Basic Skills for Chemistry
CHEM-1020
Experiment No 6
Temperature and Solutions

Introduction

Experiment Theory and Purpose: When a substance is dissolved in water, the resulting mixture is called an aqueous solution. The bulk phase, in this case water, that dissolves the solid is referred to as the solvent. The dispersed phase, which may be a solid, liquid or gas, is the solute. When a solute dissolves in water, the temperature of the system may change. For example, when the salt calcium chloride dissolves in water, the solution becomes warm. The more calcium chloride is dissolved, the warmer the solution becomes. Other solutes may absorb heat as they dissolve in water, lowering the temperature of the system. In this experiment, you will measure the (low) temperatures achieved as you prepare solutions containing different masses of the salt ammonium nitrate. Using the data collected, you will construct a graph of Temperature vs. Mass of Solute and answer questions by interpolating or extrapolating on your graph.

Use of Equipment: In this experiment you will learn the use of several laboratory measuring devices, the electronic balance, the volumetric pipet and the liquid-in-glass thermometer.

a) Electronic Balance: Electronic balances are simple and convenient to use. To weigh out solid or liquids, turn the balance switch on, make sure the balance pan is clean and dry and place a clean container on the pan. Press the tare or "T" button once and wait until the balance display registers 0.000 g. (The tare button programs the balance to regard the object on the pan as having zero mass so you won't have to subtract its mass from the mass of the container plus chemical to obtain the mass of the substance being weighed.) Then transfer the desired amount of chemical from a laboratory supply container to the receiving container. Remember to tare every time you use a different container.

b) Volumetric Pipet: Volumetric pipets are designed to deliver a precisely known volume of water or solution. Common pipet sizes are 1, 2, 5, 10, 25, 50 and 100 mL. With care, the delivered volume can be controlled to 0.1 or even 0.01 mL. Rubber pipet bulbs or plastic pumps are used to provide suction to fill the pipet. *Pipetting by mouth is never allowed.* To begin, gently insert about 5-10 mm of the upper pipet stem into the bottom opening of a pipet bulb. Then, simultaneously squeeze the bulb and the top "A" valve, to expel air from the bulb. Immerse the tip of the pipet into the liquid to be dispensed. Squeeze the suction "S" valve, to draw a few mL of liquid into the pipet. Rinse the pipet three times with small portions of the liquid so the inside is wetted with the solution. To fill the pipet, suction liquid to 2 cm above the top stem fill line. Remove the bulb from the pipet and use your finger to lower the liquid level so the bottom of the liquid meniscus just rests on the fill mark. Remove the pipet from the supply container, blot excess liquid from the tip with a tissue and touch the tip to the inside wall of the receiving container. Let the pipet drain by gravity, count to 10 after the flow stops and withdraw the pipet. Do not shake our or blow out the liquid remaining in the tip. Volumetric pipets are designed to *deliver*, not to contain the designated volume.

c) Liquid-in-Glass Thermometer: To measure the solution temperatures, you will use a -10 to +100 °C range liquid-in-glass thermometer. This type of thermometer has a reservoir of liquid, typically mercury or dyed alcohol that expands and contracts in response to temperature changes. The liquid climbs up a narrow bore to indicate the temperature. Mercury thermometers are no longer used for many applications because of heightened awareness of mercury's toxicity and environmental hazards. A liquid-in-glass thermometer is read at the top of the liquid column. As with any instrument, you must determine the smallest division on the thermometer (typically

1°C). The temperature is properly estimated to one-tenth that amount. A laboratory thermometer is not "shaken down" before reading like a mercury fever thermometer. It always registers the instantaneous temperature of the liquid in the bulb. For this reason, it must be read with the bulb fully immersed in the medium whose temperature is to be measured.

Ammonium Nitrate Facts: Ammonium nitrate, NH_4NO_3, a common ionic compound has many uses. It is soluble in water and widely used as a fertilizer ingredient because green plants utilize both the cation and the anion nitrogen atoms. Ammonium nitrate absorbs heat when dissolved in water and so is used in cold packs to treat sports injuries. The oxidizing power of the nitrate ion finds use in the preparation of pyrotechnics and industrial explosives.

Experimental

1) Obtain five 50 mL beakers. Clean and dry them. Label the white patch on the side of each beaker A, B, C, D and E with a pencil (not pen). On the electronic balance, using a metal spatula, transfer ammonium nitrate from the laboratory supply container until you have close to the amount indicated for each of the trials B, C, D, and E. It is not necessary to get the exact mass listed in the table as long as you know how much you have weighed out. Do not return any leftover ammonium nitrate to the laboratory supply container. Offer it to another student or dispose of it as directed by your instructor. (To prevent contamination and unexpected chemical reactions, excess chemicals are never returned to laboratory supply containers. They must always be disposed of properly. In particular, nitrate salts must never be mixed with other chemicals or thrown in the trash because they are powerful oxidizing agents, capable of initiating violent chemical reactions or fires.)

2) Obtain a ring stand, clamp and paper clip. Place the empty beaker A on the ring stand base and hang your thermometer with the paper clip so the thermometer bulb almost touches the bottom of the beaker. For guidance, examine the setup provided by your instructor.

3) Pipet 25.0 mL of distilled water into beaker A as instructed on the previous page. Your instructor will demonstrate the proper use of the volumetric pipet.

4) Making sure the thermometer bulb is completely immersed in the water, stir the water with a stirring rod or the hanging thermometer and measure the water temperature. Record the temperature in the space provided for zero grams of ammonium nitrate.

5) Weigh about 1.7 g of NH_4NO_3 into beaker B to the nearest 0.001 g. Record the exact mass in the space provided.

6) Pipet 25 mL of water into beaker B. Stir the solution to dissolve the solid and quickly read the solution temperature.

7) Record the lowest temperature attained by the solution. The temperature will drop quickly, so watch the thermometer carefully.

8) Repeat steps 5 through 7 for each of the three remaining ammonium nitrate amounts in beakers C, D and E.

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Data Page for Experiment No 6
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Beaker	Approx. Mass of NH_4NO_3	Measured Mass of NH_4NO_3	Minimum Temperature
A	0 g		
B	1.7 g		
C	3.4 g		
D	5.1 g		
E	6.8 g		

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Report Page for Experiment No 6
Temperature and Solutions

1. Convert the measured temperatures of the solutions in beakers B and E from degrees Celsius to degrees Fahrenheit and from degrees Celsius to kelvins using the equations $F = (9/5)C + 32$ and $K = °C + 273.15$, respectively. Show all four calculation setups in the space below. (4 points)

2. Using black ink, make a graph of Temperature vs. Mass of Ammonium Nitrate. Draw the best straight line for the data. Staple the graph to this report. (8 points)

3. Answer the following questions by interpolation or extrapolation. Clearly indicate each interpolation and extrapolation procedure on your graph.

   a) What mass of ammonium nitrate dissolved in 25.0 mL of water would produce a temperature of 3.0 ºC? (2 points)

   b) What mass of ammonium nitrate dissolved in 25.0 mL of water would produce a temperature of 15.0 °C? (2 points)

   c) If 0.500 g of ammonium nitrate were dissolved in 25.0 mL of water, what temperature would the system attain? (2 points)

   d) If 18.550 g of ammonium nitrate were dissolved in *50.0 mL* of water, what temperature would the system attain? (2 points)