Weather & Station Models

Units 7-2 & 7-3
Subject(s) Earth Science / New Media Art
Grades Jr. High School / High School (8 -11)
Class Periods 18

A variety of factors combine to create the atmospheric conditions we know as weather.   Each day, hourly weather forecasts are available to us through countless media outlets; with one click on our phone, we can determine whether we will need a jacket, if school will be closed due to snow, or if conditions are suitable to play that double-header. But do we know which combinations actually create that perfect spring day or that perfect storm? This lesson will provide students with the knowledge of how meteorologists determine our weather forecasts and the way in which this data is communicated.

Unit Overview

Unit (Prentice Hall)	7
Key Ideas & Major Performance Indicators	▪ Atmospheric Temperature & Heating ▪ Effects on Barometric Pressure ▪ Planetary Winds & Pressure ▪ Atmospheric Humidity & Dew point ▪ Clouds & Precipitation ▪ Air Masses & Fronts ▪ Storms ▪ Weather Predictions & Station Models
Essential Questions	▪ What creates weather? ▪ How can we predict weather? ▪ How do meteorologists communicate weather variables through forecasts?
Skills	▪ Reading thermometers & barometers ▪ Using conversion tables for relative humidity & dewpoint ▪ Reading & drawing station models ▪ Analyzing fronts on a map and making weather predictions ▪ Creating a storyboard ▪ Video filming and editing
ESRT Pages	Pages 1 (specific heats, properties of water, 12 (dewpoint/rel. humidity), 13 (temp., pressure, weather map symbols), 14(planetary wind & moisture, Earth's atmosphere)

Standards
NYS Learning Standards

HS. Weather and Climate

Students who demonstrate understanding can:

HS-ESS2-4. Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate.

HS-ESS3-5. Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems.

HS-ESS2-8. Evaluate data and communicate information to explain how the movement and interactions of air masses result in changes in weather conditions.

Science and Engineering Practices

Developing and Using Models Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed world(s).
• Use a model to provide mechanistic accounts of phenomena. (HS-ESS2-4)

Analyzing and Interpreting Data
Analyzing data in 9-12 builds on K-8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data.
• Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution. (HS-ESS3-5),(HS-ESS2-8)

Obtaining, Evaluating, and Communicating Information Obtaining, evaluating, and communicating information in 9–12 builds on K–8 experiences and progresses to evaluating the validity and reliability of the claims, methods, and designs.
• Communicate scientific ideas (e.g., about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically). (HS-ESS2-8)

Connections to Nature of Science Scientific Investigations Use a Variety of Methods
• Science investigations use diverse methods and do not always use the same set of procedures to obtain data. (HS-ESS3-5)
• New technologies advance scientific knowledge. (HS-ESS3-5)

Scientific Knowledge is Based on Empirical Evidence
• Science knowledge is based on empirical evidence. (HS-ESS3-5)
• Science arguments are strengthened by multiple lines of evidence supporting a single explanation. (HS-ESS2-4), (HSESS3-5)

Disciplinary Core Ideas

ESS2.D Weather and Climate
The foundation for Earth's global climate systems is the electromagnetic radiation from the sun, as well as its reflection, absorption, storage, and redistribution among the atmosphere, ocean, and land systems, and this energy's re-radiation into space. (HS-ESS2-4), (secondary to HS-ESS2-2)
• Changes in the atmosphere due to human activity have increased carbon dioxide concentrations and thus affect climate. (HS-ESS2-4)
• (NYSED) Concepts of density and heat energy can be use

ESS3.D Global Climate Change
Though the magnitudes of human impacts are greater than they have ever been, so too are human abilities to model, predict, and manage current and future impacts. (HS-ESS3-5)

Crosscutting Concepts

Patterns
• Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena. (HS-ESS2-8)
• Empirical evidence is needed to identify patterns. (HS-ESS2-8)

Cause and Effect
• Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-ESS2-4),(HS-ESS2 8)

Stability and Change
• Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible. (HS-ESS3-5)

Common Core State Standards Connections
ELA /Literacy
RST .11-12.1 Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.

RST .11-12.7 Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem. (HS-ESS3-5),(HS-ESS2-8)

RST .11-12.9 Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.

SL.11-12.5 Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest. (HS-ESS2-4)

WHST .9-12.1 Write arguments focused on discipline-specific content. (HS-LS3-2)

Media Arts Learning Standards

Media Arts – Creating – Conceiving and Developing New Artistic Ideas and Work

Anchor Standard 1 Generate and conceptualize artistic ideas and work.

Enduring Understanding 1.1	Media arts ideas and works are shaped by the imagination, creative processes, artistic traditions, and experiences	
Artistic Process	CREATING	
Process Component	CONCEIVE	
Essential Questions	• How do media artists generate ideas? • How can ideas for media arts productions be formed and developed to be effective and original?	
HS Proficient	**HS Accomplished**	**HS Advanced**
MA:Cr1.1.HSI	MA:Cr1.1.HSII	MA:Cr1.1.HSIII
Use identified generative methods to formulate multiple ideas, develop artistic goals for media artwork.	Strategically utilize generative methods to formulate multiple ideas, refine artistic goals, and increase the originality of approaches in media arts creation	Integrate aesthetic principles with a variety of generative methods to fluently form original ideas, solutions, and innovations in media arts creation processes.

Anchor Standard 2 Organize and develop artistic ideas and work.

Enduring Understanding 2.1	Media artists plan, organize, and develop creative ideas, plans, and models into process structures that can effectively realize the artistic idea	
Artistic Process	CREATING	
Process Component	DEVELOP	
Essential Questions	How do media artists organize and develop ideas and models into process structures to achieve the desired end product?	
HS Proficient	**HS Accomplished**	**HS Advanced**
MA:Cr2.1.HSI	MA:Cr2.1.HSII	MA:Cr2.1.HSIII
a. Apply aesthetic criteria in developing, proposing, and refining artistic ideas, plans, prototypes, and production processes for media arts productions, considering original inspirations, goals, and presentation context.	a. Apply a personal aesthetic in designing, testing, and refining original artistic ideas, prototypes, and production strategies for media arts productions, considering artistic intentions, constraints of resources, and presentation context	a. Integrate a sophisticated personal aesthetic and knowledge of systems processes in forming, testing, and proposing original artistic ideas, prototypes, and production frameworks, considering complex constraints of goals, time, resources, and personal limitations

Anchor Standard 3 Refine and complete artistic work

Enduring Understanding 2.2	Media artists plan, organize, and develop creative ideas, plans, and models into process structures that can effectively realize the artistic idea	
Artistic Process	CREATING	
Process Component	CONSTRUCT	
Essential Questions	• What is required to produce a media artwork that conveys purpose, meaning, and artistic quality? How do media artists improve/refine their work?	
HS Proficient	**HS Accomplished**	**HS Advanced**
MA:Cr3.1.I	MA:Cr3.1.II	MA:Cr3.1.II

a. Consolidate production processes to demonstrate deliberate choices in organizing and integrating content and stylistic conventions in media arts productions, demonstrating understanding of associated principles, such as emphasis and tone. b. Refine and modify media artworks, honing aesthetic quality and intentionally accentuating stylistic elements, to reflect an understanding of personal goals and preferences.	a. Consolidate production processes to demonstrate deliberate choices in organizing and integrating content and stylistic conventions in media arts production, demonstrating understanding of associated principles, such as continuity and juxtaposition. b. Refine and elaborate aesthetic elements and technical components to intentionally form impactful expressions in media artworks for specific purposes, intentions, audiences and contexts.	a. Synthesize content, processes, and components to express compelling purpose, story, emotion, or ideas in complex media arts productions, demonstrating mastery of associated principles, such as hybridization b. Intentionally and consistently refine and elaborate elements and components to form impactful expressions in media artworks, directed at specific purposes, audiences, and contexts.

Anchor Standard 5 Develop and refine artistic techniques and work for presentation.

Enduring Understanding 5.1	Media artists require a range of skills and abilities to creatively solve problems within and through media arts productions		
Artistic Process	PRODUCING		
Process Component	PRACTICE		
Essential Questions	What skills are required for creating effective media artworks and how are they improved? How are creativity and innovation developed within and through media arts productions? How do media artists use various tools and techniques?		
HS Proficient	HS Accomplished		HS Advanced
MA:Cr5.1.HSI	MA:Cr5.1.HSII		MA:Cr5.1.HSIII
a. Demonstrate progression in artistic, design, technical, and soft skills, as a result of selecting and fulfilling specified roles in the production of a variety of media artworks. b. Develop and refine a determined range of creative and adaptive innovation abilities, such as design thinking, and risk taking, in addressing identified challenges and constraints within and through media arts productions. c. Demonstrate adaptation and innovation through the combination of tools, techniques and content, in standard and innovative ways, to communicate intent in the production of media artworks.	a. Demonstrate effective command of artistic, design, technical and soft skills in managing and producing media artwork b. Demonstrate effective ability in creative and adaptive innovation abilities, such as resisting closure, and responsive use of failure, to address sophisticated challenges within and through media c. Demonstrate the skillful adaptation and combination of tools, styles, techniques, and interactivity to achieve specific expressive goals in the production of a variety of media artworks.		a. Employ mastered artistic, design, technical, and soft skills in managing and producing media artworks. b. Fluently employ mastered creative and innovative adaptability in formulating lines of inquiry and solutions, to address complex challenges within and through media arts productions. c. Independently utilize and adapt tools, styles, and systems in standard, innovative, and experimental ways in the production of complex media artworks.

Anchor Standard 7 Perceive and analyze artistic work

Enduring Understanding 7.1	Identifying the qualities and characteristics of media artworks improves one's artistic appreciation and production		
Artistic Process	RESPONDING		
Process Component	PERCEIVE		
Essential Questions	How do we 'read' media artworks and discern their relational components? How do media artworks function to convey meaning and manage audience experience?		
HS Proficient	HS Accomplished		HS Advanced
MA:Cr7.1.HSI	MA:Cr7.1.HSII		MA:Cr7.1.HSIII
a. Analyze the qualities of and relationships between the components, style, and preferences communicated by media artworks and artists	a. Analyze and synthesize the qualities and relationships of the components in a variety of media artworks, and feedback on how they impact audience		a. Analyze and synthesize the qualities and relationships of the components and audience impact in a variety media artworks.

Anchor Standard 9 Apply criteria to evaluate artistic work.

Enduring Understanding 9.1	Skillful evaluation and critique are critical components of experiencing, appreciating, and producing media artworks.		
Artistic Process	RESPONDING		
Process Component	EVALUATE		
Essential Questions	How and why do media artists value and judge media artworks? When and how should we evaluate and critique media artworks to improve them?		
HS Proficient	HS Accomplished		HS Advanced

MA:Cr9.1.HSI	MA:Cr9.1.HSII	MA:Cr9.1.HSIII
Evaluate media art works and production processes at decisive stages, using identified criteria, and considering context and artistic goals	Form and apply defensible evaluations in the constructive and systematic critique of media artworks and production processes.	Independently develop rigorous evaluations of, and strategically seek feedback for media artworks and production processes, considering complex goals and factors.

Anchor Standard 10 Synthesize and relate knowledge and personal experiences to make art.

Enduring Understanding 10.1	Media artworks synthesize meaning and form cultural experience.	
Artistic Process	CONNECT	
Process Component	SYNTHESIZE	
Essential Questions	How do we relate knowledge and experiences to understanding and making media artworks? How do we learn about and create meaning through producing media artworks?	
HS Proficient	HS Accomplished	HS Advanced
MA:Cr10.1.HSI	MA:Cr10.1.HSII	MA:Cr10.1.HSIII
a. Access, evaluate, and integrate personal and external resources to inform the creation of original media artworks, such as experiences, interests, and cultural experiences.	a. Synthesize internal and external resources to enhance the creation of persuasive media artworks, such as cultural connections, introspection, research, and exemplary works	a. Independently and proactively access relevant and qualitative resources to inform the creation of cogent media artworks.

Anchor Standard 11 Relate artistic ideas and works with societal, cultural, and historical context to deepen understanding

Enduring Understanding 11.1	Media artworks and ideas are better understood and produced by relating them to their purposes, values, and various contexts	
Artistic Process	CONNECT	
Process Component	RELATE	
Essential Questions	How does media arts relate to its various contexts, purposes, and values?	
HS Proficient	HS Accomplished	HS Advanced
MA:Cr11.1.HSI	MA:Cr11.1.HSII	MA:Cr11.1.HSIII
a. Demonstrate and explain how media artworks and ideas relate to various contexts, purposes, and values, such as social trends, power, equality, and personal/cultural identity. b. Critically evaluate and effectively interact with legal, technological, systemic, and vocational contexts of media arts, considering ethics, media literacy, social media, virtual worlds, and digital identity.	a. Examine in depth and demonstrate the relationships of media arts ideas and works to various contexts, purposes, and values, such as markets, systems, propaganda, and truth b. Critically investigate and ethically interact with legal, technological, systemic, and vocational contexts of media arts, considering ethics, media literacy, digital identity, and artist/audience interactivity.	a. Demonstrate the relationships of media arts ideas and works to personal and global contexts, purposes, and values, through relevant and impactful media artworks. b. Critically investigate and strategically interact with legal, technological, systemic, and vocational contexts of media arts.

Content Objectives

At the end of this unit,

- Students will be able to define weather and describe at least 5 weather variables.
- Students will be able to define air mass and front and explain how storms develop at frontal boundaries.
- Students will be able to decode a weather station model using page 14 of the ESRT.
- Students will be able to draw a weather station model based on provided data and the ESRT.
- Students will be able to convert barometric pressure to 3-digits for use on a station model.
- Students will be able to observe and record local weather variables.
- Students will be able to compile and compare collected data on a graph.
- Students will be able to identify the key elements of a weather report.
- Students will be able to create an original storyboard.
- Students will be able to record appropriate video footage with sound free of background noise.
- Students will be able to combine audio and visual elements into a digitally edited weather report.

Prior Knowledge and Skills
- Students will have completed Topics 6 & 7-1 which focused on air pressure, density, and temperature relationships.
- Students are able to read a thermometer.
- Students are able to recognize surface wind patterns.
- Students have knowledge of the Coriolis Effect.
- Students have basic videography skills.

Vocabulary
Weather, weather variables, fronts, occluded front, cold front, warm front, stationary front, wind vane, anemometer, sling psychrometer, barometer, relative humidity, dew point, jet stream

Lesson Overview

- **Engage: What do students know about precipitation and how it occurs?**
After viewing photos of extreme NYC weather, students share initial observations, without inference. As a group, they compile a list of observations. In groups, they discuss why and make inferences based on their prior knowledge and information from previous topics. What questions do you have about these weather events?
- **Explore: Students conduct hands-on activities and simulations to explore the movement of air.**
Students will complete 4 mini-lab modules exploring the movement of gases within the atmosphere.
- **Explain: Students develop an explanation for how rain occurs at a front boundary.**
Air masses are introduced. Students differentiate between the air masses that form over specific regions. They discuss and explain how rain occurs at a front based on the patterns in the relationship between temperature of water and its phase. [Weather front simulator]
- **Elaborate: Students deepen their understanding of how precipitation occurs by making connections between the dew point temperature, air temperature and relative humidity.**
Students collect/analyze data from a sling psychrometer, then they will use their understanding of dew point and relative humidity to make predictions about precipitation.
- **Elaborate: Students deepen their understanding of how meteorologists communicate current weather conditions and predict future weather by analyzing and recording weather station models.**
Students analyze data from a weather report and station models. Students review the weather forecast and create a station model based on the information provided and ESRT page 13.
- **Extend: Students collect weather data in a weather journal and create an original weather report video.**
Students collect daily weather variables for 3-4 days. In groups, they create a station models for their entries and compare their data in graphic form. Then, students will create a storyboard, film, & edit their forecast.

Materials Needed
Engage images
Chart paper
Markers
Post-its
Personal phones with recording capabilities (or video cameras)
Access to computers / chromebooks / iPads with editing software (ex: iPhoto) and the internet (includes Google Classroom)
Explore 1: Liter Bottles, tubing, incense sticks, water
Explore 2: Plastic cups, water, ice
Elaborate 1: sling psychrometer, tin filled halfway with water, dropper, goggles for each group member

Engage Day 1

1. **Present an image (or short video clip) of intense local weather.**
A. For this lesson, I have used images of Hurricane Sandy or extreme snowstorms in NYC.
B. Prompt students to share initial observations, without inference. *Note: Remind students that when viewing a still image, they may only be able to rely on their sense of sight (and possibly measurement) to note an observation.*
C. In small groups, they compile a list of observations on Post-it notes. They will them post these notes onto chart paper or around the image projection on a SmartBoard.
D. As a class, review these observations and ask students to make inferences based on their observations and prior knowledge.
E. Ask: What questions do you have about these weather events? Post these questions on chart paper.

Figure 1   *Figure 2*

Figure 1: Cars are submerged on the street after severe flooding caused by Hurricane Sandy, on Oct. 29, 2012 in Manhattan, New York. *Credit: Christos Pathiakis*
https://www.livescience.com/56447-hurricane-floods-more-likely-climate-change.html
Figure 2: Snowstorm aftermath in NYC. From https://www1.nyc.gov/site/em/ready/winter-weather-prep.page

Explore 1 Days 2-3

1. **Students will investigate wind formation through a variety of models related to pressure gradients.**
Students use models to surface patterns, and establish relationships between temperature, pressure, and density.
Throughout the exploration models, confer with students as they work in collaborative groups. Suggested conferring questions to elicit students' thinking around establishing relationships, observing patterns, identifying variables, and questioning events:

What did you notice was happening to the air in the bottle where the air was being heated by *warm land*?
What did you notice was happening to the air in the bottle where the air was being cooled by *cool land*?
Which direction was the air flowing horizontally across the *Earth's surface*?
In the 'Gas Laws' simulator, how does the density of the air molecules after heating compare to the density before heating?
When observing the gas container gif, what did you notice happened to the air molecules when the barrier was removed?

A. Model 1: Flow of Air Molecules in the Atmosphere

• Provide students with the Explore Model 1 handout.

• Prompt students to connect bottles with the tubing, fill with water, and continue according to the instructions.

B. Model 2: Heating and Cooling Air Molecules

• Recall that heat energy from the Earth's surface is transferred to the air above it which raises the air's temperature.

• Provide students with the Explore Model 2 handout.

• Use the Gas Law Simulator to better understand how changes in temperature will affect air. Complete the worksheet provided. *Simulator link:*   https://ch301.cm.utexas.edu/simulations/js/idealgaslaw/

C. Models 3 & 4: Movement of Air Across Earth's Surface

• Provide students with the Models 3 & 4 worksheet.

• Open the PhET Gas Properties Simulator: https://phet.colorado.edu/en/simulation/legacy/gas-properties

• Prompt students to complete the exploration worksheet.

• Link to pressure gradient GIF: https://docs.google.com/document/d/1hh-LRb-X-ki6p2pCbbuATbtQ49bBzHeBgql0ko_d52w/edit?usp=sharing

D. Complete the See, Think, Wonder Table in small groups and discuss.

Explain 1 Day 4

1. **Students develop an explanation for how wind occurs.**

A. *Review* concepts related to convection (Topics 5/6). *Discuss*:

High pressure regions of air are located where cold air contracts. This air is more dense, so it sinks.

Air moves horizontally across Earth's surface due to differences in air pressure.

Low pressure regions of air are located where warm air expands. This air is less dense, rises (because air converges due to a pressure gradient) and is forced up.

• Be sure to highlight important vocabulary at this point, while making connections to the explore phase.

• Students explain how wind occurs, using the patterns in relationships between temperature, pressure, and density on the **Explain 1 worksheet.**

B. *Ask*: *What causes wind to form?* Prompt students to read and discuss the **Explain 1A worksheets** in small groups. Explain that they should use what they have learned to create a cause-and-effect model that:

• Explains how and why wind forms.

• Exhibits an annotated diagram with explanations for what is drawn.

• Explanations should include the concepts of temperature, density, and pressure.

C. *Homework:* Review **Unit 7 Powerpoint** on Wind. Circle or underline any information you may still question. Post these reflections on the "Wind" Discussion Stream on **Google Classroom.** Feel free to respond to one another. [*Students receive credit for their participation on Google Classroom discussions*]

Explore 2 Days 5-6

1. **Students will investigate air masses and fronts.**

Students use models of cloud formation and frontal boundaries in order to gather evidence for precipitation at frontal boundaries.

A. Quickly ask students to recall a time/place when they experience extreme humidity. I ask students to envision our 5th floor during September and June; they typically refer to our 5th floor hallways as "walking through soup." Call upon a few volunteers to discuss this feeling.

B. Inform students they will be conducting an investigation that will help them understand how water moves through the atmosphere, with a focus on how rain occurs and how it is connected to wind. Provide students with the **Explore 2 – Model 5 worksheet** (Air Masses and their Interactions)

C. Launch the Weather Fronts Simulator:

http://www.phschool.com/atschool/phsciexp/active_art/weather_fronts/

Students will complete this investigation on their worksheet.

D. Model 6: How Water Behaves in the Atmosphere

• Provide students with cups, water, ice, and the **Explore 2 – Model 6 worksheet.**

• Ask students to complete this exploration and the accompanying observation charts/questions.

- Have each student complete the See-Think-Wonder chart to help them articulate their ideas so far. Elicit student ideas as you circulate the room.
- Confer with students as they work in collaborative groups. Suggested conferring questions (these should push students' thinking around establishing relationships, observing patterns, identifying variables, and questioning events):
  - Why do you think moist air was rising?
  - What happens when it reaches the top of the container? Why?
  - How do you think this is similar to what happens in Earth's atmosphere?
  - Think about your experience feeling air in NYC. Do you think all air contains a high level of moisture?

E. *Homework:* Review **Unit 7 Powerpoint** on Cloud Formation and Air Masses. Post any questions on the Google Classroom Discussion Stream for clarification.

Explain 2 Days 7-8

1. **Students develop an explanation for how rain occurs at a front boundary.**

Introduce air masses of different moisture levels. Students will explain how rain occurs at a front, using the patterns in the relationship between temperature of water and its phase.

A. Begin the class discussion to ensure that students understand the following:
- Air in our atmosphere varies in temperature and moisture level
- Sometimes large amounts of air will have uniform temperature and moisture levels. We call these air masses
- When air masses of different temperature and moisture level meet they interact in predictable ways or patterns

Inform students that they will use their understanding of how relatively cold air interacts with relatively warm air, as well as their understanding of how water behaves as its temperature changes, to explain the weather patterns they observe at the boundaries between air masses of different properties.

B. Provide students with the **Explain 2 – How Do Clouds Form?** worksheet. Launch the PhET states of matter simulator to review how water phase changes. Link: https://phet.colorado.edu/sims/html/states-of-matter-basics/latest/states-of-matter-basics_en.html

C. Ask students to complete the cause-and-effect model and wrap-up the class with a displaying discussion of their annotated models.

D. *Homework:* Students should have the Explain 2 – How Do Clouds Form? Homework worksheet. Students should watch the video and/or read the powerpoint to complete the reflection questions.
Video link: https://www.youtube.com/watch?v=UZEETyzql0Q

The Day 8 class should begin with small group discussion regarding their notes. Teachers should facilitate students' use of a self-assessment, so they can reflect on where they are. Once students have clarified their thinking, it is appropriate to move onto the Elaborate stage.

Elaborate Days 8 -11

1. **Students deepen their understanding of how precipitation occurs by learning about to dew point and relative humidity.**

A. Briefly introduce the day's activity by informing students that they will investigate the necessary for the occurrence of precipitation and that this will help them prepare to make predictions about whether rain or snow will fall.

B. Students will receive their **Elaborate1: Digging Deeper into Cloud Formation and Precipitation worksheet** and the listed materials.

C. The class will view slides 18 through 41 (Atmospheric Moisture and Humidity) in the unit powerpoint. The teacher should demonstrate how to use a sling psychrometer.

D. Students will collect/analyze data from a sling psychrometer and use their understanding of dew point and relative humidity to make predictions about precipitation. They will have access to the video: https://www.youtube.com/watch?v=QbcaCxuA1LI for additional assistance.

E. After completing the investigation, students will complete the **Elaborate 1A: How Does the Sling Psychrometer Data Allow Us to Make Predictions About the Weather?** Worksheet.

Video Link: https://www.youtube.com/watch?v=zsb4ZEQLFxQ

Readings: Atmospheric Moisture & Humidity and Clouds and Precipitation powerpoint slides

F. *Homework: Collect daily weather information using class measurement tools, observations, and digital forecasts in your journal/notebook.*

2. Students deepen their understanding of how meteorologists communicate current weather conditions and predict future weather by analyzing and recording weather station models.

A. The class will view the station model powerpoint.

B. Students will complete the ESRT-based worksheet lab from nyscienceteacher.com. There is also a powerpoint attached to assist in reviewing this lab.

Link: https://newyorkscienceteacher.com/sci/files/user-submitted/StationModelLab.pdf

C. Recall/review and discuss the Coriolis Effect and isolines (Unit 2).

D. The class will view a recent weather forecast report and in small groups, analyze the data from this report in their notebooks.

E. Groups should create a station model based on the information provided and ESRT page 13.

2B. In small groups, students will view the following video: https://www.youtube.com/watch?v=9NZz-EeveJ8 and complete the **Elaborate 2B: Representing Weather Variables on a Map in Order to Make Weather Predictions** worksheet.

Extend / Evaluate Days 12-18

1. Students collect weather data in a weather journal and create station models.

A. Students collect daily weather variables for 3-4 days. In groups, they create a station models for their entries and compare their data in graphic form.

B. Students will refer back to the questions posed on Day 1and reflect in their notebooks.

2. Students create an original weather report video.

A. Students will choose one station model from their group as the focus of their final project. They may watch local forecasts and take notes regarding the general format.

B. Students will create a storyboard for their forecast (worksheet will be provided). These will be discussed in small groups prior to moving forward (teacher will approach each group throughout 1-2 class periods).

Storyboard: https://docs.google.com/document/d/1rITMWc_TSpjwNDJ77rll7Qqx_xb3n2k8PHuP-8YQDgU/edit

C. Students will film & edit their forecast. *Note: Students have access to modules on* https://create.mouse.org/ *for guidance on filming and editing techniques. Many students are currently enrolled in my New Media Art class and have filming/editing experience. They will also receive demos as requested during class.*

Here are a few screenshots from my student videos:

3.*Optional* **Students will complete a 1-period Regents-based assessment on Unit 7.**
Assessment will contain multiple-choice and short-answer Regents-based questions. Many questions will require students to refer to the ESRT for data. Link: https://drive.google.com/file/d/1_Toiy4adA-7VFdWqId-Kv057LA3Oztxa/view?usp=sharing

Link for Resources & Worksheets

https://drive.google.com/open?id=1MyiufGLQTkilyHW01YmYDhIIhfRHQZRI

Website Resources

NYS Science Learning Standards
http://www.nysed.gov/curriculum-instruction/science-learning-standards

National Art Standards
http://www.nationalartsstandards.org/sites/default/files/Media%20Arts%20at%20a%20Glance%20-%20new%20copyright%20info.pdf

NGSS Science and Engineering Practices
https://ngss.nsta.org/PracticesFull.aspx

New Visions for Public Schools (NYC)
https://www.newvisions.org/

IB MYP Sciences Guide
https://www.spps.org/site/handlers/filedownload.ashx?moduleinstanceid=38378&dataid=21234&FileName=sciences_guide_2014.pdf

Engage Image Websites
https://www.livescience.com/56447-hurricane-floods-more-likely-climate-change.html
https://www1.nyc.gov/site/em/ready/winter-weather-prep.page

University of Texas (Gas Simulator)
https://ch301.cm.utexas.edu/simulations/js/idealgaslaw/
PhET Interactive Simulations (Gas Properties)
https://phet.colorado.edu/en/simulation/legacy/gas-properties

Pearson Prentice Hall
http://www.phschool.com/atschool/phsciexp/active_art/weather_fronts/

The Making of a Cloud (NOVA – PBS)
https://www.youtube.com/watch?v=UZEETyzql0Q

Using a Sling Psychrometer (Hommocks Earth Science Dept.)
https://www.youtube.com/watch?v=QbcaCxuA1LI

Evaporation & Condensation (GCSE Physics – Doodle Science)
https://www.youtube.com/watch?v=zsb4ZEQLFxQ

NY Science Teacher Station Model Lab
https://newyorkscienceteacher.com/sci/files/user-submitted/StationModelLab.pdf

Meteorologist Ryan Davidson Explain Weather Maps
https://www.youtube.com/watch?v=9NZz-EeveJ8

Storyboard & Editing Modules (membership required)
Create.mouse.org

Name(s)_____

	5	4	3	2	1
Storyboard Outline (x2) Storyboard properly outlines and highlights important scenes/shots in sequential order. Necessary edits are made accordingly throughout the process to improve overall project.					
Readability Storyboard is legible and properly communicates the group's ideas without a verbal explanation.					
Time Requirement Storyboard accounts for a minimum 90-second video.					
Audience / Genre Consideration The story is appropriate for the chosen audience (and for viewing within the school community) and properly communicates the chosen genre.					
Participants The "jobs" of all group members are apparent, even if they are not being filmed.					
Requirements All aspects from the chosen station model are present in the storyboard. This includes (but is not limited to): air temp., dew point, barometric pressure, cloud coverage, current conditions, wind speed & direction.					
Forecast Aspects of the forecast predictions are present in the storyboard.					
Submission Storyboard was submitted on-time.					
Effort Overall effort and participation throughout this project.					
Total Score: _____/50 = _____/100%					

Name_____

	Amazingly Awesome (5)	Skillfully Talented (4)	Capable (3)	Developing (2)	Needs Attention (1)
Difficulty Level	The difficulty level is determined by the overall scope of the project, individual challenges & the time required to complete the project in comparison to the projects within the class. The most difficult project(s) will be awarded a 5, and levels will be assigned accordingly.				
Project Parameters / Requirements	The following requirements were met and/or exceeded. The video demonstrates: Min. 90 seconds Clips are cut/edited Sound present Text Labels are present Based upon station model	Four out of the five requirements were included.	Three out of the five requirements were included.	Two out of the five requirements were included.	One or less of the five requirements were included.
Creativity & Artistic Expression (x2)	Project contains many unique ideas/ solutions; the student's signature is truly apparent. All material is appropriate for the audience.	Project contains many unique ideas. All material is appropriate for the audience.	The student's signature is less apparent than others'. All material is appropriate for the audience.	Project lacks complete originality; many ideas have been sourced from class examples.	Project lacks originality &/or is inappropriate for the audience.
Technique, Detail, Craftsmanship & Presentation (x2)	Exhibits mastery of skills, use of programs, techniques, and materials. Student has gone beyond the minimum to design & execute an extremely original project. Demonstrates excellent finishing touches. The design was well thought-out and presented professionally.	Exhibits an adequate level of skill, program & material use. Student did a strong job developing an original design and applied it to their project. Demonstrates a substantial level of finish.	Exhibits some errors in technique, program use, and/or material use. Student attempted to create an original design, but it lacked consistency.	Exhibits errors specific to the task and use of programs and/or materials. There is a lack of details. Student has developed an idea but requires extensive work to bring it together into a working piece. The project may be lacking in neatness & presentation.	Exhibits critical errors specific to the task and use of programs and/or materials. There is a lack of details. Little consideration was made throughout the initial design process. Project is haphazard.

Effort & Time (x2)	The student utilized class-time appropriately throughout the assignment. Additional personal time was scheduled in addition to the time allotted in class. Excellent effort was put forth into this project.	A strong effort was put forth for this project and the student was rarely off-task. Some elements were created on personal time.	Adequate time management and effort was put forth for this project. The student was occasionally off task, but managed to complete their project on schedule.	The student struggled to stay on task and was often focused on other matters. More time focused on the project would have improved the overall outcome of the project.	Little to no attention was appropriated to finishing the project. Limited effort was put forth.
Appropriate Use of Media / Technology	Media/technology is used appropriately & effectively; media choice is excellent to express intentions. Student adhered to the school's *Acceptable Use Policy.*	Media/ technology is used appropriately; good expressing the overall idea. Student adhered to the school's *Acceptable Use Policy.*	Overall media use is satisfactory. Additional time experimenting / exploring the chosen media may have yielded better results. Student adhered to the school's *Acceptable Use Policy.*	Media/ technology use reflects limited knowledge and practice; choices do not reflect overall intentions. Student may not have adhered to the school's *Acceptable Use Policy.*	Student did not adhere to the school's *Acceptable Use Policy.*
Submitted Complete By Due-Date	Project was submitted in its entirety on/before the due-date.	Project was submitted on the due-date, somewhat incomplete or 1 day late.	Project was submitted 2 days late.	Project was submitted 3 days late.	Project was submitted 4 days late.
Forecast Accuracy (x10)	The forecast in the video: -Features all aspects of the original station model -Includes proper reasoning for the relationship between dew point & air temp. -Correctly identifies air masses and fronts -Correctly identifies wind speed and direction -Includes current / future weather				

Overall Total _____/100

Name_____

	5	4	3	2	1
Participation Student initiates posts and/or responds to the Google Classroom stream for specified topics.					
Scientific Concepts Discussion topics are relevant to the current concept. Student discusses topic material accurately, asks applicable questions, and responds appropriately.					
Use of Resources Student provides accurate and relevant support within the discussion; statements made are supported by material from class articles, powerpoints, videos, labs, modules, and class discussion.					
Respect The student's participation aligns with the school's Acceptable Use Policy. All posts are respectful and with good intent.					
Timeliness The student posts within the assigned time-frame.					

Total: _____/25 x4 = _____/100%

Name_____

	Needs Improvement *"I don't understand or cannot discuss the information taught."* 1	Partially Proficient *"I think I can discuss the information, but with minor errors."* 2	Moderately Proficient *"I think I understand, but am not confident I can discuss it and/ or apply it with accuracy."* 3	Proficient *"I am confident that I understand the information and can discuss or apply it with accuracy."* 4	Proficient with Distinction *"I can use the information taught and learned, and go beyond."* 5
Entries	Most entries (65% or more) are missing and/or out of order.	Some entries (no less than 50%) are up-to-date, in order and complete.	Some entries (no less than 60%) are up-to-date, in order and complete.	Entries are mostly complete and in order.	All (100%) of the entries are complete and in proper order.
Legibility & Organization	Most entries (65% or more) are incorrectly labeled; Ideas lack organization; illegible.	Many entries (50%) are labeled correctly & legible.	Many entries (60%) are labeled & legible.	Most entries (75%) are labeled correctly & legible.	All (100%) of the entries are complete, legible, and labeled.
Vocabulary Usage	Minimal amount of vocabulary (less than 40%) is present and/or many inaccuracies in usage.	Notebook contains some of the required vocabulary. There are some inaccuracies in usage.	Notebook contains most of the required vocabulary; some terms may not be used accurately.	Notebook contains most of the required vocabulary, which are used accurately.	Notebook contains the required vocabulary for student understanding. All vocabulary words are used accurately.
Notes	Notebook has less than 50% of the required notes. Many (50% or more) of notes are incomplete, inaccurate. Notes lack evidence of student staying on task. Student has few/no	Notebook has some of the required notes. A limited amount of notes are complete, or accurate, well organized, and/or easy to read. Limited entries show evidence of student staying on task & minimal	Notebook has about 75% of the required notes. Many notes are complete and accurate (even for days student was absent), well organized, and/or easy to read. Many entries show evidence of	Notebook has most of the required notes. Many notes are complete and accurate (even for days student was absent), well organized, and/or easy to read. Many entries show evidence of student staying on	Notebook has all of the required entries. All notes are complete and accurate (including days student was absent), well organized, and/or easy to read. All entries show evidence of student staying on

	examples of utilizing the assigned resources for information.	examples of utilizing the assigned resources for information.	student staying on task & moderate examples of pertinent information from the assigned resources.	task & moderate examples of pertinent information to notes from the assigned resources.	task & include pertinent information from the assigned resources.
Investigations (x2)	Less than 25% of investigations are complete, thoughtful or creative. Minimal entries show evidence of student staying on task. Student has not included any personal responses or extension to learning. Responses are general comments and are not unique	Notebook has about half of the required investigations complete or accurate. Limited entries show evidence of student staying on task. Student has not included any personal responses or extension to learning. Responses are general comments and are not unique.	Notebook has some of the required investigations. Many entries are complete and accurate (even for days student was absent).	Notebook has most of the required investigations. Many (no less than 90%) responses are thoughtful, detailed, colorful, and/or creative. Student has included many (90%) responses or extensions to learning.	Notebook has over 90% of the required investigations. Responses are thoughtful, detailed, colorful, and/or creative. Student has included responses or extensions to learning.
Reflections (x2)	Response demonstrates no reflection on, or personalization of, the theories, concepts, and/or strategies presented lesson(s) to date. Viewpoints and interpretations are missing, inappropriate, and/or unsupported. Examples, when applicable, are not provided.	Response demonstrates a lack of reflection on, or personalization of, the theories, concepts, and/or strategies presented in the lesson(s) to date. Viewpoints and interpretations are missing, inappropriate, and/or unsupported. Examples, when applicable, are not provided.	Response demonstrates a minimal reflection on, and personalization of, the theories, concepts, and/or strategies presented in the lesson(s) to date. Viewpoints and interpretations are unsupported or supported with flawed arguments. Examples, when applicable, are not provided or are irrelevant to the assignment.	Response demonstrates a general reflection on, and personalization of, the theories, concepts, and/or strategies presented in the lesson(s) to date. Viewpoints and interpretations are supported. Appropriate examples are provided, as applicable.	Response demonstrates an in-depth reflection on, and personalization of, the theories, concepts, and/or strategies presented in the lesson(s) to date. Viewpoints and interpretations are insightful and well supported. Clear, detailed examples are provided, as applicable.

Writing	Student writing has no focus, includes no supporting details and has numerous mechanical errors. Writing consists of inaccurate use of scientific language and terminology. Science content is not accurate, is not connected to the big ideas and demonstrates limited understanding.	Student writing lacks focus, includes limited supporting details and has several mechanical errors. Writing consists of little use of appropriate scientific language and terminology. Science content is inaccurate, consists of unclear connections to the big ideas and demonstrates partial understanding.	Student writing has limited focus, includes some supporting details and has several mechanical errors. Writing consists of little use of appropriate scientific language and terminology. Science content is somewhat accurate, consists of some connections to the big ideas and demonstrates partial understanding.	Student writing consists of a single focus; includes some supporting details. Writing consists of some appropriate science language and terminology. Science content is mostly accurate; somewhat connected to the big ideas and demonstrates some understanding.	Student writing consists of a distinct focus; includes effective supporting details. Writing consists of appropriate science language and terminology. Science content is accurate, connected to the big ideas and demonstrates deep understanding.
Illustrations, Diagrams, & Graphic Organizers	Few/no images are present; items that need to be identified are not clear and accurate. Some images are not relevant current topic.	Images are lacking, incomplete or inaccurate. Less than 50% of the items that need to be identified have clear and correct labels. Some images are not relevant current topic.	Images are mostly complete, accurate and informative. Some items that need to be identified have clear and correct labels but some may be difficult to identify. Some images may not be relevant to current topic.	Images are complete, accurate and informative. Most items that need to be identified have clear and correct labels. Visuals are relevant to class material.	Images are complete, accurate and informative. All items that need to be identified have clear and correct labels. Visuals are relevant to class material.
	Needs Improvement 1	Partially Proficient 2	Moderately Proficient 3	Proficient 4	Proficient with Distinction 5

Total _____/50 x2 = _____/100%

Criterion A: Knowing and Understanding
Maximum: 8
Students should be able to:
i. describe scientific knowledge
ii. apply scientific knowledge and understanding to solve problems set in familiar and unfamiliar situations
iii. analyze information to make scientifically supported judgments.

Achievement level	Level descriptor
0	The student does not reach a standard described by any of the descriptors below.
1-2	The student is able to: i. **recall** scientific knowledge ii. apply scientific knowledge and understanding to **suggest solutions** to problems set in **familiar situations** iii. **apply** information to make **judgments**.
3-4	The student is able to: i. **state** scientific knowledge ii. apply scientific knowledge and understanding to **solve problems** set in **familiar situations** iii. **apply** information to make **scientifically supported judgments**.
5-6	The student is able to: i. **outline** scientific knowledge ii. apply scientific knowledge and understanding to **solve problems** set in **familiar situations** and **suggest solutions** to problems set in **unfamiliar situations** iii. **interpret** information to make **scientifically supported judgments**.
7-8	The student is able to: i. **describe** scientific knowledge ii. apply scientific knowledge and understanding to **solve problems** set in **familiar and unfamiliar situations** iii. **analyze** information to make **scientifically supported judgments**.

Criterion B: Inquiring and Designing
i. Explain a problem or question to be tested by a scientific investigation
ii. Formulate a testable hypothesis and explain it using scientific reasoning
iii. Explain how to manipulate the variables, and explain how data will be collected
iv. Design scientific investigations

Achievement level	Level descriptor
0	The student does not reach a standard described by any of the descriptors below.
1-2	The student is able to: i. state a problem or question to be tested by a scientific investigation ii. outline a testable hypothesis iii. outline the variables iv. design a method, with limited success.
3-4	The student is able to: i. outline a problem or question to be tested by a scientific investigation ii. formulate a testable hypothesis using scientific reasoning iii. outline how to manipulate the variables, and outline how relevant data will be collected iv.

	design a safe method in which he or she selects materials and equipment.
5-6	The student is able to: i. describe a problem or question to be tested by a scientific investigation ii. formulate and explain a testable hypothesis using scientific reasoning iii. describe how to manipulate the variables, and describe how sufficient, relevant data will be collected. iv. design a complete and safe method in which he or she selects appropriate materials and equipment.
7-8	The student is able to: i. explain a problem or question to be tested by a scientific investigation ii. formulate and explain a testable hypothesis using correct scientific reasoning iii. explain how to manipulate the variables, and explain how sufficient, relevant data will be collected iv. design a logical, complete and safe method in which he or she selects appropriate materials and equipment.

Criterion C: Processing and evaluating
Maximum: 8
Students should be able to:
i. present collected and transformed data
ii. interpret data and describe results using scientific reasoning
iii. discuss the validity of a hypothesis based on the outcome of the scientific investigation
iv. discuss the validity of the method
v. describe improvements or extensions to the method

Achievement level	Level descriptor
0	The student does not reach a standard described by any of the descriptors below.
1-2	The student is able to: i. **state** the ways in which science is used to address a specific problem or issue ii. **state** the implications of the use of science to solve a specific problem or issue, interacting with a factor iii. **apply** scientific language to communicate understanding but does so **with limited success** iv. documents sources, **with limited success**.
3-4	The student is able to: i. **outline** the ways in which science is used to address a specific problem or issue ii. **outline** the implications of using science to solve a specific problem or issue, interacting with a factor iii. **sometimes apply** scientific language to communicate understanding iv. **sometimes** documents sources **correctly**.
5-6	The student is able to: i. **summarize** the ways in which science is applied and used to address a specific problem or issue ii. **describe** the implications of using science and its application to solve a specific problem or issue, interacting with a factor iii. **usually apply** scientific language to communicate understanding **clearly and precisely** iv. **usually** documents sources **correctly**.
7-8	The student is able to: i. **describe** the ways in which science is applied and used to address a specific problem or issue ii. **discuss and analyze** the implications of using science and its application to solve a

specific problem or issue, interacting with a factor

iii. **consistently apply** scientific language to communicate understanding **clearly and precisely**

iv. documents sources **completely**.

Criterion D: Reflecting on the impacts of science
Maximum: 8
Students should be able to:

i. describe the ways in which science is applied and used to address a specific problem or issue

ii. discuss and analyze the various implications of using science and its application in solving a specific problem or issue

iii. apply scientific language effectively

iv. document the work of others and sources of information used.

| Achievement level	Level descriptor
0	The student does not reach a standard described by any of the descriptors below.
1-2	The student is able to: The student is able to: i. **state** the ways in which science is used to address a specific problem or issue ii. **state** the implications of the use of science to solve a specific problem or issue, interacting with a factor iii. **apply** scientific language to communicate understanding but does so **with limited success** iv. document sources, **with limited success**.
3-4	The student is able to: i. **outline** the ways in which science is used to address a specific problem or issue ii. **outline** the implications of using science to solve a specific problem or issue, interacting with a factor iii. **sometimes apply** scientific language to communicate understanding iv. **sometimes** document sources **correctly**.
5-6	The student is able to: i. **summarize** the ways in which science is applied and used to address a specific problem or issue ii. **describe** the implications of using science and its application to solve a specific problem or issue, interacting with a factor iii. **usually apply** scientific language to communicate understanding **clearly and precisely** iv. **usually** document sources **correctly**.
7-8	The student is able to: i. **describe** the ways in which science is applied and used to address a specific problem or issue ii. **discuss and analyze** the implications of using science and its application to solve a specific problem or issue, interacting with a factor iii. **consistently apply** scientific language to communicate understanding **clearly and precisely** iv. document sources **completely**.

Explore 1: Movement of Air Molecules in the Atmosphere
Model 1: Flow of Air Molecules in the Atmosphere

1. Obtain a piece of tubing and two empty 1-liter bottles from your teacher.

2. The bottles each have a hole in the side that will allow you to fit the tubing. Connect the bottles like the ones seen on the right.

3. Fill one bottle with hot water and the other with cold water, up to about an inch below the tubing.

Cold Water   Hot Water

4. Light an incense stick and allow it to burn about 5 seconds, then blow it out. It should be producing smoke instead of fire at this point. This smoke will be representing the atmosphere in your model.

5. Insert the smoking incense stick into the bottle with cold water and hold it just above the water for about 15 seconds. Pull the incense stick out and observe the movement of the smoke. **Record your observations below.**
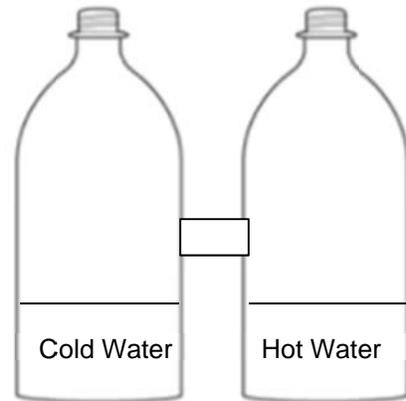
Observations: Sketch and describe air movement from the model

3   5   4

1   2
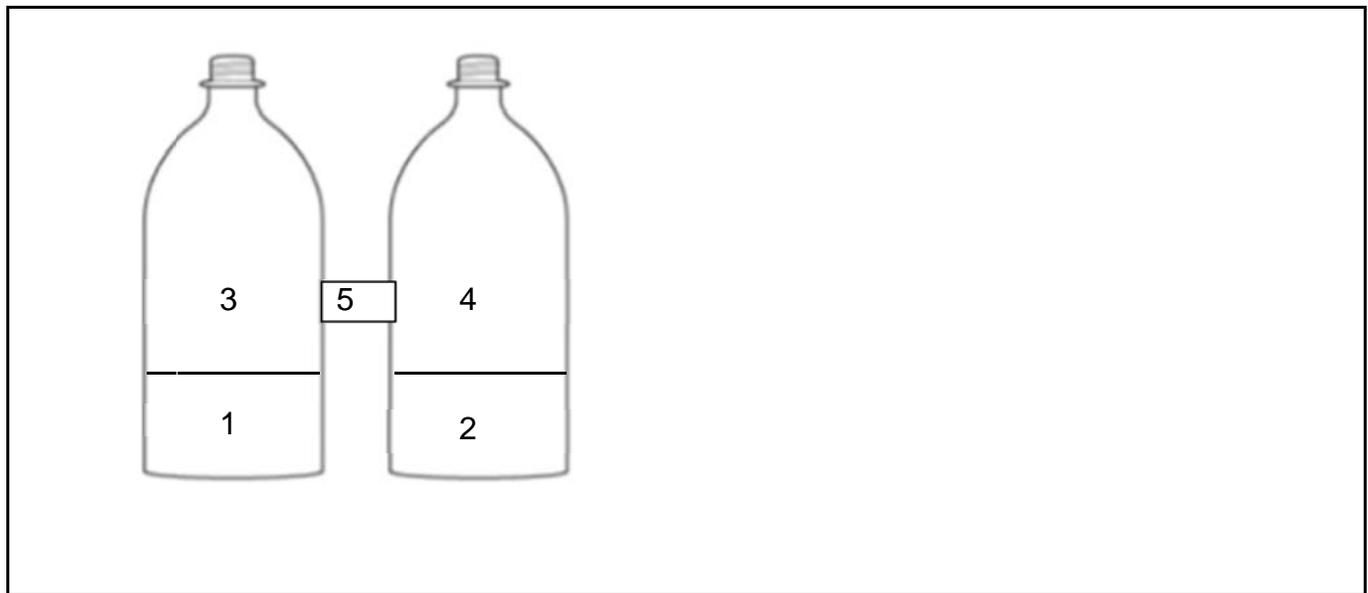
Use the choices in the box on the right to make connections to what the different parts of the model represents in real life.

1 =   3 =   5 =

2 =   4 =

warm air
air moving across Earth's surface
very warm land
cool air
very cool land

Model 2: Heating and Cooling Air Molecules

Recall that heat energy from the Earth's surface is transferred to the air above it which raises the air's temperature. Use this Gas Law Simulator to better understand how changes in temperature affects air.

1. Pump more gas into the container by clicking on the pump 2-3 times.

2. Lower the volume with the down arrow next to the word volume until the volume is about 300 L. This is your starting position. Record the temperature and sketch the starting position in the table below.

3. Heat the air with the 'Heat' dial in the bottom left corner. After heating the air, record your data in the table below.

4. Cool the air with the 'Cool' dial in the bottom left corner. After cooling the air, record your data in the table below.

Observations of Heating and Cooling Effects on Air

	Temperature	Sketch of container with air molecules	Was there an increase or decrease in the density of the air molecules?
Starting position			
After heating			
After cooling			

Model 3 and 4: Movement of Air Across Earth's Surface

1. Open the <u>gas properties simulator</u>. Play with it for 3 minutes and note any observations below.

2. Reset the gas properties simulator and move the handle up and down 2 times to fill the container with gas molecules (air).
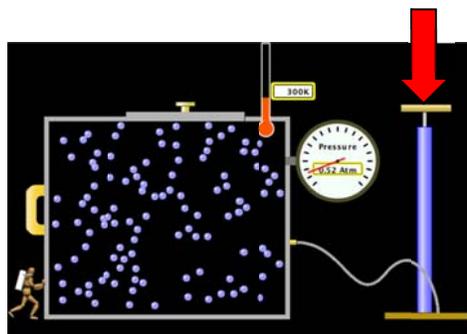
3. Reduce the size of the container to about half the original size using the handle on the left side of the container.
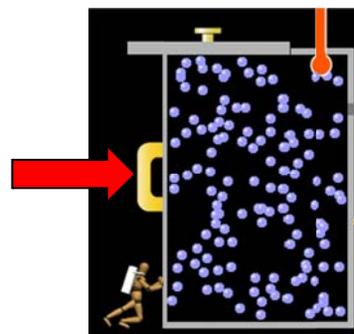
4. Make a prediction. What do you think will happen to the air molecules in the container if you expand the container? Write your prediction below.

5. Test your prediction. Expand the container to its full size and observe what happens to the movement of air as you expand the container. Write your observations below.

6. What do you think explains the movement of air molecules you observed as you expanded the container?

Containers A and B seen below are separated by a wall, and each contains air molecules.

1. What differences do you see between the two containers? (besides the color)

2. If these air molecules were moving around as you have seen air molecules move in other simulators, what do you predict will happen if the wall is removed?

Container A   Container B
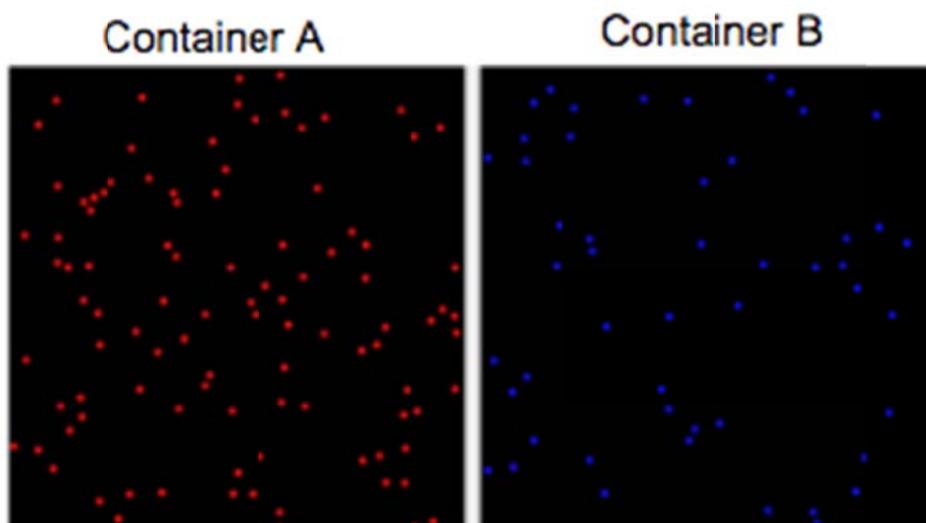
3. Click on this link and observe what happens to the air molecules when the barrier is removed. You can watch it at two different speeds. Record your observations below.

4. In which direction do most of the molecules flow? Explain why you think most air molecules flowed in that direction.

See-Think-Wonder

See What did you observe?	Think What does each observation make you think?	Wonder What questions do you have about each observation?
What did you notice was happening to the air in the bottle where the air was being heated by 'warm land'?		
What did you notice was happening to the air in the bottle where the air was being cooled by 'cool land'?		
Which direction was the air flowing horizontally across the 'Earth's surface'?		
In the Gas Laws Simulator, how does the density of the air molecules after heating compare to the density before heating?		
When observing the gas container gif, what did you notice happened to the air molecules when the barrier was removed?		

Explain 1: What caused the movement of air in Model 1?

Turn to a partner and discuss any ideas you have about the following two questions, then write your ideas in the space below.

- What causes air to sink or rise?
- Why would air move horizontally to create wind?

_____

Notes from class discussion:

Movement of Air Due to Pressure Differences: Respond to the following three questions to check your understanding of how differences in air pressure cause air to move.

The container below has two sides separated by a wall. The grey dots represent air molecules.
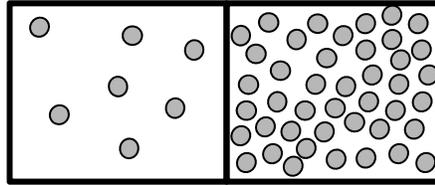
1. Label the side of the container you think has a higher air pressure as 'high pressure'. Then label the side you think has lower air pressure as 'low pressure'. **Be sure to explain your thinking in the space below.**

2. If the wall separating the two sides of the container was removed, in what direction do you think more air molecules would move? **Be sure to explain your thinking in the space below.**

3. Examine the two containers below. If the wall was removed from each, in which container do you think air molecules would flow from one side to another faster? **Be sure to explain your thinking in the space below.**
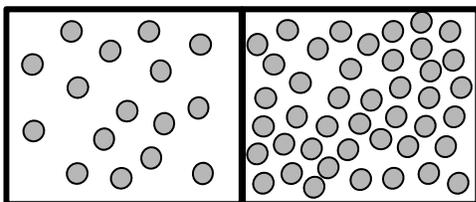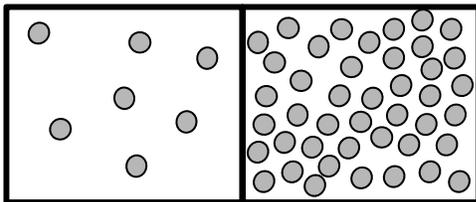
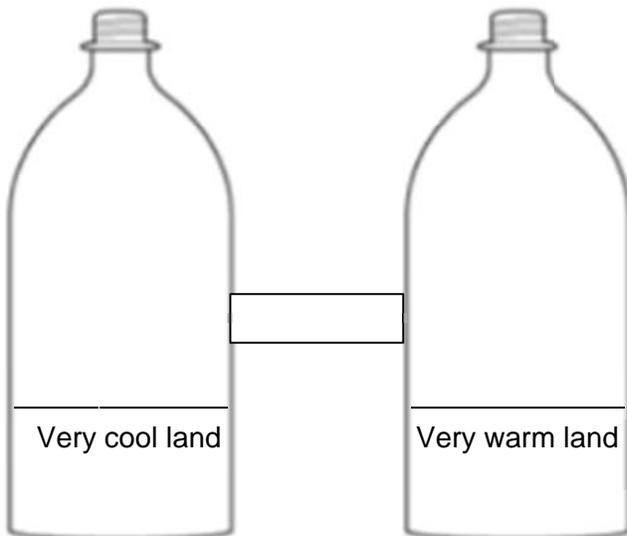# What caused the rising and sinking of air in the bottles?

1. Think back to the simulator you were using as you explored how heating and cooling affect air. In which bottle do you think the air molecules are further apart due to the difference in heating?

   Be sure to make your thinking visible by drawing the air molecules on each side and explaining what you drew in words.

   Very cool land   Very warm land
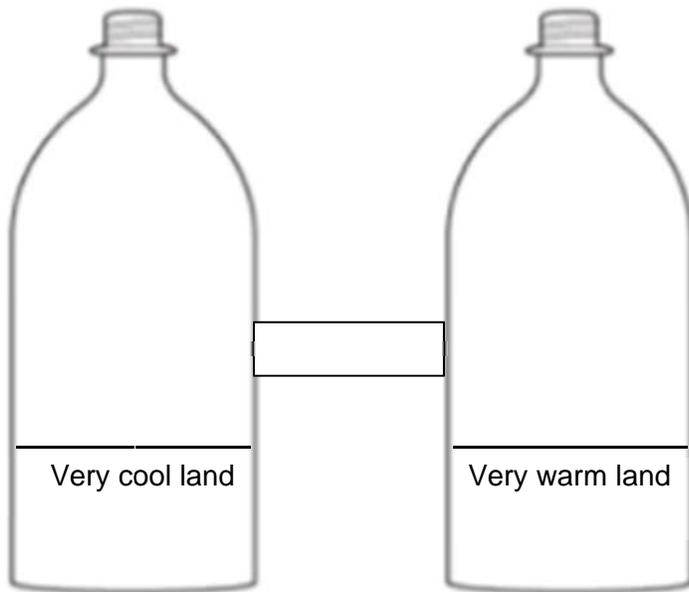
2. Now think about what you know about how density of air affects whether it sinks or rises. On which side was the air rising and on which side was it sinking due to differences in density?
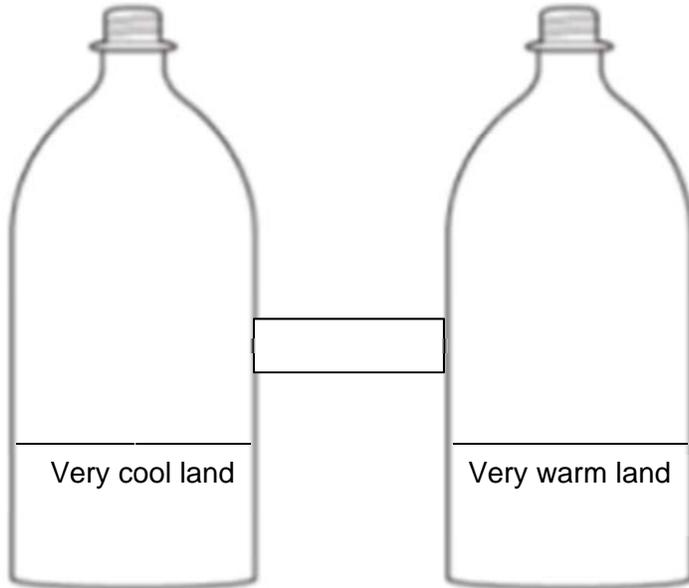
   Be sure to make your thinking visible by drawing the air molecules on each side and using arrows to show the movement of the air molecules. Explain your drawing with words.

   Very cool land   Very warm land

# What caused the air to move horizontally from one bottle to the other?

1. What effect do you think the sinking and rising of air had on the air pressure in each bottle?

   Be sure to make your thinking visible by drawing the air molecules on each side and explaining what you drew in words.

   Very cool land   Very warm land

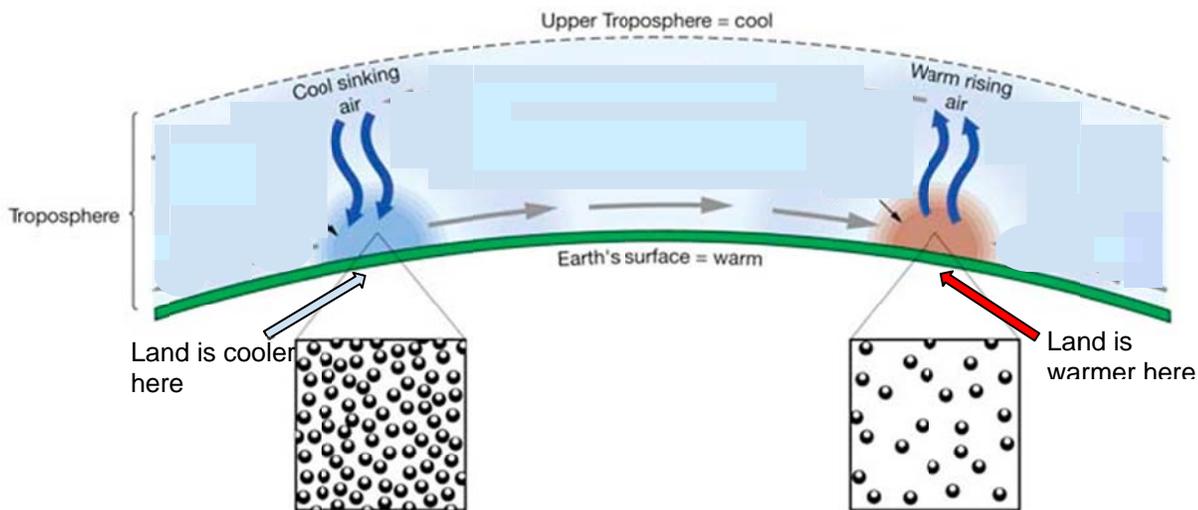2. In what direction did the difference in pressure cause the air to flow?

   Be sure to make your thinking visible by drawing the air molecules on each side and using arrows to show the movement of the air molecules. Explain your drawing with words.

   Very cool land   Very warm land
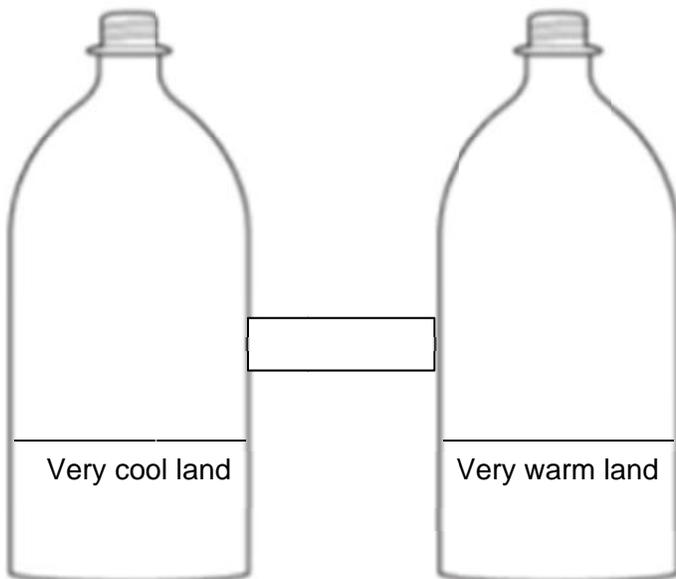
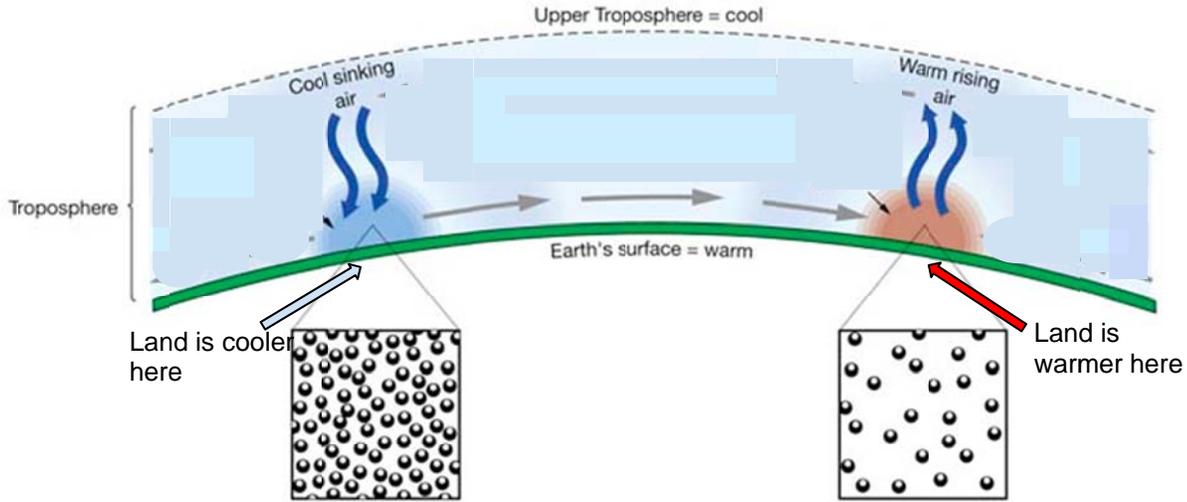# Explain 1A: Making Connections to Earth's Troposphere

1. You will be participating in a small group discussion with the goal of explaining the movement of air shown by the arrows in the diagram below. Before you discuss, independently annotate the diagram by:

   ● Labeling things you recognize
   ● Explaining things that you know
   ● Jotting down remaining questions

Upper Troposphere = cool

Cool sinking air

Warm rising air

Troposphere

Earth's surface = warm

Land is cooler here

Land is warmer here

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Based on what you have learned from the previous activities and discussion with your classmates, you will now write an explanation for the movement of air, as depicted by the arrows in the diagram below.

Upper Troposphere = cool

Cool sinking air

Warm rising air

Troposphere

Earth's surface = warm

Land is cooler here

Land is warmer here

Image source: http://www.iupui.edu/~g115/assets/mod08/air_move_sm.jpg

    A. Label the high pressure region at the Earth's surface and explain why that region is high pressure. You should be including the concepts of heating/cooling and density.

    B. Label the low pressure region at the Earth's surface and explain why that region is low pressure. You should be including the concepts of heating/cooling and density.

    C. Explain why the warm air is rising.

    D. Explain why the cool air is sinking.

    E. Using the concept of pressure, explain why the wind is moving across Earth's surface in the direction shown in the diagram.

Name _____ ES Section _____

Explore 2: Movement of Water in the Atmosphere
Model 5: Air Masses and their Interactions

Air in our atmosphere varies in temperature and moisture level. Sometimes large amounts of air will have uniform temperature and moisture levels -- we call these air masses. When air masses of different temperature and moisture level meet there are observable patterns in the way they interact and resulting weather.

You will use a simulator to observe and identify patterns when a relatively cold dry air mass interacts with a relatively warm moist air mass.

1. Open the Weather Fronts simulator. Play the simulator for each of the four types of fronts and record your observations in the table below.

Front Type	Observation of warm air mass	Observation of cool air mass	Observation of resulting weather
Cold Front			
Warm Front			
Stationary Front			
Occluded Front			

2. What patterns did you notice when observing all the fronts? In other words, what were some things you observed when observing all the front types?

Model 6: How Water Behaves in the Air/Atmosphere

How is water vapor different from the rest of the air in Earth's atmosphere?

Procedure:

1. Fill a wide clear plastic cup about 2/3 full of hot tap water.

2. Quickly place a taller clear plastic cup upside down as shown.

3. Watch the cups for 1–2 minutes.

4. Use a magnifier to look at the sides and top of the cup.

5. Take the top cup off and feel the inside surface.

Observations

What did you notice at the surface of the warm water in the bottom cup?	What did you notice on the inside surface of the top cup?	What other observations did you make?

1. What do you think was happening to the hot water in the bottom cup?

2. How do you think the tiny drops of water on the inside of the top cup got there?

3. What could you do to water vapor to increase the rate at which becomes liquid again?

Does cooling water vapor increase the rate at which it becomes a liquid?

Procedure
1. Fill two wide clear plastic cups about 2/3 full of hot tap water.

2. Quickly place the taller, clear plastic cups (with smaller rims) upside down on each cup, as shown.

3. Place a piece of ice on top of one of the cups.

4. Wait 2–3 minutes

5. Remove the ice and dry the place where the ice was with a paper towel.

6. Use a magnifier to examine the tops of the two upper cups.

Observations

Compare the amount of water on the inside surface of the top of each cup. Which top cup has more water on it?	
Diagram and description of outcomes from setup **without** ice on top	Diagram and description of outcomes from setup **with** ice on top

1. Does cooling water vapor increase the rate at which it becomes a liquid? Explain your answer based on your observations.

2. What does this tell you about air's ability to hold water at different temperatures? Does it hold water more effectively at high or low temperatures? Explain your response using evidence from the lab.

Name _____

See-Think-Wonder

| See What did you observe?	Think What does each observation make you think?	Wonder What questions do you have about each observation?

Explain 2: How do clouds form? Why does precipitation happen?

Review of relevant physical science concepts

1. Why does condensation happen? **Be sure to cite evidence from your lab activity observations.**

2. Think about the relationship between altitude and air temperature. Why do clouds tend to form at high altitudes within the troposphere?

How do clouds form? Why does precipitation happen?

Use what you have learned so far to create a cause and effect model that explains how clouds formed and why precipitation happens when a **cold dry air mass** interacts with a **warm moist air mass.** Be sure to annotate the storyboard section to ensure your thinking is visible. Use pencil only because you will be revising later!
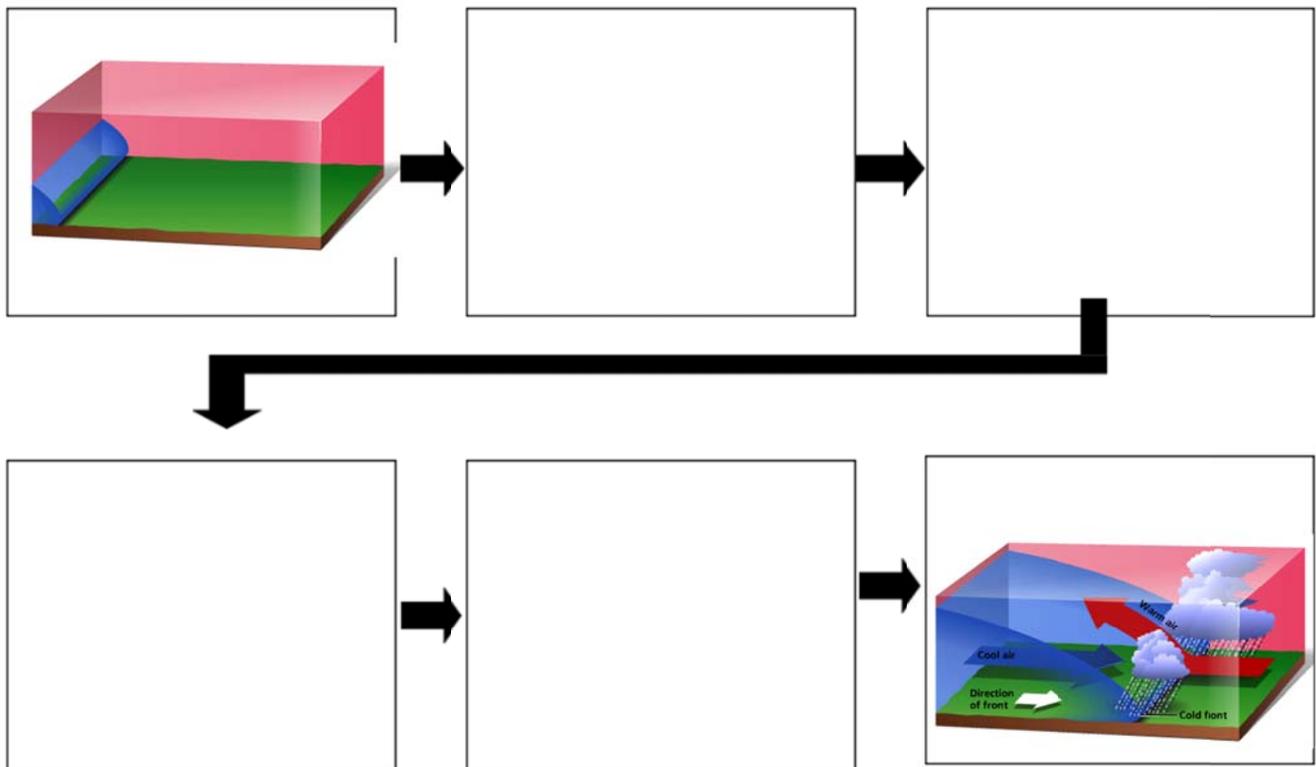
Revise your explanation for how clouds form and precipitation occurs

Name _____ ES Section _____

Homework: Watch this [video](#) and/or read the Unit 7 powerpoint slides on "Clouds & Precipitation" to better understand the science behind cloud formation and precipitation. When reading the text, follow the annotation strategy below:

- Underline ideas that confirm your thinking
- Circle ideas that make you change or refine your thinking
- Box ideas that you have questions about

Notes from video:

Refine your storyboard based on what you learned from the video, text, and your classmates!

Elaborate 1: Digging Deeper into Cloud Formation and Precipitation

So far you have learned about the process that leads to cloud formation. But some questions still remain:

- What are the conditions necessary for this process to happen?
- How much moisture must be in the air for clouds to form?
- How can we collect data that will allow us to make predictions about when it is likely to rain or snow?

Through this lab activity you will collect data that will allow you to answer these questions and better understand why clouds form.

1. Work in groups of 3. You and your partners must follow the procedures *carefully* and *precisely*. This is a student-led activity!
2. If you have any questions, please refer to the videos provided first. If you are still confused, you may then ask your teacher.

Obtaining Data to Make Predictions About Cloud Formation
You and your partners will each use the sling psychrometer at least once to obtain the wet-bulb and dry-bulb temperature in the room. This will give you three data sets for accurate measurement. You will each follow the procedures below:

1. Position yourselves at the sling psychrometer station. You need the following materials:
   a. 1 sling psychrometer
   b. 1 tin filled halfway with water
   c. 1 dropper
   d. 1 pair of goggles for each group member

2. Observe the sling psychrometer. It has two thermometers attached to a handle. You will notice one thermometer with a cloth on it. This thermometer will provide the wet-bulb temperature. The thermometer without a cloth will provide the dry-bulb temperature.

3. Fill the dropper with water from the tin, and apply 3-4 drops of water to the wet bulb cloth.

4. Put on your goggles and stand at an arm's distance away from everyone around you.

5. Swing the sling psychrometer for 2 minutes. Have your partner time you.

6. Read off the wet-bulb temperature and the dry-bulb temperature from each thermometer. Have your partners record these temperatures in the data table.

If you need assistance, click [this link](#) to watch a video about how to use a sling psychrometer.

Sling Psychrometer Data Table

Partner Name			
Dry Bulb			
Wet Bulb			
Difference			

Elaborate 1A: How Does the Sling Psychrometer Data Allow Us to Make Predictions About the Weather?

Explaining Your Data

Watch the first 29 seconds of [this video](). Then discuss the following with your partner:

1. Why do you feel cooler when sweat evaporates off your skin? Use evidence from the video to support your claim.

2. Look at your data from the lab. Which temperature tends to be lower, wet or dry-bulb temperature?

3. What process is taking place that would cause the wet-bulb temperature to be lower than the dry-bulb temperature after you sling it around for two minutes? Use evidence from the video to support your claim.

Water in the Air (Humidity)

Read the slides about Atmospheric Moisture & Humidity and Clouds and Precipitation. The text will introduce some concepts and related vocabulary that will allow you to better explain how the data you collected with the sling psychrometer allows you to make predictions about the likelihood of cloud formation, and therefore precipitation.

1. Define the term relative humidity in your own words:

2. What does the relative humidity need to be in order for cloud formation and precipitation to occur? Why?

3. When air reaches 100% relative humidity, that means it cannot hold any more moisture. Do you think that more water can evaporate into the air at that point? Why?

4. Do you think more water will evaporate of the wet-bulb if the air is at 100% relative humidity or 85% relative humidity? **Explain your thinking.**

5. Do you think more water will evaporate of the wet-bulb if the air is at 50% relative humidity or 65% relative humidity? **Explain your thinking.**

6. Jot down your ideas about why the difference between dry-bulb temperature and wet-bulb temperature tells you how close the air is to its maximum capacity for holding water (100% relative humidity).

Elaborate 1A: Calculating Relative Humidity and Dew Point from Your Wet and Dry-bulb Data.

When using sling psychrometer data to obtain the *dew point* and *relative humidity* of an air mass, there are certain steps you must follow. Pay close attention:

1. Find the difference between the wet-bulb temperature and the dry-bulb temperature using

   Dry-bulb temperature – wet-bulb temperature = difference between wet-bulb and dry-bulb

   the following equation:

2. Open your Earth Science Reference Table to page 12.

3. To find the *dew point*, find the dry-bulb temperature on the left side of the chart.

4. Next, find the **difference between the wet-bulb and dry-bulb temperatures** from the math you performed in step 3 on the top of the chart.

5. Line up both numbers to find the *dew point* of the air mass.

6. Repeat these steps on the *relative humidity* chart.

If you need assistance, watch this video: http://tinyurl.com/nave3fm or refer to the class slides.

Dry Bulb	12 °C	2 °C	4 °C
Wet Bulb	8 °C	2 °C	-2 °C
Difference			
Dew Point			
Relative Humidity			

Now, re-record your data from the lab below. Then follow the steps you learned in order to obtain the relative humidity and dewpoint of the air mass in the room.

Sling Psychrometer Data Table

Partner Name			
Dry Bulb			
Wet Bulb			
Difference			

Making Predictions Using Sling Psychrometer Data

You are given some (hypothetical) forecast information. Complete the table to fill out all the variables for each day.

1. Watch this video: http://tinyurl.com/nave3fm

   Answer the following questions:

   a. The closer the dew point is to the dry bulb temperature, the better chance you have of _____.

   b. When you have the same dry bulb and dew point temperature, what will your relative humidity be? _____%

2. Convert each temperature you are given to °C. (Page 13 ESRT)

3. Using page 12 of the ESRT, find out the dry-bulb, wet-bulb, difference, dew point, and relative humidity for each day. (Watch this video if you need assistance: http://tinyurl.com/nave3fm)

4. Make sure the Dry Bulb is given in BOTH °F AND °C!

5. The first column is done for you!

Day	Day 1	Day 2	Day 3	Day 4
Dry Bulb	30 °F -1°C	32 °F		36 °F
Wet Bulb	-3°C			-2°C
Difference	2°C		1°C	
Dew Point	-7 °C		4°C	
Relative Humidity	60%	45%		

Application Question:

Which day on the table above is it most likely to rain? Why?

Elaborate 2: Station Models and Weather Predictions

See Station Model Lab and Powerpoint File

Elaborate 2B: Representing Weather Variables on a Map in Order to Make Weather Predictions (Analyzing a Complete Surface Observation Map)

Objective
Now you will use what you have learned so far to analyze a weather map that consists of station models with all data relevant to representing weather conditions and making predictions.

Procedure
Watch the following video which will explain weather maps.

As you know, the boundary between two air masses is called a front. As a result, fast moving cold fronts indicate a rapid change in the weather. Warm fronts also can have large changes in weather but the change is usually not as rapid as with a cold front.

1. Place a red "L" on the Surface Observation map in the same location as they placed it on their Surface Air Pressure map.

On a weather map fronts are drawn where there is large changes in temperature, changes in wind direction and speed, and between areas where there are large changes in pressure.

2. Use the information provided by the station models around the low-pressure L on the map to draw a cold front, in blue, and a warm front, in red, on the Surface Observation map.

3. Compare, and comment on, the direction the wind blows around high and low pressure (based on the arrows you drew on the Surface Air Pressure map) compared to the direction of the staffs on the Surface Observation map. What do you notice?

4. Examine the weather station data on the Surface Observation map. What do you notice about the cloud cover and precipitation under the areas of high and low pressure, as well as the areas around the cold and warm front?

Bringing it all together: Why does precipitation and wind occur along mid-latitude cyclonic systems?

The diagram below provides a map representation of a mid-latitude cyclonic system. You will need to explain the existence and direction of wind, as well as why precipitation is happening at the areas shaded light blue.

Answer the questions below and annotate the diagram in order to provide an explanation that others can easily understand. Be sure to refer to what you have observed and learned from specific activities in class.
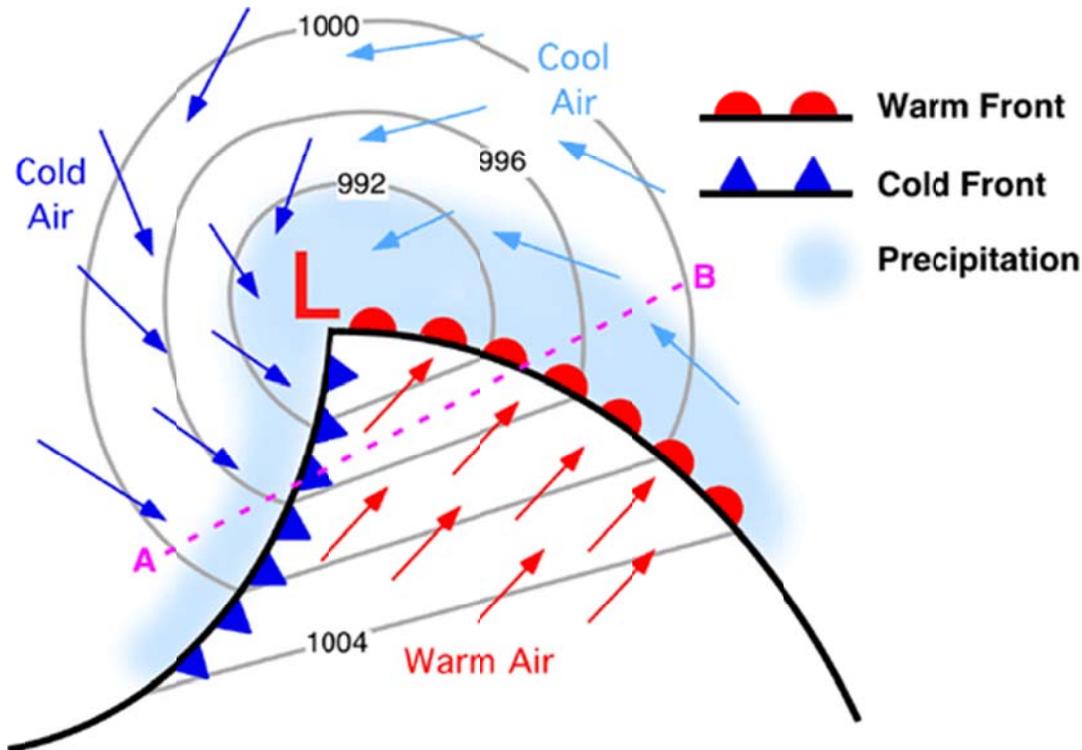
1. Why is wind occurring here? Be sure to discuss air pressure in your response.

2. Why is the wind moving toward the low-pressure center in a counterclockwise motion as indicated by the diagram?

3. Why is precipitation occurring in at the shaded areas?