Solutions Exercises

Purpose: The purpose of this exercise is to give the student practice in problems requiring calculations of solution concentrations.

Do not hand in this work sheet. When you are ready, you will be given an examination over this material. Complete the examination by your self and hand it in to receive credit.

1) Calculate the concentration of a solution made by diluting a 0.125 M solution of HCl from 25 mL to 250 mL.
SET-UP:

Using MV = n parametrically, $M_1V_1 = M_2V_2$

ANS: **0.0125** M

2) Calculate the concentration of an acetic acid solution prepared by mixing 13.5 mL of 10.0 M acetic acid with 250.0 mL of 0.15 M NaCl solution.
SET-UP:

Final volume is 263.5 mL

ANS: **0.51** M

3) For problem 2, what is the resultant NaCl concentration?
SET-UP:

ANS: **0.14** M

4) Calculate the concentration of each ion in a solution prepared by mixing 200.0 mL of 0.20 M NaCl with 50.0 mL of 0.50 M KNO_3.
SET-UP:

[NaCl] = 0.16 M ∴ $[Na^+] = [Cl^-] = 0.16$ M

$[KNO_3] = 0.10$ M ∴ $[K^+] = [NO_3^-] = 0.10$ M

Na^+ = **0.16** M

Cl^- = **0.16** M

K^+ = **0.10** M

NO_3^- = **0.10** M

For the following questions, refer to the reaction:

$NaOH + HCl \rightarrow NaCl + H_2O$

5) If 25.0 mL of 0.1025 M NaOH is reacted completely with HCl, how many moles of NaCl are produced?
SET-UP:

n_{NaOH} = (0.1025 M)(25.0 mL) = 2.56 mmol (what does *m*mol mean?)

$n_{NaOH}/1 = n_{NaCl}/1$ from $NaOH + HCl \rightarrow NaCl + H_2O$

ANS: **2.56×10^{-3}** mol

6) If 45.0 mL of 0.1025 M NaOH is reacted completely with HCl and the resultant volume is 125 mL, what is the molarity of the resultant NaCl solution?
SET-UP:

$n_{NaOH} = 4.61$ mmol $= n_{NaCl}$

$M_{NaCl} = 4.61$ mmol/125 mL

ANS: **3.69×10^{-2}** M

7) If 45.0 mL of 0.1025 M NaOH if reacted with 35.0 mL of 0.110 M HCl, what is the molarity of the resultant NaCl, NaOH and HCl solutions?
SET-UP

Both NaOH and HCl are fully given; ∴, this is a limiting reactant problem.

n_{NaOH} = 4.61 mmol to give 4.61 mmol of NaCl
n_{HCl} = 3.85 mmol to give 3.85 mmol of NaCl. ∴ HCl is limiting.

M_{NaCl} = 3.85 mmol/80.0 mL

NaCl = **0.0481** M

n_{NaOH} left = 4.61 mmol (initial) - 3.85 mmol (reacted) = 0.76 mmol

M_{NaOH} = 0.76 mmol/80.0 mL

NaOH = **0.0095** M

HCl is used up

HCl = **0** M

If you have had difficulty with the above problems, STOP. Review the sections in your text on solutions - dilutions and the definitions of molarity. Proceeding beyond this point without being able to work the above problems will be a waste of your time.

Titration

Review the sections in your text book which refer to (strong acid-strong base) titration. In a titration, the stoichiometry is exact for the left hand side (reactants) of the reaction. Key words to look for to indicate this are "titration", "end point", "(exactly) neutralize", and "equivalence point".

(Still referring to the reaction: $NaOH + HCl \rightarrow NaCl + H_2O$)

8) A 0.1064 M NaOH solution was used to find the concentration of an HCl solution. 20.00 mL of the HCl solution was used. In order to reach an end point 18.42 mL of the NaOH solution was used. What is the concentration of the HCl?
SET-UP:

Careful with methodology! This is not a dilution problem. (See question 9)

ANS: **0.09799** M

9) For the reaction: $2NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O$, how many liters of 1.05 M NaOH are required to exactly neutralize 224 L of 1.05 M H_2SO_4?
SET-UP:

Note here: $n_{NaOH}/2 = n_{H2SO4}/1$!

ANS: **448** L

10) Benzoic acid has a molecular weight of 122.13 g/mol and has one acidic hydrogen. In a standardization procedure, 0.443 g of benzoic acid was used in a titration with a NaOH solution. The end point was observed after using 35.40 mL of NaOH solution. What was the concentration of the NaOH?
SET-UP:

let HX ≡ benzoic acid

$HX + NaOH \rightarrow NaX + H_2O$ and $n_{HX}/1 = n_{NaOH}/1$

$n_{HX} = 0.443\ g/122.12\ g/mol = 3.63 \times 10^{-3}\ mol = n_{NaOH}$

$M_{NaOH} = 3.63 \times 10^{-3}\ mol/35.40 \times 10^{-3}\ L =$

ANS: **0.1025** M