3 Density and Concentration of Aqueous KI

Purpose:
Concentrations of KI (aq) solutions are determined by measuring density very accurately.

Introduction:
In this lab, the mass (m) and volume (V) of potassium iodide solutions will be measured, and the density (D) will be calculated.

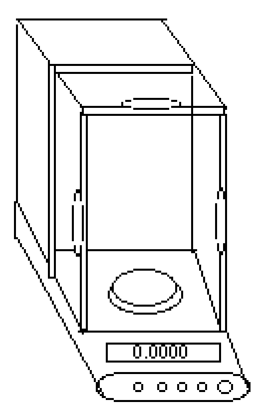
$$D = m/V$$

The densities of a range of KI solutions from 0.5 mass % to 40 % are listed in the table below. KI has a solubility of about 150 g per 100 g of water so a wide range of solution concentrations is possible.
Note: Since densities of the solutions are sufficiently different from one another, the table can still be used even if your temperature is a little different from 20^{o}C.

Concentration of Solutions of Aqueous Potassium Iodide, KI(aq) @20^{o}C

Mass %	conc. (M) mol/L	density g/mL	Mass %	conc. (M) mol/L	density g/mL
0.5	0.030	1.0019	16.0	1.088	1.1284
1.0	0.061	1.0056	18.0	1.244	1.1469
2.0	0.122	1.0131	20.0	1.405	1.1659
3.0	0.184	1.0206	22.0	1.571	1.1856
4.0	0.248	1.0282	24.0	1.744	1.2060
5.0	0.312	1.0360	26.0	1.922	1.2270
6.0	0.377	1.0438	28.0	2.106	1.2487
7.0	0.443	1.0517	30.0	2.297	1.2712
8.0	0.511	1.0598	32.0	2.495	1.2944
9.0	0.579	1.0679	34.0	2.700	1.3185
10.0	0.648	1.0762	36.0	2.913	1.3434
12.0	0.790	1.0931	38.0	3.134	1.3692
14.0	0.937	1.1105	40.0	3.364	1.3959

Apparatus
Very accurate densities are needed to determine concentrations of dilute aqueous solutions. The mass in grams is measured with analytical balances. They work like the top loaders, but have sliding doors to protect against air currents. These analytical balances measure to the nearest 0.001 or 0.0001 g. Both volumes and masses must include four significant figures so a 10.00 mL volumetric pipette is needed.
CAUTION: Do not overload the analytical balance.
The capacity is less than 120 g.



Procedure

1. Record the code # of the unknown concentration.

2. Tare (or zero) a weighing bottle with lid by placing it on the balance pan and pressing the "TARE" key on the front face, giving a digital display of 0.000 g (or 0.0000 g). Remove the weighing bottle from the balance.

3. Using a volumetric pipette and pump, pipette 10.00 mL of solution into the weighing bottle. Place the weighing bottle on the balance.
CAUTION: *Never* pipette by mouth.

4. Record the mass and calculate the density of the solution.

5. Use the table of liquid densities on the previous page to identify the unknown concentration.

Data and Results (Measuring Density of Aqueous KI Solutions)

Name(s) ____

Give Code #(s) of your unknown(s). Find the measured density and record in the table below.

Code #	Volume liquid mL	Mass liquid (g)	Density (g/mL) Measured

Compare measured density with tabulated densities to find the concentration of the unknowns.

Code #	Density Measured (g/mL)	*Density From Table (g/mL)	Conc. Mass %	Conc. Molarity mol/L

*Choose the one closest to your measured density.

Questions:

1. Suppose you were measuring accurate densities of solutions with densities < 1. Could you use a balance, such as the top loader without doors (measuring to the nearest 0.01 g) for the mass measurement? Explain.

2. We chose to use solutions of KI rather than the more accessible NaCl for this experiment. Can you think of a reason for that?

____

Instructor's Guide
#3 Density of KI (aq)

Give Code #(s) of your unknown(s). Find the measured density and record in the table below.

Code #	Volume liquid mL	Mass liquid (g)	Density (g/mL) Measured
5	*10.00*	*10.01*	*1.001*
2	*10.00*	*10.20*	*1.020*
4	*10.00*	*10.36*	*1.036*
1	*10.00*	*10.60*	*1.060*
3	*10.00*	*11.23*	*1.123*
6	*10.00*	*11.66*	*1.166*

Compare measured density with tabulated densities to find the concentration of the unknowns.

Code #	Density Measured (g/mL)	*Density From Table (g/mL)	Conc. Mass %	g KI/L	Conc. M mol/L
5	*1.001*	*1.0019*	*0.5*	*5.0*	*0.030*
2	*1.020*	*1.0206*	*3*	*30.6*	*0.184*
4	*1.036*	*1.0360*	*5*	*51.8*	*0.312*
1	*1.060*	*1.0598*	*8*	*84.8*	*0.511*
3	*1.123*	*1.1284*	*16*	*180.5*	*1.088*
6	*1.166*	*1.1659*	*20*	*233.2*	*1.405*

*Choose the one closest to your measured density.

Questions:
1. Suppose you were measuring accurate densities of solutions with densities < 1. Could you use a balance, such as the top loader without doors (measuring to the nearest 0.01 g) for the mass measurement? Explain.
2. We chose to use solutions of KI rather than the more accessible NaCl for this experiment. Can you think of a reason for that?

***1.** The liquids would weigh less than 10.00 g, so the mass would have just three significant figures. The density would also be restricted to three significant figures, which might not be enough to distinguish one dilute solution from another.*

***2.** The solubility of KI is about 150 g per 100 g water, compared to only 35 g NaCl per 100 g water. Thus, a wider range of KI solutions whose densities differ enough to be distinguished from one another can be prepared.*

Instructor's Guide
Density of KI (aq) (cont'd)

Time: 45 min

Equipment and Materials : per group:

Items	**Number**	**Comment**
Analytical Balance + power supply	1	
weighing bottles	1	Weighing bottles must be cleaned after each use.
wash bottle	1	
Kimwipes	1 box	
liquid KI samples	6 per class	
10.00 mL volumetric pipettes	6 per class	
pipette pumps	6 per class	
250 mL beakers	6 per class	For collecting the sample. Students should never dip pipettes into an unknown liquid.
magic marker	1 per class	
safety glasses	1 per student	

Ideas/ Information
Before the class, the instructor should pour the solutions into 250 mL beakers and identify with the code letter. Designate a pipette to be used with each beaker.

Mass % = Mass of solute divided by total mass of solution, expressed as percent.

Tables of densities and concentrations for many compounds are listed in the CRC Handbook: **8**-72.

More on the answer to Question 2: Densities of solutions of NaCl for concentrations of 1 % to 26% are 1.0 to 1.2. For KI, the solutions can range from 1% to 40 % with densities from 1.0 to 1.4.