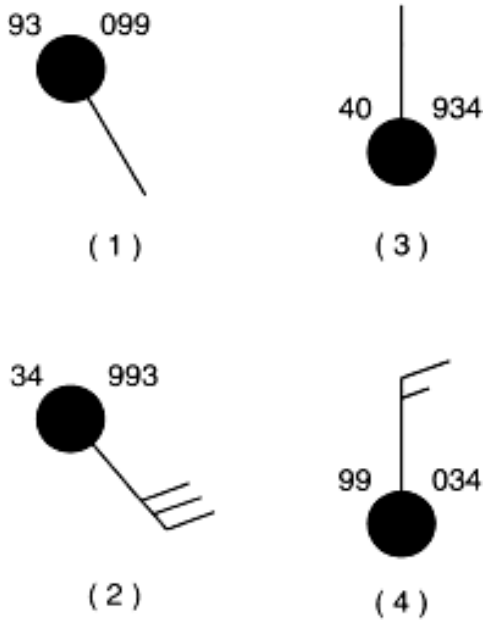
Fa Rp 1
Mr. Chase

TEACHER ANSWER KEY
May 28, 2008

3

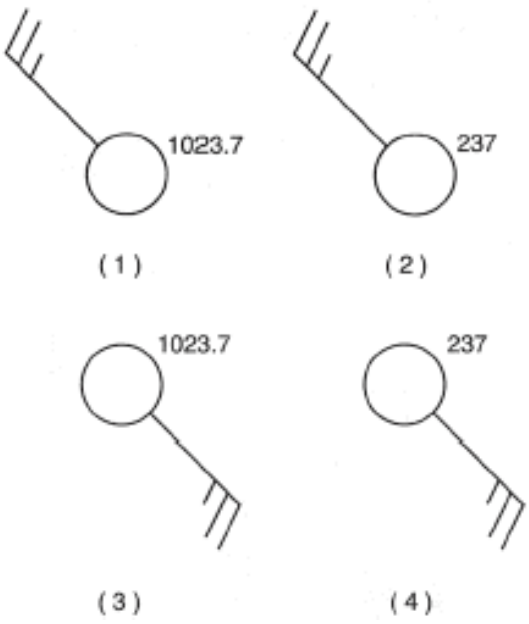
1. Which weather-station model shows an air pressure of 993.4 millibars?



3 Find the Weather Map Symbols section in the *Earth Science Reference Tables*, and locate the sample station model. Note that barometric pressure is listed to the upper right of the station model and that only the last three digits are given. Thus, the correct way to indicate a barometric pressure of 993.4 millibars on a station model is to list the last three digits--934--at the upper right, as shown in weather-station model (3).

2

2. Which station model shows the correct form for indicating a northwest wind at 25 knots and an air pressure of 1023.7 mb?



2 Find the Weather Map Symbols chart in the *Earth Science Reference Tables*, and locate the "Station Model" key. Note that the wind direction line on a station model points in the direction from which winds are blowing. Since north is by convention at the top of the station model, a northwest wind would be indicated by a line extending upward to the left as in choices (1) and (2). The station model key also states that wind speed is represented by whole feathers (10 knots) and half feathers (5 knots). Therefore, a wind speed of 25 knots would be represented by two whole feathers and one half feather as in choices (1) and (2). According to the key, barometric pressure is represented by the last three digits of the reading. Thus, an air pressure of 1023.7 would be shown as 237, as in choice (2). Therefore, only station model (2) shows the correct form for a northwest wind at 25 knots and an air pressure of 1023.7 mb.

2

3. When the dry-bulb temperature is 22ºC and the wet-bulb temperature is 13ºC, the relative humidity is

1. 10%
2. 33%
3. 41%
4. 59%

2 Find the Relative Humidity (%) chart in the *Earth Science Reference Tables*. The difference between the given wet-bulb and dry-bulb temperatures is 22ºC - 13ºC, or 9Cº. Find 22ºC in the column headed "Dry-Bulb Temperature (ºC)." Follow this row to the right until it intersects the column headed "9" in the section labeled "Difference Between Wet-Bulb and Dry-Bulb Temperatures (Cº)." Read the value of the relative humidity at the intersection: 33%.

2

4. 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

2 Find the Relative Humidity (%) chart in the *Earth Science Reference Tables*. Locate 10°C in the column headed "Dry-Bulb Temperature (°C)," and follow this row to the right to a relative humidity of 65%. Now trace upward to the scale at the top of the chart, labeled "Difference Between Wet-Bulb and Dry-Bulb Temperatures (C °)," and note the value 3. Thus, there is a difference of 3C° between the wet-bulb and dry-bulb temperatures. Since evaporation cools the wet-bulb thermometer, the wet-bulb temperature is lower than the dry-bulb temperature. Subtracting the 3C° difference from the dry-bulb temperature of 10°C yields a wet-bulb temperature of 7°C.

4

5. An observer measured the air temperature and the dewpoint and found the difference between them to be 12° C. One hour later, the difference between the air temperature and the dewpoint was found to be 4°C. Which statement best describes the changes that were occurring?

1. The relative humidity was decreasing and the chance of precipitation was decreasing.
2. The relative humidity was decreasing and the chance of precipitation was increasing.
3. The relative humidity was increasing and the chance of precipitation was decreasing.
4. The relative humidity was increasing and the chance of precipitation was increasing.

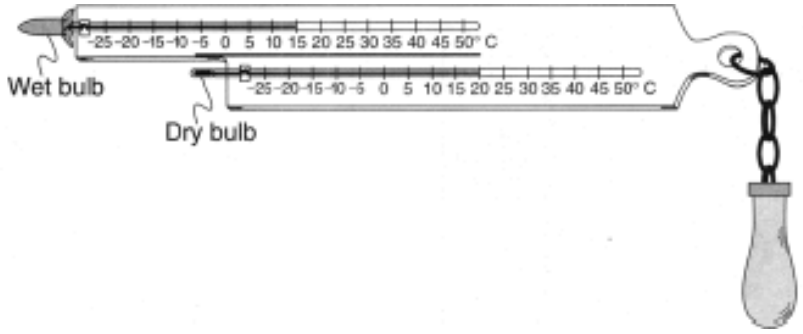
4 Find in the *Earth Science Reference Tables* the Dewpoint Temperatures (°C) chart. Note that, for any dry-bulb (air) temperature, as the difference between the wet-bulb and dry-bulb temperatures decreases, the dewpoint temperature gets closer to the air temperature. Conversely, as the difference between the dewpoint temperature and the air temperature decreases, the difference between the wet-bulb and dry-bulb temperatures decreases.

Now find in the *Earth Science Reference Tables* the Relative Humidity (%) chart. Note that, for any dry-bulb (air) temperature, as the difference between the wet-bulb and dry-bulb temperatures decreases, the relative humidity increases. Thus, as the difference between the air temperature and the dewpoint decreases, the relative humidity increases. As the relative humidity increases, the likelihood of condensation that forms precipitation increases. In the question, the difference between the air temperature and the dewpoint was decreasing. Therefore, the relative humidity was increasing and the chance of precipitation was increasing, as stated in choice (4).

2

6. The diagram below shows a sling psychrometer.

Based on the dry-bulb temperature and the wet-bulb temperature, what is the relative humidity?



1. 66%
2. 58%
3. 51%
4. 12%

2 Note, in the diagram of the sling psychrometer, that the dry-bulb temperature is 20ºC, and the wet-bulb temperature is 15ºC. Thus, the difference between the wet-bulb and dry-bulb temperatures is 5ºC. Now, find the Relative Humidity (%) table in the *Earth Science Reference Tables*. Locate the 5ºC column in the horizontal "Difference Between Wet-Bulb And Dry-Bulb Temperatures" scale at the top of the table, and the 20ºC row in the vertical "Dry-Bulb Temperature" scale at the left side. Finally, locate the cell where the 20ºC row and the 5ºC column intersect and read the relative humidity: 58%.

2

7. 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.

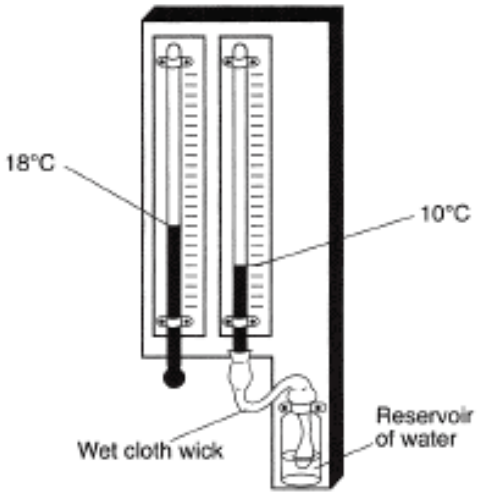
2 Water molecules are constantly entering the atmosphere as water vapor (evaporating) and leaving the atmosphere as liquid water (condensing). When these two flows are in equilibrium, the amount of water vapor in the air remains unchanged. The higher the temperature, the greater the amount of water vapor that enters the atmosphere before equilibrium is reached. Relative humidity is the ratio of water vapor currently in the atmosphere to the water vapor present at equilibrium (X100%.) Thus, as relative humidity increases, condensation and cloud formation become more likely and the chance of precipitation increases.

WRONG CHOICES EXPLAINED:
(1) The dewpoint is the temperature to which a parcel of air must cool before condensation begins to occur in the air. The farther the dewpoint is from the condensation point (temperature at which condensation will occur), the less likely that condensation will form clouds and the lower the chance of precipitation.
(3) As the amount of moisture in the air increases, water molecules displace molecules of oxygen and nitrogen. Since water molecules have a lower molecular weight than oxygen or nitrogen molecules, moist air is lighter than dry air. Furthermore, condensation is due to the loss of energy by water molecules, not the "lightness" or "heaviness" of the air.
(4) Specific heat is the measure of the heat energy needed to raise one gram of a substance by one degree Celsius. The higher the specific heat, the more heat energy that is needed to cause a temperature change in a substance. Therefore, if the specific heat of moist air were greater than that of drier air, increasing relative humidity would require the addition of energy, not the release of energy.

3

8. The weather instrument shown in the accompanying image can be used to determine relative humidity.

Based on the temperature shown, the relative humidity is

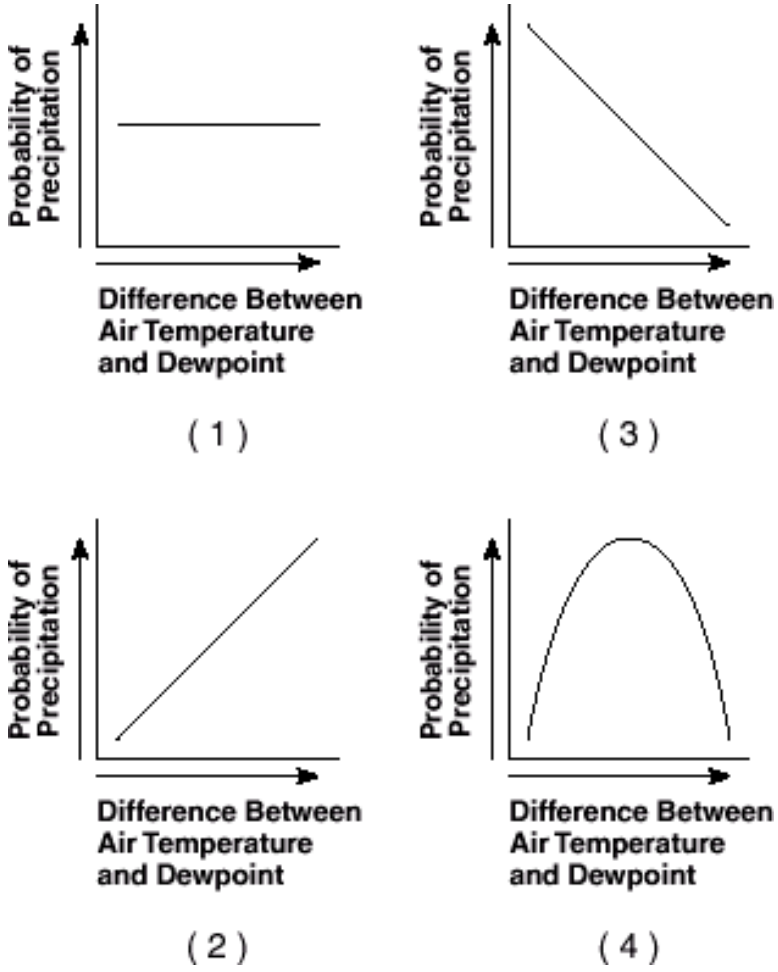


1. 19%
2. 2%
3. 33%
4. 40%

3 According to the diagram, the temperature of the wet-bulb thermometer reads 10ºC and the temperature of the dry-bulb thermometer reads 18ºC. The difference between the wet-bulb and dry-bulb temperatures is 8ºC. Find the Relative Humidity (%) chart in the *Earth Science Reference Tables*. Find 18 in the column labeled "Dry-bulb Temperature (ºC)." In the section labeled "Difference Between Wet-bulb and Dry-bulb Temperatures (ºC)," find the column labeled "8." Find the cell where the row for 18 intersects the column for 8 and read the percent relative humidity—33%.

3

9. Which graph best shows the relationship between the probability of precipitation and the difference between air temperature and dewpoint?

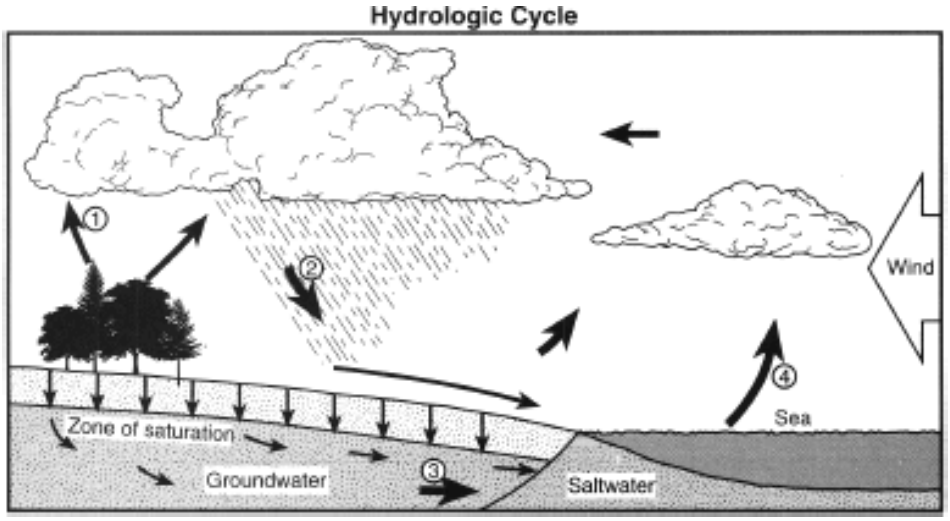


3 As the air temperature approaches the dewpoint and the difference between air temperature and dewpoint decreases, condensation becomes more likely and the probability of precipitation increases. This relationship is best shown by graph (3).

1

10. Base your answer to the question on the accompanying water cycle diagram shown. Some arrows are numbered 1 through 4 and represent various processes.

The clouds have formed primarily because moist air



1. rises, expands, and cools
2. rises, expands, and warms
3. sinks, compresses, and cools
4. sinks, compresses, and warms

1 Clouds are composed mainly of water droplets. Thus, the moisture in air must condense into a liquid to form clouds. Water vapor condenses into liquid water when air is cooled to its dewpoint. Cooling occurs when air rises and expands. Thus, the clouds have formed primarily because moist air rises, expands, and cools.

4

11. What is the relative humidity when the air temperature is 29ºC and the wet-bulb temperature is 23ºC?

1. 6%
2. 20%
3. 54%
4. 60%

4 It is given that the air temperature (dry-bulb temperature) is 29ºC and the wet-bulb temperature is 23ºC. Therefore, the difference between the wet-bulb and dry-bulb temperatures is 6ºC. Find the Relative Humidity (%) chart in the *Earth Science Reference Tables*, and locate 28 and 30 in the column headed "Dry-bulb Temperature (ºC)." In the section labeled "Difference Between Wet-bulb and Dry-bulb Temperatures (ºC)" find the column headed "6." At the intersection of row 28 and column 6, read the relative humidity: 59. Now, at the intersection of row 30 and column 6, again read the relative humidity: 61. Since 29ºC is between 28ºC and 30ºC, the relative humidity at 29ºC is between 59 and 61. Thus, when the air temperature is 29ºC and the wet-bulb temperature is 23ºC, the relative humidity is 60%.

3

12. The air outside a classroom has a dry-bulb temperature of 10°C and a wet-bulb temperature of 4°C. What is the relative humidity of this air?

1. 1%
3. 33%

2. 14%

4. 54%

3 Find the Relative Humidity (%) chart in the *Earth Science Reference Tables*. The difference between the wet-bulb and dry-bulb temperatures given in the question is 10°C – 4°C, or 6°C. In the chart, locate 10°C in the column headed "Dry-Bulb Temperature (°C)." Follow this row to the right until it intersects the column headed "6" in the section labeled "Difference Between Wet-Bulb and Dry-Bulb Temperatures (°C)." Read the value of the relative humidity at the intersection: 33%.

4

13. An observer measured the air temperature and the dewpoint and found the difference between them to be 12° C. One hour later, the difference between the air temperature and the dewpoint was found to be 4°C. Which statement best describes the changes that were occurring?

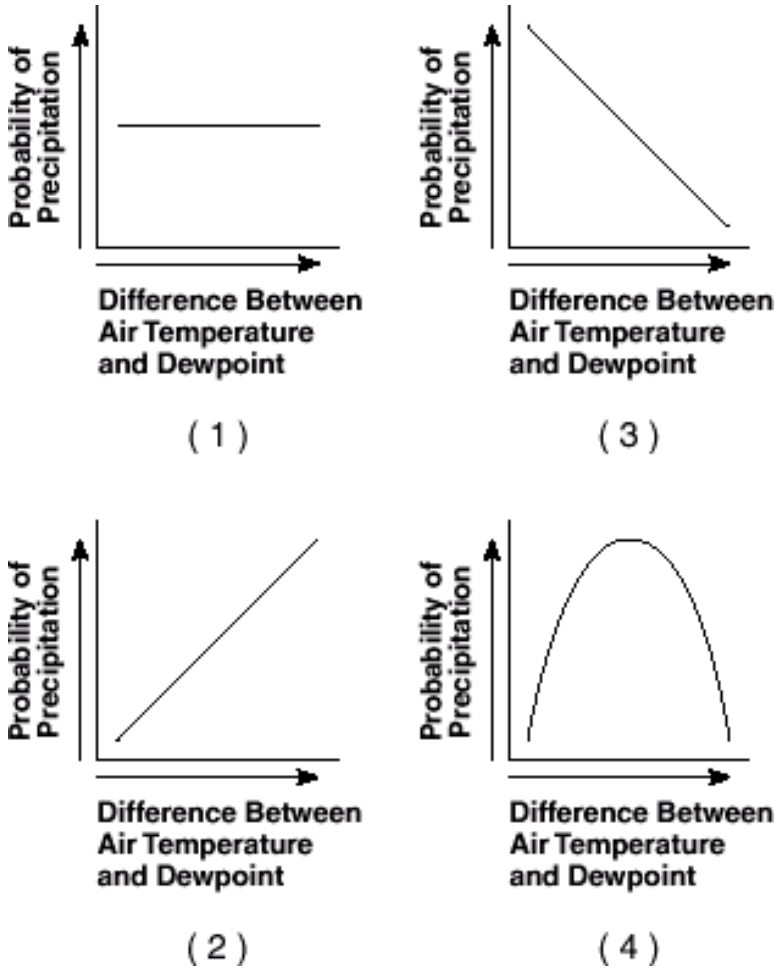
1. The relative humidity was decreasing and the chance of precipitation was decreasing.
2. The relative humidity was decreasing and the chance of precipitation was increasing.
3. The relative humidity was increasing and the chance of precipitation was decreasing.
4. The relative humidity was increasing and the chance of precipitation was increasing.

4 Find in the *Earth Science Reference Tables* the Dewpoint Temperatures (°C) chart. Note that, for any dry-bulb (air) temperature, as the difference between the wet-bulb and dry-bulb temperatures decreases, the dewpoint temperature gets closer to the air temperature. Conversely, as the difference between the dewpoint temperature and the air temperature decreases, the difference between the wet-bulb and dry-bulb temperatures decreases.

Now find in the *Earth Science Reference Tables* the Relative Humidity (%) chart. Note that, for any dry-bulb (air) temperature, as the difference between the wet-bulb and dry-bulb temperatures decreases, the relative humidity increases. Thus, as the difference between the air temperature and the dewpoint decreases, the relative humidity increases. As the relative humidity increases, the likelihood of condensation that forms precipitation increases. In the question, the difference between the air temperature and the dewpoint was decreasing. Therefore, the relative humidity was increasing and the chance of precipitation was increasing, as stated in choice (4).

3

14. Which graph best shows the relationship between the probability of precipitation and the difference between air temperature and dewpoint?



3 As the air temperature approaches the dewpoint and the difference between air temperature and dewpoint decreases, condensation becomes more likely and the probability of precipitation increases. This relationship is best shown by graph (3).

2

15. What is the dewpoint temperature when the dry-bulb temperature is 16ºC and the wet-bulb temperature is 11ºC?

1. 5ºC
2. 7ºC
3. 9ºC
4. -17ºC

2 Find the Dewpoint Temperatures (ºC) chart in the *Earth Science Reference Tables*. The difference between the wet-bulb and dry-bulb temperatures given in the question is 16ºC - 11ºC, or 5Cº. Find 16ºC in the column headed "Dry-Bulb Temperature (ºC)." Follow this row to the right until it intersects the column headed "5" in the section labeled "Difference Between Wet-Bulb and Dry-Bulb Temperatures (Cº)." Read the value of the dewpoint temperature at the intersection: 7ºC.

1

16. What is the dewpoint temperature when the dry-bulb temperature is 12°C and the wet-bulb temperature is 4° C?

1. -9°C
2. 19°C
3. 8°C
4. 4°C

1 Find the Dewpoint Temperatures chart in the *Earth Science Reference Tables*. First determine the difference between the dry- and wet-bulb temperatures given in the question (12°C - 4°C = 8C°). Then find a difference of 8C° along the horizontal axis and a dry-bulb temperature of 12°C along the vertical axis. The intersection of these two readings yields a dewpoint temperature of -9°C.

2

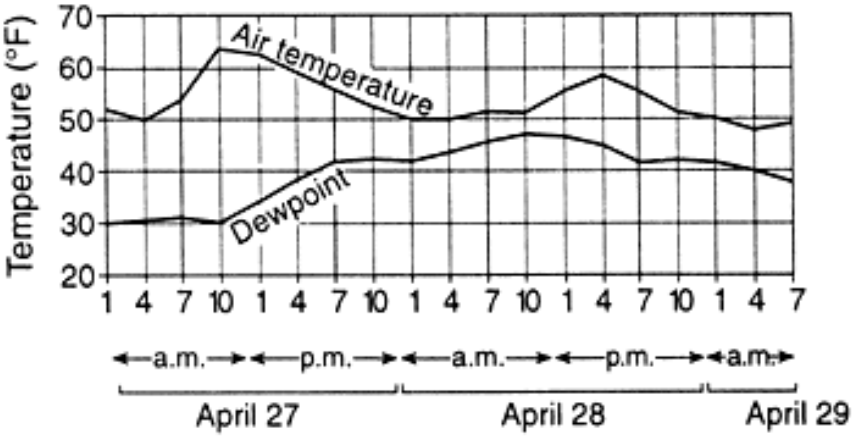
17. A parcel of air has a dry-bulb temperature of 24ºC and a relative humidity of 55%. What is the dewpoint of this parcel of air?

1. 6ºC
2. 14ºC
3. 24ºC
4. 29ºC

2 Find the Relative Humidity (%) chart in the *Earth Science Reference Tables*, and locate 24 on the vertical "Dry-Bulb Temperature (ºC)" scale. Trace horizontally to the right from 24 until you reach the value 55. Then trace vertically upward until you intersect the "Difference Between Wet-Bulb and Dry-Bulb Temperatures (ºC)" scale, and note the value 6. Now, in the Dewpoint Temperatures (ºC) chart in the *Earth Science Reference Tables*, locate 24 on the "Dry-Bulb Temperature (ºC)" scale and locate 6 on the "Difference Between Wet-Bulb and Dry-Bulb Temperatures (ºC)" scale. Trace horizontally to the right from 24 and vertically down from 6 until you reach the box where these values intersect, and note the entry 14. Thus, the dewpoint of this parcel of air is 14ºC.

1

18. The graph is a computer-generated forecast of air temperature and dewpoint for a city during a period of 2¼ days. At which time during this period is the rate of evaporation expected to be highest?



1. April 27 at 10 A.M.
2. April 28 at 10 A.M.
3. April 28 at 4 P.M.
4. April 29 at 4 A.M.

1 Evaporation is most likely to occur when the air is warmest and driest. The air is warmest at the point on the air temperature line corresponding to the highest value on the axis labeled "Temperature (°F)." The air is driest when the difference between the air temperature and the dewpoint is the greatest. This difference occurs when the air temperature and dewpoint lines are the greatest vertical distance apart. Both of these conditions occur on April 27 at 10 A.M., so this is the time when the rate of evaporation is expected to be highest.