# 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.

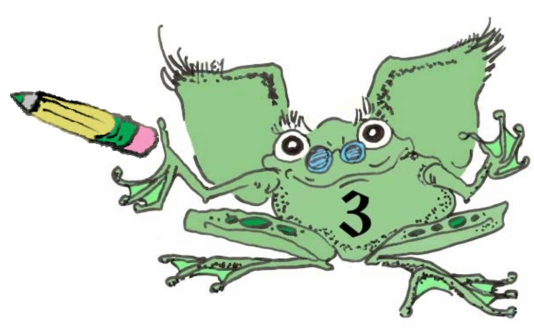
*Mixing ratio* also measures the amount of water vapor contained in air at a given temperature. It is measured as mass of water vapor in a defined mass of air (usually expressed as grams per kilogram of air). *Saturation mixing ratio* is the amount of water vapor (grams) needed to completely "fill" a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

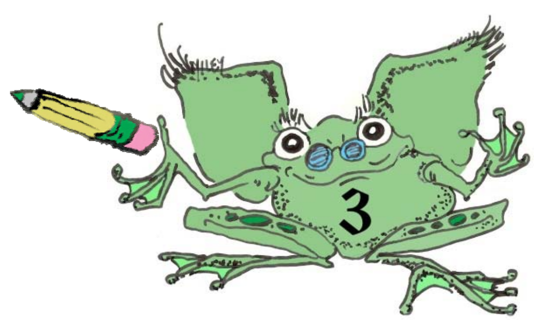
How does temperature affect the maximum amount of water (in grams) that one kilogram of air can contain?

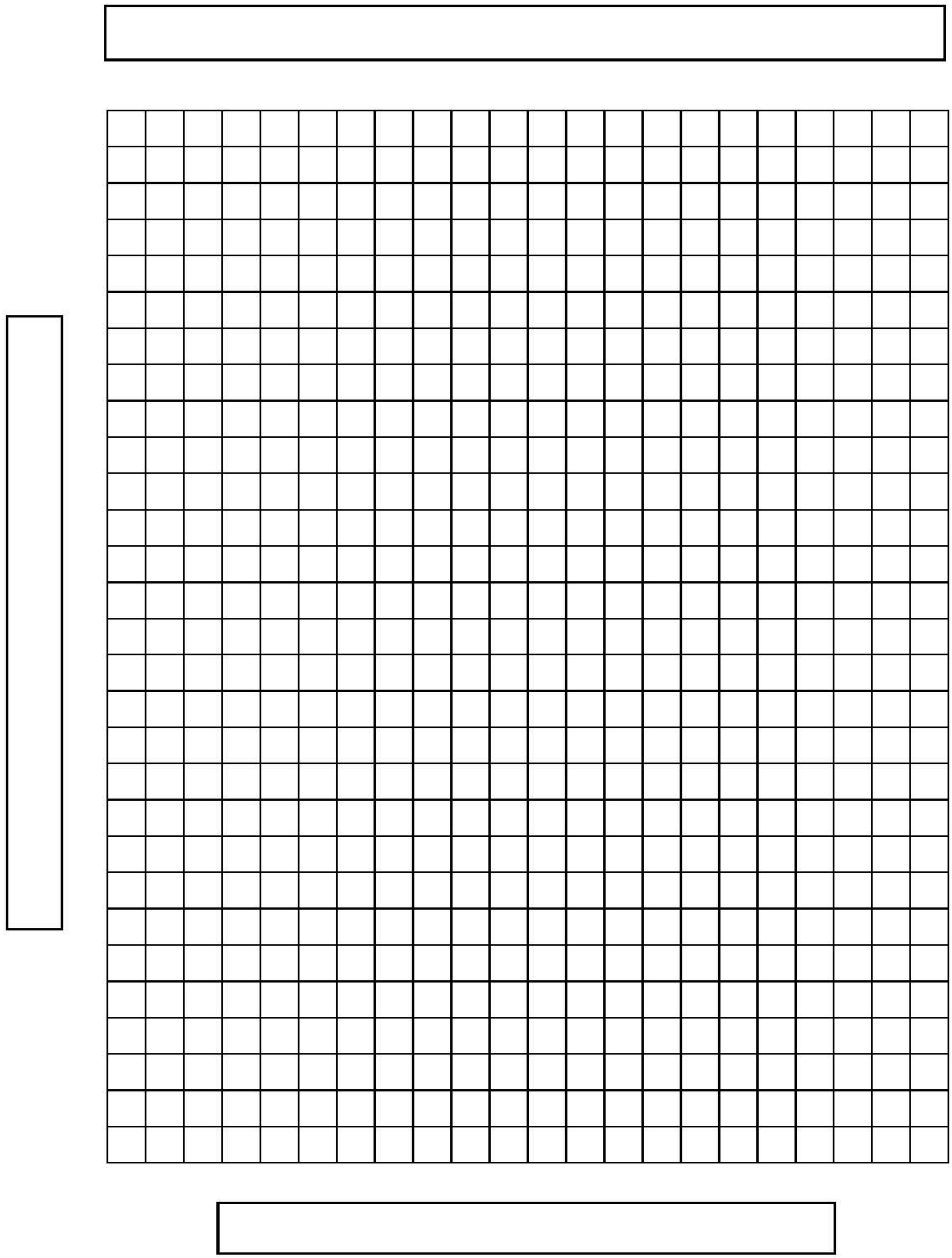


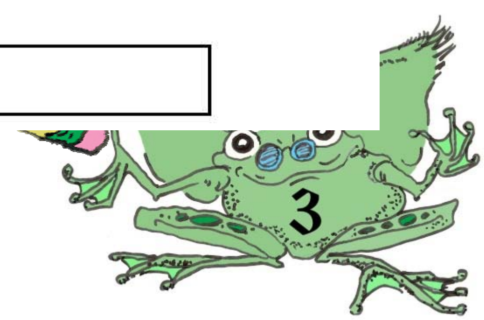
| Data: Saturation mixing ratio (at 1000 mb). | |
|---|---|
| Temperature Degrees Celsius | Maximum Amount of Water Vapor (g) per Kilogram of Dry Air |
| 0 | 4.0 |
| 10 | 8.0 |
| 20 | 15 |
| 30 | 28 |
| 40 | 50 |
| 50 | 88 |

**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.






3

## 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$^{\circ}$C

   1 kilogram of air at 50$^{\circ}$C

3. Look at the data on the graph from 30$^{\circ}$C to 50$^{\circ}$C. If three samples of air at 30$^{\circ}$C, 40$^{\circ}$C, and 50$^{\circ}$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$^{\circ}$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.*

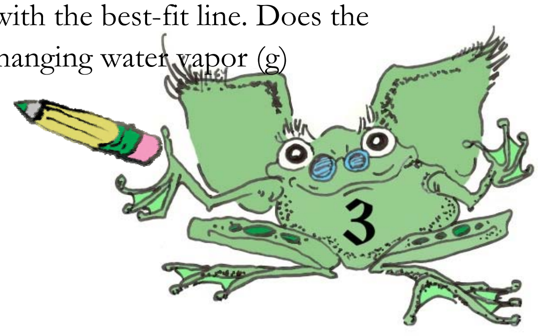
$$\textbf{Unit Rate of Change} = \frac{\Delta \text{ Mass of Water (g)}}{\Delta \text{ Temperature } ^{\circ}\text{C}} = \frac{\Delta y}{\Delta x} = \frac{(y_2 - y_1)}{(x_2 - x_1)}$$

| Ordered Pair used for calculation $(x_1, y_1)$ $(x_2, y_2)$ | Δ Mass of Water (g) $\Delta y$ | Δ Temperature °C $\Delta x$ | **Unit Rate of Change (slope)** $\Delta y/\Delta x$ |
|---|---|---|---|
| | | | |

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

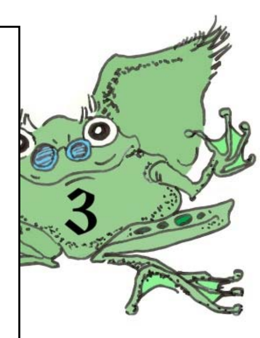
| *Y*-Intercept |
| --- |
| $m =$<br><br>Ordered pair $(x, y)$ = ( ___ , ___ ) [from the best-fit line]<br><br>$y = mx + b$<br>Solve for $b$: |

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 $\boldsymbol{y = mx + b}$ and $m$ is the unit rate of change (slope) and $b$ is the $y$-intercept.

| Equation |
| --- |
| |

11. Use the formula above to calculate the amount of water (grams) that would be found in 1 kilogram of saturated air at 37ºC. Show your work.

| $x = 37^{\circ}C$ |
| --- |
| |



$y$ = ___________ grams