MiSP Weather Data Worksheet #1 L3

Name ________________________________ Date ____________

TEMPERATURE AND WATER VAPOR (HUMIDITY)

Introduction:

*Absolute humidity* is the amount of water vapor contained in a given amount of air. It is measured as the mass of water in a certain volume of air (often expressed as grams per cubic meter). For any temperature of air, only a certain amount of water can “fit” in the air. Once that limit is reached, the air is saturated; it cannot hold any more water.

*Mixing ratio* also measures the amount of water vapor contained in air at a given temperature. It is measured as mass of water vapor in a defined mass of air (usually expressed as grams per kilogram of air). *Saturation mixing ratio* is the amount of water vapor (grams) needed to completely “fill” a kilogram of air.

*Relative humidity* compares the mass of water vapor in the air with the maximum mass of water vapor that could “fit” in the air to make it saturated using the *saturation mixing ratio*. Relative humidity is expressed as a percent.

*Dew point* is the temperature at which air, with a particular amount of water vapor in it, releases some of the air as liquid water (condensation or “dew”). It is the temperature at which the air’s relative humidity is 100%.

Problem:

How does temperature affect the maximum amount of water (in grams) that one kilogram of air can contain?
**Data:** Saturation mixing ratio (at 1000 mb).

<table>
<thead>
<tr>
<th>Temperature Degrees Celsius</th>
<th>Maximum Amount of Water Vapor (g) per Kilogram of Dry Air</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>4.0</td>
</tr>
<tr>
<td>10</td>
<td>8.0</td>
</tr>
<tr>
<td>20</td>
<td>15</td>
</tr>
<tr>
<td>30</td>
<td>28</td>
</tr>
<tr>
<td>40</td>
<td>50</td>
</tr>
<tr>
<td>50</td>
<td>88</td>
</tr>
</tbody>
</table>

**Graphing the data:**

- Label the x-axis.
- Label the y-axis.
- Connect the points.
- Draw a best-fit line through the points.
- Put a title on your graph.
Discussion Questions:

1. Make a generalization about the maximum amount of water 1 kilogram of air can contain by completing the following sentence:
   As air temperature increases, the maximum amount of water (g) that 1 kilogram of air can contain ________________________.

2. Relative humidity compares the amount of water (g) in 1 kilogram of air with the maximum amount of water (g) that the air could contain at a given temperature (saturation mixing ratio – what you graphed). Relative humidity is expressed as a percent:

   \[ \text{Relative humidity (\%)} = \frac{\text{Water (g)}}{\text{Maximum water (g)}} \times 100 \]

   What is the relative humidity of the following 1 kilogram samples of air if 6.0 g of water vapor is contained in the samples? Show your work.

   1 kilogram of air at 10°C

   ________________________

   1 kilogram of air at 50°C

   ________________________

3. Look at the data on the graph from 30°C to 50°C. If three samples of air at 30°C, 40°C, and 50°C each contained 26 g of water vapor, which sample would have the highest relative humidity? Explain how you found your answer from the data on the graph.

   ________________________

   ________________________

   ________________________

4. Air at 20°C with 15 g water vapor per kilogram of air is saturated. What would happen if the air is cooled?
5. Use the best-fit line to estimate how much water would be contained in a saturated 1 kilogram sample of air at:

15°C ________________

60°C ________________

6. Compare the changes in the mass of water (g) in 1 kilogram of saturated air as temperature (°C) increases by calculating the unit rate of change (slope). Use ordered pairs from the best-fit line. Do not use your data chart.

Unit Rate of Change = \frac{\Delta \text{Mass of Water (g)}}{\Delta \text{Temperature °C}} = \frac{\Delta y}{\Delta x} = \frac{(y_2 - y_1)}{(x_2 - x_1)}

<table>
<thead>
<tr>
<th>Ordered Pair used for calculation</th>
<th>\Delta \text{Mass of Water (g)}</th>
<th>\Delta \text{Temperature °C}</th>
<th>Unit Rate of Change (slope)</th>
<th>\Delta y/\Delta x</th>
</tr>
</thead>
<tbody>
<tr>
<td>((x_1, y_1))</td>
<td>\Delta y</td>
<td>\Delta x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>((x_2, y_2))</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

7. Put the unit rate of change (slope) of the best-fit line into words by completing the sentence below:

When temperature increases by 1 °C, the maximum amount of water vapor that 1 kilogram of air may contain

______________________________ by _____________ grams.

8. Look at the graph. Compare the lines connecting each data point with the best-fit line. Does the unit rate of change (slope) of the best-fit line fairly represent the changing water vapor (g) capacity of 1 kilogram of air as temperature increases? Explain.
9. Use the equation for a line to calculate the $y$-intercept. Use the best-fit line you used in #6. The equation for a line is

$$y = mx + b$$

where $m$ is the unit rate of change (slope) and $b$ is the $y$-intercept

<table>
<thead>
<tr>
<th>$y$-Intercept</th>
</tr>
</thead>
<tbody>
<tr>
<td>$m =$</td>
</tr>
<tr>
<td>Ordered pair $(x, y) = (_, _)$ [from the best-fit line]</td>
</tr>
<tr>
<td>$y = mx + b$</td>
</tr>
<tr>
<td>Solve for $b$:</td>
</tr>
</tbody>
</table>

10. Based on the unit rate of change (slope) that you calculated above and the $y$-intercept, write an equation for the best-fit line on the graph. Remember that the equation for a line is $y = mx + b$ and $m$ is the unit rate of change (slope) and $b$ is the $y$-intercept.

<table>
<thead>
<tr>
<th>Equation</th>
</tr>
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11. Use the formula above to calculate the amount of water (grams) that would be found in 1 kilogram of saturated air at 37°C. Show your work.

$x = 37°C$
\[ y = \underline{\text{grams}} \]