Name: ____

Lab Instructor:__________________________________

PREPARATION FOR CHEMISTRY LAB: SOLUTIONS

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1. Define the terms:

   solution:

   solute:

   solvent:

2. Write the formula if the name is given and the name if the formula is given for each of the following: (Be sure to use the Stock system (Roman numeral) when appropriate.)

   $BaCl_2$ ____________________________

   $CuSO_4$ ________________________________

   calcium chloride __________________________

3. What is an endothermic reaction? If you were holding a beaker in which an endothermic reaction just took place, would the beaker feel hot or cold?

4. Calculate the molar mass of NaCl and enter this number on the appropriate blank on page 5 of the report sheet.

   Calculate the molar mass of sucrose, $C_{12}H_{22}O_{11}$, and enter this number on the appropriate blank on page 5 of the report sheet.

SOLUTIONS

INTRODUCTION

This week in lab you will be looking at several solution-based chemical reactions. You will work with "invisible inks", produce solutions that get hot or cold, observe and compare the freezing points of water, a sugar solution, and a salt solution, and make colors appear or disappear.

Review and/or review Section 3-4.2 and Section 4-3 through 4-5 in your textbook.

Three activity sites are set up in the laboratory corresponding to the three parts to the lab. You don't have to do the experiments in the order in which they are listed, but you must do them all. Make careful observations as you go along and **RECORD** all of your observations in report style.

Part 1: Invisible Ink

1. Label (pen or pencil) two filter paper circles. Write your name on circle #1 with phenolphthalein indicator and on circle #2 with copper(II) sulfate solution. The solutions are in test tubes. Use the swab in each solution as your "pen".

2. Let the papers dry. Speed up drying by fanning the air with the paper.

3. Swab circle #1 with a solution of sodium hydroxide. Use the swab in the test tube.

4. Set circle #2 over one of the glass containers containing concentrated ammonia (NH_3) located in the hood. Replace the container cover after your paper has developed.

Part 2: Energy Changes

1. Put about 15 mL of water into a test tube (Test Tube 1). Put the LabQuest temperature probe in the water and record the temperature. Sprinkle about 1 g of ammonium nitrate into the water. Gently stir the solution with the temperature probe and record the temperature when it stabilizes.

2. Put about 15 mL of water into a test tube (Test Tube 2). Put the LabQuest temperature probe in the water and record the temperature. Sprinkle about 1 g of magnesium sulfate into the water. Gently stir the solution with the temperature probe and record the temperature when it stabilizes.

Part 3: Freezing Points

The freezing point of an aqueous solution is lower than the freezing point of pure water. Furthermore, the amount the freezing point is lowered is related to the number of solute particles in solution. When a solution is prepared from a molecular compound (like sucrose) that is not an acid or a base, the number of moles of the compound is the same as the number of moles of solute particles. When a solution is prepared from an ionic compound, the number of ions resulting from each formula unit of the compound must be taken into consideration. For example, a 50 mL solution containing 1 mole of $CaCl_2$ will have a lower freezing point than a 50 mL solution containing 1 mole of KBr. This is because three moles of ions are released into solution for each mole of $CaCl_2$ that dissolves and two moles of ions are released into solution for each mole of KBr that dissolves.

Procedure:

Your teaching assistant will show you how to determine freezing points from your graphs.

1. Plug the temperature probe into one of the sensor ports on the front edge of the LabQuest.

2. Turn on the LabQuest with the power button which is located on the upper left corner.

3. Make a freezer containing about 200 mL of a saturated common salt solution in a Styrofoam-jacketed beaker as follows.

   Add some ice and sprinkle a spoonful of salt on top of the ice. Add more ice, layering salt and ice to within an inch of the top.

   Push the LabQuest temperature probe into the salt solution. Remove the probe when the reading falls below **-10°C** and rinse it off. Gently insert a glass thermometer in the ice bath to monitor its temperature during the rest of the experiment.

4. Using the stylus, touch: Sensors; Data Collection; change length from 180 s to an appropriate time interval (900 s should be long enough for each run in this experiment, you can always stop collecting data, but you can't add in more time once you have started); touch OK.

5. Put 10 mL of deionized water in a large test tube. Place the test tube in the ice bath. Immediately touch the begin data collection button (triangle) on the lower left of the screen. Hold the probe in place with either hand and stir the liquid occasionally with a slow up-and-down motion. Do not stir vigorously. When the water freezes, make a few more temperature readings and touch the stop data collection button (square) on the lower left of the screen.

6. If the graph is not displayed, touch the graph button.

7. You may want to periodically save your data. Touch: File; Save (enter a unique data file name); Save.

8. Print out a copy of the graph for each lab partner. Each lab report must have a LabQuest generated printout of the graph attached to it. The printout must show the graph and the axis labels. Be sure that the graph title (specifying which freezing point curve the graph goes along with) and the names of all lab partners are entered in the footnote and that the date box is checked.

9. Dissolve between 4.05 and 4.15 g of sucrose in 10 mL of water in a test tube, record the exact mass on the report sheet. Using the same technique as you used before (Steps 4 through 8; don't forget to do Step 4; you don't want the LabQuest to time out before the freezing point has been reached), track the temperature change in this solution as it cools to freezing. When printing out the graph (Step 8), be sure the graph title is specific.

10. Dissolve between 0.62 g and 0.65 g of NaCl in 10 mL of water in a test tube, record the exact mass on the report sheet. Using the same technique as before (Steps 4 through 8; don't forget to do Step 4; you don't want the LabQuest to time out before the freezing point has been reached), track the temperature change in this solution as it cools to freezing. When printing out the graph (Step 8), be sure the graph title is specific.

DATA AND ANALYSIS SHEET: SOLUTIONS

Name: ____

Date ____________ Lab Partner ___________________________________

Part 1: Invisible Ink

Circle #1 Observations and explanation:

Circle #2 Observations and explanation:

Part 2: Energy Changes

Test Tube 1:

Initial Temperature: _________________________

Final Temperature: ___________________________

Was the solution process that took place in Test Tube 1 exothermic or endothermic? ____________

Test Tube 2:

Initial Temperature: _________________________

Final Temperature: ___________________________

Was the solution process that took place in Test Tube 2 exothermic or endothermic? ____________

Part 3: Freezing Points

Each lab report must have a LabQuest generated printout of each graph attached to it. The printouts must show the graph and the axis labels. Be sure that the graph title (specifying which freezing point curve the graph goes along with) and the names of all lab partners are entered in the footnote and that the date box is checked.

3.5: Freezing point of water: ___________________________________

3.9: Exact mass of sucrose used: _____________

Molar mass of sucrose: _________________

Moles of sucrose used: _______________

Freezing point of the solution: _____________________

3.10: Exact mass of NaCl used: _____________

Molar mass of NaCl: ____________________

Moles of NaCl used: __________________

Freezing point of the solution: ____________________

Did the sucrose solution or the NaCl solution have the lower freezing point?

Both solutions should have contained approximately the same amount of water and approximately the same number of moles of solute. How do you explain the differences you observe in the freezing points of the two solutions?

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QUESTIONS ABOUT THIS LAB: SOLUTIONS

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1. Give the formulas for the following compounds.

   ammonium nitrate: ____________________

   cobalt(III) acetate: _____________________

   aluminum sulfate: _____________________

   lead(II) chlorate: _______________________

2. In separate flasks, you add 0.3 moles of the following solutes (all of which are soluble in water) to 50 mL of water. How would you arrange the solutions, based on the solute present, in order of **lowest** freezing point to the **highest** freezing point of the resulting solution?

   ammonium nitrate , cobalt(III) acetate , aluminum sulfate , lead(II) chlorate

   Explain why you came up with the ordering that you did.

3. Reactions between acids and bases (neutralization reactions) are exothermic. You have a solution of an acid and a solution of a base, both at 23^{o}C. If you mix the two solutions together, would you expect the final temperature to be greater or less than 23^{o}C?