

Meteorology

Meteorology _____

Meteorologist _____

Weather _____

Atmosphere _____

PART I: Energy in Earth's Systems

Internal energy _____
Causes _____

External energy _____
effected by _____

Insolation _____

“Selected Properties of Earth's Atmosphere”

For the following questions, refer to the Earth Science Reference Tables, page _____

1. In which sphere is all of the water vapor found? _____
2. What happens to atmospheric pressure as altitude increases? _____
3. In which sphere does weather occur? _____
4. What happens to the temperature in each sphere as altitude increases? It . . .

Troposphere _____ Mesosphere _____

Stratosphere _____ Thermosphere _____

“Average Chemical Composition of Earth’s Crust, Hydrosphere, and Troposphere”

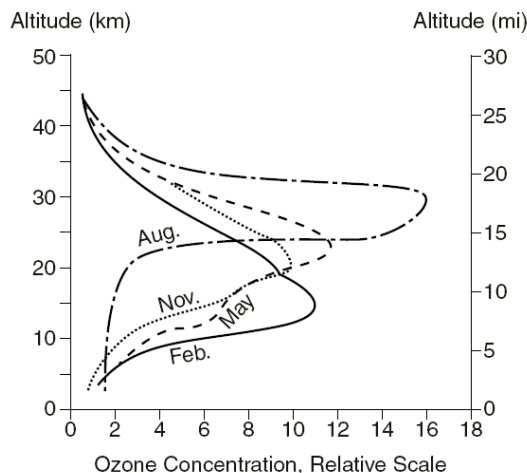
Write the composition of the Troposphere in the table below. Refer to the Earth Science Reference Tables, page _____

Percent	Element
%	
%	
%	

1. The graph to the right shows the average concentration of ozone in Earth’s atmosphere over Arizona during 4 months of the year.

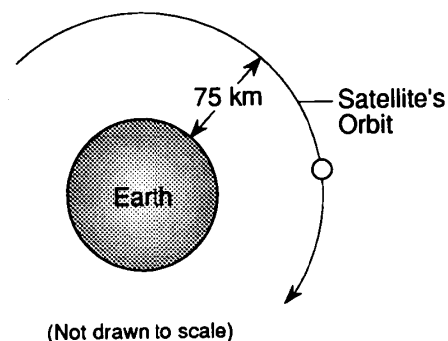
Which layer of Earth’s atmosphere contains the greatest concentration of ozone?

- (1) troposphere (3) mesosphere
(2) stratosphere (4) thermosphere
2. An air temperature of 95°C most often exists in which layer of the atmosphere?
(1) troposphere (3) mesosphere
(2) stratosphere (4) thermosphere
3. The greatest atmospheric pressure occurs in the
(1) troposphere (2) mesosphere (3) stratosphere (4) thermosphere
4. As the elevation above sea level in Earth’s atmosphere increases, the measured atmospheric pressure will
(1) decrease (2) increase (3) remain the same
5. Which part of the atmosphere has the smallest distance from the bottom to the top of its zone?
(1) troposphere (2) mesosphere (3) stratosphere (4) thermosphere
6. Nearly all the water vapor in the atmosphere is found within the
(1) mesosphere (2) troposphere (3) thermosphere (4) stratosphere
7. Which statement most accurately describes Earth’s atmosphere?
(1) The atmosphere is layered, with each layer possessing distinct characteristics.
(2) The atmosphere is a shell of gasses surrounding most of Earth.
(3) The atmosphere’s altitude is less than the depth of the ocean.
(4) The atmosphere is more dense than the lithosphere.



8. Ozone is concentrated in Earth's atmosphere at an altitude of 20 to 35 kilometers. Which atmospheric layer contains the greatest concentration of ozone?
 (1) mesosphere (2) troposphere (3) thermosphere (4) stratosphere
9. What is the approximate temperature of the mesosphere at an elevation of 68 kilometers above sea level?
 (1) 0 °C (2) -55 °C (3) 42 °C (4) -90 °C
10. What is the approximate altitude of the mesopause in the atmosphere?
 (1) 50 km (2) 82 km (3) 66 km (4) 90 km
11. The temperature in the stratosphere ranges from
 (1) -55 °F to 0 °F (2) 10 °F to 35 °F (3) -55 °C to 0 °C (4) 10 °C to 35 °C

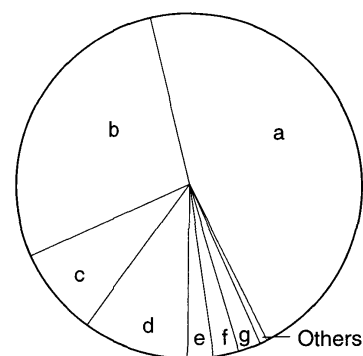
12. Base your answers on the diagram to the right which shows part of the orbit of a satellite around Earth. The distance from the satellite's orbit to Earth's surface is 75 kilometers.



Which portion of Earth's atmosphere is the satellite located?

- (1) troposphere (2) stratosphere (3) mesosphere (4) thermosphere
13. What is the most abundant element in the troposphere?
 (1) helium (2) hydrogen (3) nitrogen (4) oxygen
14. Which element in the hydrosphere is most abundant by volume?
 (1) oxygen (2) nitrogen (3) helium (4) hydrogen
15. The graph to the right shows the percent by mass of the elements of Earth's crust. Each letter on the graph represents an element.

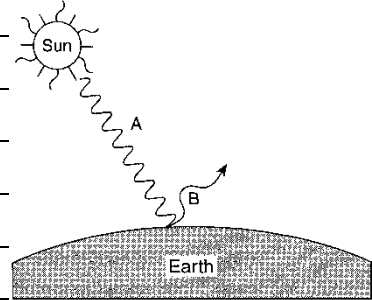
Which elements are represented by the letters **a** and **b**, respectively?



- (1) aluminum and iron
 (2) calcium and nitrogen
 (3) potassium and sodium
 (4) oxygen and silicon
16. Earth's troposphere, hydrosphere, and lithosphere contain relatively large amounts of which element?
 (1) iron (2) hydrogen (3) oxygen (4) potassium

How energy reaches Earth

Radiation



Electromagnetic spectrum

Earth Science Reference Tables, page

1. Heat waves

2. Lead protects you from these at the dentist

3. Skin cancer is a result of too much exposure to

4. Music is sent along these waves

5. Nuclear bombs deadly rays

6. Most of the waves sent by the sun are in the range.

7. What type of radiation has the shortest wavelength?

8. What type of radiation has the longest wavelength?

9. Which color in the spectrum has the shortest wavelength?

10. Which color in the spectrum has the longest wavelength?

11. X rays may have the same wavelength as which two other forms of radiation

and

12. Microwaves may have the same wavelength as which two other forms of radiation

and

13. Between which two types of radiation does the visible light range fall?

and

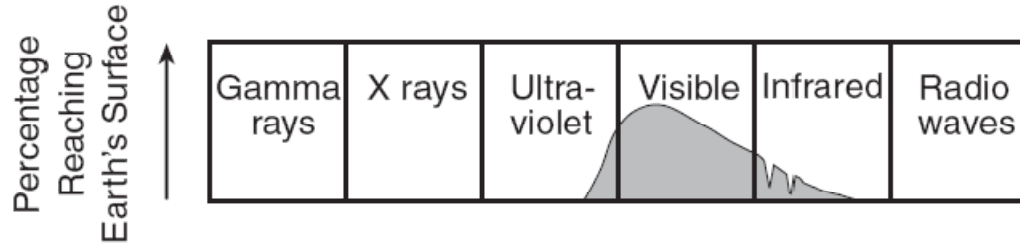
1. Which form of electromagnetic radiation has a wavelength of 1.0×10^{-3} centimeter?

(1) ultraviolet (2) radio waves (3) infrared (4) microwaves

2. Scientists are concerned about the decrease in ozone in the upper atmosphere primarily because ozone protects life on Earth by absorbing certain wavelengths of

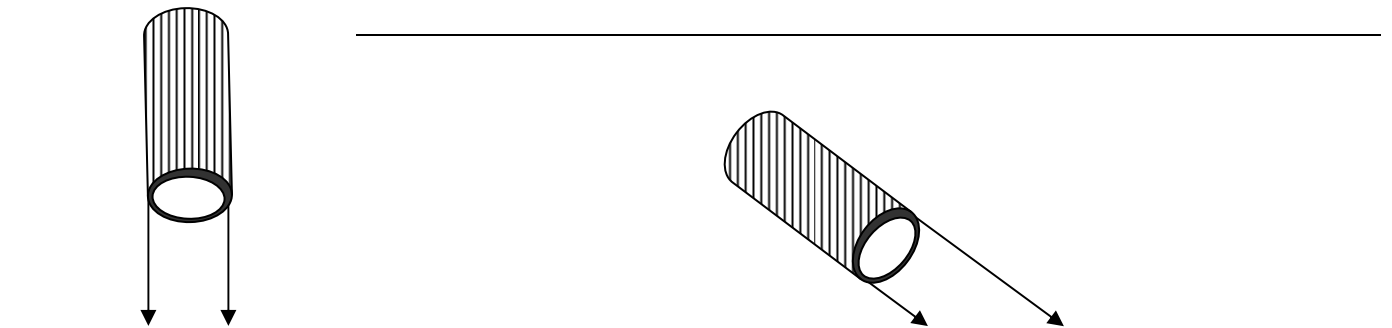
(1) x-ray radiation (3) ultraviolet radiation
(2) infrared radiation (4) microwave radiation

3. Which part of the Sun's electromagnetic spectrum has the longest wavelength?
 (1) radio wave radiation (3) infrared radiation
 (2) visible light radiation (4) x-ray radiation
4. The diagram below shows the types of electromagnetic energy given off by the Sun. The shaded part of the diagram shows the approximate amount of each type actually reaching Earth's surface. Which conclusion is best supported by the diagram?



- (1) All types of electromagnetic energy reach Earth's surface.
 (2) Gamma rays and x rays make up the greatest amount of electromagnetic energy reaching Earth's surface.
 (3) Visible light makes up the greatest amount of electromagnetic energy reaching Earth's surface.
 (4) Ultraviolet and infrared radiation make up the greatest amount of electromagnetic energy reaching Earth's surface.
5. What is the basic difference between ultraviolet, visible, and infrared radiation?
 (1) half-life (2) wavelength (3) temperature (4) wave velocity
6. Radiation with the wavelength between blue and yellow is usually visible as what color?
 (1) violet (2) green (3) blue (4) yellow

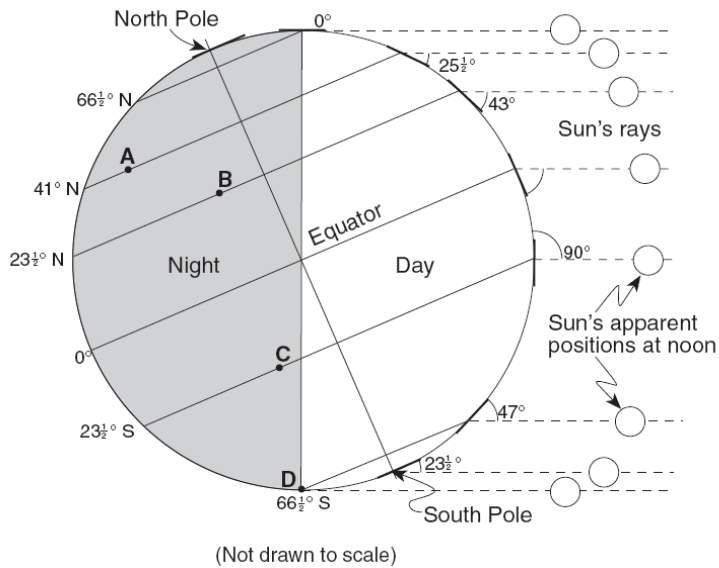
Angle of Insolation



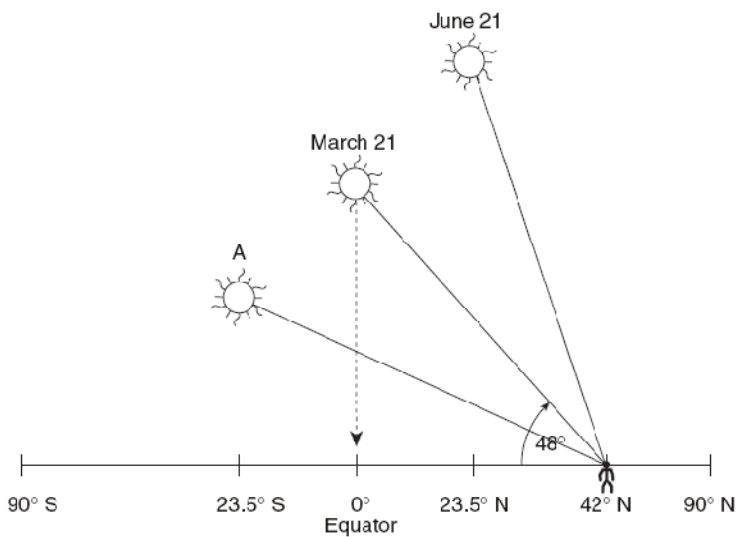
Angle of insolation changes depending on three things:

- 1) _____
- Sunrise - _____
- Solar noon - _____
- Sunset - _____

- 2) _____



- 3) _____

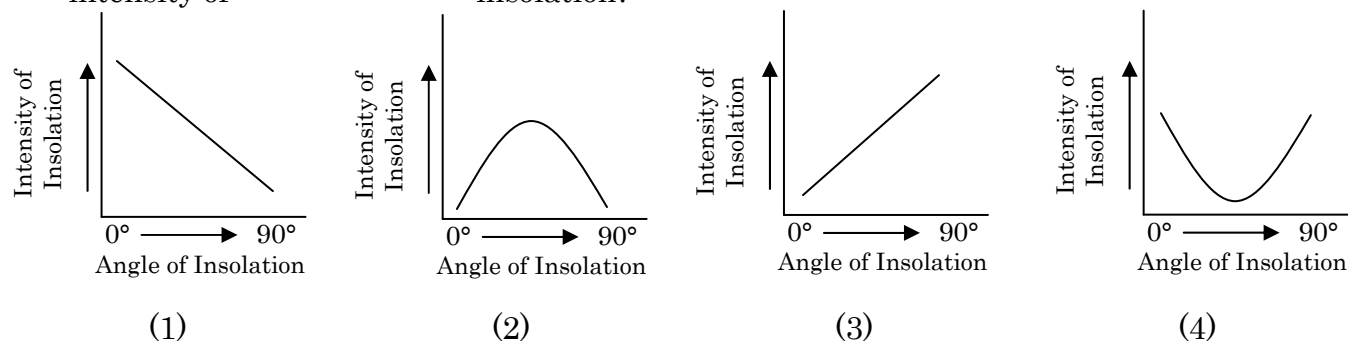


At the equator (0°) _____

As the latitude increases . . .

summer	
Winter	

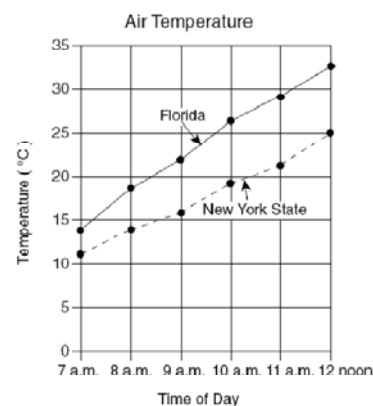
1. Which graph best represents the relationship between the angle of insolation and the intensity of insolation?



- The graph to the right shows air temperatures on a clear summer day from 7 a.m. to 12 noon at two locations, one in Florida and one in New York State.

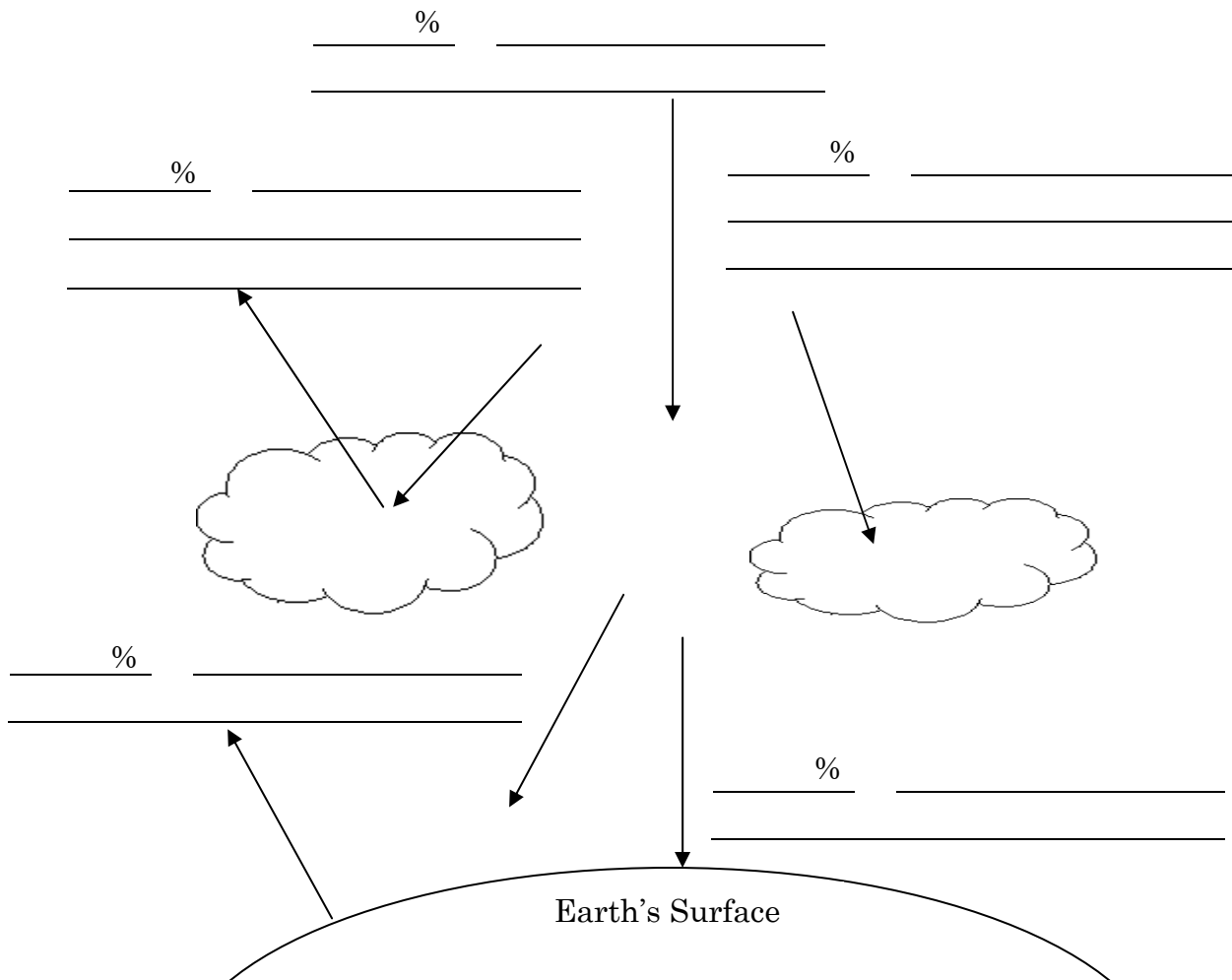
Air temperature rose slightly faster in Florida than in New York State because Florida

- (1) has a lower angle of insolation
- (2) has a higher angle of insolation
- (3) is closer to the Prime Meridian
- (4) is farther from the Prime Meridian



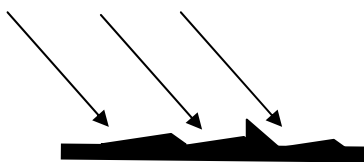
3. The average temperature at Earth's North Pole is colder than the average temperature at the Equator because the Equator
- | | |
|---|--------------------------------------|
| (1) receives less ultraviolet radiation | (3) receives more intense insolation |
| (2) has more cloud cover | (4) has a thicker atmosphere |

Atmospheric Transparency

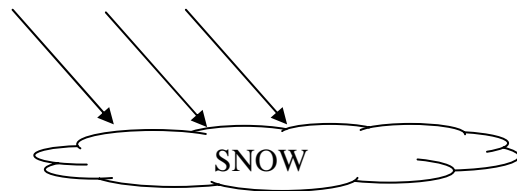


Reflection / Refraction / Absorption of insolation

Light vs. Dark

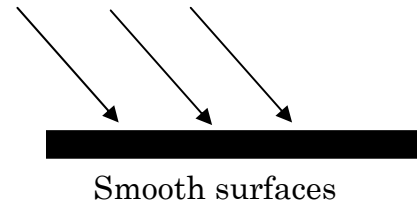
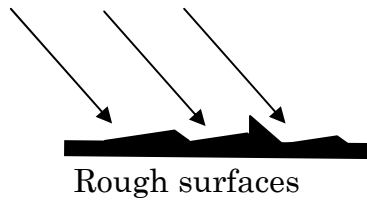


Dark surfaces



Light surfaces

Rough vs. Smooth



Land vs. Water

Specific Heat: _____

ESRT page _____

- (a) Which material on the specific heat chart heats up the fastest? _____
- (b) Which material on the specific heat chart heats up the slowest? _____
- (c) Which material needs the most amount of energy to raise its temperature? _____
- (d) In each set below, circle the material that would heat up the fastest:

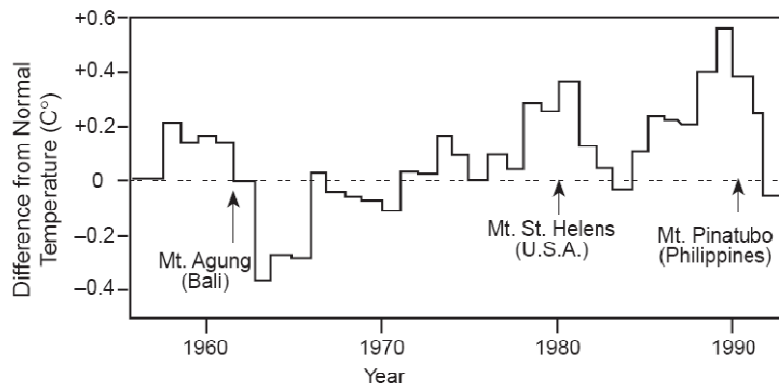
Water	Iron	Copper
Ice	Basalt	Granite
Lead	Water	Iron

Dry air	Lead	Granite
Iron	Basalt	Water vapor
Ice	Copper	Dry air

- (e) Compare the heating and cooling rate of land and water, using the term “specific heat” to explain your comparison. _____
- _____

A good absorber of electromagnetic energy is a good radiator of electromagnetic energy.

1. The graph to the right shows atmospheric temperature variations on Earth between 1956 and 1993. The dates of three major volcanic eruptions are indicated. What is the most probable reason that Earth's atmospheric temperature decreased shortly after each major volcanic eruption?

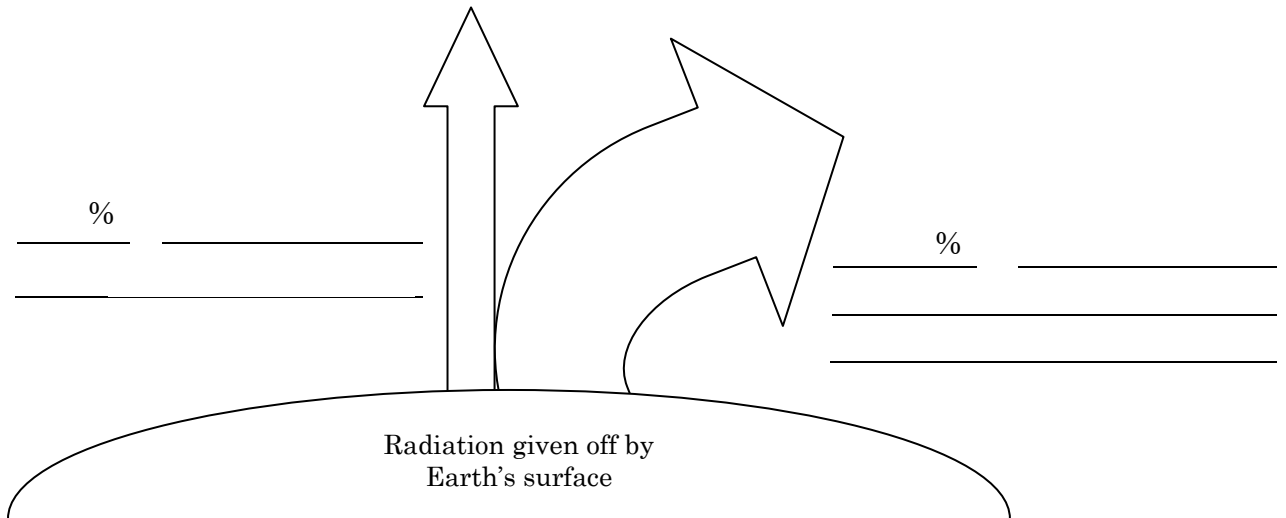


- (1) Water droplets produced by the eruptions absorbed terrestrial reradiation.
(2) Ozone produced by the eruptions absorbed ultraviolet radiation from the Sun.
(3) Volcanic dust from the eruptions blocked insolation.
(4) Carbon dioxide gas from the eruptions blocked terrestrial reradiation.
2. Which of the following Earth surfaces usually reflects the most incoming solar radiation?
(1) snow cover (2) dark soil (3) green grass (4) lake water
3. The diagram to the right shows a light source that has been heating two metal containers of air for 10 minutes. Both cups are made of the same material and are equal distances from the light source. Compared to the amount of energy reflected by the shiny cup during the 10 minutes of heating, the amount of energy reflected by the black cup is
-
- (1) less (2) greater (3) the same
4. Which type of land surface would probably reflect the most incoming solar radiation?
(1) light colored and smooth (3) light colored and rough
(2) dark colored and smooth (4) dark colored and rough
5. A person in New York State worked outdoors in sunlight for several hours on a day in July. Which type of clothing should the person have worn to absorb the *least* electromagnetic radiation?
(1) dark colored with a rough surface (3) dark colored with a smooth surface
(2) light colored with a rough surface (4) light colored with a smooth surface

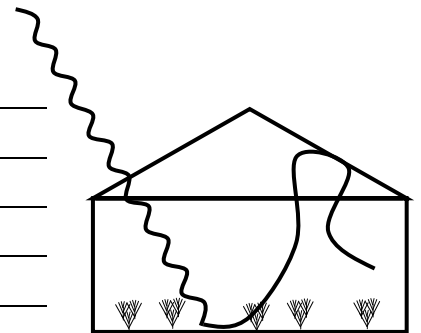
Terrestrial Radiation

Terrestrial Radiation

Infrared



Greenhouse effect:



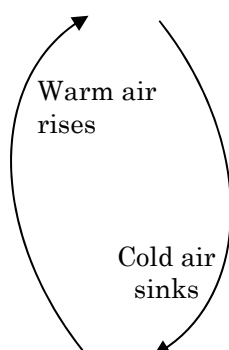
1. Short waves of electromagnetic energy are absorbed by Earth's surface during the day. They are later reradiated into space as
 (1) visible light rays (2) infrared rays (3) X-rays (4) ultraviolet rays
2. What is the most likely reason for a decrease in air temperature observed between 12 midnight and 6 a.m. in New York State?
 (1) Air pressure was decreasing (3) Cloud cover was increasing
 (2) Earth was radiating heat. (4) Plants were giving off water vapor

3. In which region of the electromagnetic spectrum is most of the outgoing radiation from Earth?
(1) infrared (2) ultraviolet (3) visible (4) X-ray
4. Which component of Earth's atmosphere is classified as a greenhouse gas?
(1) oxygen (2) carbon dioxide (3) helium (4) hydrogen
5. Which two gases in Earth's atmosphere are believed by scientists to be greenhouse gases that are major contributors to global warming?
(1) carbon dioxide and methane (3) oxygen and nitrogen
(2) hydrogen and helium (4) ozone and chlorine
6. An increase in which gas would cause the most greenhouse warming of Earth's atmosphere?
(1) nitrogen (2) carbon dioxide (3) oxygen (4) hydrogen
7. A gradual increase in atmospheric carbon dioxide would warm Earth's atmosphere because carbon dioxide is a
(1) poor reflector of ultraviolet radiation (3) good reflector of ultraviolet radiation
(2) poor absorber of infrared radiation (4) good absorber of infrared radiation
8. Which method of energy transfer is primarily responsible for energy being lost from Earth into space?
(1) conduction (2) solidification (3) convection (4) radiation
9. Earth's atmosphere is warmed when
(1) ultraviolet radiation emitted by Earth is absorbed by nitrogen and carbon dioxide in the atmosphere
(2) x-ray radiation emitted by Earth is absorbed by nitrogen and carbon dioxide in the atmosphere
(3) infrared radiation emitted by Earth is absorbed by carbon dioxide and water vapor in the atmosphere
(4) gamma radiation emitted by Earth is absorbed by carbon dioxide and water vapor in the atmosphere

Conduction _____

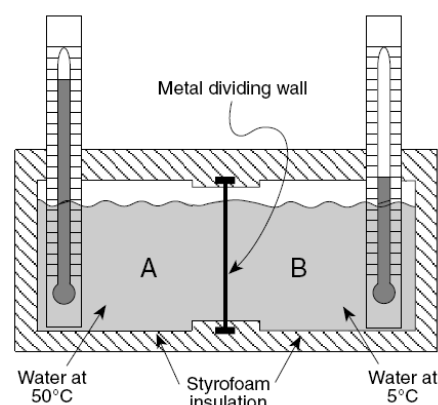
Example: _____

Convection

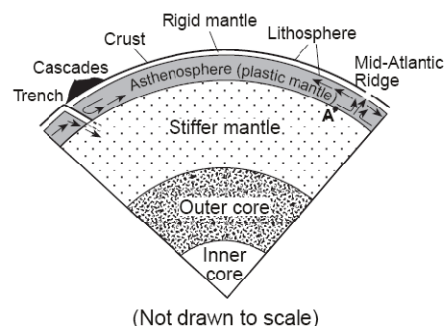


- The cross section to the right shows two compartments of water of equal volume insulated by Styrofoam and separated by a metal dividing wall, forming a closed energy system. When the temperature of the water in compartment *A* decreases by 10 C°, the temperature of the water in compartment *B* will

- remain unchanged
- decrease by only 5 C°
- decrease by approximately 10 C°
- increase by approximately 10 C°

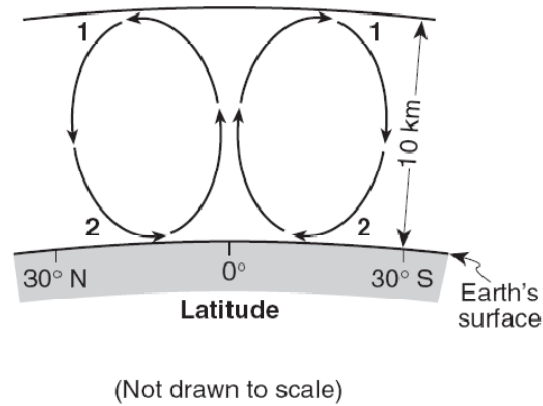


- During which process does heat transfer occur because of density differences?
 (1) conduction (2) radiation (3) convection (4) reflection
- What is the primary method of heat transfer through solid rock during contact metamorphism?
 (1) advection (2) absorption (3) convection (4) conduction
- The diagram to the right shows a portion of Earth's interior. Point *A* is a location on the interface between layers. The arrows shown in the asthenosphere represent the inferred slow circulation of the plastic mantle by a process called
 (1) insolation (3) conduction
 (2) convection (4) radiation



Section Review

Base your answers to questions 1 through 3 on the cross section below and on your knowledge of Earth science. The cross section shows the general movement of air within a portion of Earth's atmosphere located between 30° N and 30° S latitude. Numbers 1 and 2 represent different locations in the atmosphere.



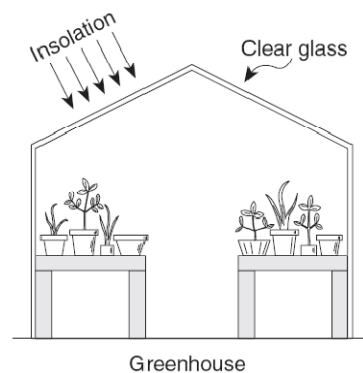
1. Which temperature zone layer of Earth's atmosphere is shown in the cross section?
 - (1) troposphere (3) mesosphere
 - (2) stratosphere (4) thermosphere

2. The air movement shown in the cross section is due to the process of
 - (1) condensation (3) evaporation
 - (2) conduction (4) convection

3. What is the approximate percentage by volume of oxygen present in Earth's atmosphere at location 2?

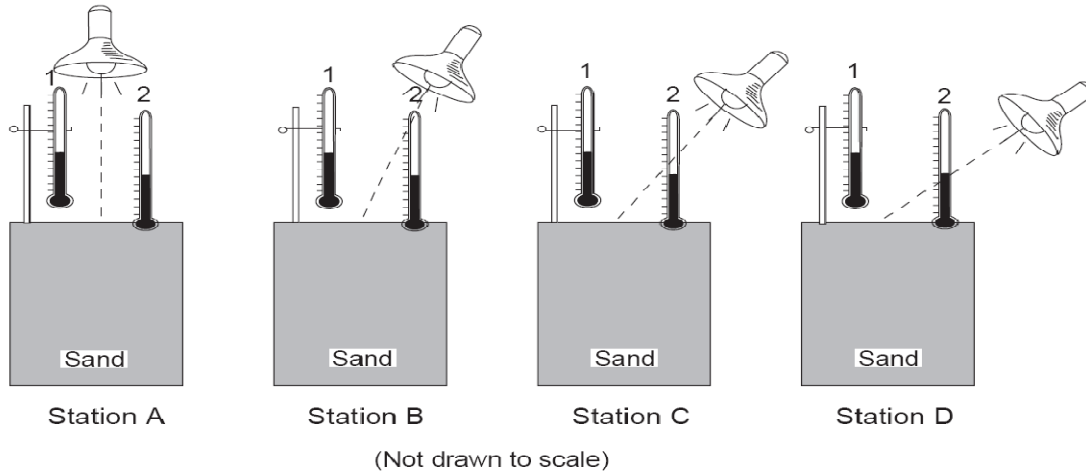
(1) 10%	(2) 33%	(3) 21%	(4) 46%
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4. The diagram to the right shows a greenhouse. What is the primary function of the clear glass of the greenhouse?
 - (1) The glass reduces the amount of insolation entering the greenhouse.
 - (2) The glass allows all wavelengths of radiation to enter and all wavelengths of radiation to escape.
 - (3) The glass allows short wavelengths of radiation to enter, but reduces the amount of long wavelength radiation that escapes.
 - (4) The glass allows long wavelengths of radiation to enter, but reduces the amount of short wavelength radiation that escapes.

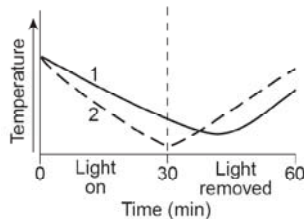


5. One reason Massena, New York, has a colder climate than Binghamton, New York, is that Massena
 - (1) absorbs more rays of incoming solar radiation
 - (2) is usually closer to the source of solar radiation
 - (3) receives shorter wavelengths from the source of solar radiation
 - (4) receives lower angle rays of incoming solar radiation

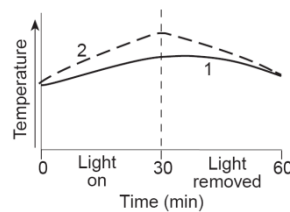
Base your answers to questions 6 through 10 on the diagram below and on your knowledge of Earth science. The diagram represents four stations, *A*, *B*, *C*, and *D*, in a laboratory investigation in which equal volumes of sand at the same starting temperature were heated by identical light sources. The light sources were the same distance from each station, but at different angles to the surfaces. Two thermometers were used at each station, one just above the surface and the other just below the surface. The lights were turned on for 30 minutes and then removed for the next 30 minutes. Temperatures were recorded each minute for the 60 minutes.



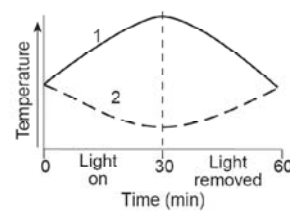
6. Most of the energy from the light sources was transferred to the sand by the process of
 (1) conduction (2) transpiration (3) convection (4) radiation
7. Which type of sand surface would most likely absorb the most radiation?
 (1) dark colored smooth surface (3) dark colored rough surface
 (2) light colored smooth surface (4) light colored rough surface
8. Which station received the *least* intense light energy?
 (1) A (2) B (3) C (4) D
9. After the light sources were removed, the electromagnetic energy radiated by the cooling sand was mostly
 (1) infrared rays (2) visible light rays (3) ultraviolet rays (4) gamma rays
10. Which graph best represents the temperatures that would be shown by thermometers 1 and 2 at station *A*?



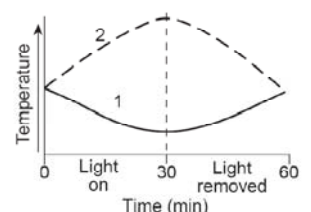
(1)



(2)

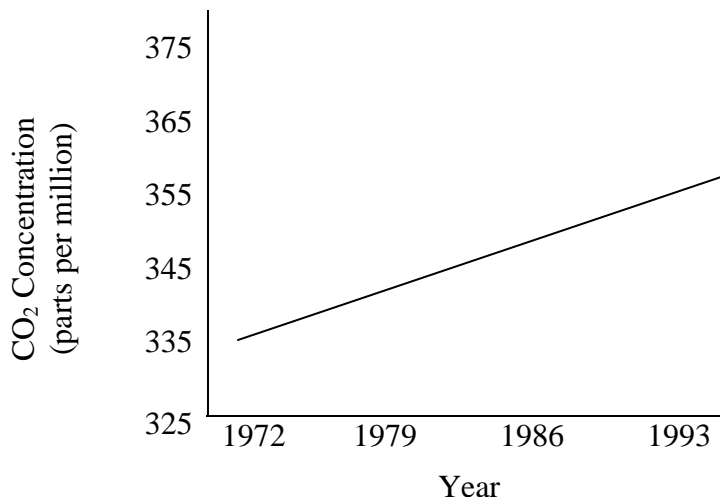


(3)



(4)

11. Which type of surface absorbs the greatest amount of electromagnetic energy from the Sun?
(1) smooth, shiny, and dark in color (3) rough, dull, and dark in color
(2) smooth, shiny, and light in color (4) rough, dull, and light in color
12. Electromagnetic energy that is being given off by the surface of Earth is called
(1) convection (3) insolation
(2) specific heat (4) terrestrial radiation
13. What is the usual cause of the drop in temperature that occurs between sunset and sunrise at most New York State locations.
(1) strong winds (3) cloud formation
(2) ground radiation (4) heavy precipitation
14. As the ability of a substance to absorb electromagnetic energy increases, the ability of that substance to radiate electromagnetic energy will
(1) decrease (2) increase (3) remain the same
15. At an altitude of 95 miles above Earth's surface, nearly 100% of the incoming energy from the Sun can be detected. At 55 miles above Earth's surface, most incoming x-ray radiation and some incoming ultraviolet radiation can no longer be detected. This missing radiation was most likely
(1) absorbed in the thermosphere (3) absorbed in the mesosphere
(2) reflected by the stratosphere (4) reflected by the troposphere
16. The graph below represents the average yearly concentration of carbon dioxide (CO₂) in Earth's atmosphere from 1972 to 1993.



- This change in CO₂ concentration most likely caused
- (1) a decrease in the average wavelength of solar radiation
 - (2) a decrease in the thickness of Earth's atmosphere
 - (3) an increase in the absorption of long-wave heat radiation by Earth's atmosphere
 - (4) an increase in the thickness of Earth's glaciers

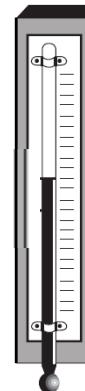
PART II: Weather Variables

1. Temperature _____

Instrument used to measure temperature: _____

Measured in . . . ° _____
 ° _____
 ° _____

Shown on a weather map with _____ - _____



Convert the temperatures below by using the conversion chart in the Earth Science Reference Tables, page ____.

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

Find the following temperatures:

	Fahrenheit	Celsius	Kelvin
Water boils			
Water freezes			
Body temperature			
Room temperature			

2. Air pressure

Instrument used to measure pressure:

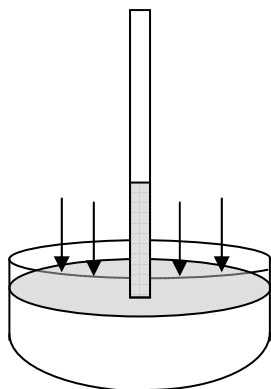
Measured in . . .

and

Shown on a weather map with



Mercury barometer:



Using the Pressure Conversion Chart in the Earth Science Reference Tables page _____, complete the tables below.

Inches	Millibars
29.06	
29.94	
30.50	
29.44	

Millibars	Inches
1011.0	
1021.0	
1035.0	
991.0	

Normal pressure at sea level is _____ atmosphere and is equal to . . .

_____ millibars and _____ inches

State the relationship between altitude and air pressure.

As altitude increases, pressure _____

Draw the relationship on the graph to the right.



3. Relative Humidity _____

measured in _____

When the air is holding as much water vapor as it can, the air is _____

When the air is saturated, the relative humidity is _____

Temperature & Relative Humidity _____

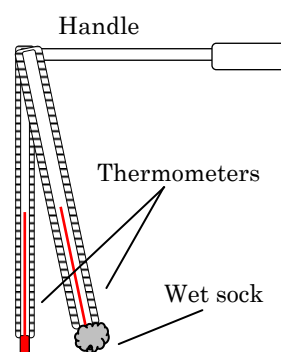
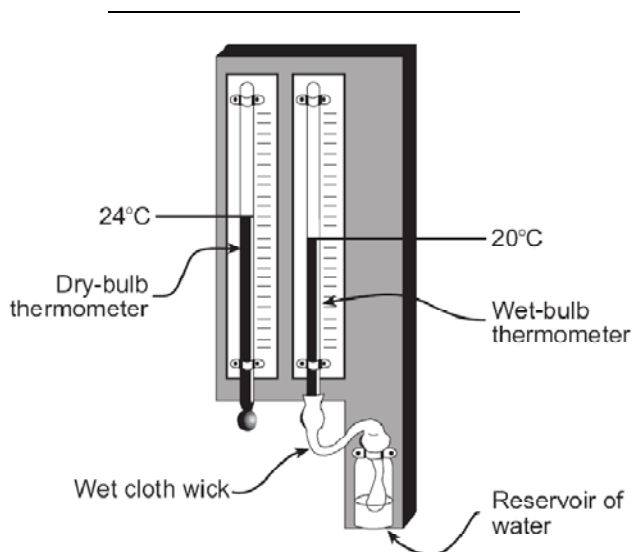
State the relationship between temperature and relative humidity.

As temperature increases, relative humidity _____

Draw the relationship on the graph to the right.



Instruments used to determine relative humidity:



Dew point Temperature _____

Determining Relative Humidity and Dew point Temperatures

Dry bulb – _____
Wet bulb – _____

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

Use the Dew point Temperature and Relative Humidity charts in the Earth Science Reference Tables on page _____.

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:

Determine the difference between dry bulb and wet bulb.

Dry bulb	_____
Wet bulb	- _____
Difference	_____

Using the Dew point Temperature chart, find the dry bulb temperature on the Dew point chart (left side) and the difference between the wet bulb and dry bulb temperatures (top).

- Match these places within the chart. What is the Dew point Temperature? _____ °C

Relative Humidity:

Same as Dew point, except use the Relative Humidity chart. Find the dry bulb temperature on the relative humidity chart (left side) and the difference between the wet bulb and dry bulb temperatures (top).

- Match these places within the chart. 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?	_____ %

Fill in the following table: Be careful! Make sure you are using the correct chart.

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			

- What is the dew point temperature if the dry bulb is 24°C and the wet bulb is 22°C? _____ °C
- What is the relative humidity if the dry bulb is 20°C and the wet bulb depression (difference between wet and dry bulb) is 6? _____ %
- What is the relative humidity if the dew point temperature is 6°C and the wet bulb depression is 1? _____ %
- What is the dew point temperature if the wet bulb depression is 6 and the relative humidity is 61%? _____ °C
- 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

Condensation

Examples:

Three things needed for Condensation to occur:

(1)

(2)

(3)

Density of Air:

-

-

Formation of Clouds:

Adiabatic cooling –

Precipitation –

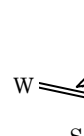
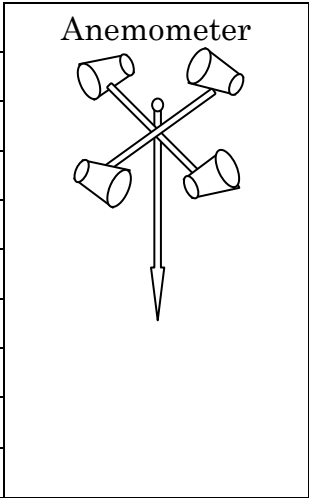

Examples -

What does precipitation do for the environment? _____

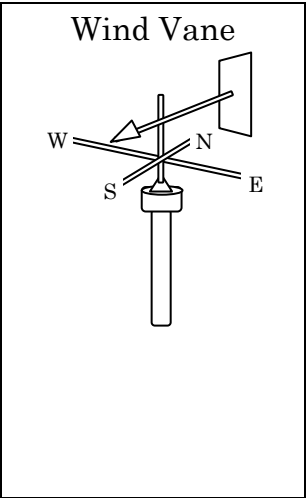
Wind:

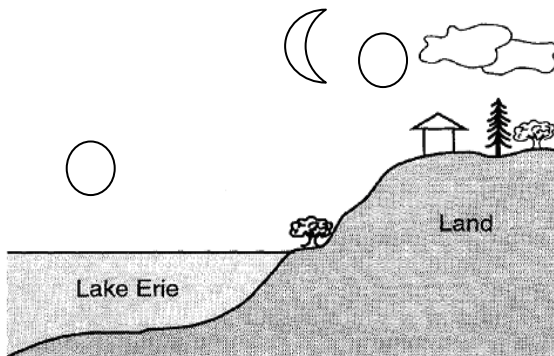
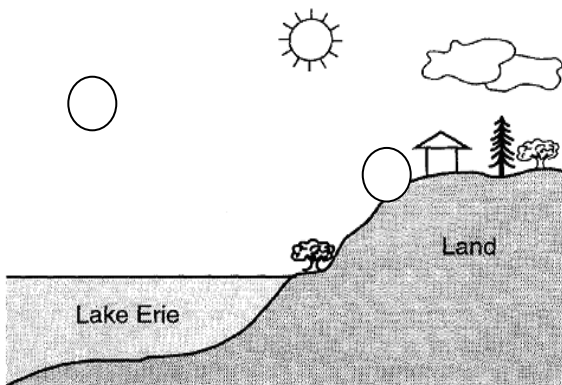
This image shows a blank sheet of white paper with horizontal ruling lines. The lines are evenly spaced and extend across the width of the page. There are no margins, text, or other markings on the paper.

Anemometer



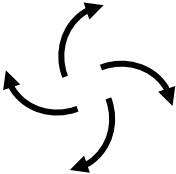
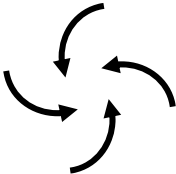
A diagram of a wind vane. It consists of a vertical rod passing through a cylindrical base. A horizontal arm is attached to the rod, and a rectangular plate is mounted on the end of this arm. A second arm, perpendicular to the first, has four directional labels: 'W' (West) at the left end, 'E' (East) at the right end, 'S' (South) at the front-left end, and 'N' (North) at the back-right end. An arrowhead is shown on the 'W' arm, pointing towards the left.





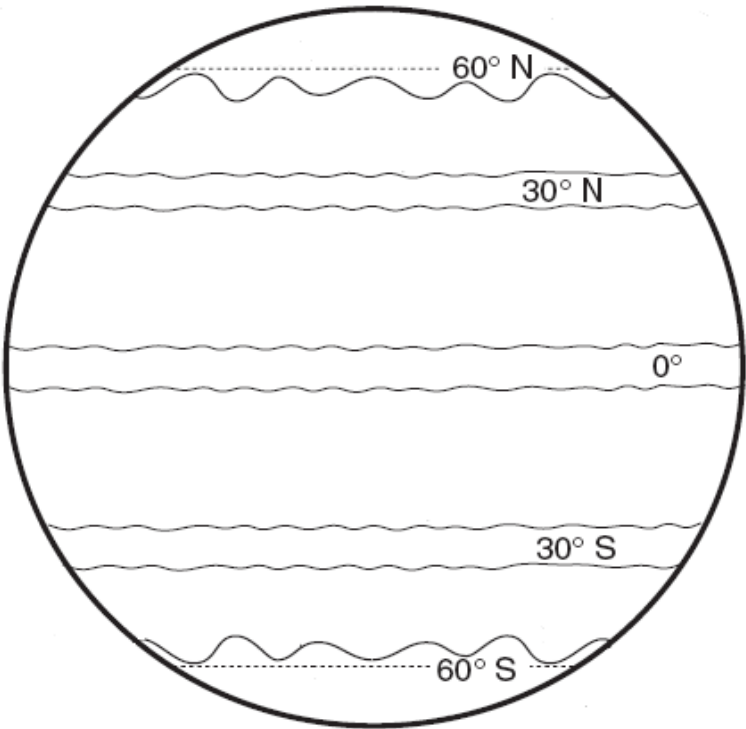
Coriolis Effect – _____

Weather Factors Associated with Different Pressure Areas

High Pressure	→	Low Pressure
		

Planetary winds: ESRT pg _____

- Fill in the diagram to the right.
- 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.



Weather changes:

State the relationship for each of the following variables. Draw the graph of the relationship – 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:



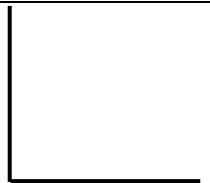
As altitude increases, water vapor content _____

Reason:



As altitude increases in the troposphere, temperature _____

Reason:



As altitude increases, pressure _____

Reason:



Air Masses

ESRT – pg _____

Symbol	Written form	Type of weather
cP		
cT		
mP		
mT		
cA		

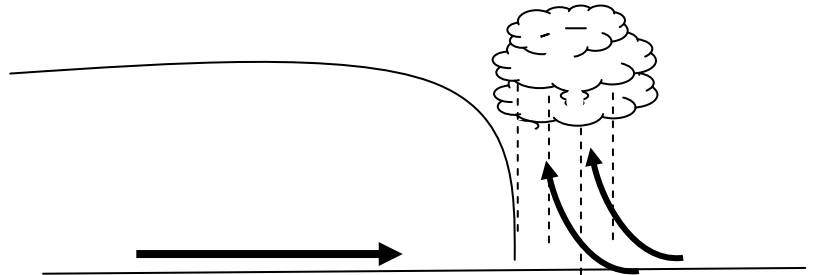
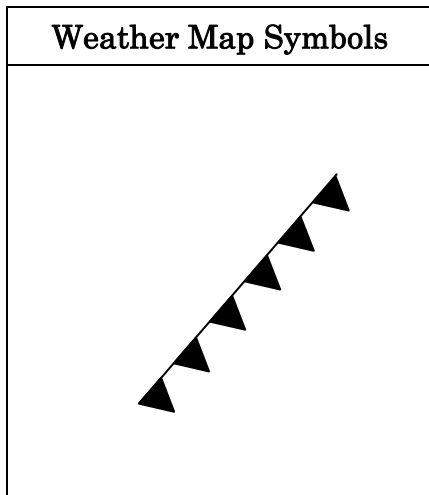
In the map below, write the correct abbreviation (cP, cT, mP, mT) in the corresponding location, to show the characteristics of an air mass that originated there



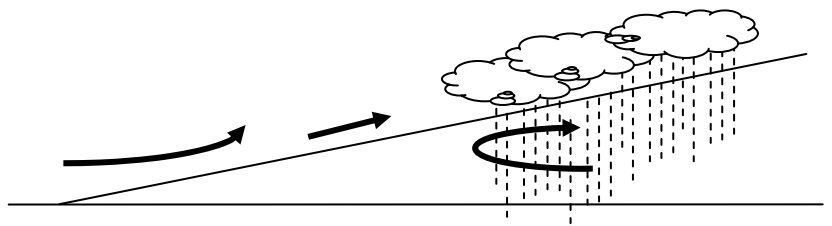
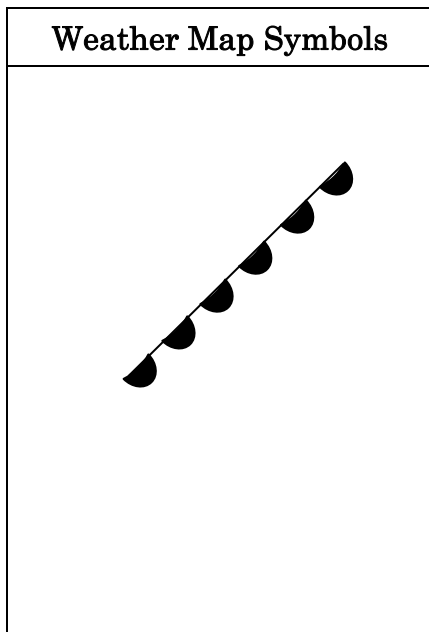
Fronts

Earth Science Reference Tables page _____

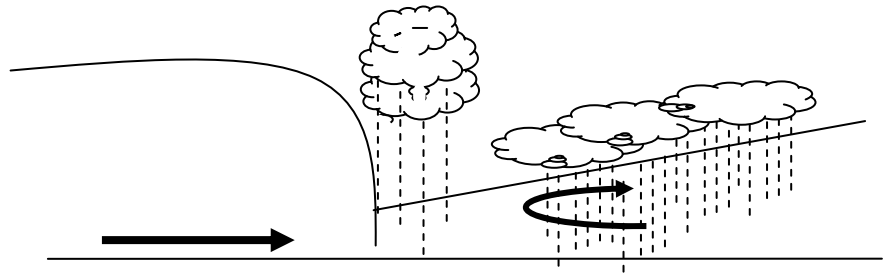
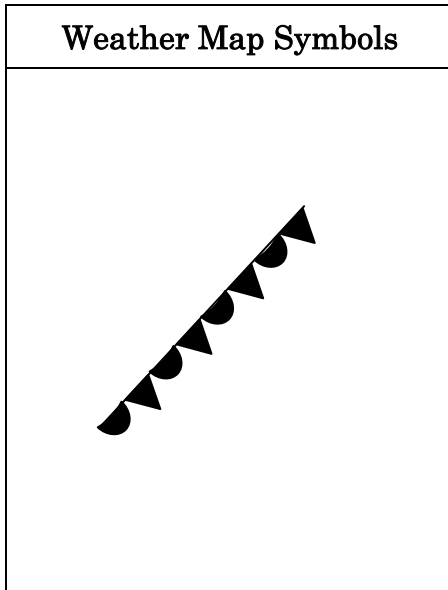
COLD FRONT:



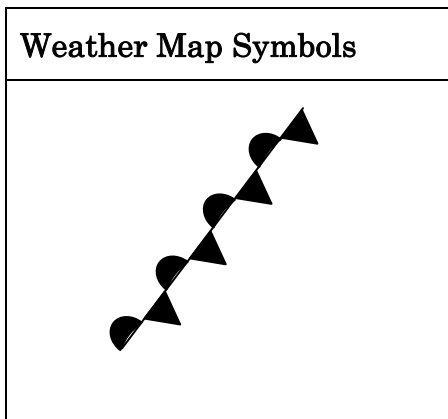
WARM FRONT



OCCLUDED FRONT



STATIONARY FRONT



Fronts are usually associated with . . .

Station Models

On a station model, barometric pressure is **ALWAYS** written in a three - digit format.

Converting from millibars:

Drop wither 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 =	1022.2 mb =	994.9 mb =
984.2 mb =	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 =
950.3 mb =	986.4 mb =	1033.9 mb =
973.4 mb =	962.2 mb =	1000.0 mb =

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.

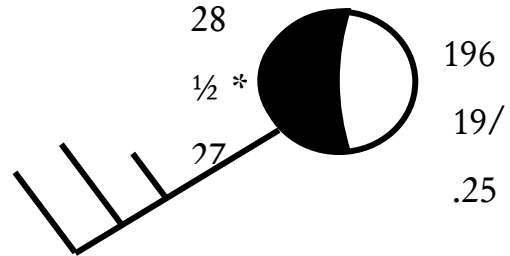
If the first number on the station model is 5 – 9, place a 9 in front of the number.

Place a decimal point between the last 2 numbers.

Station Model / Millibars	Station Model / Millibars	Station Model / Millibars
146 = mb	015 = mb	080 = mb
457 = 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
778 = mb	708 = mb	321 = mb
502 = mb	399 = mb	116 = mb
385 = mb	010 = mb	698 = mb

Weather stations:

Inside the circle – the amount of cloud cover	
Top right - barometric pressure (shorthand)	
Middle right - barometric tendency (rising/falling)	
Bottom right - precipitation (past 6 hours)	
Top left - temperature (°F)	
Middle left - present weather & visibility	
Bottom left - dew point temperature (°F)	
Wind line - direction (where wind is coming from)	
Feathers - speed (long=10 knots/short 5 knots)	



Draw a weather station using the following information:

Completely cloudy

Top right pressure = 1024.3

barometric tendency = falling

precipitation = 3 inches

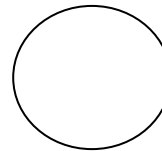
temperature 25°F

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

dew point temperature 23°F

Wind = Northeast

Wind speed 25 knots



NEED TO KNOW: Dew Point Temperature & Air Temperature

Determine each of the values below by looking at the diagram at the top of each column.

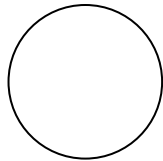
Wind Direction			
Wind Speed			
Cloud cover			
Air pressure			
Barometric tendency			
Precipitation			
Temperature			
Dew Point			
Present weather			
Visibility			

Determine each of the values below by looking at the diagram at the top of each column.

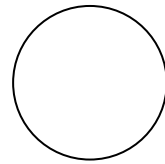
Wind Direction			
Wind Speed			
Cloud cover			
Air pressure			
Barometric tendency			
Precipitation			
Temperature			
Dew Point			
Present weather			
Visibility			

Draw a station model for each description below. Remember to draw the wind direction and speed first.

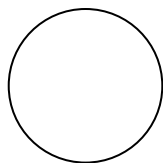
Completely cloudy
pressure = 1034.6 mb
barometric tendency = falling .1 mb
precipitation = 3 inches
temperature 45°
present weather (drizzling)
visibility (.5 miles)
dew point 42°
Wind = Northwest
Wind speed 15 knots



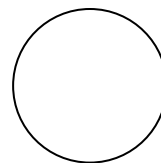
3/4 cloudy
pressure = 999.5 mb
barometric tendency = falling .2 mb
precipitation = .75 inches
temperature 38°
present weather (sleet)
visibility (.5 miles)
dew point 34°
Wind = southeast
Wind speed 20 knots



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

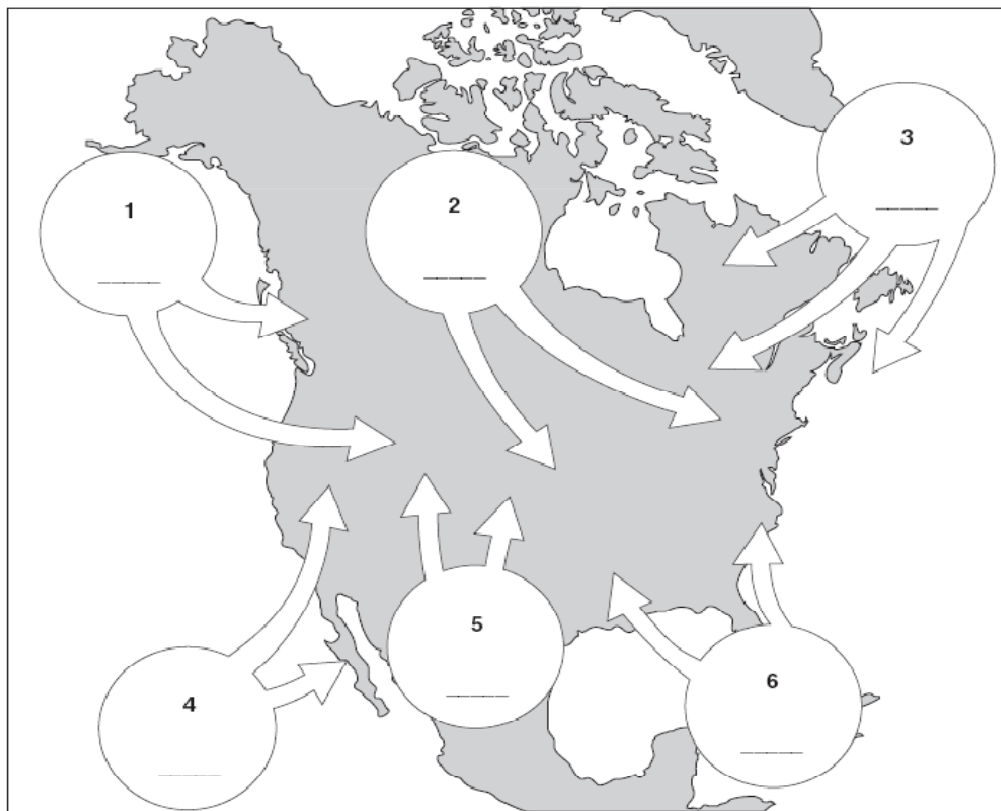


No clouds
pressure = 1008.5 mb
barometric tendency = rising .2 mb
precipitation = 0 inches
temperature 78°
present weather (clear)
visibility (full)
dew point 47°
Wind = Northeast
Wind speed 25 knots



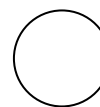
Weather Map Practice

1. The map provided 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.



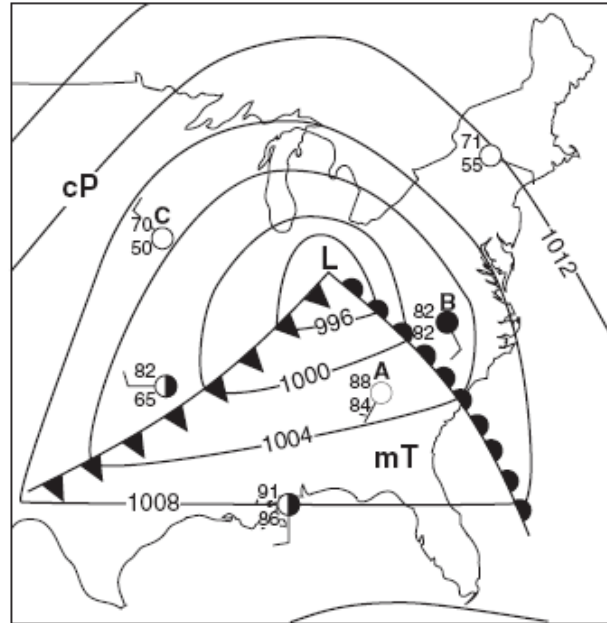
2. Using the station model below, draw and label the following information. Cloud cover has been left out. Using the information determine what the coverage would be and shade in the station model.

Wind direction	Northeast
Wind speed	20 knots
Present weather	Hail
Visibility	$\frac{1}{4}$ mile
Temperature	52 °F
Dew point	52°F
Cloud cover	?



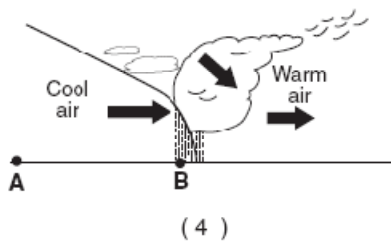
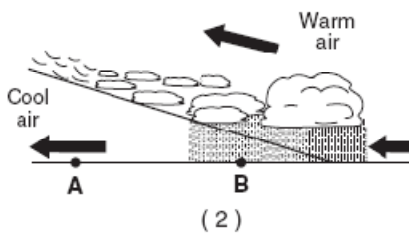
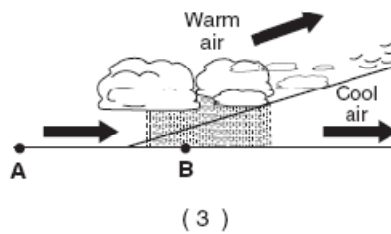
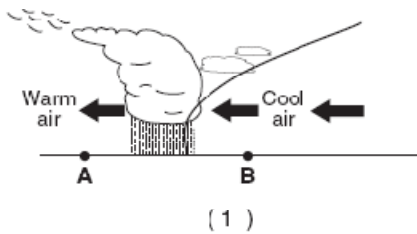
Base your answers to questions 3 – 12 on the weather map below. The map shows a low pressure system and some atmospheric conditions at weather stations A, B, and C.

3. What is the symbol for the warm and moist air mass? _____
4. What is the symbol for the cold and dry air mass _____
5. Where did the warm air mass originate? _____
6. Where did the cold air mass originate? _____
7. Which weather station (A, B, or C) has 100% relative humidity? _____
8. Which weather station (A, B, or C) will show colder temperatures within the next couple days? _____



9. In what direction is the wind blowing toward in weather station C? _____
10. List three things that indicate that this is a low pressure area on the map above.

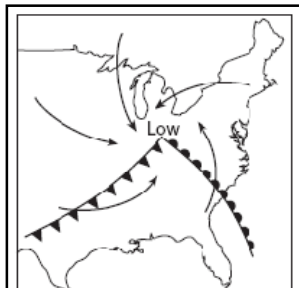
11. Which cross sections below best represents the air masses, air movement, clouds and precipitation occurring behind and ahead of the warm front located between stations A and B?



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



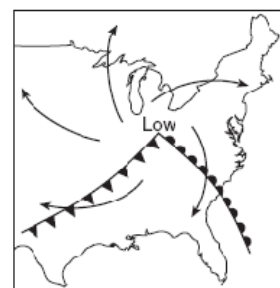
(1)



(2)

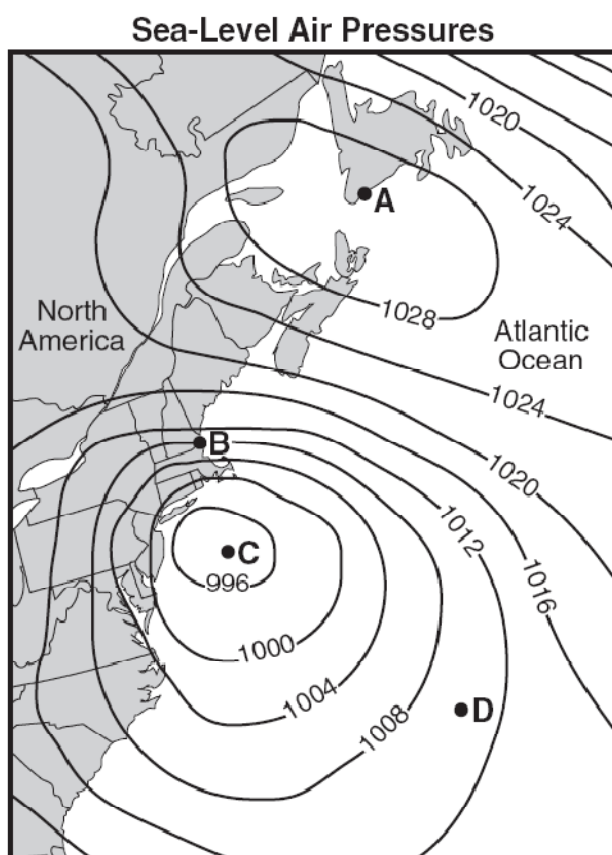


(3)



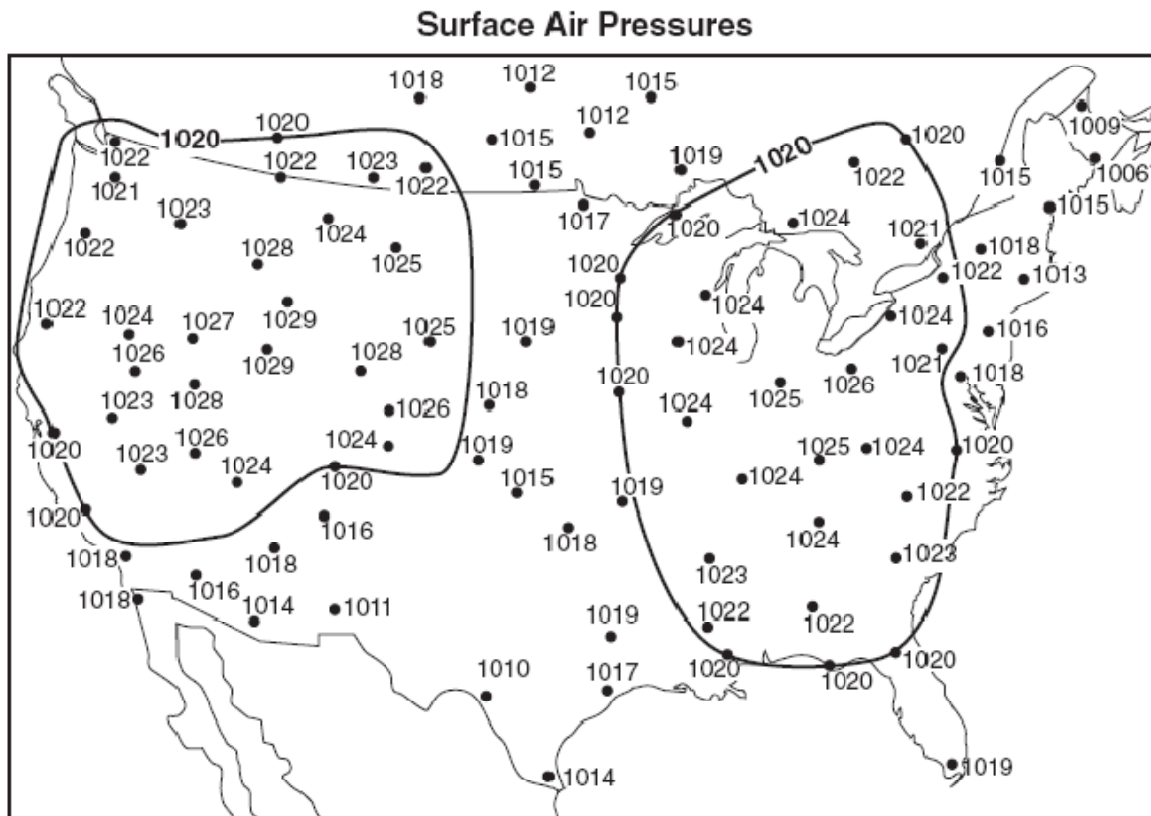
(4)

Base your answers to questions 13 through 23 on the map below, which shows sea-level air pressure, in millibars, for a portion of the eastern coast of North America. Points *A*, *B*, *C*, and *D* are sea-level locations on Earth's surface.

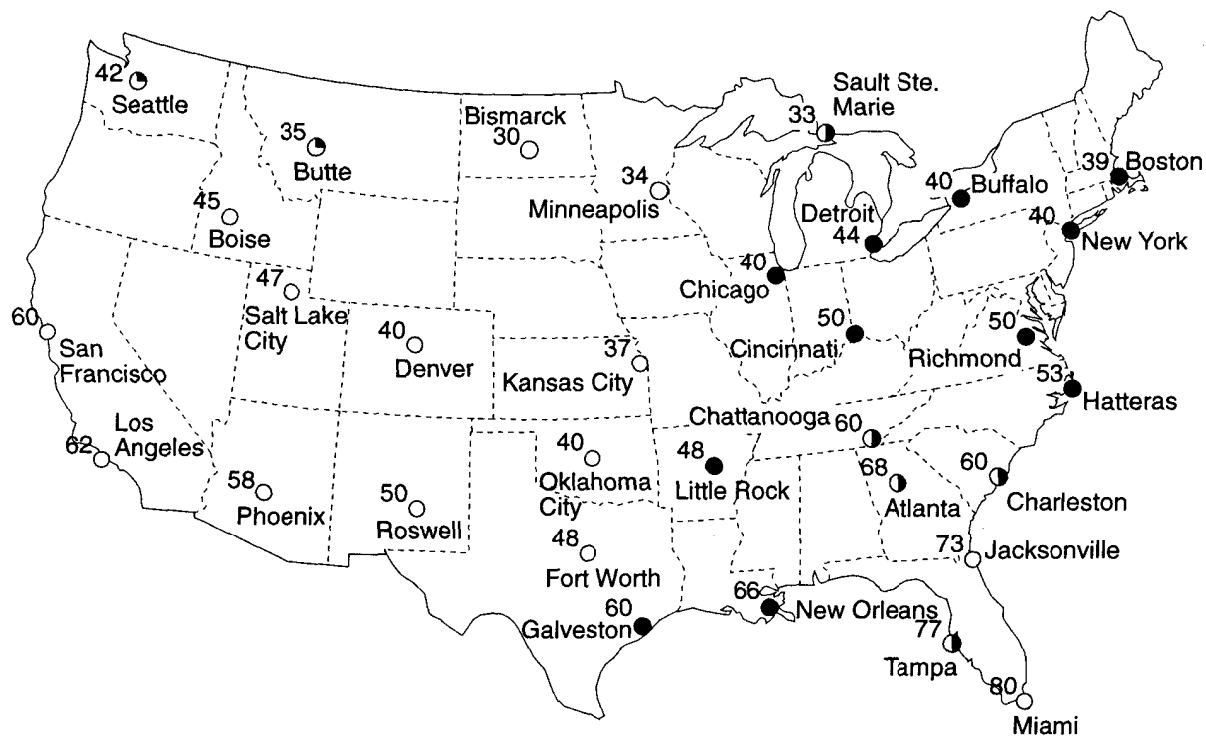


13. What weather instrument was used to measure the air pressures? _____
14. Which location (*A*, *B*, *C*, or *D*) recorded the highest wind speed? _____
15. Which location (*A*, *B*, *C*, or *D*) is in the center of a high pressure area? _____
16. Which location (*A*, *B*, *C*, or *D*) is in the center of a low pressure area? _____
17. What is the approximate air pressure of location *D*? _____
18. Between points *A* and *B*, which direction is the wind blowing? Towards _____
19. Which location (*A* or *C*) is the wind blowing counter clockwise? _____
20. At which location (*A* or *C*) is the wind blowing in a clockwise direction? _____
21. In which direction do the prevailing winds carry our weather systems across the United States? _____
22. At which location (*A*, *B*, *C*, or *D*) is the air rising? _____
23. At which location (*A*, *B*, *C*, or *D*) is the air sinking? _____

24. Draw the 1024 and 1028 isobar on the map below.

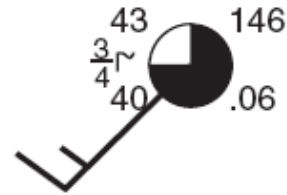


25. Draw the 30, 40, 50 and 60 isotherm on the map below.

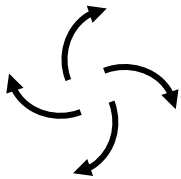
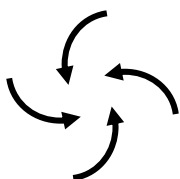


26. Using the station model below, fill in the following information:

Wind direction _____
 Wind speed _____
 Present weather _____
 Visibility _____
 Temperature _____
 Dew point _____
 Cloud cover _____
 Pressure _____
 Precipitation _____



27. Fill in the following chart with the terms to the left of the chart:

	<i>High Pressure</i>	<i>Low Pressure</i>
Draw an arrow on the line provided to illustrate which way the wind is blowing.		
Air rises / sinks		
Air moves outward / inward		
Air is cool / warm		
Clockwise / Counter clockwise		
Clouds / No clouds		
Precipitation / No precipitation		

28. How do clouds form?

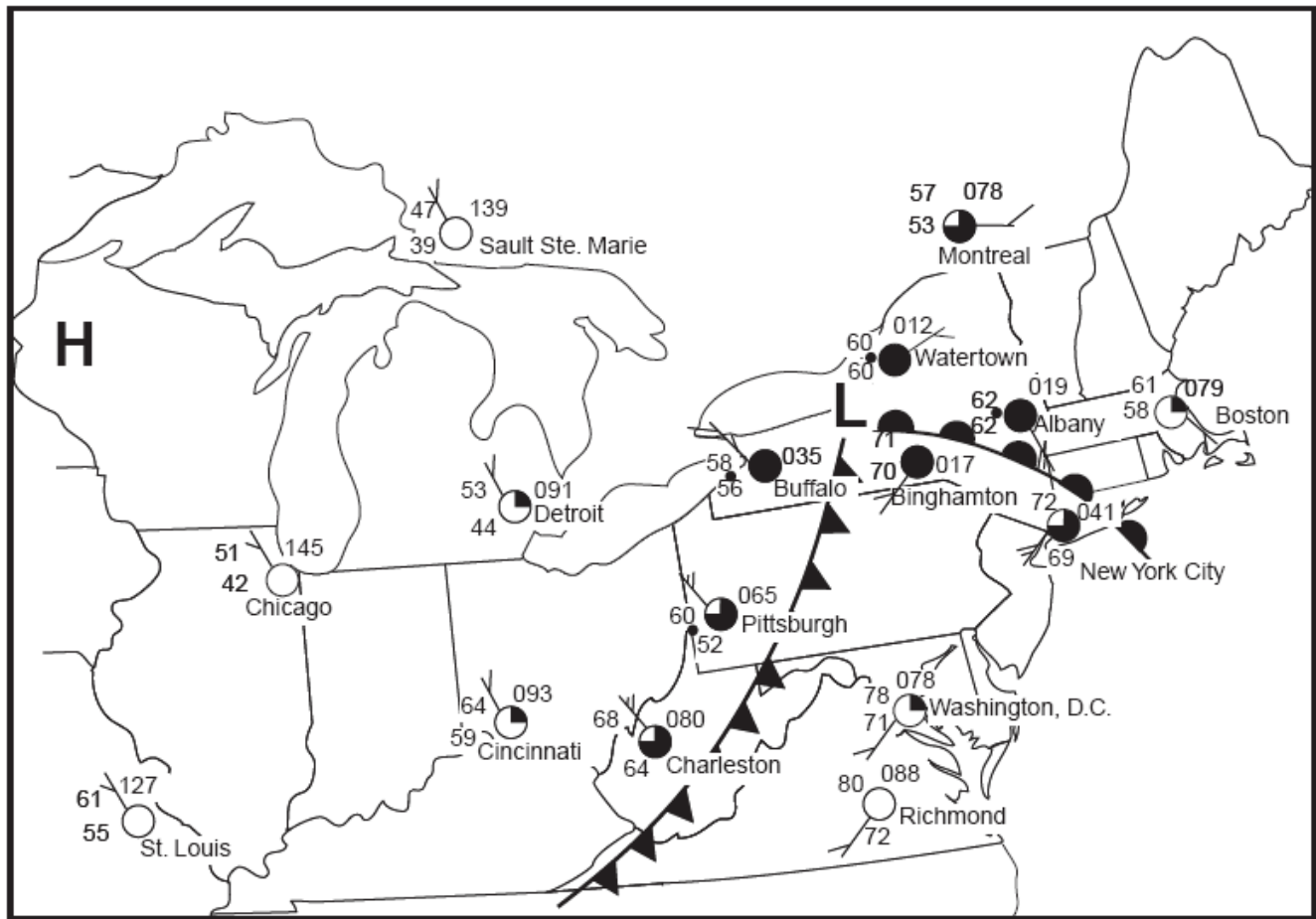
29. What is indicated when the dew point temperature and air temperature are close?

30. What is the relative humidity when there is fog? _____ %

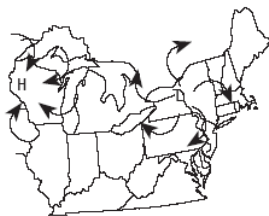
31. What usually happens when a front passes through an area? _____

More Regents Questions:

Base your answers to questions 1 through 8 on the weather map below showing part of the United States.



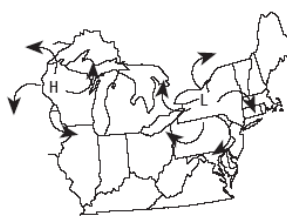
1. Name the type of air mass that is located over Binghamton, New York _____
2. Name the type of air mass that is located over Chicago, Illinois. _____
3. What is the present weather in St. Louis? _____
4. What is the relative humidity at Watertown? _____ %
Explain how you determined this. _____
5. The arrows on which map best represent the direction of surface winds associated with the high-pressure and low-pressure systems?



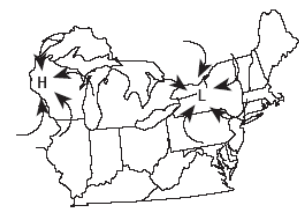
(1)



(2)

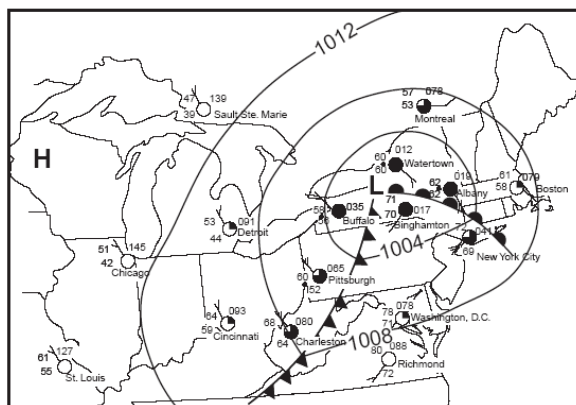


(3)

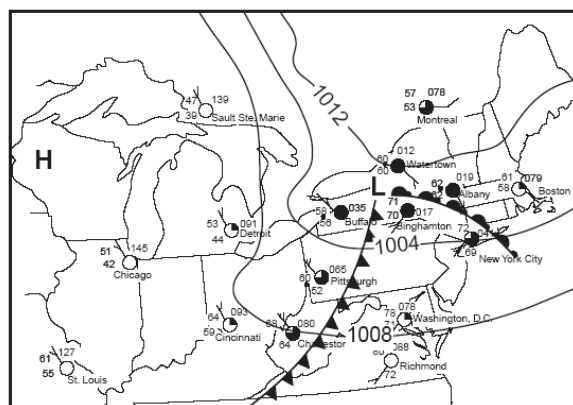


(4)

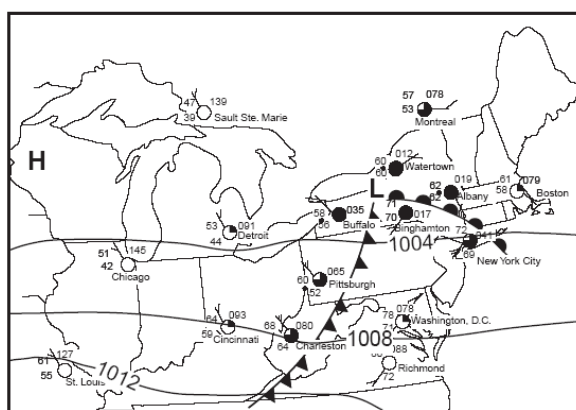
6. Which map best represents the correct location of the 1004-mb, 1008-mb, and 1012-mb isobars?



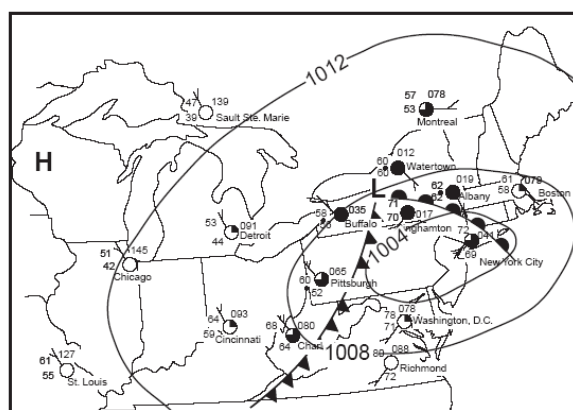
(1)



(3)

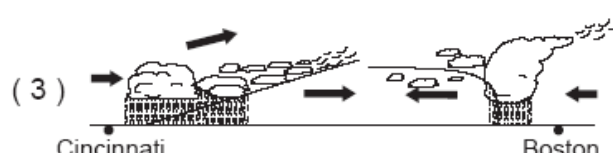
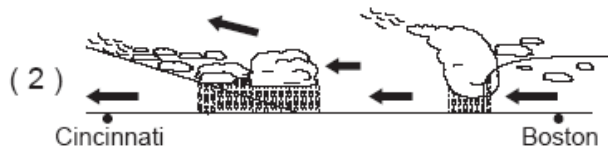
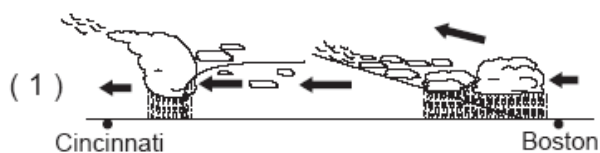


(2)



(4)

7. If the fronts continue on their current paths, name two cities that will be experience colder temperatures? _____ and _____
8. The arrows in the cross sections below represent the general direction of air movement. Which cross section along a straight line between Cincinnati and Boston best represents the weather fronts, clouds, precipitation, and general direction of air movement shown in the map?



Base your answers to questions 9 through 14 on the weather to the right, which shows partial weather-station data for several cities in eastern North America.

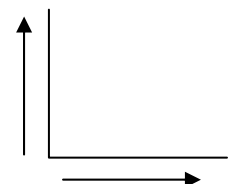
9. Draw isotherms every 10°F, starting with 40°F and ending with 70°F. Isotherms must extend to the edges of the map.
10. Calculate the temperature gradient between Richmond, Virginia, and Hatteras, North Carolina, by following the directions below.
 - a. Write the equation for gradient.
 - b. Substitute data from the map into the equation.
 - c. Calculate the average gradient and label your answer with the correct units.



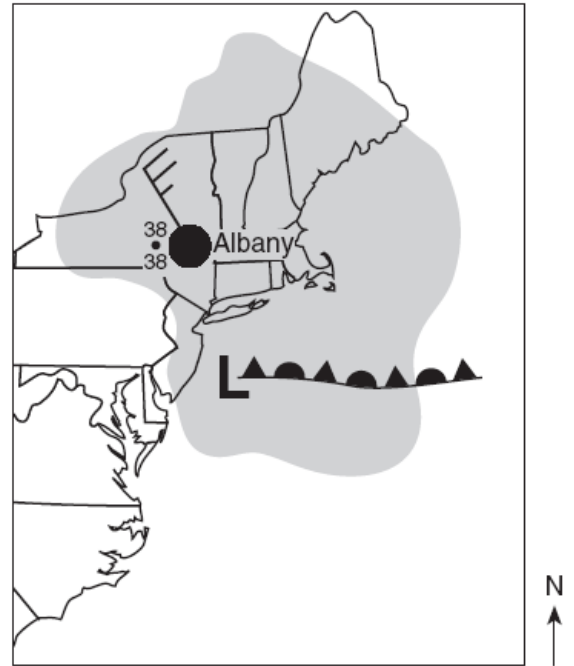
11. State the actual air pressure, in millibars, shown at Miami, Florida. _____ mb
12. Is Cincinnati in a low pressure area or a high pressure area? _____
13. State two pieces of evidence that supports your answer above.

14. State the general relationship between air temperature and latitude for locations shown on the map.

[Hint: air temperature changes because of latitude.]
 Draw the relationship on the graph to the right.
 Remember to label it.



Base your answers to questions 15 and 16 on the weather map below, which shows the position of a low pressure system. The **L** is the center of the low. The shaded portion represents an area of precipitation. A weather station model for Albany, New York, is shown on the map.



15. What type of front extends eastward from the low-pressure center? _____

16. Complete the weather data table for Albany, New York, based on the station model shown on the map.

Relative humidity (%)	_____
Wind direction from	_____
Wind speed (knots)	_____
Present weather	_____

17. What is the approximate dew point temperature if the dry-bulb temperature is 26°C and the wet-bulb temperature is 21°C? _____

18. What is the approximate dew point temperature if the dry-bulb temperature is 24°C and the wet-bulb temperature is 18°C? _____

19. The dry-bulb temperature of a sample of air is 18°C and its dew point temperature is 4°C. What is the approximate relative humidity? _____

20. Which weather instrument has most improved the accuracy of weather forecasts over the past 40 years?

- | | |
|---------------------|------------------------|
| (1) thermometer | (3) sling psychrometer |
| (2) weather balloon | (4) weather satellite |

21. Which form of electromagnetic radiation has a wavelength of 10^{-9} meter?

- | | | | |
|----------------|--------------|-----------------|-----------------|
| (1) gamma rays | (2) infrared | (3) ultraviolet | (4) radio waves |
|----------------|--------------|-----------------|-----------------|

22. 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.

STORMS:

American Red Cross: <http://www.redcross.org/services/disaster/> (*disaster safety link*)

NOAA - National Oceanic and Atmospheric Administration: <http://www.noaa.gov/>

Thunderstorms

[illegible]

Dangers:

Preparedness:

[illegible]

If caught

[illegible]

[illegible]

[illegible]

Dangers:

Preparedness:

If caught

Winter Storms

Blizzards:

Lake effect:

Dangers:

Preparedness:

If caught

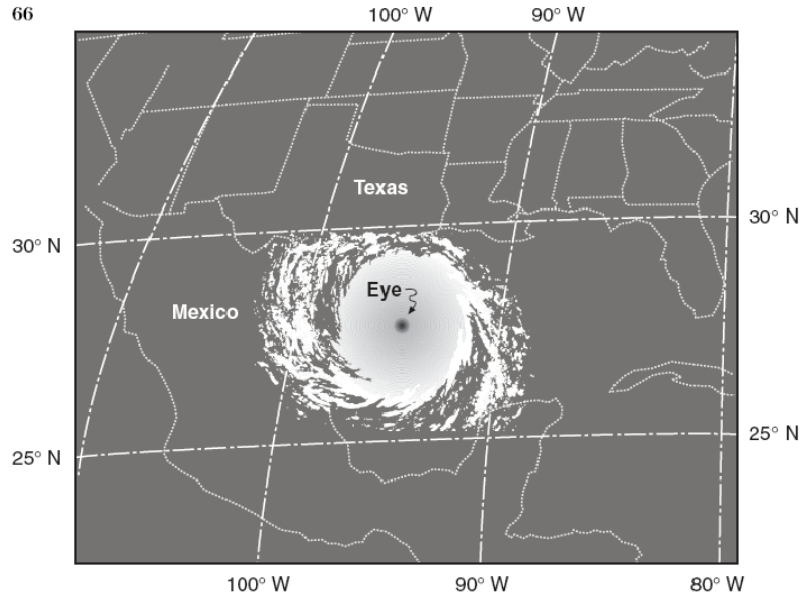
Disaster planning: Directions: find a website that will help to develop a disaster plan and supply kit. The American Red Cross is a valuable place to look. Write down the information you feel is most important. You will not be able to copy it all so choose carefully.

Create a Disaster Plan

Disaster Supplies Kit –

Base your answers to questions 1 through 5 on the weather satellite photograph of a portion of the United States and Mexico to the below.

The photograph shows the clouds of a major hurricane approaching the eastern coastline of Texas and Mexico. The calm center of the hurricane, the eye, is labeled.



1. This hurricane has a pattern of surface winds typical of all low-pressure systems in the Northern Hemisphere. On the satellite photograph provided, draw *three* arrows on the clouds to show the direction of the surface wind movement outside the eye of the hurricane.
2. Cloud droplets form around small particles in the atmosphere. Describe how the hurricane clouds formed from water vapor. Include the terms "Dew point" and either "condensation" or "condense" in your answer.

3. State the latitude and longitude of the hurricane's eye. The compass directions must be included in the answer

Latitude

Longitude

4. At the location shown in the photograph, the hurricane had maximum winds recorded at 110 miles per hour. Within a 24-hour period, the hurricane moved 150 miles inland and had maximum winds of only 65 miles per hour. State why the wind velocity of a hurricane usually decreases when the hurricane moves over a land surface.

5. State *two* dangerous conditions, other than hurricane winds, that could cause human fatalities as the hurricane strikes the coast.

6. Describe *one* emergency preparation humans could take to avoid a problem caused by one of these dangerous conditions

Base your answers to questions 7 through 11 on the passage below and on your knowledge of Earth science. The passage describes a tornado produced from a thunderstorm that moved through a portion of New York State on May 31, 1998.

New York Tornado

A small tornado formed and moved through the town of Apalachin, New York, at 5:30 p.m., producing winds between 40 and 72 miles per hour. The tops of trees were snapped off, and many large limbs fell to the ground. The path of the destruction measured up to 200 feet wide. At 5:45 p.m., the tornado next moved through the town of Vestal where winds ranged between 73 and 112 miles per hour. Many people experienced personal property damage as many homes were hit with flying material. At 6:10 p.m., the tornado moved close to Binghamton, producing winds

between 113 and 157 miles per hour. A 1000-foot television tower was pushed over, and many heavy objects were tossed about by the strong winds. Then the tornado lifted off the ground for short periods of time and bounced along toward the town of Windsor. At 6:15 p.m., light damage was done to trees as limbs fell and small shallow-rooted trees were pushed over in Windsor.

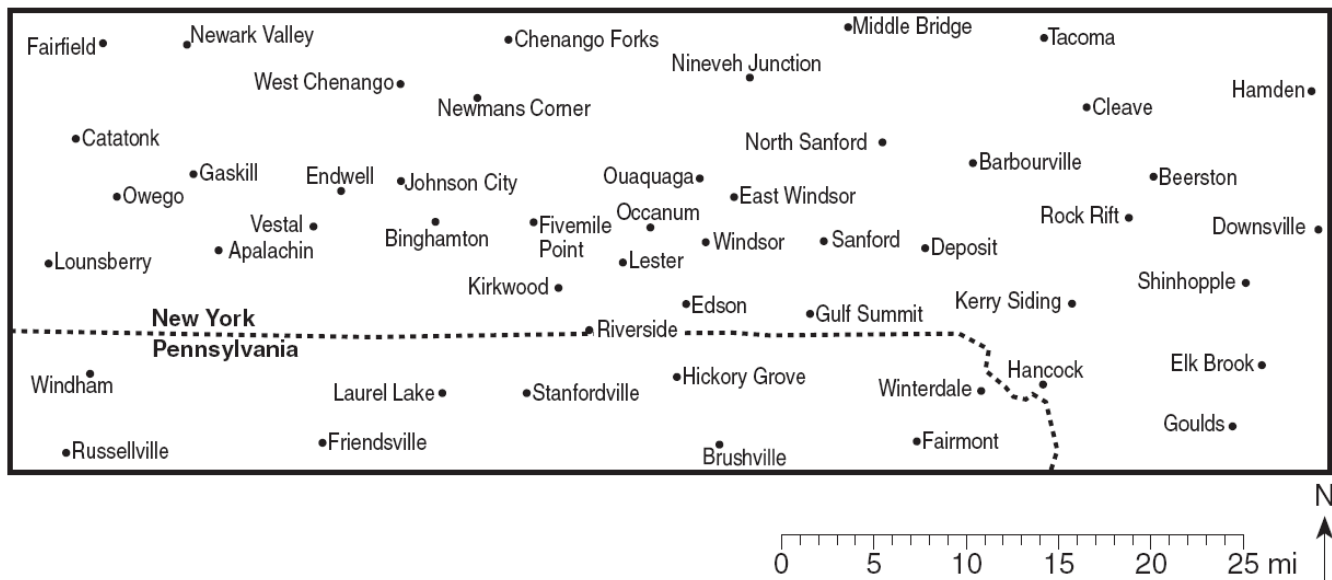
The tornado increased in strength again at 6:20 p.m. as it moved into Sanford. Some homes were damaged as their roof shingles and siding were

ripped off. One mobile home was turned over on its side.

The tornado moved through the town of Deposit at 6:30 p.m., creating a path of destruction 200 yards wide. The tornado skipped along hilltops, touching down occasionally on the valley floors. However, much damage was done to homes as the tornado's

winds reached their maximum speeds of 158 to 206 miles per hour. The tornado weakened and sporadically touched down after leaving Deposit. By 7:00 p.m. the tornado had finally ended its 1-hour rampage.

7. On the map *below*, draw the path of the tornado and the direction the tornado moved, by following the directions below.
 - Place an **X** through the point for *each of the six* towns mentioned in the passage.
 - Connect the **X**s with a line in the order that each town was mentioned in the passage.
 - Place an arrow at one end of your line to show the direction of the tornado's movement.



8. The tornado mentioned in this passage was produced by cold, dry air from Canada quickly advancing into warm, moist air already in place over the northeastern United States. List the two-letter air-mass symbols that would identify *each* of the two air masses responsible for producing this tornado. _____ and _____
9. Which type of front was located at the boundary between the advancing cold, dry air mass and the warm, moist air mass? _____ front.

Fujita Scale

F-Scale Number	Wind Speed (mph)	Type of Damage Done
F-0	40–72	some damage to chimneys; breaks branches off trees; pushes over shallow-rooted trees; damages sign boards
F-1	73–112	peels surface off roofs; mobile homes pushed off foundations or overturned; moving autos pushed off the roads; attached garages may be destroyed
F-2	113–157	considerable damage; roofs torn off frame houses; mobile homes demolished; boxcars pushed over; large trees snapped or uprooted; light-object missiles generated
F-3	158–206	roof and some walls torn off well-constructed homes; trains overturned; most trees in forest uprooted
F-4	207–260	well-constructed houses leveled; structures with weak foundations blown off some distance; cars thrown and large missiles generated
F-5	261–318	strong frame houses lifted off foundations and carried considerable distances to disintegrate; automobile-sized missiles fly through the air in excess of 100 meters; trees debarked; steel-reinforced concrete structures badly damaged

10. Using the Fujita Scale shown above and the information in the passage, complete the table *in your answer booklet*, by assigning an F-Scale number for the tornado as it passed through each town given in the table below.

Town	F-Scale Number
Vestal	
Windsor	
Sanford	
Deposit	

11. Calculate the tornado's average rate of travel, in miles per minute, between Vestal and Windsor, by using the equation below. Express your answer to the *nearest tenth*.

$$\text{tornado's rate of travel} = \frac{\text{distance between Vestal and Windsor (miles)}}{\text{time (minutes)}}$$

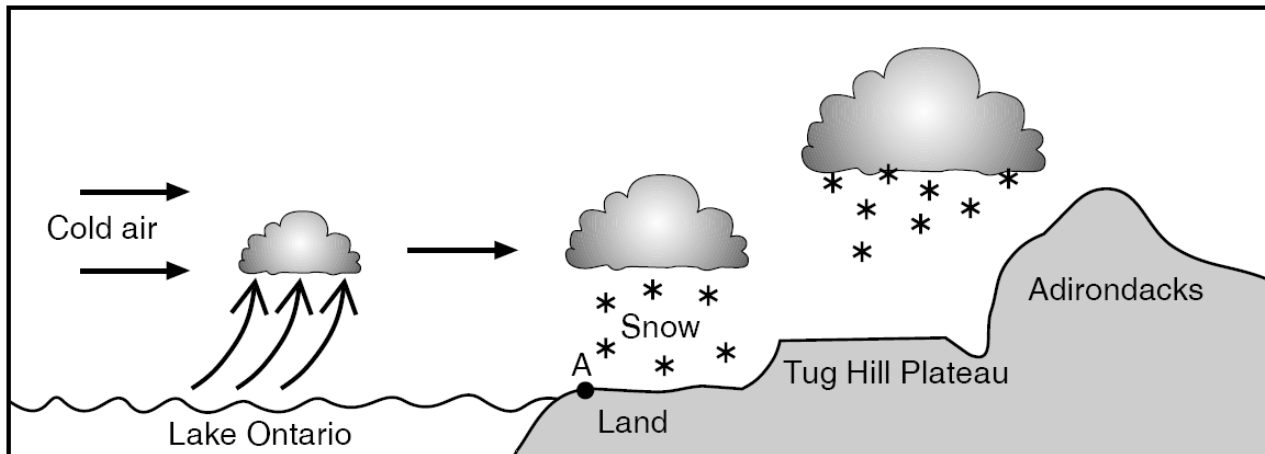
Base your answers to questions 12 through 15 on the magazine article and diagram below.

Lake-Effect Snow

During the cold months of the year, the words “lake effect” are very much a part of the weather picture in many locations in New York State. Snow created by the lake effect may represent more than half the season’s snowfall in some areas. In order for heavy lake-effect snow to develop, the temperature of the water at the surface of the lake must be higher than the temperature of the air flowing over the water. The higher the water temperature and the lower the air temperature, the greater the potential for lake-effect snow. A lake-effect storm begins when air flowing across the lake is warmed as it comes in close

contact with the water. The warmed air rises and takes moisture along with it. This moisture, which is water vapor from the lake, is turned into clouds as it encounters much colder air above. When the clouds reach the shore of the lake, they deposit their snow on nearby land. A typical lake-effect storm is illustrated in the diagram below. The area most likely to receive snow from a lake is called a “snowbelt.” Lake Ontario’s snowbelt includes the counties along the eastern and southeastern ends of the lake. Because the lake runs lengthwise from west to east, the prevailing westerly winds

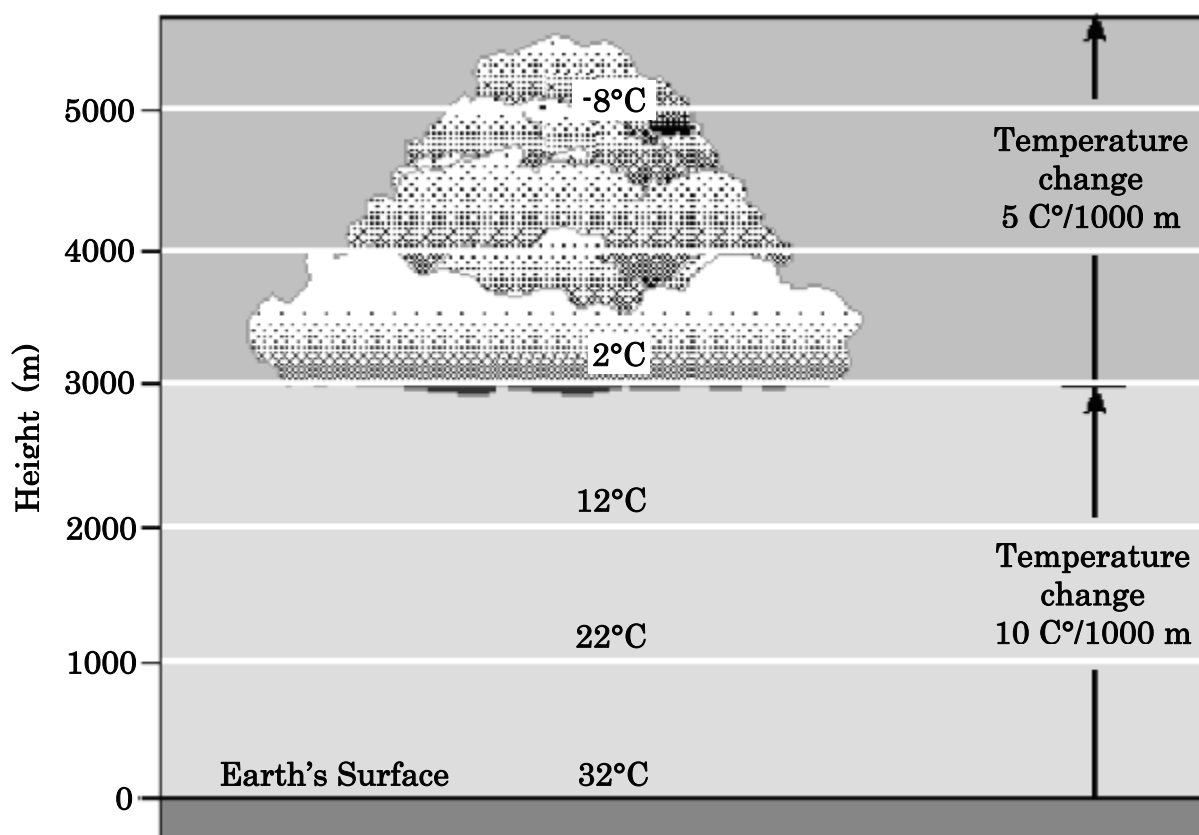
are able to gather the maximum amount of moisture as they flow across the entire length of the lake. There can be lake-effect snowfall anywhere around the lake, but the heaviest and most frequent snowfalls occur near the eastern shore. In parts of the snowbelt, the lake effect combines with a phenomenon known as orographic lifting to produce some very heavy snowfalls. After cold air has streamed over the length of Lake Ontario, it moves inland and is forced to climb the slopes of the Tug Hill Plateau and the Adirondack Mountains, resulting in very heavy snowfall.



12. State the relationship that must exist between water temperature and air temperature for lake-effect snow to develop.
13. State why locations east and southeast of Lake Ontario are more likely to receive lake-effect snow than are locations west of the lake.
14. State the name of the New York State landscape region that includes location A shown in the diagram.
15. State why very heavy snowfall occurs in the Tug Hill Plateau region.

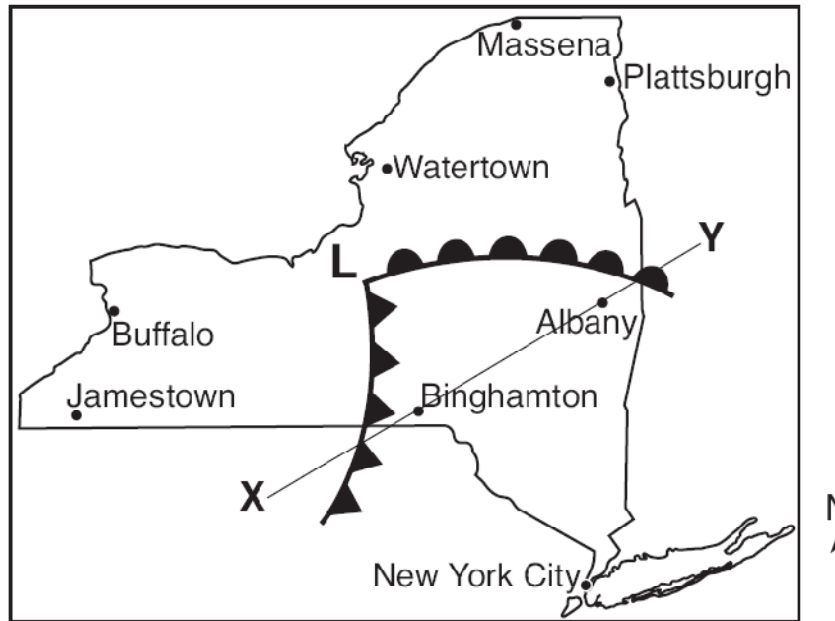
16. Which atmospheric conditions are necessary for condensation?
- (1) saturated air and dew point temperature much lower than air temperature
 - (2) unsaturated air and dew point temperature much higher than air temperature
 - (3) saturated air and equal dew point and air temperatures
 - (4) unsaturated air and equal dew point and air temperatures
17. The heavy lake-effect snowfalls in the Tug Hill Plateau region occur primarily because the plateau is located
- (1) in the path of prevailing winds from Lake Ontario
 - (2) in the Northern Hemisphere
 - (3) near the Atlantic Ocean
 - (4) west of the Hudson-Mohawk Lowlands

Base your answers to questions 18 and 19 on the diagram below, which shows temperature changes within a parcel of air on a summer day.

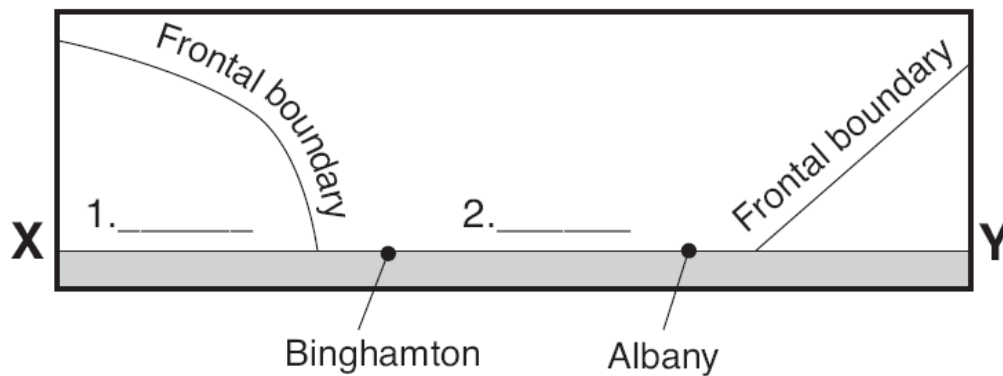


18. At 4,000 meters above Earth's surface, the temperature within the cloud is approximately
- (1) -12°C
 - (2) 3°C
 - (3) -3°C
 - (4) 0°C
19. Which process slows the rate of cooling above 3,000 meters and results in cloud formation?
- (1) condensation
 - (2) convection
 - (3) evaporation
 - (4) radiation

Base your answers to questions 20 through 22 on the weather map below. The weather map shows a low pressure system in New York State during July. The **L** represents the center of the low-pressure system. Two fronts extend from the center of the low. Line *XY* on the map is a reference line.



20. The cross section below shows a side view of the area along line *XY* on the map. On lines 1 and 2 in the cross section, place the appropriate two-letter air-mass symbols to identify the most likely type of air mass at *each* of these locations.



21. The forecast for one city located on the map is given below:

“In the next hour, skies will become cloud covered. Heavy rains are expected with possible lightning and thunder. Temperatures will become much cooler.”

State the name of the city for which this forecast was given.

22. Identify *one* action that people should take to protect themselves from lightning.