Weather Lab #1: Winds
DO NOT WRITE ON THIS, BECAUSE IT WILL BE RETURNED!

Learning Objectives:
E4.p2E Describe conditions associated with frontal boundaries (cold, warm, stationary, and occluded).
E4.p2F Describe the characteristics and movement across North America of the major air masses and the jet stream.
E4.p2I Identify major global wind belts (trade winds, prevailing westerlies, and polar easterlies) and that their vertical components control the global distribution of rainforests and deserts.
E4.2A Coriolis effect, and unequal heating of the earth

Lab 1: Uneven Heating of the Earth
Supplies: Bouncy ball (i.e., Earth analog), LabQuest, temperature probes, and lamp.
Directions: Observe the ball, this represents the Earth. The lamp represents the Sun. Now look at the LabQuest temperature readings. Temperature probe #1 is at the equator (i.e., labeled "CH 1: Temperature" on LabQuest), temperature probe #2 is at the tropical zone, temperature probe #3 is at the polar zone, and temperature probe #4 is at the pole. **In order to answer the following question, you must read page 555 to understand how winds are created.**
Question:

1. Explain how this lab proves uneven heating of the Earth.

Lab 2: Heat Transfer
Convection Conduction Radiation

Lab 2: What is Wind?
Directions: Read "What is Wind" on page 553. Complete the graphic organizer. Explain how each topic causes the next.
Questions:

Uneven Heating: (Do not write on this sheet) → Air Pressure: → Convection Currents: → Wind:

Lab 3: How is Wind Created?
Supplies: Milk Jug of Ice, Water Bottles of Hot Water, Smoke Machine, Sunlamp, and Fish Tank
Directions: Using the smoke machine, pump smoke directly into the fish tank. Let it pump for 1 to 2 seconds and then cover the fish tank with the cardboard. Watch the tank to see wind forming. After you have watched for awhile, completely uncover the fish tank (i.e. leave cardboard off) and watch the wind for a bit longer. Put hand over tank and see if you can feel the wind. **Finally, read "What is Wind" on page 553 and "Global Winds and Global Convection Currents" on page 555.**
Questions:

1. Which air (i.e., cold or hot) is high pressure and which low pressure?
2. Which air (i.e., cold or hot) has the greatest density?
3. How did the lab prove what the readings said about how wind is created? Don't forget to mention **convection currents**, and how gases get heated/cooled!

Lab 4: What is the Coriolis Effect?
Supplies: plastic ball (i.e., Earth analog) and black marker
Directions: Turn the ball in the same direction that the Earth spins (i.e. counterclockwise/to your right). Notice that the sun rises in the east and sets in the west. First, spin the ball and draw a line from the North Pole to the equator, with the marker. Then spin the ball and draw a line from Antarctica (i.e. South Pole) to the equator. **Finally, read the "Coriolis Effect" on page 555.**
Questions:

1. Do winds spin in the same direction for both hemispheres (curve to right or left)?
2. If cold air were moving south from Canada into the continental United States, how would its movement be impacted by Earth's rotation?
3. Do winds spin in the same direction in both hemispheres (e.g. clockwise or counterclockwise)? (Don't be fooled… Flip ball upside-down.) – Look at picture on 555

Lab 5: Proving the Coriolis Effect
Supplies: two marbles, and the Coriolis Spinning Machine
Directions: Turn the machine on low (i.e., L). Imagine that you are standing at the South Pole. Your goal is to roll the marble onto the equator (i.e., the red X in the black circle). You must **gently** roll the marble from the **edge** of the cardboard circle. The marble represents global wind and how it spins. **Finally, read the "Coriolis Effect" on page 555.**
Question:

1. How did the lab prove what the readings said about how wind spins/turns (i.e. Coriolis Effect)? Think about how the marble spun and curved.

Lab 6: Global Wind Belts
Directions: Draw and label the picture on page 557 (Figure 11: Global Winds).
Question:

1. In which direction do winds blow over South America, west to east or east to west?

Lab 7: Jet Stream
Directions: Draw and label the picture on page 558 (Figure 12: Jet Stream).
Question:

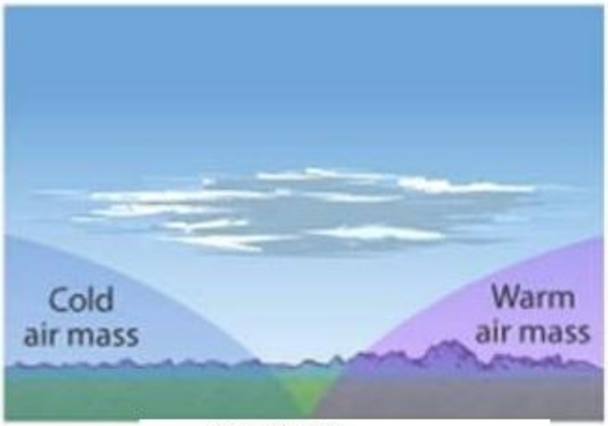
1. What impact could the polar jet stream have on Michigan's weather?

Lab 8: North American Air Masses
Directions: Draw and label the picture on page 580. **Finally, read "How Air Masses Move" on page 581**.
Question:

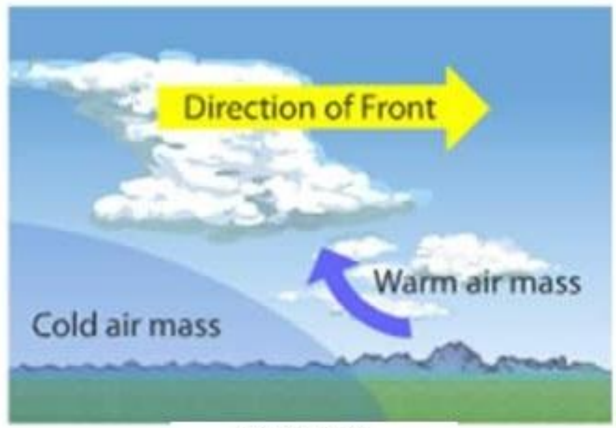
1. How do the air masses move?

Lab 9: Types of Fronts
Directions: Classify the following fronts. Read pages 582-583.
Questions:

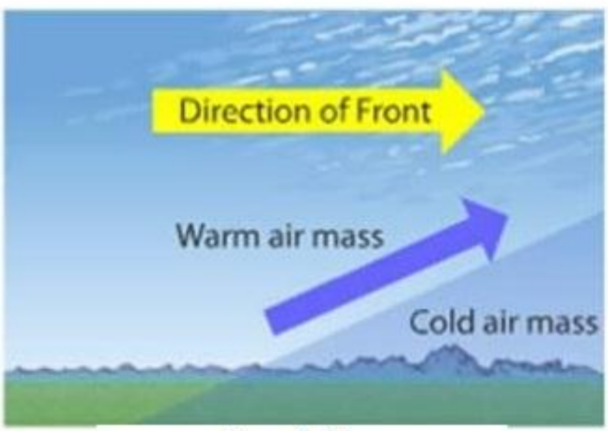
1. Front #1 Name 2. Front #2 Name 3. Front #3 Name 4. Front #4 Name



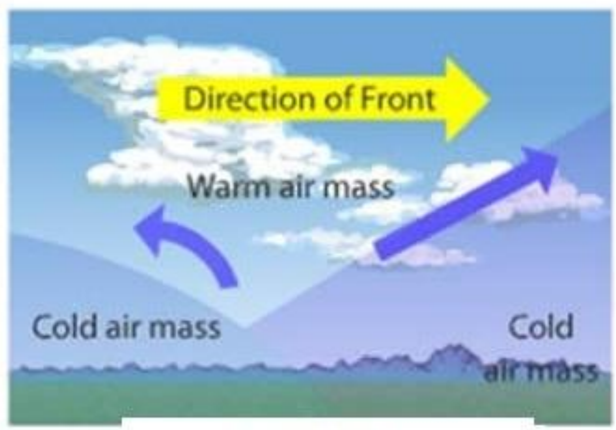
Front #1



Front #2



Front #3



Front #4

Extra Lab: Measuring Wind
Directions: Use the anemometer to measure the wind speed outside. Speak to the teacher before you leave the classroom. **Finally, read "Measuring Wind" on page 553.**
Questions:

1. What was the location where you measured the wind and what was the speed (i.e., m/s)
2. Based on your wind speed reading, do you think there is a large difference between high and low pressure, today? Explain using your knowledge of how wind is created (i.e., lab 1 or "What is Wind" on 553)

Extra Lab: Modeling Front Formation (Completed once at the middle of class and once at end of class)
Supplies: Heat-resistant beaker/jar, pepper, cold/warm water, red food coloring, and heat source
Directions: Fill a beaker half full with cold water and thoroughly stir in pepper. Add red food coloring to a container of hot water. Put an ice cube into the cold water and gently pour the hot water onto the ice cube, in the heat-resistant beaker. The two layers should remain separated and only mix slightly. Heat the beaker (medium setting) on a burner. As the water is heated the pepper will rise, because of convection currents. However, it will not penetrate the hot water layer. **Finally, read "Fronts" on page 581.**
Questions:

1. Why doesn't the pepper rise through the top layer of water?
2. What does the hot and cold water represent?
3. How does this lab model a front?

Task 8 Reading: Comfort Level - Relative humidity is the ratio of the current absolute humidity to the highest possible absolute humidity (which depends on the current air temperature). A reading of 100 percent relative humidity means that the air is totally saturated with water vapor and cannot hold any more, creating the possibility of rain. This doesn't mean that the relative humidity must be 100 percent in order for it to rain -- it must be 100 percent where the clouds are forming, but the relative humidity near the ground could be much less.

Humans are very sensitive to humidity, as the skin relies on the air to get rid of moisture. The process of sweating is your body's attempt to keep cool and maintain its current temperature. If the air is at 100-percent relative humidity, sweat will not evaporate into the air. As a result, we feel much hotter than the actual temperature when the relative humidity is high. If the relative humidity is low, we can feel much cooler than the actual temperature because our sweat evaporates easily, cooling us off. For example, if the air temperature is 75 degrees Fahrenheit (24 degrees Celsius) and the relative humidity is zero percent, the air temperature feels like 69 degrees Fahrenheit (21 C) to our bodies. If the air temperature is 75 degrees Fahrenheit (24 C) and the relative humidity is 100 percent, we feel like it's 80 degrees (27 C) out.

People tend to feel most comfortable at a relative humidity of about 45 percent. Humidifiers and dehumidifiers help to keep indoor humidity at a comfortable level.

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Winter Indoor Comfort and Relative Humidity

Compared to summer when the moisture content of the air (relative humidity) is an important factor of body discomfort, air moisture has a lesser effect on the human body during outdoor winter activities. But it is a big factor for winter indoor comfort because it has a direct bearing on health and energy consumption.

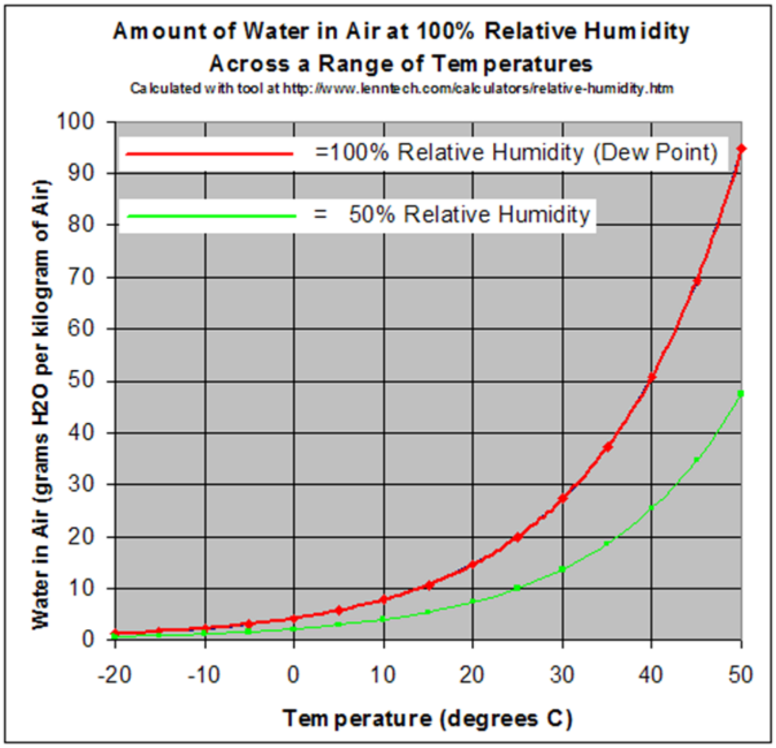
The colder the outdoor temperature, the more heat must be added indoors for body comfort. However, the heat that is added will cause a drying effect and lower the indoor relative humidity, unless an indoor moisture source is present.

While a room temperature between 71° and 77° F may be comfortable for short periods of time under very dry conditions, prolonged exposure to dry air has varying effects on the human body and usually causes discomfort. The moisture content of the air is important, and by increasing the relative humidity to above 50% within the above temperature range, 80% or more of all average dressed persons would feel comfortable.

See the table Apparent Temperature for the apparent temperatures for various combinations of room temperature and relative humidity. As an example of how to read the table, a room temperature of 70° F combined with a relative humidity of 10% feels like 64° F, but at 80% it feels like 71° F.

Although degrees of comfort vary with age, health, activity, clothing, and body characteristics, the following table can be used as a general guideline when raising the apparent temperature and the level of comfort through an increase in room moisture, rather than by an addition of heat to the room. This method of changing the apparent temperature can give the direct benefit of reducing heating costs because comfort can be maintained with a lower thermostat setting if moisture is added.

Task 9: Humidity Graph



Task 10: Fog and Relative Humidity Data Tables

Average Number of Days with Clouds or Fog

City	Cloud	Fog
Atlanta, Georgia	149	159
Austin, Texas	136	127
Baltimore, Maryland	152	144
Birmingham, Alabama	155	178
Boston, Massachusetts	164	139
Buffalo, New York	208	174
Charlotte, North Carolina	152	168
Chicago, Illinois	176	124
Cincinnati, Ohio	186	166
Columbus, Ohio	190	166
Dallas, Texas	133	91
Denver, Colorado	120	56
Detroit, Michigan	185	156
Hartford, Connecticut	175	162
Houston, Texas	161	194
Indianapolis, Indiana	179	175
Jacksonville, Florida	144	198
Kansas City, Missouri	149	123
Las Vegas, Nevada	73	5
Los Angeles, California	103	92
Memphis, Tennessee	151	115
Miami, Florida	115	43
Milwaukee, Wisconsin	175	142
Minneapolis, Minnesota	169	103

Average Annual Relative Humidity (%)

City	Daily (RH%)
Atlanta, Georgia	68
Austin, Texas	67
Baltimore, Maryland	66
Birmingham, Alabama	70
Boston, Massachusetts	67
Buffalo, New York	72
Charlotte, North Carolina	67
Chicago, Illinois	70
Cincinnati, Ohio	70
Columbus, Ohio	70
Dallas, Texas	65
Denver, Colorado	52
Detroit, Michigan	71
Hartford, Connecticut	66
Houston, Texas	75
Indianapolis, Indiana	72
Jacksonville, Florida	76
Kansas City, Missouri	68
Las Vegas, Nevada	30
Los Angeles, California	71
Memphis, Tennessee	67
Miami, Florida	73
Milwaukee, Wisconsin	72
Minneapolis, Minnesota	68

Water in the Atmosphere Worksheet – Lab #2

Learning Objectives:
E4.p1A Describe that the water cycle includes evaporation, transpiration, condensation, precipitation, infiltration, surface runoff, groundwater, and absorption. *(prerequisite)*
E4.p2B Describe the difference between weather and climate. *(prerequisite)*
E4.p2C Explain the differences between fog and dew formation and cloud formation. *(prerequisite)*
E4.p2D Describe relative humidity in terms of the moisture content of the air and the moisture capacity of the air and how these depend on the temperature. *(prerequisite)*
E4.3g Explain the process of adiabatic cooling and adiabatic temperature changes to the formation of clouds.

Directions: You will use the packet and reading section 4 (pages 560-566) to answer the questions.

Task 1: Give a definition for the following terms.

1. Water Cycle:
2. Evaporation:
3. Humidity:
4. Relative Humidity:
5. Dew Point:
6. Condensation:
7. Water Vapor:

Task 2: Explain how the following items <u>form</u> (i.e., not a simple definition)

1. Dew:
2. Fog:
3. Clouds

Task 3: On a separate sheet of paper, draw and label the **cloud formation picture** (i.e., Figure 15), found on page 563.

Task 4: Complete the **"Discovery Activity"** (i.e., How does fog form?) on page 560 and answer the questions.
1. How can you explain your observations?
2. Why is there a difference between what happened with the hot water and the cold water?

Task 5: Water Cycle
1. Go up to the SmartBoard and start/watch the video on the water cycle. http://teacher.scholastic.com/activities/studyjams/water_cycle/
2. On a separate sheet of paper, draw a sketch of the water cycle. (Note: you can also find a drawing of the water cycle on page 561 – Figure 13)
3. Next, take the quiz on the water cycle.

Task 6: Measuring the Dew Point -review the definition of dew
Materials: Beaker, water at room temperature, ice cubes, thermometer
Steps: Fill a beaker with water, **half full**, and record the temperature. **Make sure the outside of the beaker is dry.** Then add ice cubes to the beaker and stir. When moisture condenses on the outside of the beaker, record the temperature of the water, again. This temperature is the dew point in the classroom.

1. Why does the atmosphere reach its dew point?
2. Explain why the dew point may not be the same, if this experiment was performed on a different day.

Task 7: Complete the **"Analyzing Data"** activity on page 562 and answer the questions. Make sure you read the paragraph "Determining Relative Humidity" or you will never understand how to read the graph.

1. Interpreting Data:

2. Interpreting Data:

3. Interpreting Data:

4. Interpreting Data:

5. Drawing Conclusions:

Task 8: Read the **"Comfort Level"** section of the packet.

1. Summarize what you learned about personal comfort and relative humidity.

Task 9: Study the **"Humidity"** graph, from the packet.

1. Use the graph data, to explain how temperature (X axis) and the amount of water in the atmosphere (Y axis) correlate. Meaning: use the actual data to explain how a change in temperature impacts the amount of suspended water vapor in the atmosphere.

Task 10: Study the **fog and relative humidity data tables** from the packet.

1. What observations can you make about the geographic location of a city and the amount of annual fog?
2. Explain why there is a correlation between the relative humidity data and fog data.

Task 11: How do Clouds Form?

Supplies: textbook, bicycle pump, rubbing alcohol, 3-liter, valve stem, goggles, and Mr. Jacobs

Directions: GOGGLES ON! MR. JACOBS MUST SUPERVISE THIS EXPERIMENT! NOTE: YOU MUST HOLD THE STOPPER AND 3-LITER AT ALL TIMES. THE DEPRESSURIZATION IS EXPLOSIVE. Pump the 3-liter about 5 times. Then quickly release the pressure from the 3-liter by pulling out the rubber stopper. You will see a cloud form inside. Repeat the steps to see the cloud disappear and reappear. Read "Relative Humidity" on page 561 and "How Clouds Form" on page 563.

Questions:

1. What happened to the atmospheric pressure and temperature inside the bottle when you pumped it up?
2. What happened to the atmospheric pressure and temperature inside the bottle when you released the pressure?
3. Beyond cooling, what else do you need for a cloud to form? Knowing this, what must have been inside your bottle?
4. How did the lab prove what the readings said about how clouds form? Don't forget to mention cooling, particulate matter (i.e. dust particles in air), and water vapor.
5. On days when you are in a zone of high pressure, are you more likely to have clouds or clear skies?
6. **Advanced Question:** Explain why under high pressure there was no cloud but when the bottle was under low pressure a cloud formed. You should mention relative humidity; heating and cooling; dew point; condensation; and particulate matter.