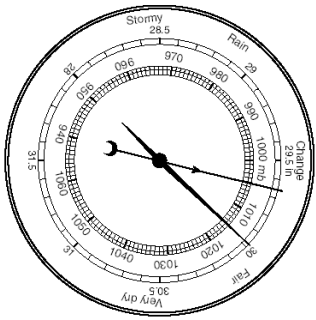


# **Topic VI**

## **Part 1**

# **Atmospheric Variables**

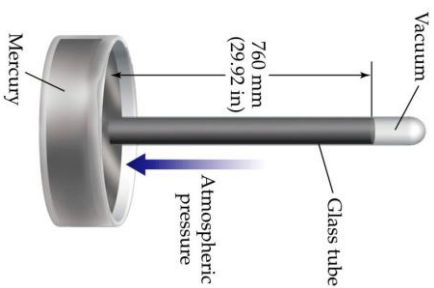


Topic: Atmospheric Variables

Aim:

Air Pressure / Atmospheric Pressure / Barometric Pressure:

Instrument:



1.

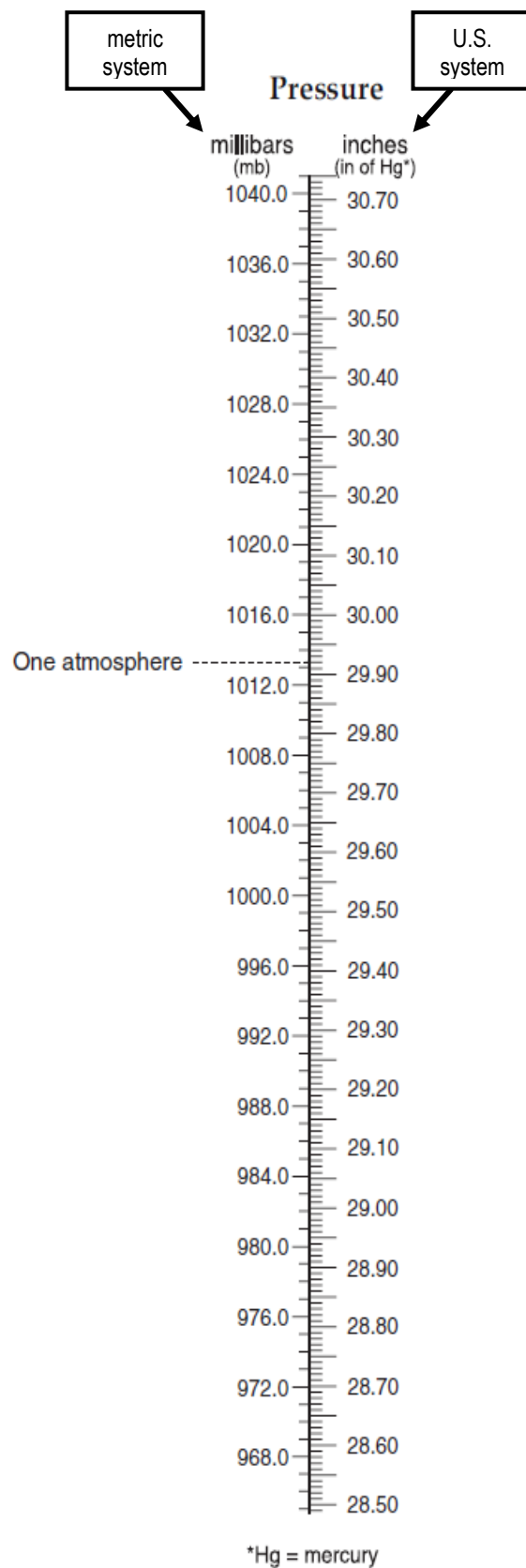
2.

3.

Special Study Note:

## Pressure Conversions Worksheet

1. 1004.0 mb \_\_\_\_\_ inches
2. 999.0 mb \_\_\_\_\_ inches
3. 976.0 mb \_\_\_\_\_ inches
4. 1016.0 mb \_\_\_\_\_ inches
5. 1000.0 mb \_\_\_\_\_ inches
6. 1020.0 mb \_\_\_\_\_ inches
7. 29.00 inches \_\_\_\_\_ millibars
8. 29.56 inches \_\_\_\_\_ millibars
9. 30.24 inches \_\_\_\_\_ millibars
10. 30.53 inches \_\_\_\_\_ millibars



This pressure conversion scale  
is on page 13 of the *ESRT*.

# Topic: Atmospheric Variables

## Aim:

recall

notes

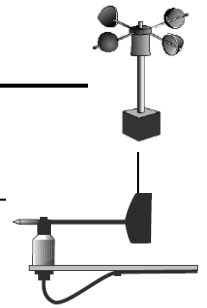
1. What causes wind to blow?

2. How is wind measured?

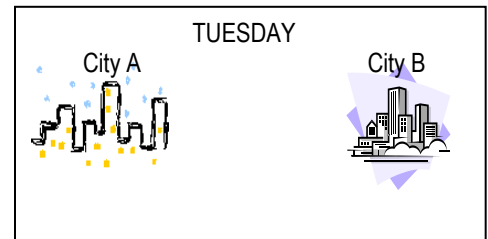
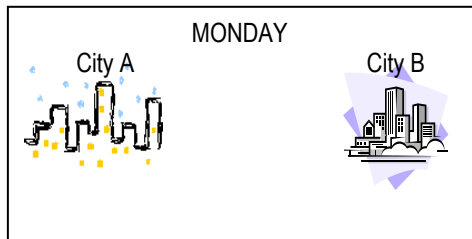
a. anemometer – wind speed

b. wind vane - direction

wind is named by the direction it comes from



3. How does the Pressure Gradient Force affect wind?



a. The Pressure Gradient Force (PGF) is the difference in air pressure

between two locations.

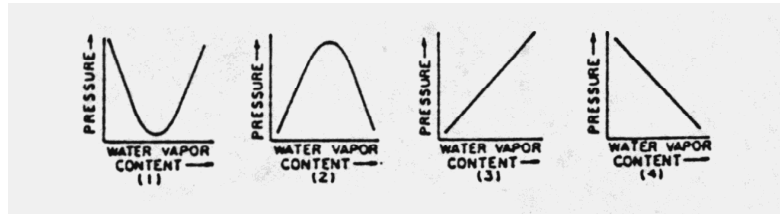
b.

4. How do isobars  
(lines that connect equal pressure)  
help indicate  
wind speed?

On a weather map, the closer the isobars, the greater the PGF, the faster the winds.

## Temperature, Pressure, and Wind

- According to the *Earth Science Reference Tables*, an air pressure of 30.15 inches of mercury is equal to  
 (1) 1017 mb (3) 1021 mb  
 (2) 1019 mb (4) 1023 mb
- According to the *Earth Science Reference Tables*, an atmospheric pressure of 1019.0 millibars is equal to  
 (1) 31.05 inches of mercury (3) 30.09 inches of mercury  
 (2) 30.15 inches of mercury (4) 30.00 inches of mercury
- As the temperature of the atmosphere at a given location increases, the air pressure will most likely  
 (1) decrease (2) increase (3) remain the same
- As warm, moist air moves into a region, barometric pressure readings in the region will generally  
 (1) decrease (2) increase (3) remain the same
- Which graph best shows the relationship between atmospheric pressure and water vapor content at the Earth's surface?



- As altitude increases the atmospheric pressure will  
 (1) decrease (2) increase (3) remain the same
- The table below shows the noontime data for air pressure and air temperature at a location over a period of one week.

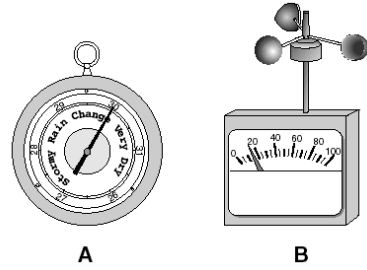
WEATHER DATA RECORDED AT NOON							
Date	Nov. 9	Nov. 10	Nov. 11	Nov. 12	Nov. 13	Nov. 14	Nov. 15
Air Temperature (°C)	1	6	0	-2	-4	5	10
Air Pressure (millibars)	1024	998	1015	1021	1030	1013	?

Based on the data provided, which air pressure would most likely occur at noon on November 15?

- 987 millibars (3) 1017 millibars  
 (2) 1015 millibars (4) 1022 millibars

8. The diagram to the right shows weather instruments A and B.

Which table correctly indicates the name of the weather instrument and the weather variable that it measures?



Instrument		Weather Variable Measured
Letter	Name	
A	thermometer	humidity
B	wind vane	wind direction

( 1 )

Instrument		Weather Variable Measured
Letter	Name	
A	barometer	wind speed
B	anemometer	air pressure

( 3 )

Instrument		Weather Variable Measured
Letter	Name	
A	thermometer	wind direction
B	wind vane	humidity

( 2 )

Instrument		Weather Variable Measured
Letter	Name	
A	barometer	air pressure
B	anemometer	wind speed

( 4 )

9. Winds blow from regions of
- (1) high air temperature to regions of low air temperature
  - (2) high air pressure to regions of low air pressure
  - (3) high precipitation to regions of low precipitation
  - (4) convergence to regions of divergence

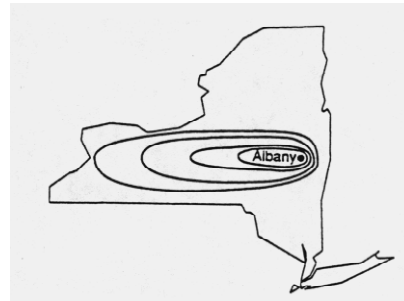
10. Wind velocity is most dependent upon

- (1) gradient of the air pressure field
- (2) moisture content of the air
- (3) value of the Coriolis Effect
- (4) rotational velocity of the Earth

11. The weather map below shows closely spaced isobars in the region of Albany, New York.

At the time that the weather data were collected, Albany was most probably experiencing

- (1) a high wind velocity
- (2) a high temperature
- (3) the passage of a dry air mass
- (4) the passage of a warm air mass

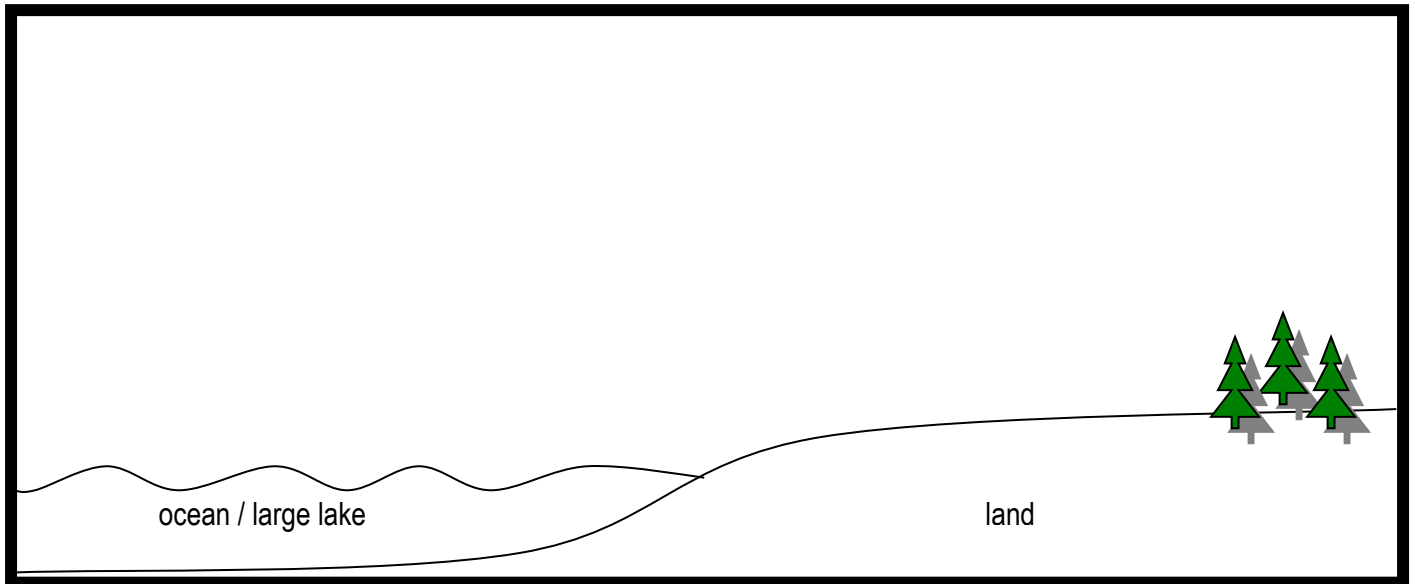


12. As wind velocity increases, the distance between isobars on a weather map will
- (1) decrease
  - (2) increase
  - (3) remain the same
13. The highest surface wind speeds occur when there is a
- (1) 4-millibar air-pressure difference between two nearby locations
  - (2) 4-millibar air-pressure difference between two distant locations
  - (3) 20-millibar air-pressure difference between two nearby locations

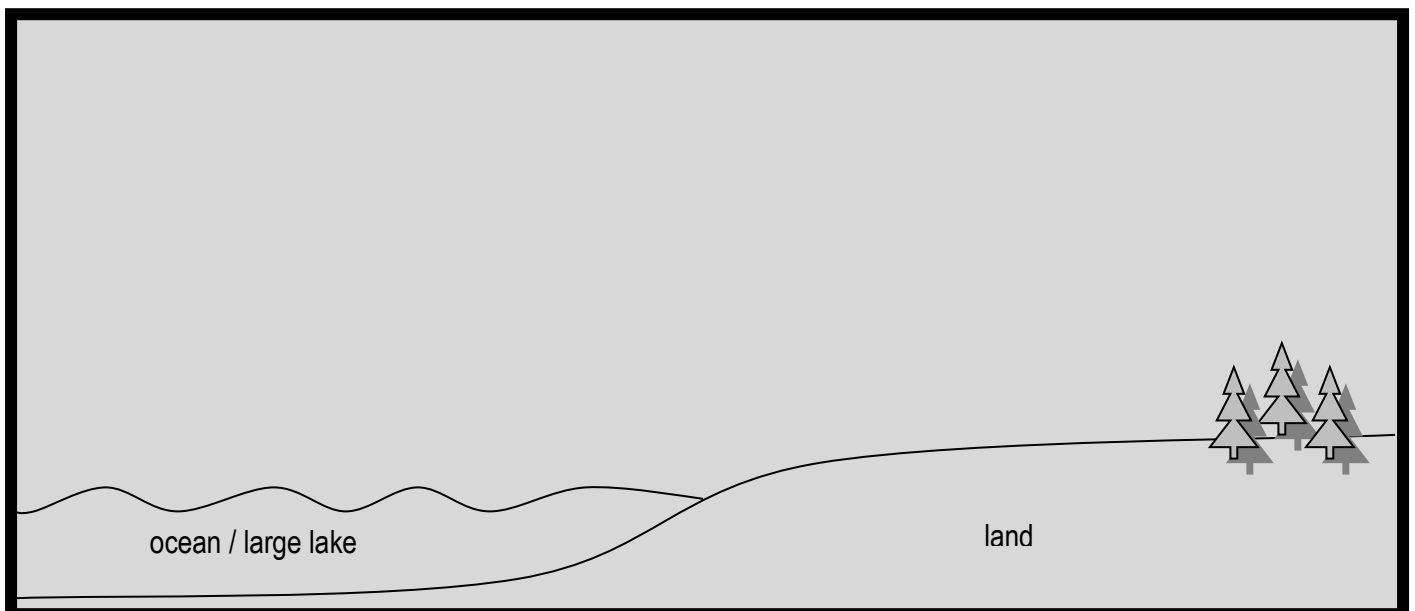
# Topic: Atmospheric Variables

Aim:

1. Sea Breeze or Lake Breeze – During the daytime, a surface wind blows from the water towards the land.



2. Land Breeze - During the evening and at night, a surface wind blows from the land towards the water.



# Topic: Atmospheric Variables

## Aim:

### Pressure Centers -

Isobars form circles (“bulls-eyes”) around high or low pressure centers on a pressure map.

#### 1. High Pressure Systems

a.

b.

c.

diagram showing local surface wind pattern  
(arrows represent wind direction around pressure center)

d.

#### 2. Low Pressure Systems

a.

b.

c.

diagram showing local surface wind pattern  
(arrows represent wind direction around pressure center)

d.

Always Remember:



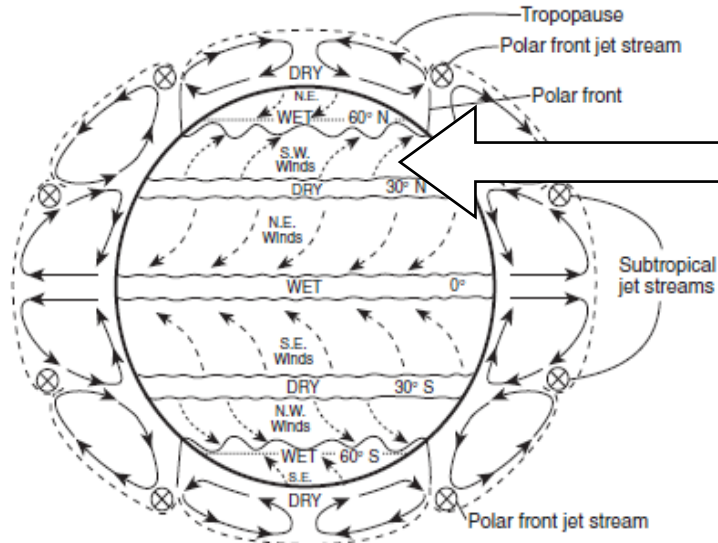
# Topic: Atmospheric Variables

## Aim:

### Planetary Wind and Moisture Belts in the Troposphere

The drawing on the right shows the locations of the belts near the time of an equinox. The locations shift somewhat with the changing latitude of the Sun's vertical ray. In the Northern Hemisphere, the belts shift northward in the summer and southward in the winter.

(Not drawn to scale)



In the U.S., the prevailing westerlies move weather from the SW → NE

recall

notes

1. What causes the Earth's Planetary Wind Belts?

2. What are jet streams?

3. What causes the deflection (bending) of the winds?  
(and ocean currents ...)

The Coriolis Effect caused by the Earth's rotation causes wind to deflect (bend).

In the **Northern Hemisphere** winds bend to the \_\_\_\_\_ of the expected path.

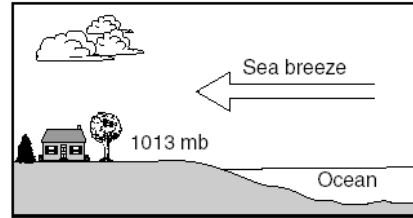
In the Southern Hemisphere winds bend to the \_\_\_\_\_ of the expected path.

## Pressure Centers, Local Winds, and Planetary Winds

1. The cross section below shows a sea breeze blowing from the ocean toward the land. The air pressure at the land surface is 1013 millibars.

The air pressure at the ocean surface a few miles from the shore is most likely

- |             |             |
|-------------|-------------|
| (1) 994 mb  | (3) 1013 mb |
| (2) 1005 mb | (4) 1017 mb |



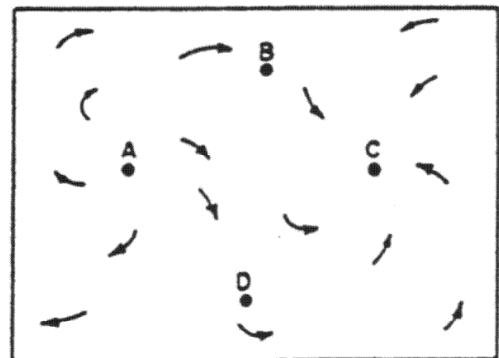
2. During the warmest part of a June day, breezes blow from the ocean toward the shore at a Long Island beach. Which statement best explains why this happens?
- (1) Air pressure over the land is higher than the air pressure over the ocean.
  - (2) Air pressure over the ocean is higher than the air pressure over the land.
  - (3) Winds usually blow from hot to cold areas.
  - (4) Winds never blow from the shore toward the ocean.
3. The primary cause of winds is the
- (1) unequal heating of the Earth
  - (2) rotation of the Earth
  - (3) uniform density of the atmosphere
  - (4) friction between the atmosphere and the lithosphere
4. Which map best represents the normal air circulation around a high-pressure air mass located over central New York State?



5. A high pressure center is generally characterized by
- (1) cool, wet weather
  - (2) cool, dry weather
  - (3) warm, wet weather
  - (4) warm, dry weather

6. The arrows on the diagram below represent surface wind directions on a weather map. The points represent the locations of four weather stations in the Northern Hemisphere. Which weather station probably has the lowest air pressure?

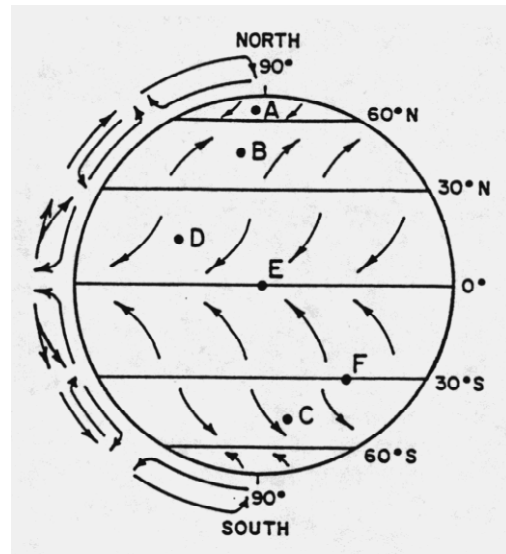
- |       |       |
|-------|-------|
| (1) A | (3) C |
| (2) B | (4) D |



7. The curving path of planetary winds is caused by
  - (1) the Earth's revolution
  - (2) ocean currents
  - (3) the Earth's rotation
  - (4) weather fronts
8. How does air circulate within a cyclone (low-pressure area) in the Northern Hemisphere?
  - (1) counterclockwise and toward the center of the cyclone
  - (2) counterclockwise and away from the center of the cyclone
  - (3) clockwise and toward the center of the cyclone
  - (4) clockwise and away from the center of the cyclone
9. Air will probably have the lowest pressure when it is
  - (1) warm and moist
  - (2) warm and dry
  - (3) cold and moist
  - (4) cold and dry

Base your answers to **questions 10 through 12** on the diagram to the right.

10. Which location might be New York State?
  - (1) A
  - (2) B
  - (3) C
  - (4) D
11. Which location is experiencing a southwest planetary wind?
  - (1) A
  - (2) B
  - (3) C
  - (4) F
12. Which location is near the center of a low-pressure belt where daily rains are common?
  - (1) E
  - (2) B
  - (3) F
  - (4) D

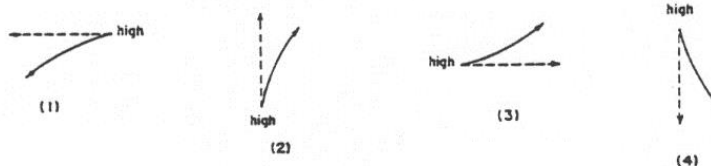


13. If a storm system is guided by the planetary winds and is moving across the United States, the storm will generally move from the
  - (1) southeast to the northwest
  - (2) west to the east
  - (3) northeast to southeast
  - (4) south to the north
14. Which drawing best illustrates the general result that the Earth's rotation would have on the direction of the wind as it moves away from the center of a high-pressure system in the Northern Hemisphere?
 

**KEY:**

----- Direction of wind if the Earth did not rotate

————— Observed path of wind due to Earth's rotation



# Topic: Atmospheric Variables

1.

2.

Aim:

**Evaporation:** - phase change in which a liquid turns into a gas (water vapor)  
- main process by which moisture enters the air

\*\* evaporation is a cooling process – it removes heat from the surface water is evaporating from \*\*

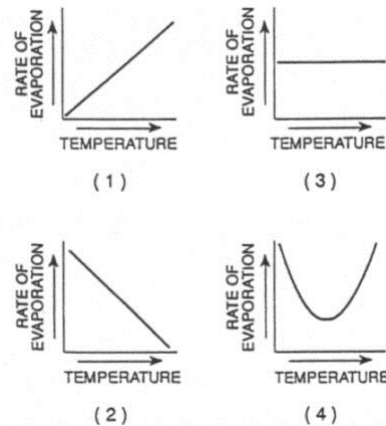
3.

4.

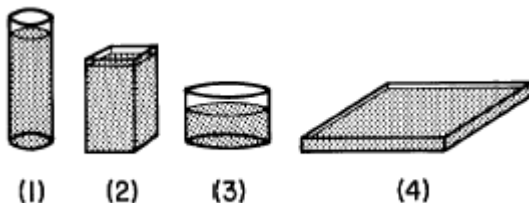
## Evaporation

- Which two changes increase the rate of evaporation of water into the atmosphere?
  - decreasing air pressure and increasing cloud cover
  - decreasing air temperature and increasing surface area
  - increasing relative humidity and decreasing dewpoint temperature
  - increasing air temperature and increasing wind velocity
- Which atmospheric condition will cause the greatest amount of evaporation from the surface of a lake?
  - calm, dry, cold
  - moist, cold, windy
  - calm, moist, hot
  - dry, hot, windy
- When a person leaves the ocean after swimming on a windy day, the person usually feels cold because
  - water evaporates from the skin
  - water condenses on the skin
  - salt is absorbed through the skin
  - radiation is absorbed through the skin

- Which graph best represents the relationship between rate of evaporation and air temperature?



- A container of water is placed in an open area outdoors so that the evaporation rate may be observed. The water will probably evaporate the fastest when the air is
  - cool and humid
  - cool and dry
  - warm and humid
  - warm and dry
- All of the glass containers shown below contain the same amount of water and are receiving the same amount of heat energy. In a given amount of time, the most water vapor will evaporate from which container?



# Topic: Atmospheric Variables

## Aim:

recall

notes

1. What is relative humidity?

The amount of water vapor in the air compared to the amount of vapor the air can hold at that temperature measured in %.

2. How does the temperature of the air affect its ability to hold moisture?

3. What is the dew point temperature and how does it help indicate the moisture content of the air?

a. **DEWPOINT TEMPERATURE -**

the temperature at which the air becomes **saturated** (100% full) and forms **condensation** (water vapor turns to liquid water droplets).

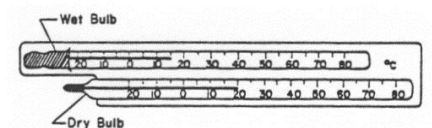
b.

c.

4. What instrument is used to measure relative humidity and dew point?

**sling psychrometer –**

When swung around, water from the wet-bulb evaporates and cools the wet-bulb thermometer. Then, by using the dry-bulb (air temp.) and the difference between wet and dry-bulbs, the relative humidity and dewpoint can be found on the charts (ESRT page 12).



## Finding Relative Humidity and Dewpoint Using the *ESRT*

Directions: Use the data below and the charts from the *Earth Science Reference Tables* page 12 to determine the missing information in each of the rows of the chart.

	Temperature (°Celsius)		Temperature Difference (Wet Bulb Depression)	Relative Humidity	Dew Point Temperature
	dry bulb	wet bulb			
1.	20	15			
2.	16	12			
3.	20	10			
4.	13	10			
5.	7	5			
6.	2	-2			
7.	22			83%	
8.	14				4°C
9.	25		13		
10.	5			71%	
11.	17	11			

# Topic: Atmospheric Variables

## Aim:

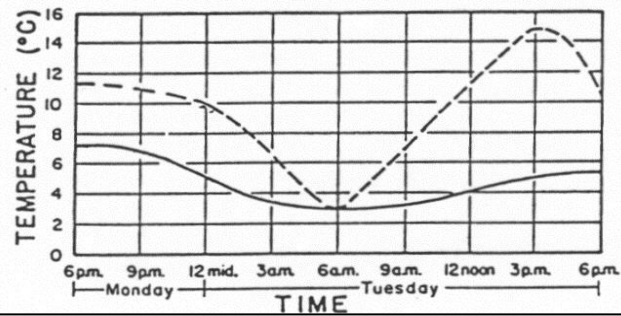
recall

notes

1. What are four different types of condensation?

2. What conditions must exist for condensation to form?

AIR TEMPERATURE -----  
DEWPOINT TEMPERATURE ———



a.

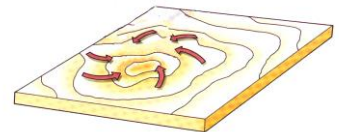
b.

3. How do clouds form over low pressure centers (cyclones)?

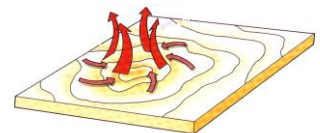
### Adiabatic Temperature Changes

when a change in pressure forces a change in temperature

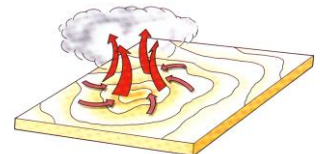
I



II



III





## Moisture

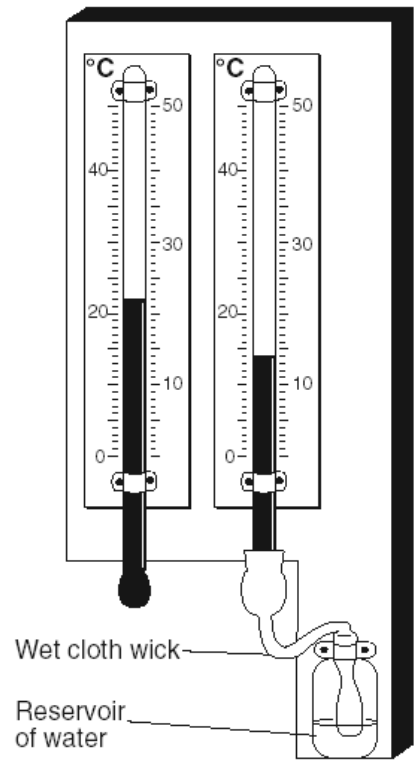
Use the diagram to the right to answer **questions 1 and 2**.

1. The weather instrument below is used to determine dew point and relative humidity. Based on the temperatures shown, the approximate dew point and relative humidity are

(1)  $-19^{\circ}\text{C}$  and 4%  
 (2)  $-5^{\circ}\text{C}$  and 25%  
 (3)  $8^{\circ}\text{C}$  and 40%  
 (4)  $12^{\circ}\text{C}$  and 53%

2. Which statement best explains the difference in the readings of the two thermometers?

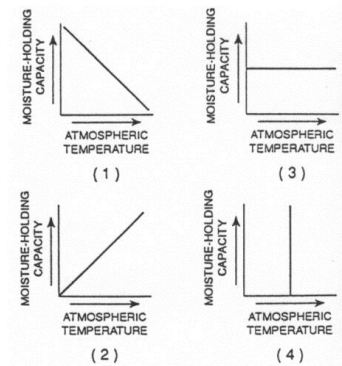
(1) evaporation removes energy from the wet bulb  
 (2) evaporation absorbs heat from the surrounding air  
 (3) condensation removes heat from the wet bulb  
 (4) condensation absorbs heat from the surrounding air



3. At which dewpoint temperature would the amount of water vapor in the air be the greatest?

(1)  $20^{\circ}\text{C}$   
 (2)  $18^{\circ}\text{C}$   
 (3)  $10^{\circ}\text{C}$   
 (4)  $0^{\circ}\text{C}$

4. Which graph best represents the relationship between the moisture-holding capacity (ability to hold water) of the atmosphere and atmospheric temperature?



5. What is the approximate dewpoint temperature when the air temperature is  $4^{\circ}\text{C}$  and the wet-bulb temperature is  $-2^{\circ}\text{C}$ ?

(1)  $-1^{\circ}\text{C}$   
 (2)  $-3^{\circ}\text{C}$   
 (3)  $-13^{\circ}\text{C}$   
 (4)  $-19^{\circ}\text{C}$

6. What is the dewpoint temperature when the relative humidity is 30% and the air temperature is  $20^{\circ}\text{C}$ ?

(1)  $-28^{\circ}\text{C}$   
 (2)  $2^{\circ}\text{C}$   
 (3)  $6^{\circ}\text{C}$   
 (4)  $9^{\circ}\text{C}$

7. Which event usually occurs when air is cooled to the dewpoint temperature?
  - (1) freezing
  - (2) evaporation
  - (3) condensation
  - (4) transpiration
8. As a sample of very moist air rises from sea level to a higher altitude, the probability of condensation occurring in the air sample will
  - (1) decrease
  - (2) increase
  - (3) remain the same
9. The upward movement of air in the atmosphere generally causes the temperature of that air to
  - (1) decrease and become closer to the dewpoint
  - (2) decrease and become farther from the dewpoint
  - (3) increase and become closer to the dewpoint
  - (4) increase and become farther from the dewpoint
10. Clouds form over low pressure systems primarily because moist air
  - (1) rises, expands, and cools
  - (2) rises, expands, and warms
  - (3) sinks, compresses, and cools
  - (4) sinks, compresses, and warms
11. As the difference between the dewpoint temperature and the air temperature decreases, the probability of condensation
  - (1) decreases
  - (2) increases
  - (3) remains the same

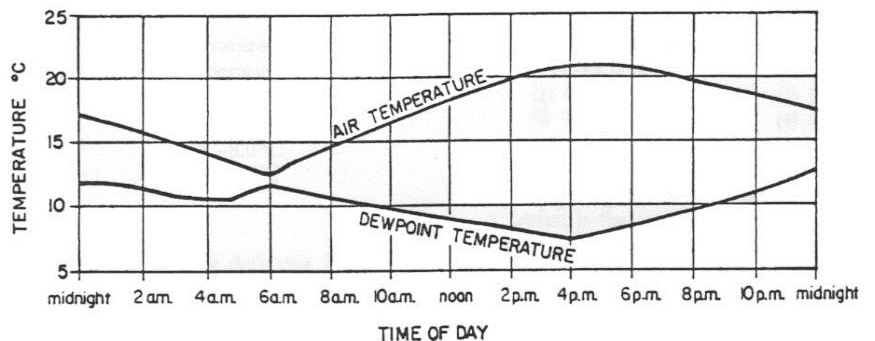
Base your answers to **questions 12-14** on graph below which shows the air temperature and dewpoint temperature over a 24-hour period for a location in New York State.

12. When was the air at ground level nearly saturated with water vapor?

- (1) 4 a.m.
- (2) 6 a.m.
- (3) noon
- (4) 4 p.m.

13. The air's capacity to hold water vapor was greatest at

- (1) 6 a.m.
- (2) noon
- (3) 6 p.m.
- (4) 4 p.m.



14. At what time would the relative humidity of the air be the least?

- (1) 6 a.m.
- (2) noon
- (3) 6 p.m.
- (4) 4 p.m.

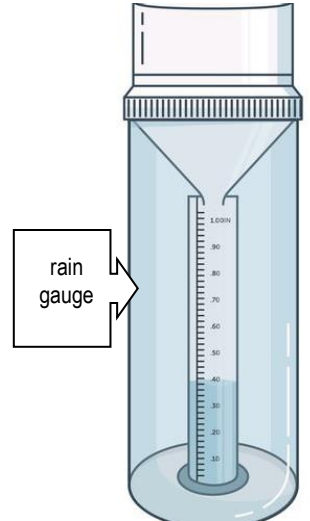
# Topic: Atmospheric Variables

## Aim:

**PRECIPITATION** is known as the “atmospheric cleanser”.

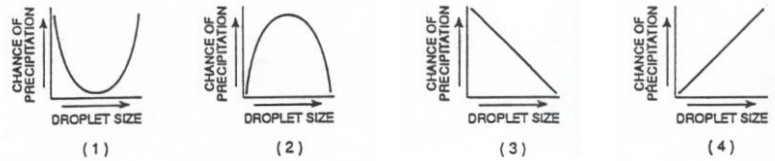
When water falls out of the sky, it brings dust particles back to the Earth’s surface temporarily cleaning the air.

Type of Precipitation	How it Forms
<b>RAIN</b>	Water vapor condenses to form cloud droplets, <u>when water droplets are large enough, they fall.</u>
<b>SNOW</b>	Water vapor turns directly to ice, when ice crystals are large enough, they fall.
<b>SLEET</b>	Rain freezes on its trip toward the Earth.
<b>FREEZING RAIN</b>	Rain or melted snow freezes upon contact with a cold surface (also known as “black ice”)
<b>HAIL</b>	Frozen raindrops get continuously recycled by updrafts and downdrafts. Downdrafts allow the accumulation of water, and updrafts allow the freezing of that water to form new layers of ice. When enough layers are accumulated, the spherical hailstone becomes too heavy and falls.



## A Very Quick Precipitation Practice ...

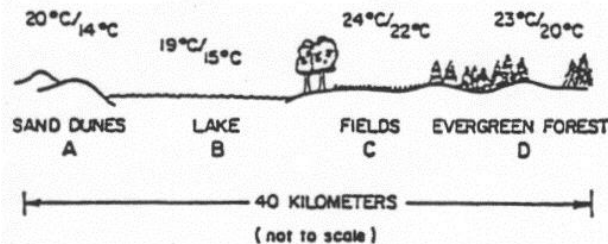
1. Which graph best represents the relationship between water droplet size and the chance of precipitation?



2. Which natural process removes aerosols from the atmosphere?

- |                           |                   |
|---------------------------|-------------------|
| (1) the greenhouse effect | (3) convection    |
| (2) the Coriolis Effect   | (4) precipitation |

3. The diagram below shows the air temperatures/dewpoint temperatures 100 meters above four locations, A, B, C, and D, on the Earth's surface. Which location has the greatest chance of precipitation?



- |       |       |
|-------|-------|
| (1) A | (3) C |
| (2) B | (4) D |
4. Rain that freezes upon contact with a frozen surface is known as
- |           |                   |
|-----------|-------------------|
| (1) sleet | (3) snow          |
| (2) hail  | (4) freezing rain |

In the cartoon below, Calvin makes a wish.



5. Which statement best explains why Calvin's wish did not come true?

- |   |
|---|
| (1) The temperature was below the dewpoint.         |
| (2) The relative humidity was too low for snow.     |
| (3) The atmospheric temperature was well above 0°C. |
| (4) The clouds in the area lacked water droplets.   |