SCH3U3 Period # 2 / Room 311

"Solubility Curves"

Given: Nov. 18, 2019

Due: Nov. 20, 2019

Lab Partners:

Dhrumil Patel

Kevin Wang

Ryan Chang

Purpose:

It has been established that the solubility of a substance in water is dependent on both the temperature and pressure at which the solute is being dissolved in the solvent. The solubility curve of a compound, which visually represents the masses at which the given compound will form unsaturated, saturated, and supersaturated solutions within the 100mL of water, can be found experimentally by testing multiple different concentrations to find the temperature at which the solute will precipitate out of the solution, which indicates that the solute has reached its maximum concentration.

Materials

- Eye protection
- Medicine dropper
- Scoopula
- Small test tube
- 250 mL beaker
- Graduated cylinder
- Thermometer
- 10 mL Distilled water
- 3g of KNO_3
- Balance
- Hot plate

Procedure:

Please refer to the lab sheet “Solubility Curves Lab”

Observations:

Trial Number	Volume of water (mL)	Mass of KNO_3 (g)	Temperature of solution (°C)
1	2	3.003	66
2	3	3.003	56
3	4	3.003	49
4	5	3.003	43

Table 1.1

Analysis:

1. For each trial, calculate the solubility in grams of KNO_3 per 100 mL of water.

Solubility is given by $Solubility = \frac{mass\ of\ KNO_3}{Volume\ of\ water}$. For each trial, the solubility can be calculated using the mass of KNO_3 and the volume of water in the solution. Then, multiply the ratio so that the volume of water is equal to 100 mL.

Trial 1:

$$Solubility = \frac{Mass\ of\ KNO_3}{Volume\ of\ water}$$
$$Solubility = \frac{3.000}{2}$$
$$Solubility = \frac{3.003 \times 50}{2 \times 50}$$
$$Solubility = 150.15\ g/100mL$$

Trial 2:

$$Solubility = \frac{Mass\ of\ KNO_3}{Volume\ of\ water}$$
$$Solubility = \frac{3.003}{3}$$
$$Solubility = \frac{3.003 \times 33.3}{3 \times 33.3}$$
$$Solubility = 100.099\ g/100mL$$

Trial 3:

$$Solubility = \frac{Mass\ of\ KNO_3}{Volume\ of\ water}$$
$$Solubility = \frac{3.003}{4}$$
$$Solubility = \frac{3.003 \times 25}{4 \times 25}$$
$$Solubility = 75.075\ g/100mL$$

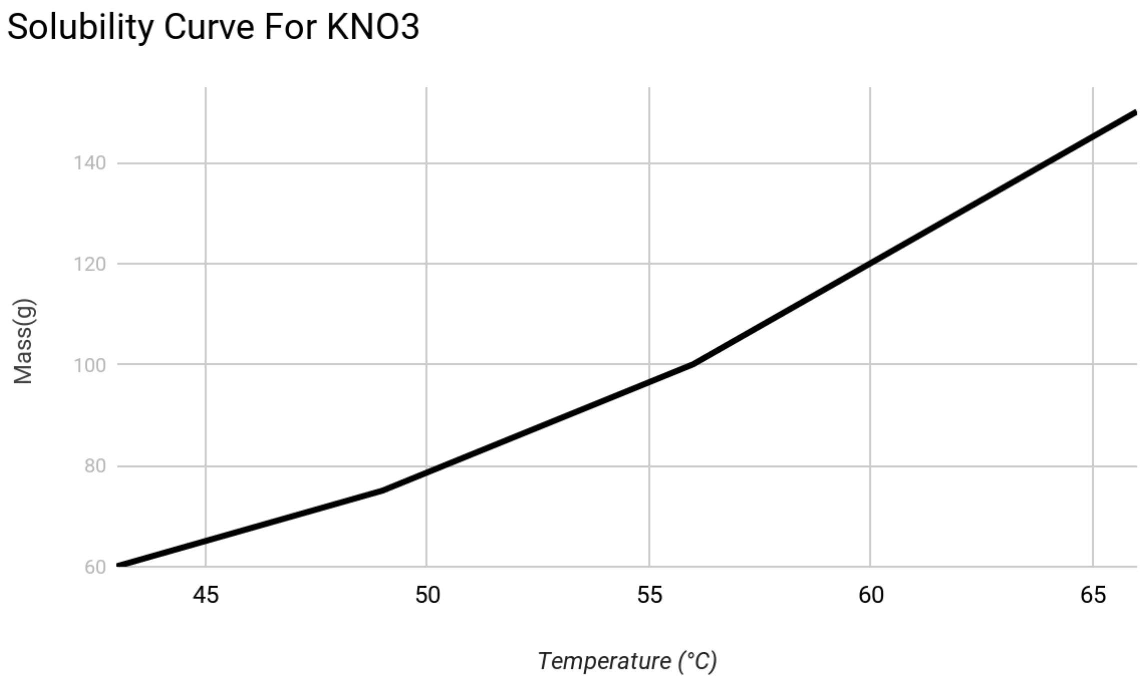
Trial 4:

$$Solubility = \frac{Mass\ of\ KNO_3}{Volume\ of\ water}$$
$$Solubility = \frac{3.003}{5}$$
$$Solubility = \frac{3.003 \times 20}{5 \times 20}$$
$$Solubility = 60.060\ g/100mL$$

2. Plot a graph of solubility (in g/100 mL) against temperature.

3. Write a sentence to answer the question: what is the relationship between the solubility of potassium nitrate and the temperature of its solution?

The relationship between the solubility of KNO_3 and the temperature of the solution is directly proportional; as the temperature of the solution increases, the solubility of KNO_3 also increases.



4. Identify sources of error

This experiment had three main sources of error: the method in which water was extracted from the graduated cylinder, determining whether crystals had formed, and the method in which temperatures were recorded. Water was extracted from the graduated cylinder using a medicine dropper. The medicine dropper would suck water from the graduated cylinder until it was visually determined that 2/1 mL of water had been removed. Relying on visual determination is where the error comes from, as the level of water in the graduated cylinder clings to the edges, yielding an inaccurate and inconsistent value for the volume of water removed from the graduated cylinder per trial. Next, determining when the first crystals appear is very difficult as the crystals look similar to particles of dust. Confusion over the crystal arises because the dust may genuinely be dust or the crystal. Moreover, when a bright light is brought close to the test tube, the particles of dust became clearer, which suggests that there were crystals appearing much earlier than the temperature recorded. Finally, the temperatures recorded for each trial depended on the thermometer brought with the test tube. The thermometer was repeatedly plunged into vastly differing temperatures for each trial, which would cause sporadic increases and decreases in the temperature recorded, yielding values larger that are too high.

5. According to your graph, which of the following mixtures is a saturated solution and which is an unsaturated solution?
   a) 100 g of KNO 3 in 100 mL of H_2O at 40ºC.
   According to my graph, at 40ºC, the number of grams of KNO_3 that would dissolve into 100 mL of water is projected to be 52.924 grams using exponential regression, which yields the function: $s = 10.6e^{0.0402t}$. Therefore, 100g of KNO_3 in 100 mL of water would be a supersaturated solution.

   b) 50 g of KNO 3 in 100 mL of H_2O at 70ºC.
   According to my graph, at 70ºC, the number of grams of KNO_3 that would dissolve into 100 mL of water is projected to be 176.771 grams using exponential regression. Therefore, 50g of KNO_3 in 100 mL of water would be an unsaturated solution.

   c) 120 g of KNO 3 in 200 mL of H_2O at 60ºC.
   According to my graph, at 60ºC, the number of grams of KNO_3 that would dissolve into 100 mL of water is 120 grams. Therefore, 120g of KNO_3 in 100 mL of water would be a saturated solution.

6. According to your graph, what mass of potassium nitrate will dissolve in 100 mL of water at
   a) 20ºC
   At 20ºC, it is projected using exponential regression that 23.685g of KNO_3 will dissolve into 100 mL of water.

   b) 50ºC
   At 50ºC, it is projected using exponential regression that 79.111g of KNO_3 will dissolve into 100 mL of water.

Conclusion:

This lab explored the relationship between solubility and temperature of KNO_3 under identical pressure conditions. The general trend described by the data implies that there is a positive correlation between solubility and temperature - as temperature increases, solubility does as well. Further analysis showed that the solubility curve could be modelled using $s = 10.6e^{0.0402t}$, where t = temperature and s = solubility.

This experiment had three main sources of error: the method in which water was extracted from the graduated cylinder, determining whether crystals had formed, and the method in which temperatures were recorded. Water was extracted from the graduated cylinder using a medicine dropper. The medicine dropper would suck water from the graduated cylinder until it was visually determined that 2/1 mL of water had been removed. Relying on visual determination is where the error comes from, as the level of water in the graduated cylinder clings to the edges, yielding an inaccurate and inconsistent value for the volume of water removed from the graduated cylinder per trial. Next, determining when the first crystals appear is very difficult as the crystals look similar to particles of dust. Confusion over the crystal arises because the dust may genuinely be dust or the crystal. Moreover, when a bright light is brought close to the test tube, the particles of dust became clearer, which suggests that there were crystals appearing much earlier than the temperature recorded. Finally, the temperatures recorded for each trial depended on the thermometer brought with the test tube. The thermometer was repeatedly plunged into vastly differing temperatures for each trial, which would cause sporadic increases and decreases in the temperature recorded, yielding values larger that are too high.