Dilution: Definition and Calculations

To dilute a solution means to add more solvent without the addition of more solute. Of course, the resulting solution is thoroughly mixed so as to ensure that all parts of the solution are identical.

The fact that the solute amount stays constant allows us to develop calculation techniques.

First, we write:

moles before dilution = moles after dilution

From the definition of molarity, we know that the moles of solute equals the molarity times the volume.

So we can substitute MV (molarity times volume) into the above equation, like this:

$$M_1V_1 = M_2V_2$$

The "sub one" refers to the situation before dilution and the "sub two" refers to after dilution. We will call this the dilution equation.

This equation does not have an official name like Boyle's Law, so

Example #1

53.4 mL of a 1.50 M solution of NaCl is on hand, but you need some 0.800 M solution. How many mL of 0.800 M can you make?

Using the dilution equation, we write:

(1.50 mol/L) (53.4 mL) = (0.800 mol/L) (x)

Solving the equation gives an answer of 100. mL.

Notice that the volumes need not be converted to liters. Any old volume measurement is fine, just so long as the same one is used on each side.

Example #2

100.0 mL of 2.500 M KBr solution is on hand. You need 0.5500 M. What is the final volume of solution which results?

Placing the proper values into the dilution equation gives:

(2.500 mol/L) (100.0 mL) = (0.5500 mol/L) (x)

x = 454.5 mL

Sometimes the problem might ask how much more water must be added. In this last case, the answer is 454.5 - 100.0 = 354.5 mL.

Go ahead and answer the question, if your teacher asks it, but it is bad technique in the lab to just measure out the "proper" amount of water to add and then add it. The volumes are not necessarily additive. The only volume of importance is the final solution's volume. You add enough water to get to that volume without caring how much the actual volume is.

Practice Problems

1. A stock solution of 1.00 M NaCl is available. How many milliliters are needed to make 100.0 mL of 0.750 M

2. What volume of 0.250 M KCl is needed to make 100.0 mL of 0.100 M solution?

3. Concentrated H_2SO_4 is 18.0 M. What volume is needed to make 2.00 L of 1.00 M solution?

4. Concentrated HCl is 12.0 M. What volume is needed to make 2.00 L of 1.00 M solution?

5. A 0.500 M solution is to be diluted to 500.0 mL of a 0.150 M solution. How many mL of the 0.500 M solution are required?

6. A stock solution of 10.0 M NaOH is prepared. From this solution, you need to make 250.0 mL of 0.375 M solution. How many mL will be required?

7. 2.00 L of 0.800 M NaNO 3must be prepared from a solution known to be 1.50 M in concentration. How many mL are required?

These next two are a bit harder and involve slightly more calculation than the discussion above. Keep in mind the definition of molarity.

8. Calculate the final concentration if 2.00 L of 3.00 M NaCl and 4.00 L of 1.50 M NaCl are mixed. Assume there is no volume contraction upon mixing.

9. Calculate the final concentration if 2.00 L of 3.00 M NaCl, 4.00 L of 1.50 M NaCl and 4.00 L of water are mixed. Assume there is no volume contraction upon mixing.