Notes for chem 101 lecture 7a
0) admin – Test 2 is on Feb 24 (Wed). 2 Furloughs are coming up: Fri Feb 19 and Mon Feb 22. The test will be on chapters 4-5. (stoichiometry). Review session will be on Tuesday Feb 23: 12-1 pm PS 607 (if available)
0a) Review guide has been emailed and also posted
0b) a practice problem set has been emailed and posted.
0c) return pop quizzes...
0d) attendance sheet

1) **titration**.
Purpose of titration is to determine the conc of a solution (of acid or base). The nature of the solute is known but not its conc.

Examples:

a) Monoprotic acid vs monoprotic base.

Titration of 25.0 mLs of NaOH requires 16.5 mLs of 0.170 M HCl to reach the equivalence point. What is the concentration of NaOH?

Titration equation: HCl + NaOH --> H_2O + NaCl (a "1:1" titration)

$$[\text{NaOH}] = \frac{\#\,\text{mol}_{\text{NaOH}}}{\text{L}_{\text{NaOH}}} = \{\ 16.5\ \text{x}10^{-3}\text{L HCl}\ \left(\frac{0.170\ \text{mol}}{\text{L}}\right)\left(\frac{1\ \text{mol NaOH}}{1\ \text{mol HCl}}\right)\}\ /25.0\ \text{x}10^{-3}\text{L}$$
$$=0.112\ \text{mol NaOH/L} = 0.112\ \text{M}$$

Another way:
Review:
Molarity , M = [solute] = n/V where n = moles,
V= volume in liters.
We pointed out: # moles = n =MV

Always true at equivalence:
moles H^+ donated = # moles H^+ accepted
#mols HCl = # mols NaOH (since each transfers 1 H^+ /mole)
or, $M_{HCl}V_{HCl} = M_{NaOH}V_{NaOH}$ (or "$M_1V_1 = M_2V_2$")
and so:
$M_{NaOH} = M_{HCl}V_{HCl} / V_{NaOH}$

or, $M_{NaOH} = \frac{M_{HCl}V_{HCl}}{V_{NaOH}} = \frac{(0.170M)(16.5mL)}{(25.0mL)} = 0.112_2M = 0.112$ M NaOH.

In general for 1:1 titrations; $M_1V_1 = M_2V_2$ where
in this case, 1 = HCl, and 2 = NaOH

b) Diprotic acid vs monoprotic base:

Titration of 25.0 mLs of NaOH requires 16.5 mLs of 0.170 M $H_2C_2O_4$ (oxalic acid) to reach the equivalence point. What is the concentration of NaOH?

Titration equation: $H_2C_2O_4 + 2\ NaOH \rightarrow 2H_2O + Na_2C_2O_4$ (a "1:2" titration)

$$M_{NaOH} = \frac{\#\,mol_{NaOH}}{L_{NaOH}} = \{\ 16.5 \times 10^{-3} L\ H_2C_2O_4 \left(\frac{0.170\ mol}{L}\right)\left(\frac{2\ mol\ NaOH}{1\ mol\ H_2C_2O_4}\right)\}\ /25.0 \times 10^{-3} L$$

$= 0.224$ mol NaOH/L = 0.224 M

Other way:
Always true at equivalence:
moles H^+ donated = # moles H^+ accepted
#mols $H_2C_2O_4$ x 2 = # mols NaOH
or, $2\ M_{H2C2O4}V_{H2C2O4} = M_{NaOH}V_{NaOH}$
(or "$2\ M_1V_1 = M_2V_2$")
and so:

or, $M_{NaOH} = \frac{2\ M_{H_2C_2O_4}V_{H_2C_2O_4}}{V_{NaOH}} = \frac{2\ (0.170M)(16.5mL)}{(25.0mL)} = 0.224_4M = 0.224$ M NaOH.

In general for 1:2 titrations:
$2\ M_1V_1 = M_2V_2$ where in this case, 1 = $H_2C_2O_4$, and 2 = NaOH

2) Discuss dilutions

How do we dilute solutions? By adding more solvent to the solution thus increasing its volume without increasing its moles solute.

Example: A sample contains 25.0 mLs of 2.00 M NaCl solution. If we add enough water to the solution to make its final volume 100. mLs, what is the new concentration of NaCl?

moles initially = # moles after dilutions (recall that # moles = n =MV)

$M_{initial}V_{initial} = M_{final}V_{final}$

The problem asks for M_{final} :

$M_{final} = M_{initial}V_{initial} / V_{final}$ = (2.00M)(25.0)/(100.) = 0.500M

Note: $M_1V_1 = M_2V_2$; so $M_2 = M_1V_1 / V_2 = M_1 (V_1/V_2)$
We speak of V_1/V_2 as the "dilution factor". In this case 25/100 = 0.25 = dilution factor.
Remember that it is easier to dilute a sample than to concentrate it!

3) Review the concept of bronsted lowry definition of acid and base:

acid= proton donor

base = proton acceptor

H_2CO_3 is an acid because it can do this:

$H_2CO_3 + OH^- \rightarrow HCO_3^- + H_2O$

We say that HCO_3^- is the conjugate base of H_2CO_3

And H_2CO_3 is the conjugate acid of HCO_3^-

OK??

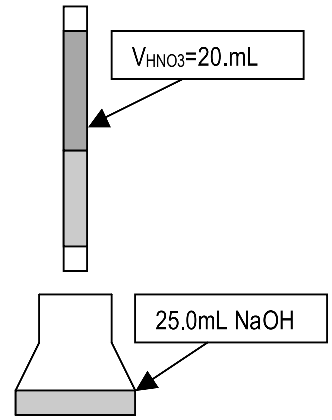
Is HCO_3^- an acid or a base??

Both! Depends on the reaction!

Try this pop quiz:
(1) Write down the balanced chemical equation for the following neutralization reaction between potassium hydroxide and phosphoric acid:

(2) Titration of 25.0 mLs of NaOH requires 20.0 mLs of 0.500 M HNO_3 to reach the equivalence point. Answer the following questions:
a) What is the concentration of NaOH, [NaOH] ?

(ans. 0.400M)



b) If instead of adding only 20.0 mLs of the HNO_3 you add 25.0 mLs (i.e. you exceed the equivalence point by 5.0 mLs), what is the [HNO_3] in the resulting solution in the flask?
(hint: don't forget to take into account the change in volume)

(ans: 0.0500M)