Water Lab

I. Distillation

Hypothesis: Water can be purified by distillation.

Objective: To distill samples of water that contains volatile and nonvolatile components.

Materials and Equipment: Sodium chloride, ammonia solution, 0.1 M silver nitrate, food coloring, litmus paper, 250 mL round bottom boiling flask, “T” connector, condenser, thermometer, one hole rubber stopper, dropper pipet, 2 ring stands, 2 ring clamps, 2 Burette clamps, wire gauze, laboratory burner, spatula, filter funnel, 100 mL beaker, 100 mL graduated cylinder, medium test tubes, 2 rubber hoses, and boiling chips.

Procedure: In distillation, a liquid is separated from a mixture by evaporating it, condensing the vapors, and collecting the condensate. Set up the distillation apparatus as shown.

1. Dissolve about 1 g of sodium chloride in 100 mL of water, add about 10 drops of food coloring, and place this solution in the boiling flask prior to set up. *Caution: Add a few boiling chips to the solution to prevent it from “bumping” as it begins to boil*. Position a clean 100 mL beaker to catch the distillate. Pass cold water through the condenser. Heat the contents of the flask, and note the temperature where the water distills (starts to condense). Collect about 10 mL of distillate, and note its color. Test a 3 mL portion of the distillate for chloride ions by adding 5 drops of 0.1 M silver nitrate, compare this to a control of pre-distilled solution. Test another portion of the distillate with red litmus paper.

2. Turn off the burner and allow the contents of the flask to cool for about 10 minutes. Remove the thermometer and stopper. Using a long stemmed funnel, carefully pour about 5 mL of ammonia solution directly into the mixture in the flask. *It is important that none of the ammonia solution runs down into the condenser*. Replace the thermometer, and reheat the contents of the flask. Note the temperature at which the solution distills. Collect about 10 mL of distillate in a clean beaker. Cautiously smell the distillate, and test a portion of it with red litmus paper. For comparison carefully check the odor of the ammonia solution. *Caution: Ammonia is a choking gas*. Test a portion of it with red litmus paper. Report your results in the data table.

3. Continue the distillation. Discard the next 25 to 30 mL of distillate, and then collect a 5 mL portion in a clean test tube. Check odor cautiously, and test it with litmus paper. Report your results in the data table.

II. Solvent Properties of Water

Hypothesis: Water is a polar solvent for ionic and other polar compounds.

Objective: To test the water solubility of some compounds.

Materials and Equipment: Sodium chloride, toluene, glycerin, sucrose, iron (II) sulfate, calcium carbonate, hexane, ammonium nitrate, ethanol, spatula, dropper pipet, and medium test tubes.

Procedure: Test each of the substances listed in the data table for water solubility. Use 3 to 4 mL of water in a medium test tube. Add a very small quantity of the substance being tested. The amount should be less that the size of a match head if the substance is a solid or 1 to 2 drops if it is a liquid. Shake the test tube gently, and note what happens. If all the substance dissolves, add another small quantity, and shake gently. Repeat the process several more times if the material is very soluble. In the data table report each substance as insoluble, slightly soluble, or very soluble.

III. Water of Hydration

Hypothesis: Water is an integral part of the crystals of many salts.

Objective: To study the composition of some hydrates.

Materials and Equipment: Copper sulfate pentahydrate, magnesium sulfate heptahydrate, sodium carbonate decahydrate, sodium chloride, medium test tubes, test tube holders, laboratory burner, and wire gauze.

Procedure: Label four clean, dry test tubes, and place them in a rack. Add small amounts (about 0.3 g) of the following substances: copper sulfate crystals to tube 1, magnesium sulfate crystals to tube 2, sodium carbonate crystals to tube 3, and sodium chloride crystals to tube 4. Holding each test tube horizontally, gently heat the *bottom* of the tube in a burner flame by slowly passing it back and forth through the flame. Report what you see in the upper cooler part of the test tube, and note any change in the appearance of the crystals during heating.

IV. Heat of Fusion of Ice

Hypothesis: The absorption of heat by ice as it melts can be used to cool water, and the extent of the cooling depends on the heat of fusion of ice.

Objective: To determine the heat of fusion of ice.

Materials and Equipment: Ice, Styrofoam cups, thermometer, 100 mL graduated cylinder, 250 mL beaker, laboratory burner, and wire gauze.

Procedure: Water has the largest heat of vaporization of any known liquid. Because of the extensive network of hydrogen bonds in water, it takes 540 cal to change 1 g of water at 100°C into steam at the same temperature. Therefore, when water as perspiration evaporates from the skin, a large amount of body heat is absorbed to change the water from the liquid to the vapor state. Since this heat comes from the body, the body becomes cooler. Similarly, water has a high heat of fusion. The heat of fusion is the energy required to convert a substance from a solid to a liquid at the melting point of the substance, without raising its temperature.

Heat 100 mL of water in a 250 mL beaker to about 60°C. Pour 20 to 30 mL of the hot water into a 100 mL graduated cylinder. After 30 seconds, pour the water out. Repeat this procedure to raise the temperature of the cylinder closer to the temperature of the water. Now add about 30 mL of hot water to the warm cylinder, and insert a thermometer. Half fill a Styrofoam cup with ice cubes. Quickly drain any excess water from the ice cubes, read the temperature and volume of the hot water in the 100 mL graduated cylinder, and pour this water onto the ice cubes. Stir the ice water rapidly but carefully, until the temperature falls to about 2°C, but do not allow all the ice to melt. It is important that some ice remain. After noting the final temperature, immediately drain the water from the ice into the 100 mL graduated cylinder. Record the volume of water in the cylinder. Use the new volume of water and the change in temperature to calculate the heat of fusion of ice.

Distillation Laboratory Report

1. Temperature at which the solution distilled: ____________
   Color of mixture in flask: ____________
   Color of distillate: ____________
   Test for chloride ions in solution: ____________
   Test for chloride ions in distillate: ____________
   Red litmus paper test on distillate: ____________

2. Temperature at which the solution distilled: ____________

Test	Distillate	Ammonia Solution
Odor		
Red litmus paper test		

3. Odor of distillate: ____________
   Red litmus paper test: ____________

Solvent Properties of Water Laboratory Report

Substance	Chemical formula	Physical state	Solubility in water
Sodium chloride			
Toluene			
Glycerin			
Sucrose			
Iron (II) sulfate			
Calcium carbonate			
Hexane			
Ammonium nitrate			
Ethanol			

Water of Hydration Laboratory Report

Substance	**Observations**
1. Copper sulfate crystals	____
2. Magnesium sulfate crystals	____
3. Sodium carbonate crystals	____
4. Sodium chloride crystals	____

Heat of Fusion of Ice Laboratory Report

Initial temperature of water: ____________

Final temperature of water: ____________

Change in temperature of water: ____________

Initial volume of water: ____________

Final volume of water: ____________

Volume of ice melted (diff. in volume): ____________

Mass of ice melted (1 mL = 1 g): ____________

Calories of heat given up by water = initial volume of water X change in temperature of water

= ____________ X ____________

= ____________ cal

Calories required to melt 1 g of ice $= \frac{\text{heat given up by water (cal)}}{\text{Mass of ice melted (g)}}$ = heat of fusion

$= \frac{\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \text{cal}}{\text{g}}$

= ______________ cal/g

The accepted heat of fusion of ice is _____________ cal/g