Your Name _____ Score _____

Group Members _____

_____ Minutes _____

Standard 4
Key idea 2

Performance Indicator: 2.1
Use the concepts of density and heat energy to explain observations of weather patterns, seasonal changes, and the movements of Earth's plates.

Major Understanding:

2.1c Weather patterns become evident when weather variables are observed, measured, and recorded. These variables include air temperature, air pressure, moisture (relative humidity and dewpoint), precipitation (rain, snow, hail, sleet, etc.), wind speed and direction, and cloud cover.

2.1d Weather variables are measured using instruments such as thermometers, barometers, psychrometers, precipitation gauges, anemometers, and wind vanes.

2.1e Weather variables are interrelated.
For example:

- temperature and humidity affect air pressure and probability of precipitation
- air pressure gradient controls wind velocity

2.1f Air temperature, dewpoint, cloud formation, and precipitation are affected by the expansion and contraction of air due to vertical atmospheric movement.

2.1g Weather variables can be represented in a variety of formats including radar and satellite images, weather maps (including station models, isobars, and fronts), atmospheric cross-sections, and computer models.

2.1h Atmospheric moisture, temperature and pressure distributions; jet streams, wind; air masses and frontal boundaries; and the movement of cyclonic systems and associated tornadoes, thunderstorms, and hurricanes occur in observable patterns. Loss of property, personal injury, and loss of life can be reduced by effective emergency preparedness.

Mini Lesson 1: Temperature

From the day you were born weather has affected you. What you wear, places you want to go and most things you do can be impacted by the weather. Winter sports need snow, but too much snow can keep you from getting there. Summer activities need sunshine and warmth. No one likes rain at a picnic or when going to an amusement park.

Meteorology is the study of Earth's atmospheric changes, weather. Meteorologists, scientists that study weather, focus on the short term conditions of the atmosphere. There are several factors that affect weather. This makes predicting weather a challenge. Satellites and radar are just some of the latest technology that meteorologists use to help make those predictions. Although these tools are accurate, one small shift in the wind can either bring a storm to your area or send it to a completely different location.

You may recall that energy transfer is the movement of heat. When we think of heat we are referring to temperature. Temperature is the measure of the average kinetic energy. The greater the kinetic energy of a substance the warmer it is. The instrument used to measure temperature is a thermometer. There are three scales used to measure temperature, Fahrenheit (°F), Celsius (°C), and Kelvin. On a weather map, isotherms are lines drawn to show patterns of temperature. Isotherms connect places of equal temperature.

1. What is meteorology? _____

_____

2. What is the short term conditions of the atmosphere called? _____
3. Why is weather difficult to predict? _____

_____

4. What is temperature? _____

_____

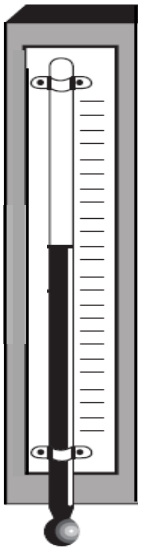
5. Place your two hands together and rub them vigorously for 2 minutes.
6. Describe what happened while you did this. _____

_____

7. Did the kinetic energy (energy in motion) increase or decrease when you rubbed your hands together? _____
8. Did the temperature increase or decrease when you rubbed your hands together? _____
9. What are isotherms? _____
10. What do isotherms connect? _____

"Temperature" Earth Science Reference Tables page 13

1. Write the names and symbols of the three scales on the chart?



_____ °____

_____ °____

_____ ____

2. Look at the scale in the first column (Fahrenheit).
   How many degrees does each line count by? _____ °F
3. Look at the scale in the second column (Celsius).
   How many degrees does each line count by? _____ °F
4. Look at the scale in the third column (Kelvin).
   How many degrees does each line count by? _____ °F
5. Find the following temperatures for each scale.

	Fahrenheit	Celsius	Kelvin
Water boils			
Water freezes			
Room temperature			

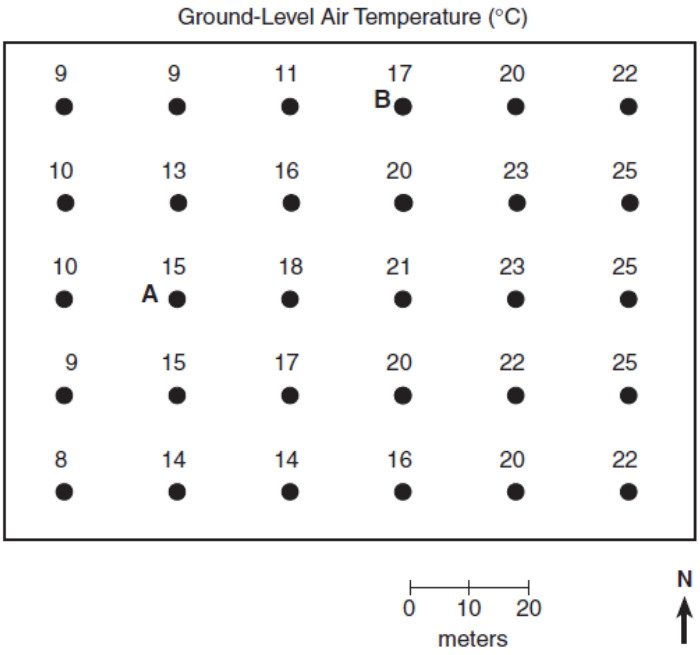
6. **Practice**: Convert the temperatures below by using the conversion chart in the Earth Science Reference Tables.

Fahrenheit	Celsius	Kelvin
20		
	70	
		260
	40	
60		
		290
	-40	
		240
75		
	50	

Regents Questions:

Base your answers to questions 1 through 4 on the field map provided below. The field map shows air temperature at specific locations in an area near a school in New York State. Part of this area is a blacktop parking lot. Accurate temperature readings were taken by Earth science students at 10 a.m. on June 1. Two reference points, *A* and *B*, are shown.

1. On the field map provided to the right, draw only the 15°C and the 20°C isotherms. Isotherms must be extended to the edge of the map.



2. Surface temperatures are higher on the east side of the field map, where the parking lot is located. Explain how a characteristic of the parking lot surface could cause these higher temperatures.

_____

3. Calculate the temperature gradient along a straight line between point A and point B on the map by following the directions below.

   a) Write the equation for determining the temperature gradient.

   b) Substitute the correct values into the equation.

   c) Solve the equation and record your answer in decimal form. Label the answer with the correct units.

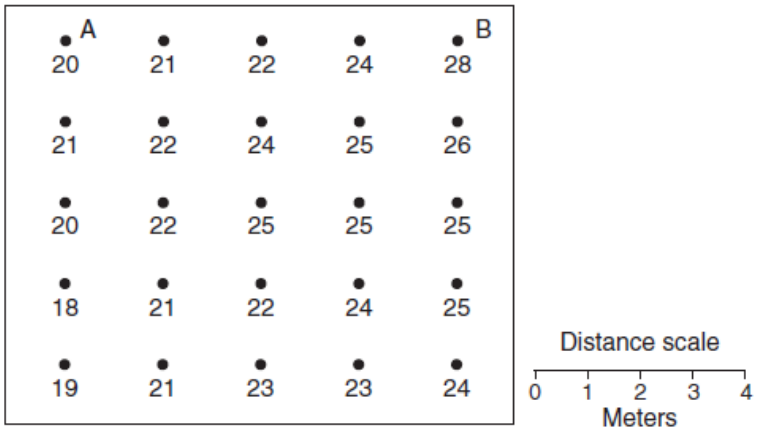
4. Another Earth science class took accurate temperature readings at 12 noon on the same day and at the same locations. At each location, the temperature was warmer than it had been at 10 a.m. Explain why the temperature readings would normally increase between 10 a.m. and 12 noon.

_____

_____

5. The field map to the right shows air temperature measurements, in degrees Celsius, taken at the same elevation within a closed room.

   Two reference points, *A* and *B,* are shown. Draw the isolines for 18°, 20°,22°,24°,26 and,28°.



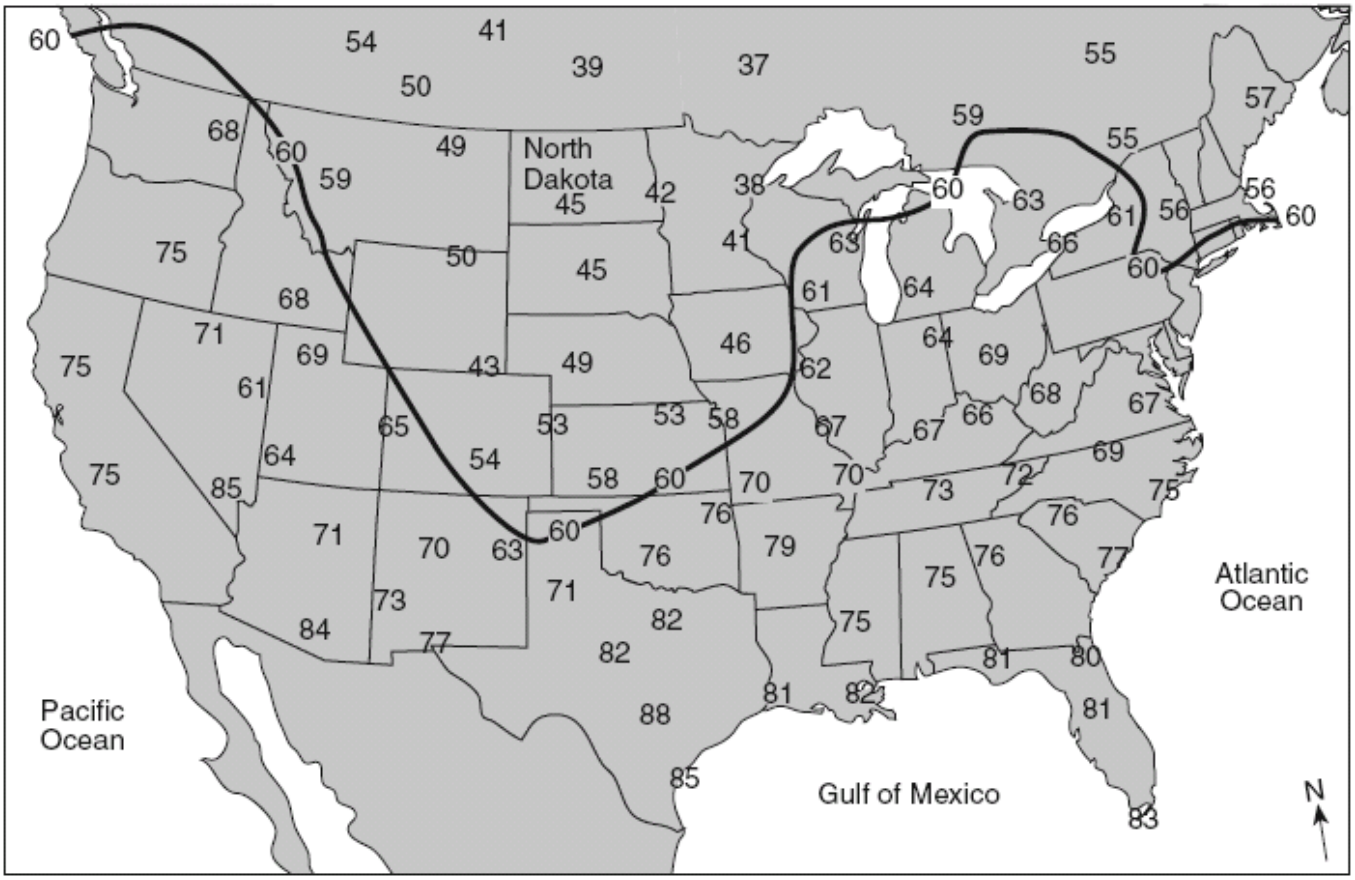
6. Calculate the temperature gradient along a straight line between point A and point B on the map by following the directions below.

   a) Write the equation for determining the temperature gradient.

   b) Substitute the correct values into the equation.

   c) Solve the equation and record your answer in decimal form. Label the answer with the correct units.

7. On the map provided, draw the 40°F, 50°F, 60°F, 70°F and 80°F isotherms. Extend the isotherm to the edges of the continent.



Introduction:

Materials
- ✓ 50 ml beaker
- ✓ 100 ml beaker
- ✓ 250 ml beaker
- ✓ 500 ml beaker
- ✓ 1000 ml beaker
- ✓ Water
- ✓ Pan to catch excess water

Humidity is the amount of water vapor in the air. Relative humidity is the ratio between the amount of moisture in the atmosphere and how much moisture the atmosphere can hold. It is measured in percent (%). When the air is "holding" as much water vapor as it can the air is saturated. The dew point temperature is the temperature at which the air is saturated. When the air is saturated, the relative humidity is 100%. Warm air can "hold" more water vapor than cold air. The more water vapor in the air the more humid it is. That's why in the summer you may say it is hot and humid. Because cold air cannot "hold" as much water vapor it is never said that it is "cold and humid"/

Objective:

- To have a better understanding of what relative humidity is

Procedure:

1. Place 600 ml of water into the 1000 mL beaker and bring it to you table. This will be your water source.
2. Keep the pan under the beakers as you are pouring the water.
3. Each beaker should already be labeled with a temperature:
   50 mL = 50 °F, 100 mL = 60 °F, 250 mL = 70°F, 500 mL = 80°F
4. Temperatures are generally cooler in the morning so try and follow the story below to better understand how relative humidity works.
5. At 8:00 in the morning the air temperature is 50°F. There is dew on the lawn so you know that the air is holding as much water vapor as it can. Fill the 50°F beaker with water. The water represents water vapor in the atmosphere.

   What is the percentage of water in the 50°F beaker? _____ %

6. At 10:00 a.m. the temperature is now 60°F. You now notice that there is no longer dew on the lawn. Take the water from the 50°F beaker and pour it into the 60°F beaker.

   How many mL of water is in the 60°F beaker? _____ mL

   How many mL of water can the 60°F beaker hold? _____ mL

   Relative humidity is a ratio between how much water vapor is in the air and how much water vapor the air can hold.

   $$Relative\ Humidity = \frac{(water\ in\ the\ beaker)}{(the\ beaker\ can\ hold)} x\ 100 \quad = \frac{\frac{mL}{mL}}{} x\ 100$$

   What is the percentage of water in the 60°F beaker? _____ %

   What happened to the relative humidity as the temperature increased? _____

7. At 12:00 noon the temperature is now 70°F. Take the water from the 60°F beaker and pour it into the 70°F beaker.

   What is the percentage of water in the 70°F beaker? _____ %

   What happened to the relative humidity as the temperature increased? _____

   As the temperature has increased, what happens to the amount of evaporation occurring?

   _____ What happens to the amount of water vapor in the air? _____

   Using the water in the 1000 mL beaker, pour an additional 100 mL of water into the 70°F beaker to represent the added water vapor in the air.

   What is the percentage of water in the 70°F beaker now? _____ %

8. At 2:00 p.m. the temperature is now 80°F. Take the water from the 70°F beaker and pour it into the 80°F beaker.

   What is the percentage of water in the 80°F beaker? _____ %

   What happened to the relative humidity as the temperature increased? _____

   As the temperature has increased, what happens to the amount of evaporation occurring?

   _____ What happens to the amount of water vapor in the air? _____

   Using the water in the 1000 mL beaker, pour an additional 200 mL of water into the 80°F beaker to represent the added water vapor in the air.

   What is the percentage of water in the 80°F beaker now? _____ %

9. At 4:00 p.m. a cold front came through and the temperature dropped to 70°F. Take the water from the 80°F beaker and pour it into the 70°F beaker.

   Describe what happened. _____

   What do you think this may represent? _____

✓ Check point

1. What happened to the relative humidity as the temperature increased?
2. Complete this statement: As temperature increased, relative humidity
3. Draw the relationship between temperature and relative humidity below. Remember to label the axis.

Terms:

Dry bulb – air temperature

Wet bulb – temperature of air that is cooled by evaporation of water (wet cloth)

Wet bulb depression - The difference between the wet bulb and dry bulb temperatures

Dewpoint Chart:

1. Highlight the top left column. What is the title of this column? _____
2. What is the "dry bulb" temperature? _____
3. Highlight the top row of the Dewpoint chart. Write down what it says in the space below.

_____

_____

4. How do you determine the difference between the Wet-Bulb and Dry-bulb Temperatures?

_____

5. What are the units for Dewpoint as listed on the chart in your reference tables? _____
6. Compare the Dry-Bulb temperature with the Dewpoint temperature if the difference between the Wet-Bulb and Dry-Bulb is "0" (zero) _____

Relative Humidity Chart:

1. Highlight the top left column. What is the title of this column? _____
2. What is the "dry bulb" temperature? _____
3. Highlight the top row of the Dewpoint chart. Write down what it says in the space below.

_____

_____

4. How do you determine the difference between the Wet-Bulb and Dry-bulb Temperatures?

_____

5. What are the units for Relative Humidity as listed on the chart in your reference tables? _____
6. If the difference between the Wet-Bulb and Dry-Bulb is "0" (zero), what is the Relative Humidity? _____

Compare:

1. Highlight the "Dry-Bulb Temperature column on each chart.
2. What do you notice about the temperatures that are listed? _____
3. Is there a column for Wet Bulb anywhere on these charts? _____
4. What do you need the Wet-Bulb value for? _____
5. Compare the Dewpoint Temperatures with the Dry-Bulb temperatures if the Relative Humidity is 100% _____

Show what you know: **Determining Relative Humidity and Dewpoint Temperatures**

When given the wet bulb and dry bulb temperatures, you can determine the dew point temperature and relative humidity. Follow the directions given in the example below.

Example 1: If the dry bulb temperature is 20°C and the wet bulb is 15°C, find the dew point temperature and the relative humidity.

Dew point:

Dry bulb _____

Wet bulb _____

Difference _____

1. Determine the difference between dry bulb and wet bulb.
2. Using the Dewpoint Temperature chart, find the dry bulb temperature on the left side. Place a scrap paper across this row, for easier reading.
3. Find the **difference** between the wet bulb and dry bulb temperatures located on the top.
4. Follow that column down until you reach your scrap paper.
5. What is the Dewpoint temperature ? _____ °C

Relative Humidity: (use Example 1 numbers)

Dry bulb _____

Wet bulb _____

Difference _____

1. Determine the difference between dry bulb and wet bulb.
2. Using the Relative Humidity chart, find the dry bulb temperature on the left side. Place a scrap paper across this row, for easier reading.
3. Find the **difference** between the wet bulb and dry bulb temperatures located on the top.
4. Follow that column down until you reach your scrap paper.
5. What is the Relative Humidity ? _____ %

Example 2: Find the relative humidity and dew point temperature when the dry bulb temperature is 14°C and the wet bulb temperature is 9°C.

Dry bulb _____ What is the Dew point Temperature? _____ °C

Wet bulb - _____

Difference _____ What is the Relative Humidity? _____ %

Practice:

Fill in the following table: Be careful! Make sure you are using the correct chart. If you get stuck on a problem, there are some hints below that may help. Try not to look at them first.

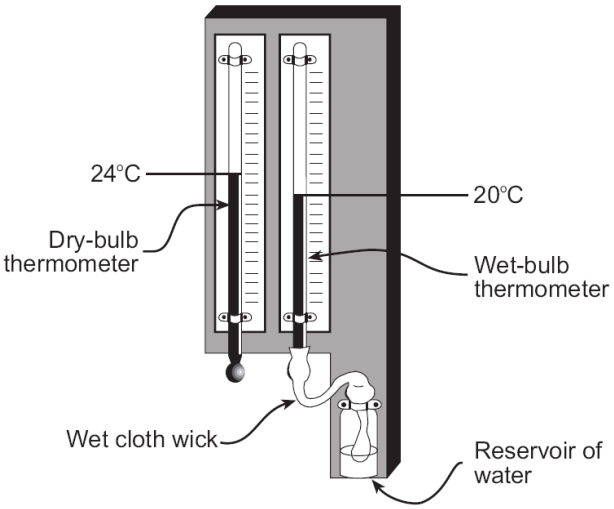
Dry bulb temperature (°C)	Wet bulb Temperature (°C)	Difference between wet/dry bulb	Dew point temperature (°C)	Relative humidity (%)
16	9			
20	12			
4		4		
10		3		
26			6	
-8			-18	
28				31
0				28
	16	2		
	14	10		
		5		58
		8		33
17	13			
25		1		
5		2		
-9	-10			

HINTS:

- The Wet-bulb temperature is always colder
- If you are given the dewpoint and dry-bulb temperatures, determine the difference first by looking at the top of the chart (same with relative humidity and dry-bulb)
- If given the difference and either dewpoint or relative humidity, start at the difference, find the given value and fill in the dry-bulb temperature first
- If the dry-bulb is an odd number, look at the temperature that is one degree warmer. The answer will be between that answer and the one above it.

Instruments used to determine relative humidity:

Hygrometer



The hygrometer has two thermometers and remains stationary on a wall.

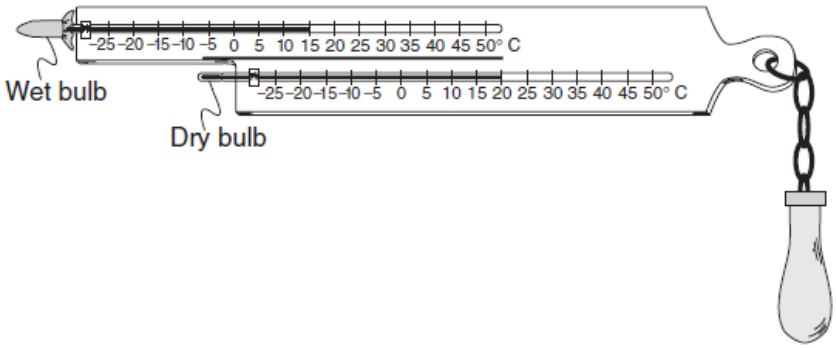
One thermometer is covered with a wet cloth. (wet bulb).

The wet bulb temperature is always cooler than the dry bulb.

By comparing these two readings you can determine relative humidity and dew point temperatures.

Sling Psychrometer

Similar to the hygrometer except it is not stationary. You walk around with the psychrometer and spin it in the air. This will give you the wet bulb and dry bulb temperatures that will allow you to determine the relative humidity and dew point temperatures.



1. Get a sling psychrometer from your teacher. Make sure the cloth on the one thermometer is wet.
2. Spin the psychrometer for at least 1 minute. Watch the temperature of the wet bulb decrease. Continue to spin the psychrometer until the wet bulb is at its lowest temperature.
3. Once the wet bulb temperature is at its lowest, record both temperatures below.

   Dry bulb temperature _____ Wet bulb temperature _____

4. What is the difference between the wet bulb and the dry bulb temperatures? _____
5. Using the information above and the Dewpoint and Relative Humidity charts determine the following:

   Dewpoint Temperture _____ Relative Humidity _____

Mini Lesson 2: Clouds

Condensation is the process by which water vapor (gas) changes phase and becomes liquid water. Condensation needs something to form on. This is called condensation nuclei.

Clouds are condensation. They consist of water droplets and ice crystals. In order for condensation to occur there must be water vapor present, the air must be saturated and condensation nuclei must be present. Water vapor enters the atmosphere by the process of evaporation. Warm, moist air rises. As the air rises it expands and cools. Once the air has reached the dewpoint, the air becomes saturated. Once this happens, condensation begins to occur. Water droplets form around dust particles that provide the condensation nuclei necessary for clouds to form. Precipitation is any form of water that falls to the Earth's surface. It occurs when the droplets are too big and heavy to remain suspended in the air and fall down towards Earth's surface.

Need to know

1. What are clouds? _____
2. What makes up a cloud? _____ and _____
3. List the three things necessary for clouds to form.

   _____

   _____

   _____
4. What is condensation nuclei? _____
5. Fill in the blanks below to describe how clouds form.

   - warm, moist air _____
   - air _____ and _____ to the _____
   - water droplets form on _____ _____
6. When does precipitation occur? _____
7. What is the difference between condensation and precipitation?

   _____

   _____

   _____
8. Since water droplets for on dust particles, where does the dust go when it rains?

   _____
9. What does precipitation do for the atmosphere? _____

Information:

Three things must be present in order for clouds to form: water vapor, air must be saturated, and condensation nuclei.

Materials
- ✓ Plastic bottle with cap
- ✓ Beaker
- ✓ Cold and hot water
- ✓ Matches

Objective:

- Create a cloud in a bottle and compare formation data

Procedure

1. Pour 75 milliliters of **cold** water into the plastic bottle.
2. Place the cap on the bottle and shake back and forth about 50 times.
3. Squeeze the bottle and then release the pressure approximately 10 times.

4. Remove the cap from the bottle.
5. Lay the bottle over on its side.
6. Light a match and hold it in the opening of the bottle.

7. Blow the match out while it is in the bottle so that the smoke and match stay inside the bottle.
8. Very quickly replace and tighten the cap on the bottle.
9. Squeeze the bottle and then release the pressure several times.
10. Write your observations below.

_____

_____

11. Rinse out the bottle.
12. Pour 75 milliliters of hot water into the plastic bottle.
13. Place the cap on the bottle and shake back and forth about 50 times.
14. Squeeze the bottle and then release the pressure approximately 10 times.
15. Remove the cap from the bottle.
16. Lay the bottle over on its side.
17. Light a match and hold it in the opening of the bottle.

18. Blow the match out while it is in the bottle so that the smoke and match stay inside.
19. Very quickly replace and tighten the cap on the bottle.
20. Squeeze the bottle and then release the pressure several times.
21. Write your observations below.

_____

_____

22. Rinse out the bottle

✓ **Check Point**

1. Phase changes: Liquid / Solid / Gas

   1. Freezing is the change in phase from _____ to _____
   2. Melting is the change in phase from _____ to _____
   3. Evaporation is the change in phase from _____ to _____
   4. Condensation is the change in phase from _____ to _____

2. Three things needed for Condensation to occur:

_____

_____

_____

3. Determine which of the following words are condensation and place a "C" on the line provided. If it is an example of precipitation, place a "P" on the line provided.

____ Dew on the grass	____ Sleet
____ Rain	____ Water on a mirror after a shower
____ Hail	____ Clouds
____ Fog	____ Snow
____ Frost	____ Water on cold glass of water

Show what you know: **Formation of Clouds**

Fill in the blanks below:

1. warm, moist air _____

   air _____ and _____ to the _____

   water droplets form on _____ _____

2. Examples of precipitation _____ _____ _____

3. Water droplets form on _____

4. Where do the dust particles go when it rains? _____
5. What happens to the amount of dust particles in the air when it rains.

_____

6. True or False: Precipitation cleans the atmosphere. _____

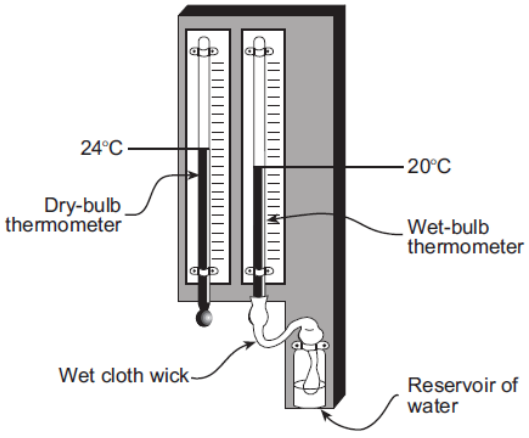
Regents questions:

____1. Most water vapor enters the atmosphere by the processes of
(1) convection and radiation
(2) condensation and precipitation
(3) evaporation and transpiration
(4) erosion and conduction

____2. Clouds usually form when
(1) air temperature reaches the dewpoint
(2) evaporation has warmed the surrounding air
(3) relative humidity is 0%
(4) condensation nuclei have been removed from the air

____3. Which statement best explains why an increase in the relative humidity of a parcel of air generally increases the chance of precipitation?
(1) The dewpoint is farther from the condensation point, causing rain.
(2) The air temperature is closer to the dewpoint, making cloud formation more likely.
(3) The amount of moisture in the air is greater, making the air heavier.
(4) The specific heat of the moist air is greater than the drier air, releasing energy.

Base your answers to questions 4 through 6 on the diagram below, which shows a hygrometer located on a wall in a classroom. The hygrometer's temperature readings are used by the students to determine the relative humidity of the air in the classroom.



4. Based on the temperature readings shown in this diagram, determine the relative humidity of the air in the classroom.

_____ %

5. Besides relative humidity, identify another weather variable of the air in the classroom that may be determined by using both temperature readings on the hygrometer.

_____

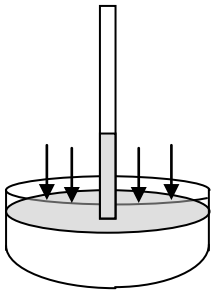
6. Describe how water evaporating from the wick attached to the wet-bulb thermometer lowers the temperature reading of that thermometer.

_____

Mini Lesson 3: Pressure

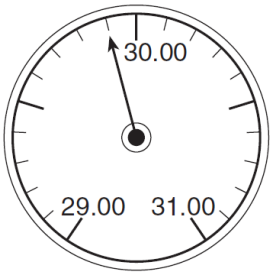
Air pressure is caused by the weight of the atmosphere. The higher your elevation, the less air there is above you and the pressure is less. Temperature also affects barometric pressure. As the air is heated, it becomes less dense and rises. Rising air means less pressure because the air is not pushing down as much. A barometer measures barometric pressure in inches of mercury or in millibars. On a weather map, isobars connect places of equal barometric pressure and show patterns in pressure systems. This is a key indicator of how the weather may be changing.

Mercury Barometer



As the air pressure pushes on the surface of the mercury in the dish, the mercury travels up the tube. As pressure increases, the mercury rises up higher in the tube. Warm air rises and the pressure is lower. The air does not push down as much on the mercury and it does not travel as far up the tube. Cold air sinks, causing higher pressure on the dish resulting in the mercury traveling farther up the tube.

Aneroid Barometer



These have a small metal box called an aneroid cell. There is a spring system that expands or contracts due to changes in air pressure. This causes the needle to move.

Need to know

1. What causes air pressure? _____
2. Why is their less pressure as your elevation increases? _____
3. Explain how temperature affects pressure. _____

_____

4. What two units are used in measuring barometric pressure? _____ and _____
5. What are drawn on weather maps to connect places of equal pressure? _____
6. What type of barometer uses an aneroid cell? _____
7. Explain how an increase of pressure causes the mercury to rise in a mercury barometer.

_____

_____

"Pressure" Earth Science Reference Tables page 13

1. Write the names and symbols of the two scales on the chart? _____ _____

   _____ _____

2. Look at the scale in the left side. How many millibars does each line count by? mb
3. Look at the scale in the right side. How many inches does each line count by? mb

4. One atmosphere is the approximate pressure at sea level. It is considered approximate because pressure at sea level changes depending on temperature.
   Referring to the chart, normal pressure at sea level is _____ atmosphere and.
   is equal to . . . _____ millibars and _____ inches

5. Using the Pressure Conversion Chart in the Earth Science Reference Tables complete the tables below.

Inches	Millibars
29.06	
29.94	
30.50	
29.44	

Millibars	Inches
1011.0	
1021.0	
1035.0	
991.0	

6. State the relationship between altitude and air pressure in the space below.

_____

_____

_____

_____

Draw the relationship on the graph below.

7. State the relationship between temperature and air pressure in the space below.

_____

_____

_____

_____

Draw the relationship on the graph below.

Show what you know: **Pressure**

1. Take the balloon and blow it up. Tie a knot at the end.
2. Place the balloon on the table with the knot at the bottom.
3. Gently push down on the top of the balloon. Circle the answer that best describes what is happening.

   a) Pushing down on the top must represent (high pressure / low pressure).

   b) The air in the balloon moved (inward / outward).

   c) The air in the balloon moved (downward / upward); the air (rises / sinks).

   d) Referring to the question above, the air is (warm / cold).

   e) Explain how you know if the air is warm or cold. _____

   _____

5. Slowly ease up on the top of the balloon. Watch carefully what happens to the air inside. Circle the answer that best describes what is happening.
   a) Letting up on the top of the balloon represents (high pressure / low pressure).
   b) The air in the balloon moved (inward / outward).
   c) The air in the balloon moved (downward / upward); the air (rises / sinks).
   d) Referring to the question above, the air is (warm / cold).
   e) Explain how you know if the air is warm or cold. _____

   _____

6. Write the three sentences that describe how clouds form. Refer to page 10 of this packet.

   _____

   _____

   _____

7. In a high pressure area the air (rises / sinks) and moves (inward / outward). The temperature is (warm / cold).

8. In a low pressure area the air (rises / sinks) and moves (inward / outward). The temperature is (warm / cold).

9. Do clouds form in a high pressure area or low pressure area? _____

   Explain your reasoning. _____

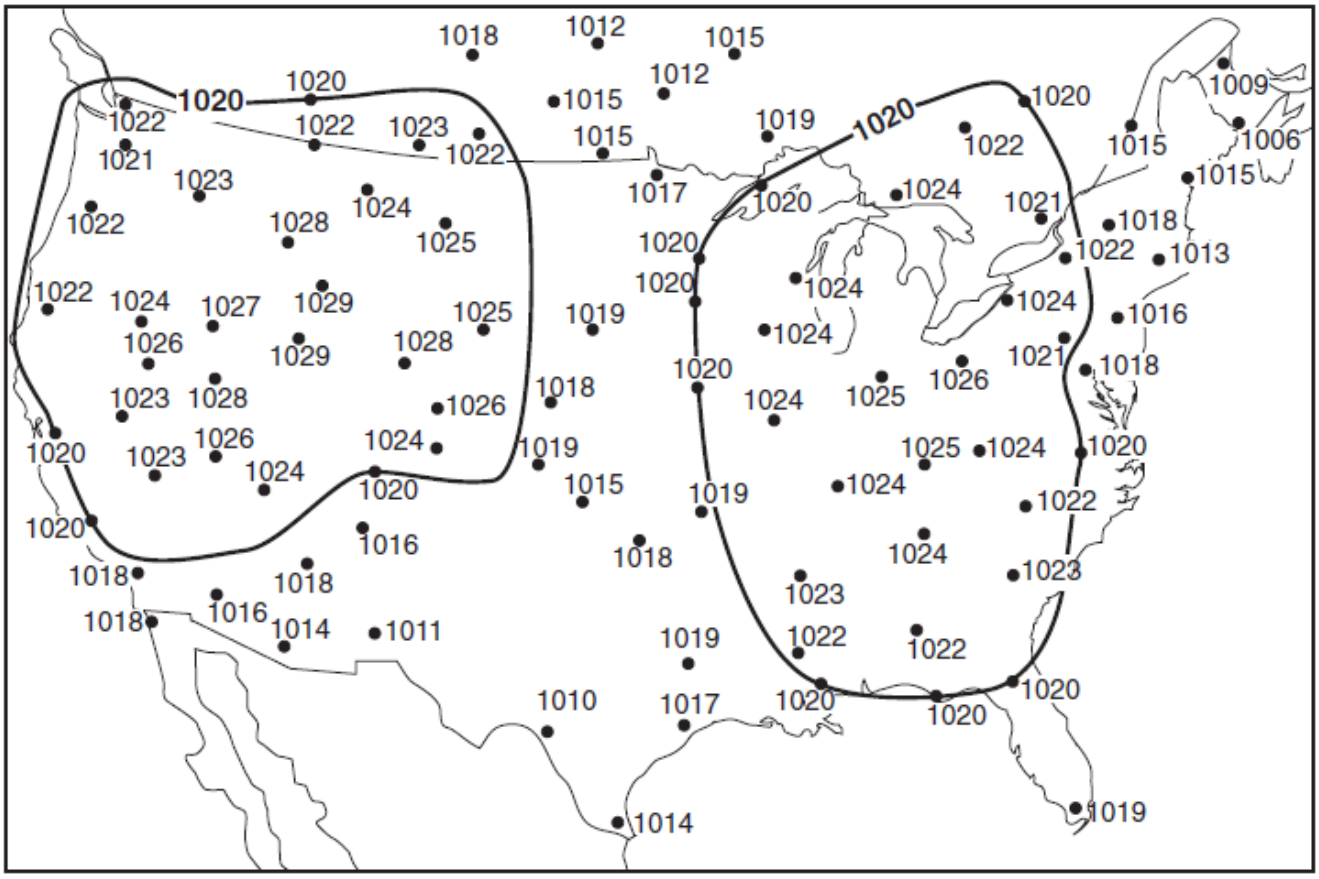
   _____

Base your answers to questions 1 through 7 on the weather map provided *in your answer booklet,* which shows surface air-pressure readings, in millibars, at various locations in the United States and Canada. The 1020-millibar isobars have been drawn and labeled.

1. Highlight all of the 1024 values on the left side of the map. Connect the points with a smooth curved line.
2. Highlight all of the 1028 values on the left side of the map. Connect the points with a smooth curved line.
3. Find the highest value in the center of the lines you just drew on the left side of the map and place an "H" on top of it. This is a High Pressure Center.
4. Highlight all of the 1024 values on the right side of the map. Connect the points with a smooth curved line.
5. As you look toward the center of these lines, are the values increasing or decreasing? _____
6. If the center has the lowest numbers in the center, find the lowest and place an "L" on top of it. This would be a Low Pressure Area. If the highest value is in the center of the lines you just drew place an "H" on top of it. This is a High Pressure Center.

7. What weather instrument was most likely used to measure these air pressures? _____

Surface Air Pressures



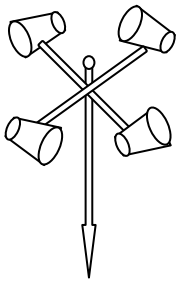
Mini Lesson 4: Wind

Wind is the horizontal movement of air. It is caused by the uneven heating of Earth's surface. Remember, it takes water longer to heat up and cool down than air because it has a higher specific heat and dark surfaces heat and cool faster than light surfaces. These are examples of uneven heating.

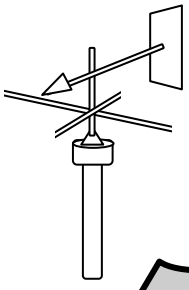
Differences in temperature result in differences in pressure. The greater the difference in pressure, the faster the wind. On a weather map, the closer the isobars the faster the wind speed.

Because wind has two variable, speed and direction, two instruments are used to measure it. Wind direction is named from where the wind is blowing from.

Anemometer
wind speed



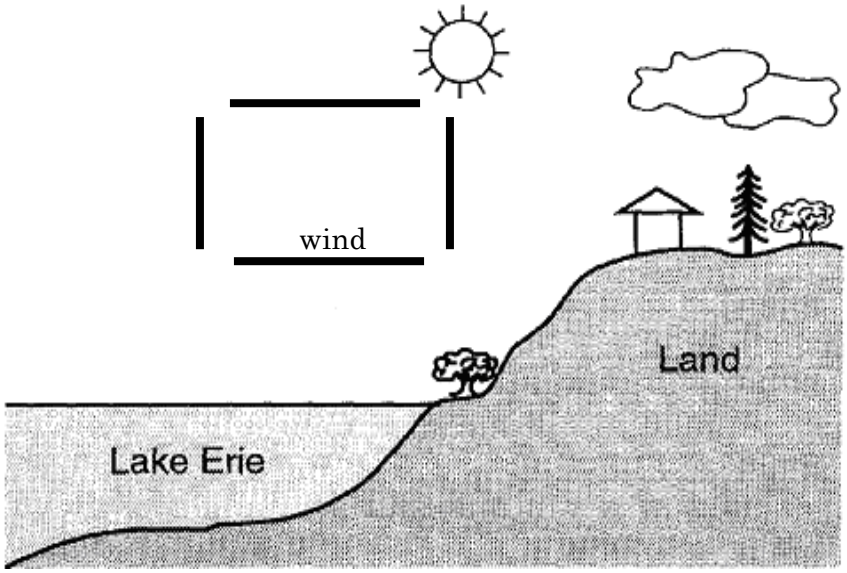
Wind Vane
wind direction



Need to know

1. What is wind? _____
2. What causes wind? _____
3. Give two examples of uneven heating? _____
   and _____
4. Explain how differences in temperature affects wind speed. _____
   _____
5. How are isobars spaced if the wind speed is very fast? _____
6. What two variables does wind have? _____ and _____
7. Name the instrument used to measure wind speed. _____
8. Name the instrument used to measure direction. _____
9. Which direction is the North wind blowing from? _____
10. If a north wind is blowing, what kind of temperatures can you expect? _____
11. Why is wind named from where the wind is blowing from? _____
    _____

1. What happens to the density of the air as it is heated? _____
2. Warm air _____
3. Cold air _____
4. Convection currents form.
5. During the day, when the sun is out, which surface is going to warm up faster (land or water) ?
6. In the diagram below draw an upward arrow ***on the thick line provided,*** above the surface (land or water) where the air is rising.
7. Draw a downward arrow ***on the thick line provided***, above the surface (land or water) where the air is sinking.
8. Draw the arrows *on the two horizontal lines provided*, that represents a convection current that illustrates the movement of the air.



9. Circle the word in parenthesis that best completes the sentence.

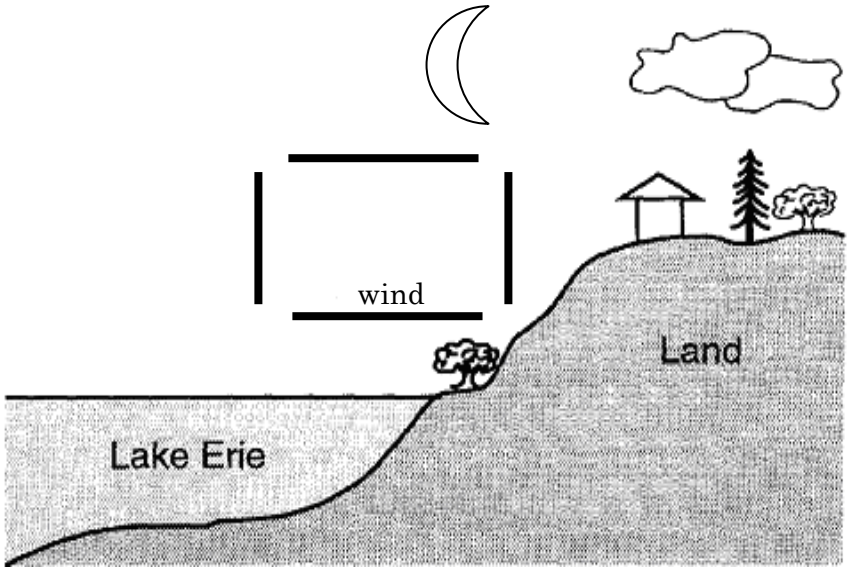
- Water heats up (faster / slower) than land because it has a (higher / lower) specific heat.
- Warm air rises over the (land / water) because the (land / water) heats up faster than the (land / water).
- The air over the land has a (higher / lower) pressure than the water because the air is (rising / sinking). The wind is blowing from (high / low) pressure to (high / low) pressure

10. At night, when the sun is no longer out, which surface is going to cool down faster (land or water)?

11. In the diagram below draw an upward arrow *on the thick line provided*, above the surface (land or water) where the air is rising.

12. Draw a downward arrow *on the thick line provided*, above the surface (land or water) where the air is sinking.

13. Draw the arrows *on the two horizontal lines provided*, that represents a convection current that illustrates the movement of the air.



14. *Circle the word in parenthesis that best completes the sentence.*
    - Water heats up (faster / slower) than land because it has a (higher / lower) specific heat.
    - Warm air rises over the (land / water) because the (land / water) cools down faster than the (land / water).
    - The air over the land has a (higher / lower) pressure than the water because the air is (rising / sinking). The wind is blowing from (high / low) pressure to (high / low pressure)

15. In the first example, when the sun was out, the wind blew from the (land / water) to the (land / water). This is called a (land breeze / sea breeze).

16. In the second example, when the sun was not out, the wind blew from the (land / water) to the (land / water). This is called a (land breeze / sea breeze).

17. In both diagrams, wind blew from (high to low pressure / low to high pressure).

High Pressure – Low Pressure Balloon Activity

1. Take the balloon and blow it up. Tie a knot at the end.
2. Place the balloon on the table with the knot at the bottom.
3. Gently push down on the top of the balloon.
   Circle the answer that best describes what is happening.

   a) Pushing down on the top must represent (high pressure / low pressure).

   b) The air in the balloon moved (inward / outward).

   c) The air in the balloon moved (downward / upward); the air (rises / sinks).

   d) Referring to the question above, the air is (warm / cold).

   e) Explain how you know if the air is warm or cold. _____

   _____

4. Slowly ease up on the top of the balloon. Watch carefully what happens to the air inside.
   Circle the answer that best describes what is happening.

   a) Letting up on the top of the balloon represents (high pressure / low pressure).

   b) The air in the balloon moved (inward / outward).

   c) The air in the balloon moved (downward / upward); the air (rises / sinks).

   d) Referring to the question above, the air is (warm / cold).

   e) Explain how you know if the air is warm or cold. _____

   _____

5. Write the three sentences that describe how clouds form. Refer to question 5 on page 11 of this packet.

   _____

   _____

   _____

6. In a high pressure area the air (rises / sinks) and moves (inward / outward). The temperature is (warm / cold).
7. In a low pressure area the air (rises / sinks) and moves (inward / outward). The temperature is (warm / cold).

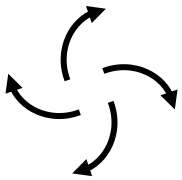
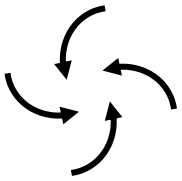
8. Do clouds form in a high pressure area or low pressure area? _____

   Explain your reasoning. _____

   _____

Weather Factors Associated with Different Pressure Areas

- Fill in the blanks below using the terms in the center of this chart.
- Draw an arrow on the line provided at the center, top of the chart to show the direction the wind blows (from _____ pressure to _____ pressure).

High Pressure	_____	**Low Pressure**
Air moves _____	(in / out)	Air moves _____
Air is _____	(rising / sinking)	Air is _____
Air is _____	(warm / cold)	Air is _____
There are _____	(clouds / no clouds)	There are _____
There is _____	(Precipitation /no precipitation)	There is _____
	Use the diagrams to the left and right to determine if the air is moving clockwise or counterclockwise around the center of the pressure system.	
Air moves _____	(clockwise / counter clockwise)	Air moves _____

"Planetary Wind and Moisture Belts in the Troposphere" Earth Science Reference Tables pg 14

Coriolis Effect: The deflection of winds and ocean currents caused by the rotation of Earth. Deflection is to the right in the Northern Hemisphere and to the left in the Southern Hemisphere.

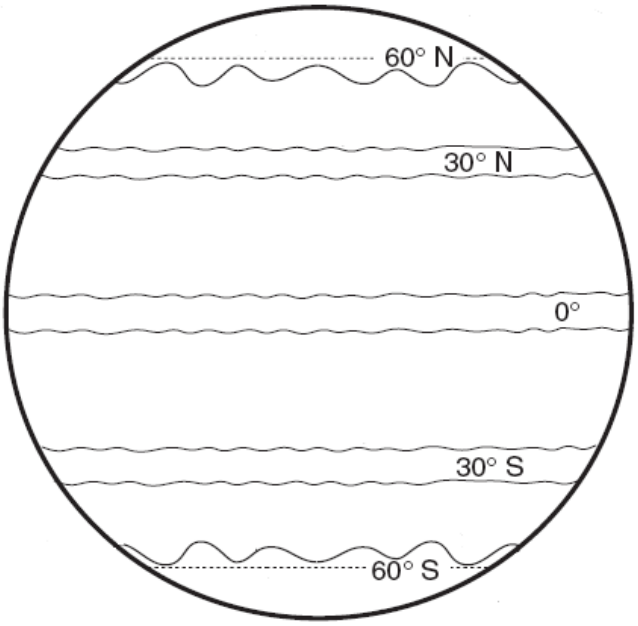
Planetary winds:

- Draw the wind arrows illustrating the direction and deflection.
- Label the areas that would be wet or dry.
- Label the areas that would be high pressure or low pressure.
- Name the planetary winds that influence New York State? (between 40°N and 45°N latitude)

_____

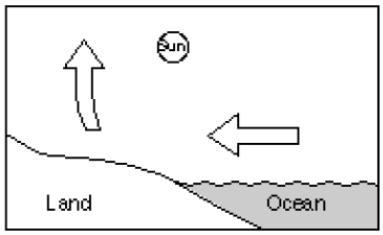
- What direction do the planetary winds move the weather systems in New York State?

_____



Regents Questions:

____ 1. In the diagram to the right, arrows represent air movement near an ocean coastline on a summer afternoon. Compared to the air over the ocean, the air over the land has a
(1) lower temperature and lower barometric pressure
(2) lower temperature and higher barometric pressure
(3) higher temperature and lower barometric pressure
(4) higher temperature and higher barometric Pressure



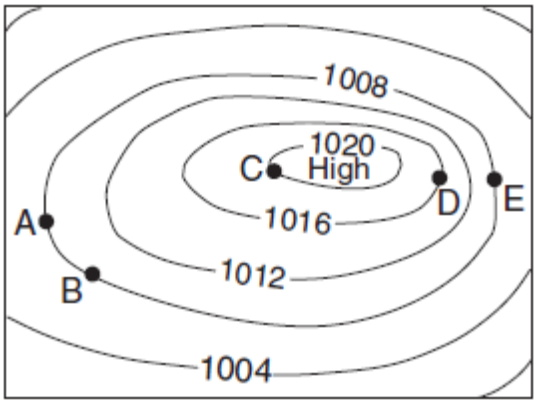
____ 2. Which atmospheric conditions would cause smoke from a campfire on a beach to blow toward the ocean?
(1) warm air over the land and cool air over the ocean
(2) humid air over the land and dry air over the ocean
(3) low-density air over the land and high density air over the ocean
(4) high air pressure over the land and low air pressure over the ocean

____ 3. Land surfaces of Earth heat more rapidly than water surfaces because
(1) more energy from the Sun falls on land than on water
(2) land has a lower specific heat than water
(3) sunlight penetrates to greater depths in land than in water
(4) less of Earth's surface is covered by land than by water

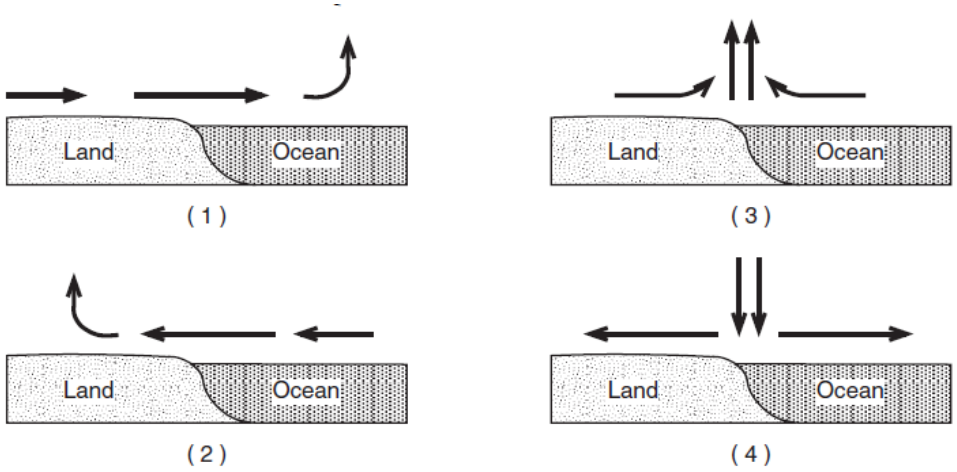
____ 4. Why are the beaches that are located on the southern shore of Long Island often considerably cooler than nearby inland locations on hot summer afternoons?
(1) A land breeze develops due to the lower specific heat of water and the higher specific heat of land.
(2) A sea breeze develops due to the higher specific heat of water and the lower specific heat of land.
(3) The beaches are closer to the Equator than the inland locations are.
(4) The beaches are farther from the Equator than the inland locations are.

____ 5. The air-pressure field map below represents a high-pressure system over the central United States. Isobars show the air pressure, in millibars. Letters *A* through *E* represent locations on Earth's surface. Between which two locations is the wind speed greatest?

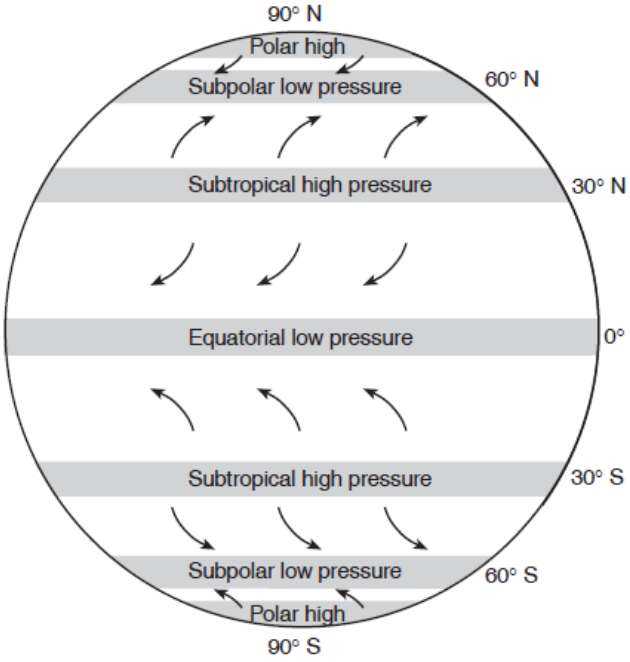
(1) A and B
(2) B and C
(3) C and D
(4) D and E



____ 6. Adjacent land and ocean surfaces have the same temperature at sunrise on a clear, calm, summer day. Then the land and water are heated by the Sun for several hours. Which cross section shows the most likely direction of surface winds that will develop at this ocean shore?



Base your answers to questions 7 and 8 on the diagram below, which shows Earth's planetary wind belts and pressure belts.



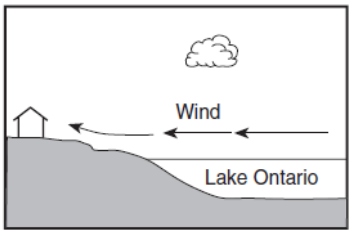
____ 7. The best inference that can be made from this diagram is that winds blow from regions of
(1) high latitude to regions of low latitude
(2) high pressure to regions of low pressure
(3) high elevation to regions of low elevation
(4) high temperature to regions of low temperature

____ 8. The surface winds shown in the diagram follow curving paths mainly due to Earth's
(1) revolution (2) magnetic field (3) rotation (4) gravitational field

____ 9. Which weather change usually occurs when the difference between the air temperature and the dewpoint temperature is *decreasing*?
(1) The amount of cloud cover decreases.
(2) The probability of precipitation decreases.
(3) The relative humidity increases.
(4) The barometric pressure increases.

____ 10. Earth's surface winds generally blow from regions of higher
(1) air temperature toward regions of lower air temperature
(2) air pressure toward regions of lower air pressure
(3) latitudes toward regions of lower latitudes
(4) elevations toward regions of lower elevations

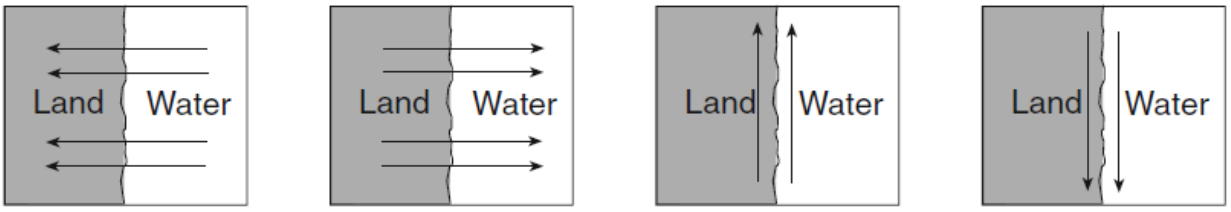
____ 11. The cross section below shows a house on the shore of Lake Ontario in August. Under which conditions would the wind shown in the cross section most likely occur?



(Not drawn to scale)

(1) at 2 a.m., when the air over land is 70°F and the air over the lake is 80°F
(2) at 6 a.m., when the air over land is 70°F and the air over the lake is 70°F
(3) at 2 p.m., when the air over land is 80°F and the air over the lake is 70°F
(4) at 10 p.m., when the air over land is 70°F and the air over the lake is 72°F

____ 12. Adjacent water and landmasses are heated by the morning Sun on a clear, calm day. After a few hours, a surface wind develops. Which map best represents this wind's direction?



(1) (2) (3) (4)

____ 13. What is the dewpoint when the dry-bulb temperature is 14°C and the wet-bulb temperature is 8°C?
(1) 1°C (2)6°C (3) -9°C (4) 22°C

____ 14. A student used a sling psychrometer to measure the humidity of the air. If the relative humidity was 65% and the dry-bulb temperature was 10°C, what was the wet-bulb temperature?
(1) 5°C (2) 7°C (3) 3°C (4) 10°C

State the relationship for each of the following variables. Draw the graph of the relationship on the graphs provided. Remember to label the graph. **Then explain why !**

As temperature increases, air pressure _____

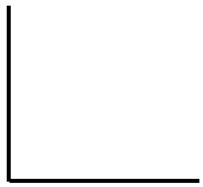
Reason: _____

As temperature increases, relative humidity _____

Reason: _____

As temperature increases, density _____

Reason: _____



As altitude increases, water vapor content _____

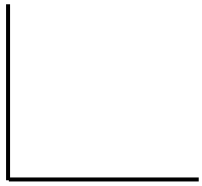
Reason: _____

As altitude increases in the troposphere, temperature _____

Reason: _____

As altitude increases, pressure _____

Reason: _____



Mini Lesson 5: Air Masses and Fronts

An air mass is a large region of the atmosphere with uniform temperature and humidity. Each air mass takes on the characteristics of the area in which it had formed (source region). If it formed over water (maritime) the air would be moist, over land (continental) the air would be dry. An air mass that formed in lower latitudes (south of NY State) the air would be warm (tropical), in higher latitudes the air would be cold (polar). If it formed in very high latitudes the air would be extremely cold (arctic).

As an air mass moves it brings the conditions of the source region with them. For example, an air mass that forms in central Canada is going to be relatively dry (formed over land) and colder (coming from the north). As they travel, the characteristics of the air mass begins to change. Using the previous example, as an air mass moves south it will begin to get a little warmer.

A **front** is the boundary between two different air masses. As a front passes it usually brings a change in temperature, precipitation and change in wind direction. There are four different types of fronts: cold front, warm front, occluded front and stationary. These will be described separately.

Need to know

1. What is an air mass? _____

_____

2. What does the term "uniform" mean when referring to temperature and humidity above?

_____

3. What is the area called where an air mass forms? _____

4. Describe the characteristics of an air mass that forms in the following regions:

   Over land _____ In the North _____

   Over water _____ In the South _____

5. For each of the locations below, circle the temperature and humidity that would be characteristic of an air mass that forms there.

   Central Canada: [warm / cold] , [wet / dry] Gulf of Mexico: [warm / cold] , [wet / dry]

6. What happens to the characteristics of an air mass as it moves over other areas?

_____

7. What is a front? _____

8. What three things might you expect if a front passes?

_____

_____

_____

"Air Masses" Earth Science Reference Tables page 13

1. Copy the written form from the reference tables into the table below.
2. Determine the <u>temperature</u> and <u>humidity</u> that each symbol represents.

Symbol	Written form	Type of weather
cP		and
cT		and
mP		and
mT		and
cA		and

3. In the map below, write the correct abbreviation (cP, cT, mP, mT) in the corresponding location, to show the characteristics of an air mass that originated there. The "X" represents NY State.

4. Write the symbol for the air mass located in Central Canada. _____

5. Write the symbol for the air mass located over the Gulf of Mexico. _____

6. Write the symbol for the air mass located over Alaska _____

7. Write the symbol for the air mass located over the Northern Pacific Ocean _____

8. Write the symbol for the air mass located over the Northern Atlantic Ocean _____.

9. Write the symbol for the air mass located over the Southern Pacific Ocean _____.

Circle the correct term that completes the sentences below.

10. As an air mass that originated in Central Canada moves south, it becomes [warmer / colder]

11. As an air mass that originated in The Gulf of Mexico moves north, it becomes [warmer / colder]

12. As an air mass that originated in the North Atlantic Ocean moves over land, it becomes [wetter / dryer]

Regents Questions:

____1. In New York State, dry, cool air masses (cP) often interact with moist, warm air masses (mT). Which statement correctly matches each air mass with its usual geographic source region?
(1) cP is from the North Atlantic Ocean and mT is from the deserts of the southwestern United States.
(2) cP is from northern Canada and mT is from the deserts of the southwestern United States.
(3) cP is from northern Canada and mT is from the Gulf of Mexico.
(4) cP is from the North Atlantic Ocean and mT is from the Gulf of Mexico.

____2. Compared to a maritime tropical air mass, a maritime polar air mass has a
(1) higher temperature and more water vapor
(2) higher temperature and less water vapor
(3) lower temperature and more water vapor
(4) lower temperature and less water vapor

____3. The properties of an air mass are mostly determined by the
(1) rate of Earth's rotation
(2) direction of Earth's surface winds
(3) source region where the air mass formed
(4) path the air mass follows along a land surface

____4. Which type of air mass would most likely have low humidity and high air temperature?
(1) cT (2) mT (3) cP (4) mp

____5. Which type of air mass usually contains the most moisture?
(1) mT (2) cT (3) mP (4) cp

____6. An air mass classified as cT usually forms over which type of Earth surface?
(1) cool water (2) warm water (3) cool land (4) warm land

____7. An air mass classified as mP usually forms over which type of Earth surface?
(1) warm land (2) cool land (3) warm ocean (4) cool ocean

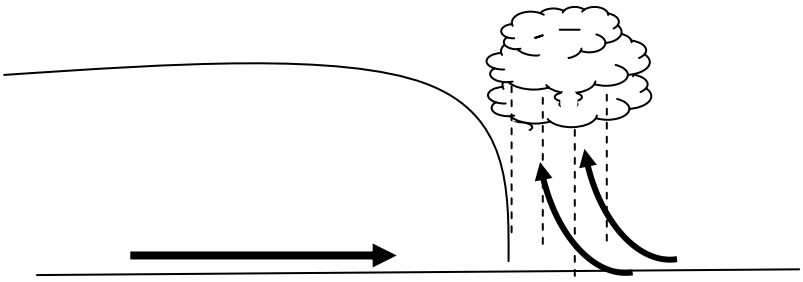
____8. Which type of air mass is associated with warm, dry atmospheric conditions?
(1) cP (2) mP (3) cT (4) mT

____9. An Earth science student observed the following weather conditions in Albany, New York, for 2 days: The first day was warm and humid with southerly winds. The second day, the temperature was 15 degrees cooler, the relative humidity had decreased, and wind direction was northwest. Which type of air mass most likely had moved into the area on the second day?
(1) continental tropical (3) maritime tropical
(2) continental polar (4) maritime polar

1. Draw the weather map symbol *diagonally* for a cold front in the space provided.
2. The front is moving in the direction of the "triangles". Think of them as arrows. Draw a line with an arrow to illustrate the movement of the front.
3. The air mass behind the cold front is cold. The air mass in front of the cold front is warm. Label the cold and warm air mass on the cold front map symbol.
4. Using the description under the diagram, label the cold air and warm air masses.

COLD FRONT:

Weather Map Symbols

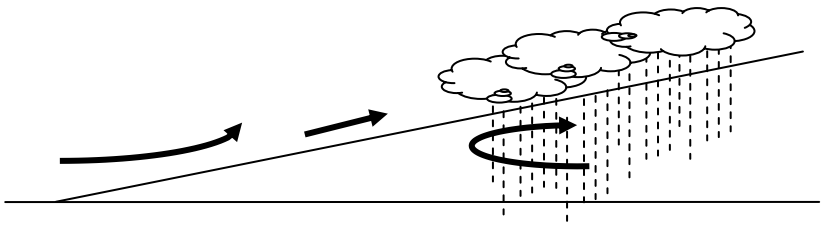


- cold air pushes the warm, moist air upward
- cold air is located behind the front
- the greater the difference in temperatures, the more likely there will be a major storm
- usually pass quickly
- brings colder but clear weather conditions

5. Draw the weather map symbol *diagonally* for a warm front in the space provided.
6. The front is moving in the direction of the "bumps". Think of them as arrows. Draw a line with an arrow to illustrate the movement of the front.
7. The air mass behind the warm front is warm. The air mass in front of the warm front is cold. Label the cold and warm air mass on the warm front map symbol.
8. Using the description under the diagram, label the cold air and warm air masses.

WARM FRONT

Weather Map Symbols

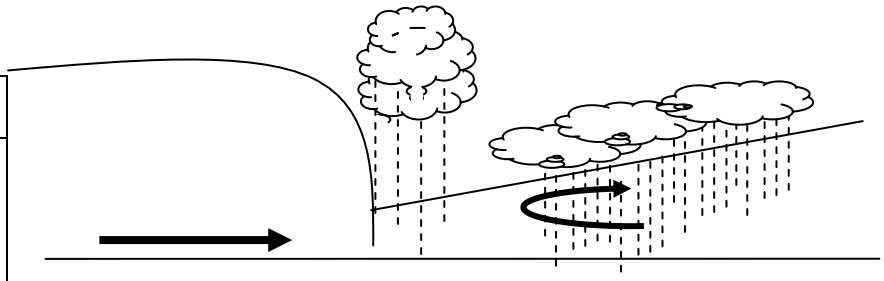


- warm air gently rolls over the colder air
- warm air is located behind the front
- conditions are usually cloudy and rainy for several several hours
- usually pass slowly
- brings warmer but rainy weather conditions

9. Draw the weather map symbol *diagonally* for an occluded front in the space provided.
10. The front is moving in the direction of the "bumps" and "triangles". Think of them as arrows. Draw a line with an arrow to illustrate the movement of the front.
11. The air mass behind the occluded front is cold. The air mass in front of the occluded front is cool. Label the cold and cool air mass on the warm front map symbol.
12. Using the description under the diagram, label the cold air and warm air masses.

OCCLUDED FRONT

Weather Map Symbols



- occurs when a cold air mass overtakes a warm mass and overtakes another cold air mass
- precipitation is possible but not definite
- very slight temperature change

13. Draw the weather map symbol *diagonally* for an stationary front in the space provided.
14. This front is not moving. No arrows are necessary.
15. The air mass behind the "triangles" on the front symbol is cold. The air mass behind the "bumps" on the front symbol is warm. Label the cold and cool air mass on the warm front map symbol.

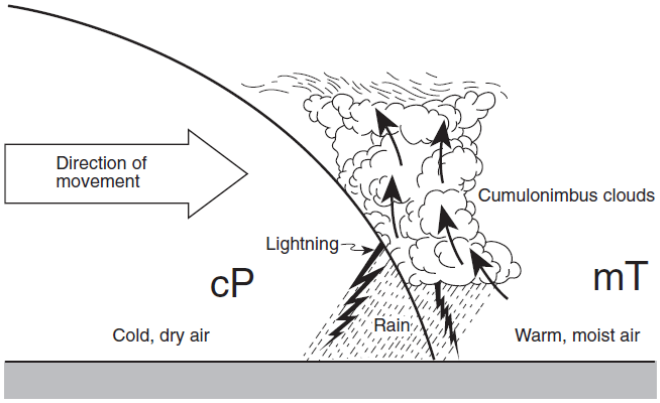
STATIONARY FRONT

Weather Map Symbols

- notice no arrows to show direction in the weather map symbols
- stationary means the front is not moving
- final direction of movement is difficult to predict
- winds are blowing in opposite directions on each side of the front
- clouds can last for days

Regents Questions:

Base your answers to questions 1 through 3 on the cross section to the right, which shows a typical cold front moving over New York State in early summer.



1. Explain why the warm, moist air is rising at the frontal boundary. _____

_____

2. State *one* process that causes clouds to form in this rising air. _____

_____

3. Central Canada was the geographic source region for the cP air mass shown in the cross section. Identify the most likely geographic source region for the mT air mass shown in the cross section. _____

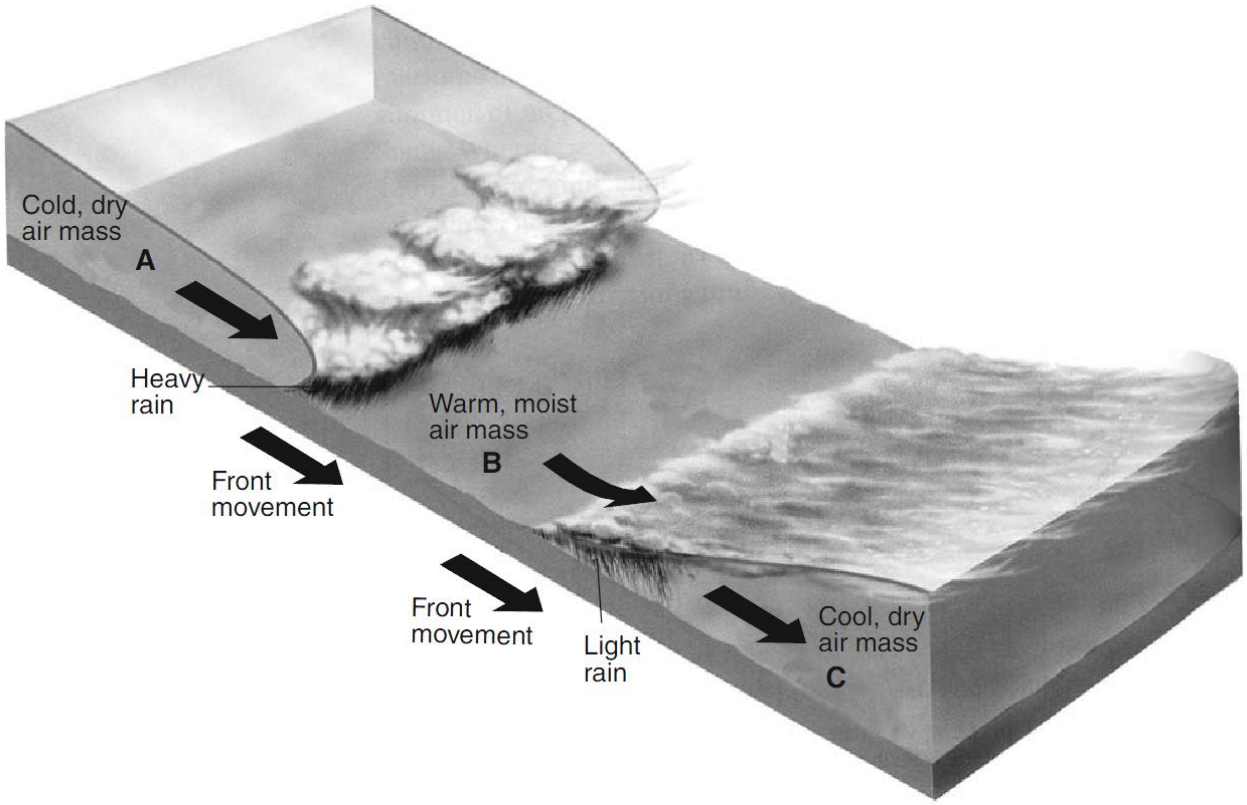
Base your answers to questions 4 through 6 on the weather map of North America below. The map shows the location of a front and the air mass influencing its movement.

4. Which region is the probable source of the air mass labeled cP on the map?
   (1) central Canada
   (2) southwestern United States
   (3) North Atlantic Ocean
   (4) Gulf of Mexico

5. Which type of front and frontal movement is shown on the weather map?
   (1) cold front moving northwestward
   (2) cold front moving southeastward
   (3) warm front moving northwestward
   (4) warm front moving southeastward

6. The cP air mass is identified on the basis of its temperature and
   (1) wind direction
   (2) cloud cover
   (3) moisture content
   (4) windspeed

Base your answers to questions 7 through 9 on the diagram below, which shows air masses, clouds, and rain associated with two fronts that are influencing weather conditions in New York State. Letters *A*, *B*, and *C* represent three air masses. The arrows show the direction of air and front movements.



7. Identify the most likely geographic source region for air mass *B*. _____

8. Identify the type of front shown between air mass *B* and air mass *C*. _____

9. Identify *one* process that causes clouds to form in the air rising along the frontal surface between air *A* and air mass *B*. _____

_____

_____

____10. Clouds usually form when
(1) air temperature reaches the dewpoint
(2) evaporation has warmed the surrounding air
(3) relative humidity is 0%
(4) condensation nuclei have been removed from the air

____11. Weather-station measurements indicate that the dewpoint temperature and air temperature are getting farther apart and that air pressure is rising. Which type of weather is most likely arriving at the station?
(1) a snowstorm
(2) a warm front
(3) cool, dry air
(4) maritime tropical air

A station model is a symbol on a weather map that helps meteorologist plot weather data in a condensed form. The station model contains information about temperature, dewpoint temperature, air pressure, wind, cloud cover, precipitation and current weather conditions.

1. On a station model, <u>barometric pressure</u> is ALWAYS written in a three - digit format.
   In order to convert to the three digit format, drop either the 9 or the 10 in the front of the number and loose the decimal point.

Millibars / Station Model	Millibars / Station Model	Millibars / Station Model
1009.3 mb = 093	1022.2 mb =	994.9 mb =
984.2 mb = 842	1000.2 mb =	1000.5 mb =
1024.2 mb =	989.8 mb =	1008.2 mb =
991.2 mb =	1011.3 mb =	971.4 mb =
1046.5 mb =	1007.5 mb =	1031.1 mb =
1049.9 mb =	957.6 mb =	961.3 mb =
999.9 mb =	1012.3 mb =	974.7 mb =
973.4 mb =	962.2 mb =	1000.0 mb =

2. Converting from the station model format to millibars:
   If the first number on the station model is 0 – 4, place a 10 in front of the number.
   If the first number on the station model is 5 – 9, place a 9 in front of the number.
   Place a decimal point between the last 2 numbers.

Station Model / Millibars	Station Model / Millibars	Station Model / Millibars
146 = 1014.6 mb	015 = mb	080 = mb
457 = 1045.7 mb	623 = mb	978 = mb
986 = mb	800 = mb	899 = mb
514 = mb	200 = mb	402 = mb
002 = mb	424 = mb	901 = mb
285 = mb	913 = mb	802 = mb
502 = mb	399 = mb	116 = mb
385 = mb	010 = mb	698 = mb

Station Model Explanation:

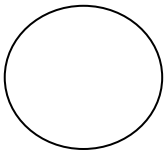
For each of the numbers and symbols below, state what they represent on the example given in the reference tables.

inside the circle		196	
line coming from the circle		.25	
feathers		+19/	
28		*	
27		½	

Draw the following present weather symbols in the space provided below.

Drizzle	Rain	Smog	Hail	Thunder-storms	Rain showers	Hurricane
Snow	Sleet	Freezing rain	Fog	Haze	Snow showers	Tornado

Draw a weather station using the following information:



Completely cloudy

Wind = Northeast (the line should go toward the NE)

Wind speed 25 knots (feathers to the right)

temperature 25°F (number only, omit °F)

present weather (snowing) and visibility (.25 miles)

dew point temperature 23°F (number only, omit °F)

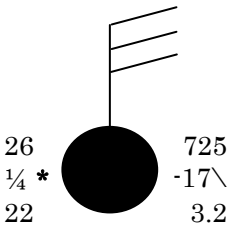
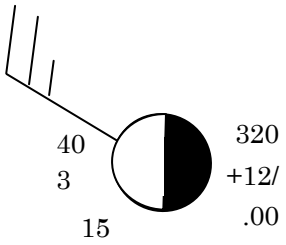
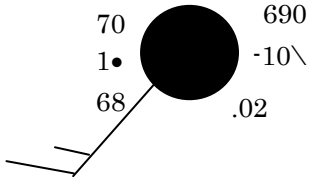
pressure = 1024.3 (use shorthand, no decimal point)

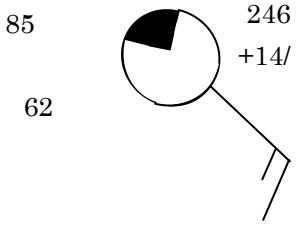
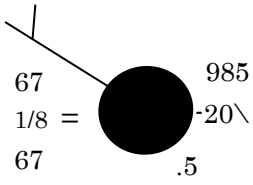
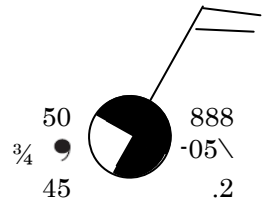
barometric tendency = a steady 1.5 mb fall in past 3 hours (do not include the decimal point)

precipitation = 3 inches (no units)

NEED TO KNOW: Dew Point Temperature & Air Temperature

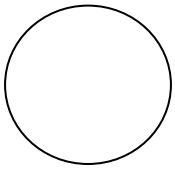
1. What is the relative humidity if the air temperature is 10°C and the dewpoint temperature is 10°C? _____ %
2. What is the relative humidity if the air temperature is 22°C and the dewpoint temperature is 22°C? _____ %
3. What is the relative humidity if the air temperature the same as the dewpoint temperature? _____ %
4. When the relative humidity is 100%, what are the chances of precipitation? _____
5. What are the chances of precipitation when the air temperature and dewpoint temperature get closer together? _____

Determine each of the values below by looking at the diagram at the top of each column.			
Wind Direction			
Wind Speed			
Cloud cover			
Air pressure			
Barometric tendency			
Precipitation			
Temperature			
Dew Point			
Present weather			
Visibility			

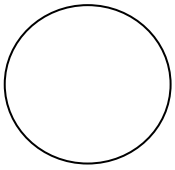
Determine each of the values below by looking at the diagram at the top of each column.			
Wind Direction			
Wind Speed			
Cloud cover			
Air pressure			
Barometric tendency			
Precipitation			
Temperature			
Dew Point			
Present weather			
Visibility			

Draw a station model for each description below.

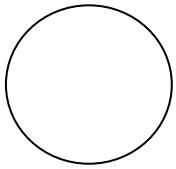
Completely cloudy
Wind = Northwest
Wind speed 15 knots
pressure = 1034.6 mb
barometric tendency = falling .1 mb
precipitation = 3 inches
temperature 45°F
present weather (drizzling)
visibility (.5 miles)
dew point 42°F



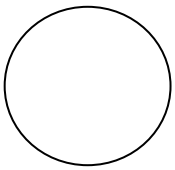
3/4 cloudy
Wind = southeast
Wind speed 20 knots pressure = 999.5 mb
barometric tendency = falling .2 mb
precipitation = .75 inches
temperature 38°F
present weather (sleet)
visibility (.5 miles)
dew point 34°F



100 % cloudy
Wind = Southwest
Wind speed 10 knots
pressure = 975.6 mb
barometric tendency = falling .1 mb
precipitation = .25 inches
temperature 55°F
present weather (fog)
visibility (.125 miles)
dew point 55°F

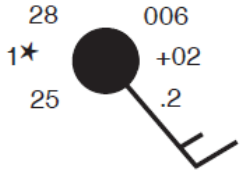


No clouds
Wind = Northeast
Wind speed 25 knots pressure = 1008.5 mb
barometric tendency = rising .2 mb
precipitation = 0 inches
temperature 78°F
present weather (clear)
visibility (full)
dew point 47°F



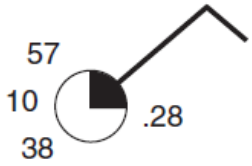
Regents Questions:

_____ 1. What is the air pressure indicated on the weather station model shown below?



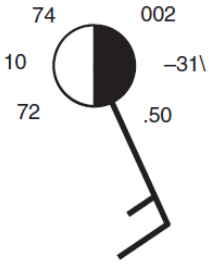
(1) 900.6 mb (3) 1000.6 mb
(2) 960.0 mb (4) 1006.0 mb

_____ 2. What is the visibility, in miles, shown on the station model below?



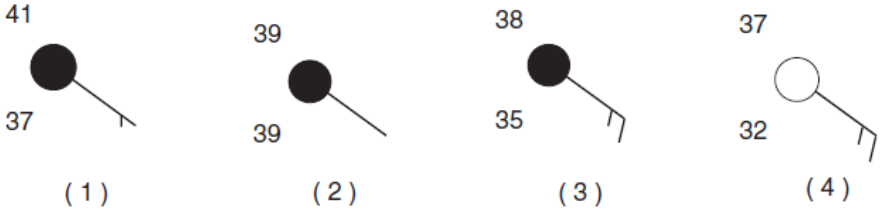
(1) 10 (3) 28
(2) 38 (4) 57

_____ 3. The station model below shows the weather conditions at Massena, New York, at 9 a.m. on a particular day in June. What was the barometric pressure at Massena3 hours earlier on that day?



(1) 997.1 mb
(2) 999.7 mb
(3) 1003.3 mb
(4) 1009.1 mb

_____ 4. Which weather station model shows the highest relative humidity?



(1) (2) (3) (4)

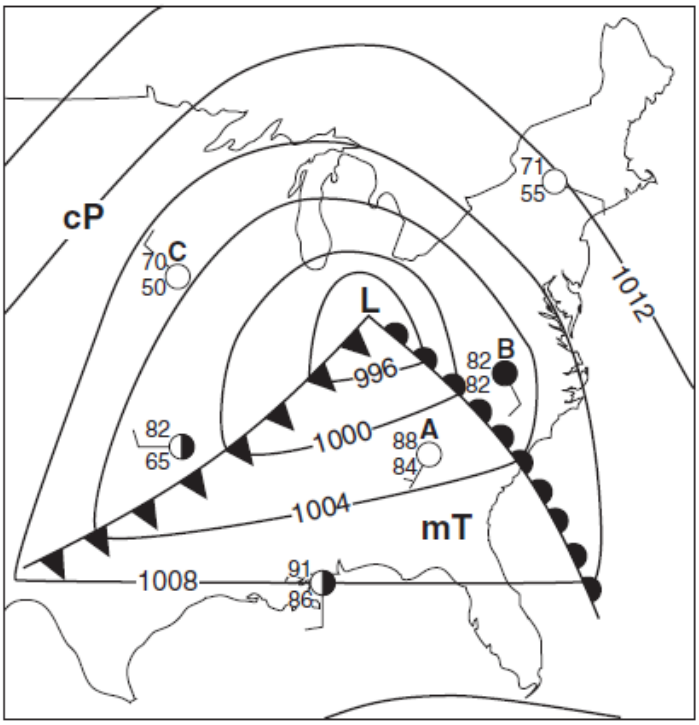
_____ 5. Which weather-station model shows an air pressure of 993.4 millibars?

(1) (2) (3) (4)

_____ 6. Which atmospheric conditions are necessary for condensation?

(1) saturated air and dewpoint temperature much lower than air temperature
(2) unsaturated air and dewpoint temperature much higher than air temperature
(3) saturated air and equal dewpoint and air temperatures
(4) unsaturated air and equal dewpoint and air temperatures

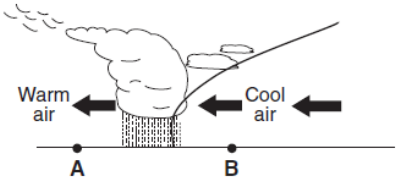
Base your answers to questions 7 through 10 on the weather map below. The map shows a low-pressure system and some atmospheric conditions at weather stations *A*, *B*, and *C*.



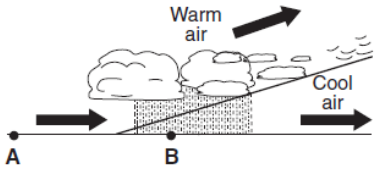
_____ 7. Which type of weather is usually associated with a cP air mass, as shown near weather station *C*?
(1) moist and cool
(2) moist and warm
(3) dry and cool
(4) dry and warm

_____ 8. If this weather system follows a normal storm track, the low-pressure center (L) will generally move toward the
(1) northeast
(2) northwest
(3) southeast
(4) southwest

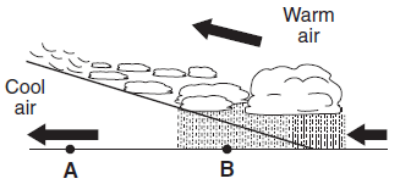
_____ 9. Which cross section best represents the air masses, air movement, clouds, and precipitation occurring behind and ahead of the warm front located between stations *A* and *B*?



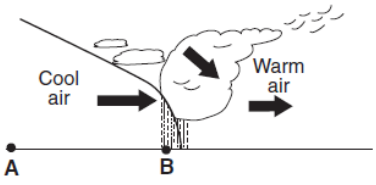
(1)



(3)

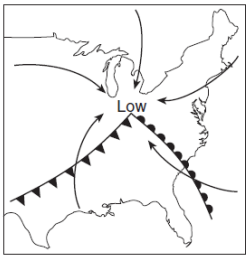


(2)

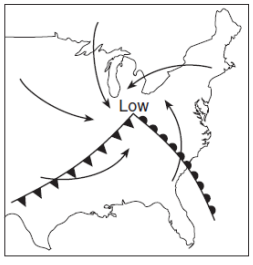


(4)

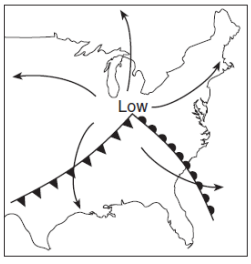
_____ 10. The arrows on which map best represent the direction of surface winds associated with this low-pressure system?



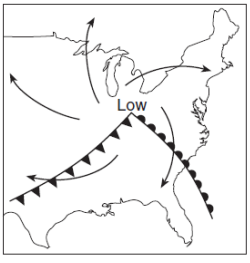
(1)



(2)



(3)

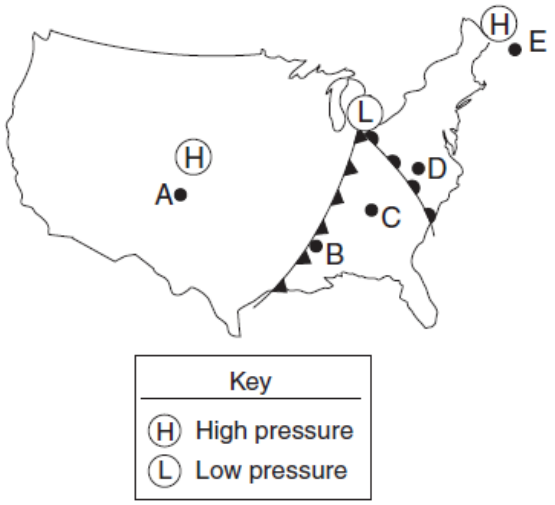


(4)

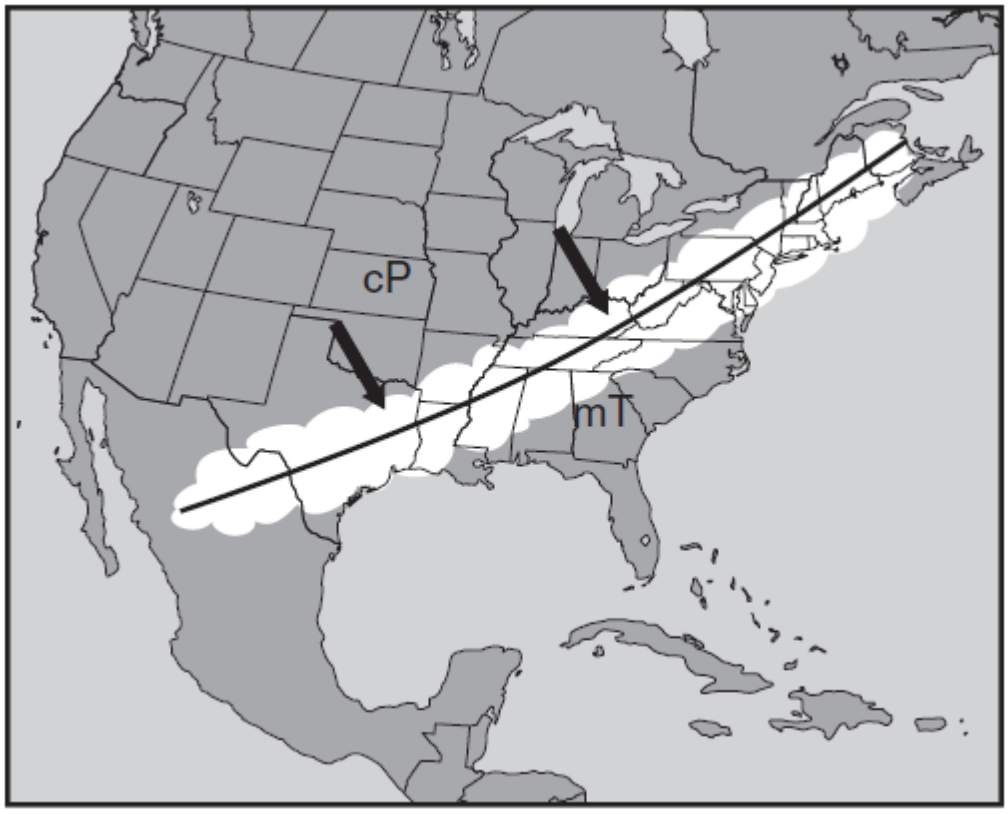
____ 11. The map to the right shows high-pressure and low pressure weather systems in the United States.

Which two lettered positions on the map are most likely receiving precipitation?

(1) *A* and *B* (3) *C* and *E*
(2) *B* and *D* (4) *A* and *D*



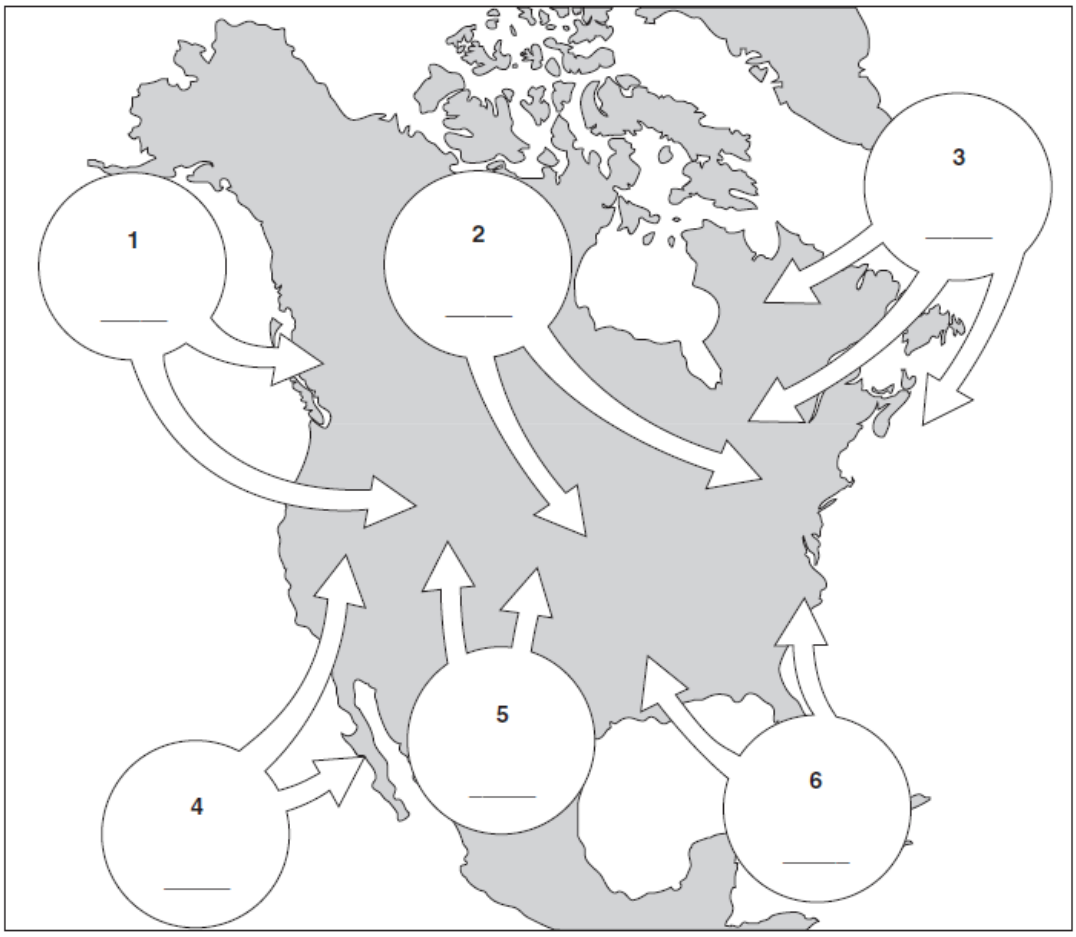
Base your answers to questions 12 and 13 on the weather map provided *below* which shows a large white band of clouds moving toward the southeast. The line shown in the middle of the white cloud band is the frontal boundary between a cP air mass and an mT air mass. Two large arrows show the direction the front is moving.



12. On the frontal boundary line on the weather map provided, draw the weather front symbol to represent the front moving toward the southeast.

13. On the same weather map, place an **X** centered on the geographic region that was most likely the source of the warm, moist (mT) air mass.

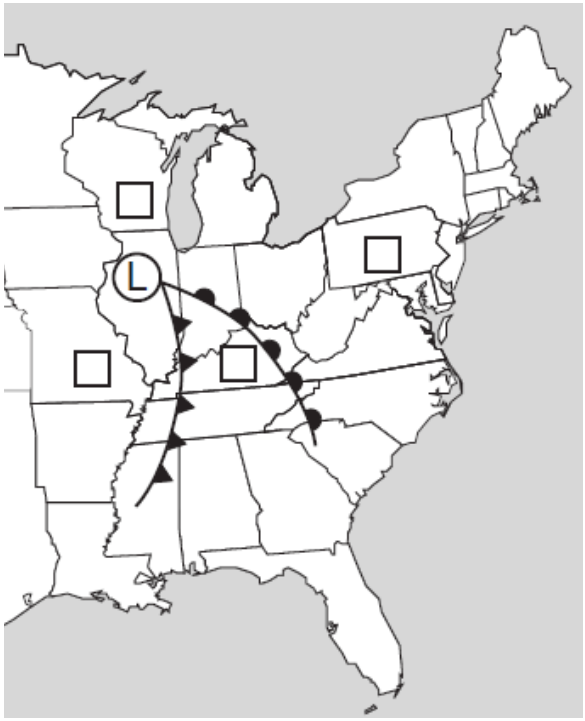
14. The map below shows six source regions for different air masses that affect the weather of North America. The directions of movement of the air masses are shown. Using the standard two-letter air-mass symbols from the *Earth Science Reference Tables,* label the air masses by writing the correct symbol in each circle on the map.



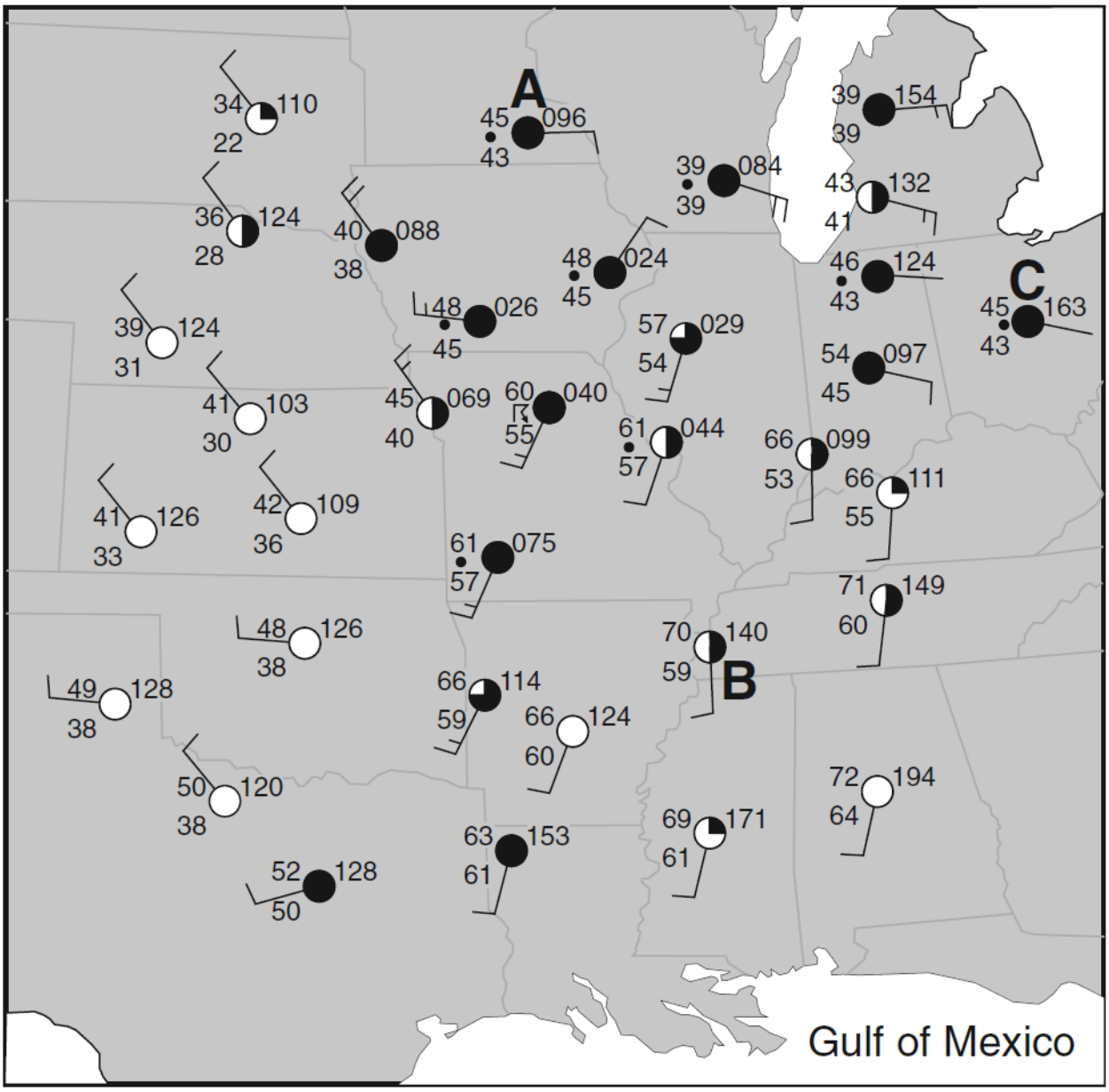
15. The weather map below shows a typical mid-latitude low-pressure system centered in Illinois.

a) On the weather map provided, indicate which boxed area has the highest surface air temperatures by marking an **X** in one of the four boxes on the map.

b) On the weather map provided, draw an arrow to predict the normal storm track that this low-pressure center would be expected to follow.



Base your answers to questions 16 through 19 on the map below, which shows weather station models and some weather variables for a portion of the United States. Selected weather stations are labeled *A*, *B*, and *C*.



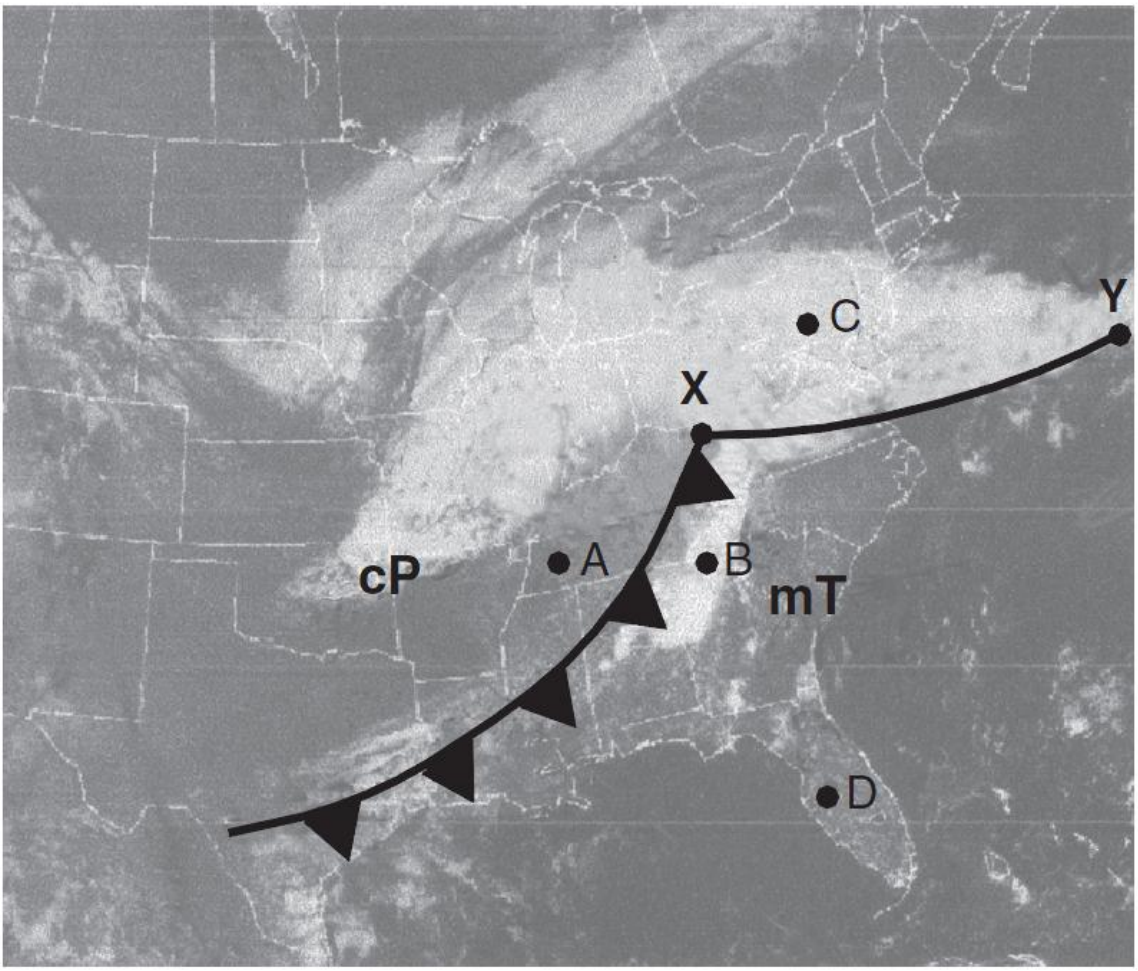
16. On the map above, draw the 40°F, 50°F, 60°F, 70°F isotherms. The isotherm must extend to the edges of the map.

17. State the air pressure, in millibars, at weather station *A*. _____

18. The city represented by weather station *B* is currently being affected by an air mass that originated over the Gulf of Mexico. What is the two-letter air-mass symbol used to represent this air mass? _____

19. Which weather condition is indicated by the present weather symbol at station *C*? _____

Base your answers to questions 20 through 24 on the satellite image shown in your answer booklet. The satellite image shows a low-pressure system over a portion of the United States. Air-mass symbols and frontal boundaries have been added. Line *XY* is one frontal boundary. Points *A, B, C,* and *D* represent surface locations. White areas represent clouds.



20. Draw the proper symbol to represent the most probable front on line *XY.*

21. State *one* process that causes clouds to form in the moist air along the cold front.

_____

22. Describe *one* piece of evidence shown on the map that suggests location *A* has a lower relative humidity than location *B.* _____

23. Explain why location *C* most likely has a cooler temperature than location *D.*

_____

24. State the compass direction that the center of this low-pressure system will move over the next few days if it follows a normal storm track. _____