OBJECTIVE

Determine the solubility of potassium chloride, KCl, in distilled water as a function of temperature.

BACKGROUND

A **solution** is a specific type of homogeneous mixture in which the particles of substance comprising the mixture are the size of individual ions or small molecules. A consequence of such small particle size is that solutions are transparent and free of cloudiness that would result from larger particles.

The **solute** and **solvent** are the minor and major components of a solution, respectively. For example, the solute and solvent of a solution of salt water are salt and water, respectively. A minor portion of salt is dissolved by a major portion of water.

Potassium chloride, KCl, is an ionic compound that readily dissolves into an aqueous solution of potassium and chloride ions in water.

$$KCl(s) \rightarrow K^+(aq) + Cl^-(aq)$$

The formation of an aqueous solution of a water soluble salt involves two processes acting together:

- **Dissociation** occurs when water molecules cause pairs of ions to separate from each other and from the solid.
- **Solvation** occurs when water molecules orient themselves in spherical configurations around dissociated ions. The polar bonds of the water molecules interact with and stabilize the net charge of the dissociated ions, thus keeping the ions in solution.

Solubility is the maximum amount of solute that can be held in solution by 100 grams of solvent.

$$Solubility = \frac{grams\ of\ solute}{100 grams\ of\ solvent} \qquad (1)$$

The solubility of a given solute in a given solvent depends on temperature. For most solid solutes, solubility increases as temperature is increased. This is because molecules or ions of a solid have higher kinetic energy at higher temperatures, and will tend to dissociate more readily as a result. For most gaseous solutes, solubility decreases as temperature is increased. Note the *decreased* solubility of HCl(g), NH_3(g) and SO_2(g) at increased temperatures in Figure 1.

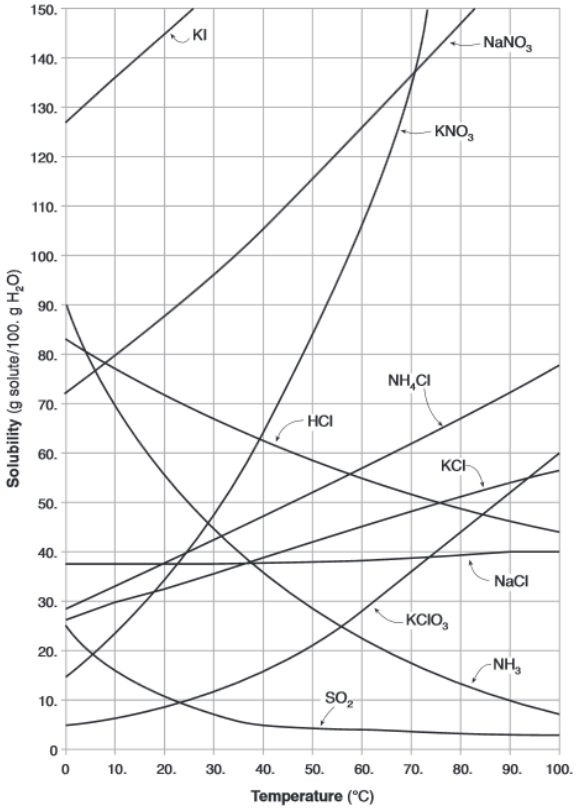


Figure 1 Solubility curves

PROCEDURE

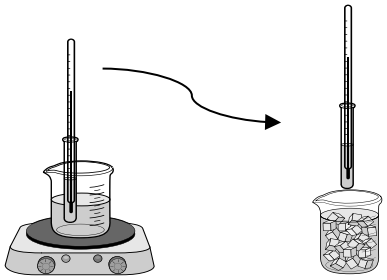
1. Prepare the following series of salt water mixtures. DO NOT weigh out salt directly on the balance. Remove the weighing boat from the balance when adding or removing salt from it. Weigh out the approximate mass of KCl and record the actual mass.

Table 1 – Solution Preparation

Mixture #	Distilled Water (mL, g)	KCl (g)
1	5.00	~1.75
2	5.00	~2
3	5.00	~2.25
4	5.00	~2.5
5	5.00	~2.75

HOT WATER BATH

2. Stir and heat each mixture until salt is fully dissolved. Do not remove thermometer. Do not punch out the bottom of the tube with the thermometer.



COLD WATER BATH

3. Stir and cool. Record temperature when precipitate begins to form. Dip in cold water if necessary. Do not remove thermometer.

Calculate the solubility at each recorded temperature (Y-axis):

$$Solubility\ of\ KCl = 100 \times \frac{Mass\ of\ KCl}{Mass\ of\ H_2O}$$

Table 2 – Solubility Data

			Plot on X-axis	***Plot on Y-axis***
Mixture #	Mass of KCl (g)	Mass of water (g)	Temperature (°C)	Solubility of KCl (gKCl/100g H_2O)
1				
2				
3				
4				
5				