topic sentence; includes a general statement of why the reader should care	Restates the claim using different wording than in the topic sentence; includes a strong statement of why the reader should care	
Grammar and mechanics	There are six or more errors in punctuation, capitalization, or spelling.	There are three to five errors in punctuation, capitalization, or spelling.	There are fewer than three errors in punctuation, capitalization, or spelling.	

Additional Feedback Notes:

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