Name:______________________________
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Chemistry 12
ACID BASE PART II Lesson # 15
Mixing STRONG acids and Bases

$M_1V_1 = M_F V_F$ mixing

Recall the NET IONIC EQUATION for the NEUTRALIZATION reaction of a strong acid with a strong base:

$2H_2O(l) + 59kJ \rightleftharpoons H_3O^+ + OH^-$

1 : 1

When you MIX A STRONG ACID WITH A STRONG BASE there are THREE POSSIBLE OUTCOMES:

1. $[H_3O^+] = [OH^-] \Rightarrow$ neutral
2. $[H_3O^+] > [OH^-]$ or $[OH^-] < [H_3O^+] \Rightarrow$ ACIDIC
3. $[H_3O^+] < [OH^-]$ or $[OH^-] > [H_3O^+] \Rightarrow$ BASIC

TO SOLVE THESE PROBLEMS THE FOLLOWING EQUATIONS ARE USED:

A. IF THE SOLUTION IS BASIC (pH > 7)

$[OH^-]_{XS} = [OH^-]_{ST} - [H_3O^+]_{ST}$

B. IF THE SOLUTION IS ACIDIC (pH < 7)

$[H_3O^+]_{XS} = [H_3O^+]_{ST} - [OH^-]_{ST}$

Example 1. If 10.0 mL of 0.100 M HCl is mixed with 90.0 mL of 0.100 M NaOH, What is the pH of the resulting mixture?

1. HCl is a strong acid , [HCl] = [H_3O+] NaOH is a strong base; [NaOH] = [OH-]

∴ 0.100 M H_3O^+ (M_1) ∴ 0.100 M OH^- (M_1)

2. Dilution calculations for [H_3O+] and [OH-]:

$[H_3O^+]_{ST} = \frac{0.100\,M \cdot 0.0100\,L}{0.1000\,L} = 0.0100\,M\ H_3O^+$

$[OH^-]_{ST} = \frac{0.100\,M \cdot 0.0900\,L}{0.1000\,L} = 0.0900\,M\ OH^-$

3. Which ion has the larger concentration? [H_3O+] or [OH-]?

$0.0900\,M\ OH^- > 0.0100\,M\ H_3O^+$

4. Solve for the XS of OH^-.

$[OH^-]_{XS} = [OH^-]_{ST} - [H_3O^+]_{ST} = 0.0900\,M - 0.0100\,M = 0.0800\,M\ OH^-$

5. Solve for the pH

$pOH = -\log(0.0800) = 1.097$

$pH = 14.000 - 1.097$

$pH = 12.903$

Example 2. Calculate the pH that results when 50.0 mL of 0.150 M LiOH is mixed with 50.0 mL of 0.200 M HNO_3.

1. HNO_3 is a strong acid; $[HNO_3] = [H_3O+]$ LiOH is a strong base; $[LiOH] = [OH-]$

∴ 0.200 M H_3O^+ ∴ 0.150 M OH^-

2. Dilution calculations for $[H_3O+]$ and $[OH-]$:

$[H_3O^+]_{ST} = \frac{0.200 M \cdot 0.0500 L}{0.1000 L} = 0.100 M\ H_3O^+$

$[OH^-]_{ST} = \frac{0.150 M \cdot 0.0500 L}{0.1000 L} = 0.0750 M\ OH^-$

3. Which ion has the larger concentration? $[H_3O+]$ or $[OH-]$?

0.100 M H_3O^+ > 0.0750 M OH^-

4. Solve for the XS of H_3O^+.

$[H_3O^+]_{XS} = [H_3O^+]_{ST} - [OH^-]_{ST}$

$= 0.100 M - 0.0750 M = 0.025 M\ H_3O^+$

5. Solve for the pH

pH = −log (0.025)

pH = 1.60

Example 3. How many grams of NaOH must be added to 40.0 mL of 0.180 M HCl to produce a solution having a pH of 12.500. Assume NO CHANGE in volume when the NaOH is added.

1. pH of 12.500 means the solution is BASIC. There is an excess of OH^-!

2. Use pH to solve for the excess concentration of $[OH^-]_{XS}$.

pOH = 14.000 − 12.500

pOH = 1.500

$[OH^-]_{XS}$ = antilog (−1.500) = $3.16 \cdot 10^{-2}$ M OH^- = 0.0316 M

3. Rearrange the XS equation to solve for $[OH^-]_{ST}$

$[OH^-]_{XS} = [OH^-]_{ST} - [H_3O^+]_{ST}$

+0.180 M 0.0316 M = $[X]_{ST}$ − 0.180 M +0.180

$[OH^-]_{ST}$ = 0.212 M

4. Now convert concentration into grams!

$0.0400 L \cdot \frac{0.212 \text{ mol NaOH}}{1 L} \left(\frac{40.0 \text{ g NaOH}}{1 \text{ mol NaOH}}\right) = 0.339 \text{ g NaOH}$

1 Na = 23.0
1 O = 16.0
1 H = 1.0

SEATWORK/HOMEWORK: Exercises 58 - 68 pgs 143-144 in Hebden

PLO's: P5