MiSP Solubility Worksheet #2 L3

Name _____ Date _____

We have considered some conditions that allow solutes to dissolve in solvents, but we have not yet considered the solubility of a solute. ***Solubility*** **is defined as the maximum mass of solute that can dissolve in a certain quantity of solvent <u>at a specified temperature</u>.** Below is a data table that shows the solubility of ammonium chloride (NH_4Cl) at various temperatures. Use the data table to construct a line graph (page 2). Remember to set up your axes and label appropriately.

Water Temperature (°C)	Maximum Mass of Ammonium Chloride that can be dissolved in 100 grams of water (g)
0	30
20	37
40	46
60	55
80	65
100	76

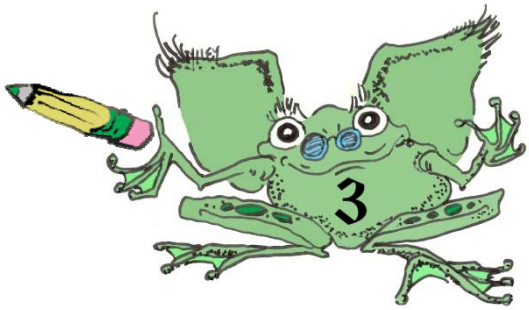
1. We want to know how many grams of ammonium chloride can dissolve in water at various temperatures. In this case, what are the independent and dependent variables?

   Independent variable _____

   Dependent variable _____

Graph the data:

- Label your *x*- and *y*-axes.
- An appropriate scale and increments should be chosen.
- The *x*-values range from _____.
- The *y*-values range from _____.
- You may use increments of 5, 10, 20, or whatever you think is appropriate. Remember that every data point does not have to fall exactly on one of the numbered lines.
- Plot the data points and draw a best-fit line through the data points.
- Add a title to the graph.



Discussion Questions:

1. Use your best-fit line to determine how many grams of ammonium chloride will dissolve at a temperature of 70°C. _____ grams

2. What temperature would be necessary to dissolve 50 grams of ammonium chloride?
   _____ °C

3. As the temperature increases from 20°C to 100°C on your best-fit line, the mass of the solute dissolved in grams increases by _____.

4. The unit rate of change is the change in the maximum amount of ammonium chloride in grams that can be dissolved for every 1°C change in temperature.

$$\text{Rate of Change} = \frac{\Delta \text{ Grams of Solute Dissolved}}{\Delta \text{ Temperature}}$$

   Use the data table to calculate the unit rate of change in dissolved ammonium chloride between 20°C and 100°C.

$$\text{Rate of Change} = \frac{\text{(grams at 100°C – grams at 20°C)}}{\text{(100°C - 20°C)}} = \frac{\_\_\_\_\_}{\_\_\_\_\_} = \_\_\_\_\_$$

5. You can also calculate the unit rate of change using the graph

$$\text{Unit Rate of Change (slope)} = \frac{\Delta y \text{ (grams)}}{\Delta x \text{ (°C)}}$$

Pick an ordered pair on your best-fit line and calculate the unit rate of change. Use the chart below.

Ordered Pair used for calculation (x_1, y_1) (x_2, y_2)	Δ Grams of solute dissolved Δy	Δ Temperature (°C) Δx	**Unit Rate of Change (slope)** $\Delta y/\Delta x$

6. Use the information from the data table to calculate the rate of change between 20°C and 40°C. Show the formula and your work.

7. Use the information from the data table to calculate the rate of change between 60°C and 80°C. Show the formula and your work.

8. Are your calculated rates of change for the two temperature ranges (20°C– 40°C and 60°C–80°C) the same or different? _____
   What does this suggest?

   _____

   _____

   _____

9. How many grams of ammonium chloride can dissolve in 100 ml of water at 0°C? _____.
   On your graph where does your line cross the *y*-axis? _____.
   This is the *y*-intercept.

10. The general equation for a line is $\boldsymbol{y = mx + b}$ when *m* represents the unit rate of change (slope) and *b* represents the *y*-intercept. What is the equation for your line?

11. Using the equation above, fill in the chart below to predict the amount of solute dissolved at various temperatures. Use your graph to check your work for the first two.

x (Temperature in °C)	y (Solute in grams)
28	
72	
130	
180	

Show your calculations.

12. Suppose you tested a different salt (e.g., potassium nitrate) instead of ammonium chloride and found that more of that salt could dissolve in 100 ml of water at 50°C. Does that necessarily mean that more potassium nitrate would dissolve in 100 ml of water at 10°C? _____ Explain your answer.

13. Suppose you tested a different salt (e.g., potassium chloride) and found that less of that salt could dissolve in 100 ml of water at every temperature tested. Add a line on your graph representing the solubility curve of this salt. (Use a different color.) Is the line representing the solubility curve of this salt necessarily parallel to that of ammonium chloride? _____ Explain your answer.