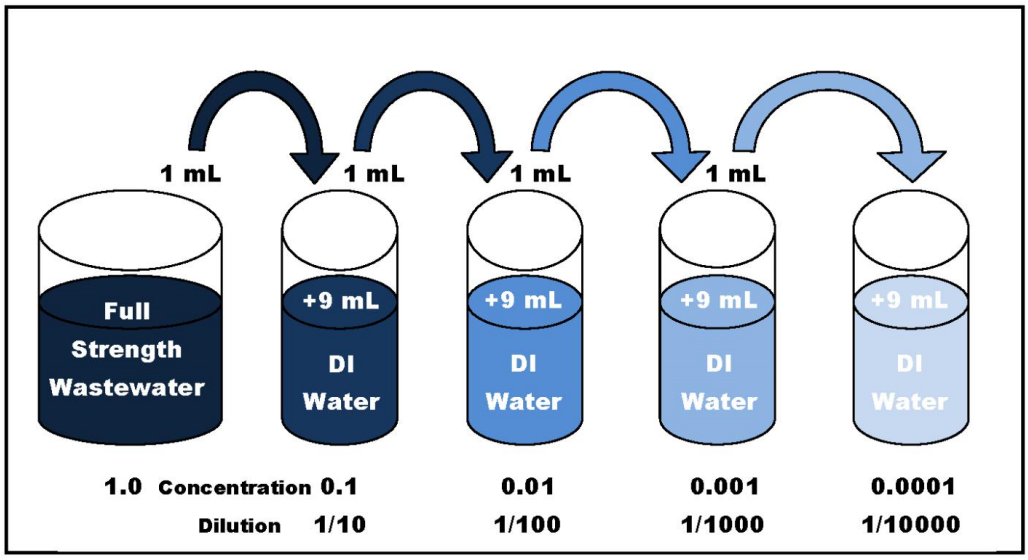
4.3 Dilutions and Ion Concentration

pg 445-450 in Heath
pg 467-468 in Matter and Change



Dilution

In the lab, we use concentrated solutions of standard molarities (stock solutions) to prepare a less concentrated solution by diluting the stock solution with solvent.

If we had a salt water solution at a specific volume, we could dilute it by adding more water.

Before Dilution

Initial Solution

After Dilution

Final Solution

M_i = initial # of moles / initial volume

M_f = final # of moles / final volume

Notice that since we did not add any more solute, the number of moles will not change. The volume changes, (increased the number of solvent particles); thereby decreasing the concentration of the solution.

Therefore, we get the following mathematical set up since the initial # of moles equals the final # of moles:

$C_1V_1 = C_2V_2$ OR $M_1V_1 = M_2V_2$

1 = initial 2 = final

Ex) What volume of concentrated (18.0 M) sulfuric acid (in mL), is required to prepare 5.00 L of 0.150 M solution when diluted with water?

Dilution

Examples from Heath Text p. 446-447

Example 16-1

If you have 500ml of a 0.4*M* NaCl solution, how much water is needed to make a 0.1*M* solution?

Example 16-2

A chemist adds water to 120mL of a 6.0*M* solution of NaOH until the final volume is 2.0L. What is the molarity of the resulting solution?

Example 16-4

What concentration results when 150mL of a 0.36 *M* solution of $MgSO_4$ is added to 750mL of water?

Serial Dilution

a process used to get a very dilute solution.

To perform a serial dilution, you take a stock solution and dilute it to a known concentration. Take some volume of the new solution and dilute it, and so on.

Ex) During a serial dilution, you use 10.0 mL of a stock solution and dilute it to 1.00 L three times. The 1.00 L stock solution contains 25.0 g of NaOH. What is the final concentration after the serial dilution?

Concentration of Ions in a Solution

Often, we will come across solutions that involve ionic compounds and acids.

These types of solutions are called **electrolytic solutions** because of their ability to conduct electricity.

In a case like this, we will want to be able to calculate the concentration of the ions, and not necessarily the concentration of the solution. We will neec balanced equations to help us with this...

Recall dissociation: $Na_2O_3 \longrightarrow 2Na^+_{(aq)} + CO_3^{2-}{}_{(aq)}$

The key to dissociation is to see the mole ratios for the ions. Therefore, the concentration of the Na^+ is double that of CO_3^{2-}

The coefficients above will become useful in the following example.

Ex) If we have a 0.20 M solution of Na_2CO_3 what is the concentration for each of the ions produced?

Concentration of Ions in a Solution

Examples from Heath Text p. 446-447

Example 16-5:

Find $[Cr^{3+}]$ and $[SO_4^{2-}]$ in a 0.020*M* solution of $Cr_2(SO_4)_3$.

Example 16-6:

A saturated solution of $PbCl_2$ is found to contain 9.9g of $PbCl_2$ per litre of solution
Find $[Pb^{2+}]$ and $[Cl^-]$

Mixing of Solutions

Often we mix two or more solutions, which increases the volume. The concentration of the solutes are therefore reduced.

Examples from Heath Text p. 446-447

Example 16-7:

250mL of 0.30M K_2SO_4 and 250 mL of 0.80M $MgCl_2$ are mixed and no reaction results. What is the concentration of each of the substances in the final solution and the concentration of each individual ion?

Example 16-8:

2.0L of 0.60M $FeCl_3$ solution is mixed with 1.0L of 0.90M $BaCl_2$ solution. No reaction occurs. What is the concentration of each ion in the final solution?

2.3 – Dilutions and Ion Concentrations Assignment

1. An experiment requires 2.00 L of 0.200 M hydrochloric acid (HCl) solution. What volume of concentrated hydrochloric acid, containing 11.9 M hydrogen chloride, is needed?

2. A chemist adds water to 120 mL of a 6.0 M solution of NaOH until the final volume is 2.0 L. What is the molarity of the resulting solution?

3. What concentration results when 150 mL of a 0.36 M solution of magnesium sulfate, MgSO4, are added to enough water to give a final solution volume of 750 mL?

4. What concentration results when 150 mL of a 0.36 M solution of magnesium sulfate, MgSO4, are added to 750 mL of water?

5. Describe how you would prepare 250.0 mL of a standard 1.00 M NaOH solution.

6. Lithium hydroxide has a solubility of 0.355 M. Find the concentration of the ions in the solution.

7. Iron(III) nitrate has a solubility of 0.15 M. Find concentration of the ions in solution.

8. Calculate ion concentrations in a 2.00 L solution containing 17.1 g aluminum sulfate, $Al_2(SO_4)_3$

9. If 12.0 mL of a standard solution is diluted to 1.50 L twice during a serial dilution, what is the final concentration? The 2.00 L standard solution contains 6.86 g of HCl.

10. After performing a serial dilution 3 times you find the concentration of the final $Mg(NO_3)_2$ solution is 1.30×10^{-5} M. If each serial dilution took 20.0 mL of a previous solution and diluted it to 1.25 L, what was the mass of $Mg(NO_3)_2$ in the standard solution?

11. Calculate the concentration of each ion in each of the following mixed solutions in which no reaction occurs

a. 2.0L of 4.0M $MgSO_4$ mixed with 2.0L of 0.80M KI

b. 3.0L of 0.48M NaOH mixed with 1.0L of 0.32M KOH

Attachments

Solution Concetration Handout.doc