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

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

$H_3O^+ + OH^- \rightleftharpoons 2H_2O$

or

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

Ratio 1 H_3O^+ : 1 OH^-

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

1. $[H_3O^+] = [OH^-]$ = neutral (pH = 7)
2. $[H_3O^+] > [OH^-]$ = acidic (pH < 7)
3. $[H_3O^+] < [OH^-]$ = basic (pH > 7)

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^-]

$[H_3O^+]_I = 0.100\,M$ $[OH^-]_I = 0.100\,M$

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

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

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

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^-.

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

5. Solve for the pH

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

$pH = 14.000 - 1.097$
$pH = 12.903$

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; [HCl] = [H_3O^+]   LiOH is a strong base; [LiOH] = [OH^-]

$[H_3O^+]_T = 0.200\ M$ $[OH^-]_T = 0.150\ M$

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

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

$$[OH^-]_{ST} = \frac{0.150\,M \times 0.0500\,L}{0.100\,L} = 0.0750\,M\ OH^-$$

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^+.

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

$[H_3O^+]_{xs} = 0.100\,M - 0.0750\,M = \boxed{0.025\,M\ H_3O^+}$

5. Solve for the pH

$pH = -\log(0.025)$

$\boxed{pH = 1.60}$

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}.

$pOH = 14.000 - 12.500$

$pOH = 1.500$

$[OH^-] = \text{antilog}(-1.500) = 3.16 \times 10^{-2}\,M\ OH^-_{xs}$

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

$[OH^-]_{xs} = [OH^-]_{ST} - [H_3O^+]_{ST}$ $\therefore$ $[OH^-]_{ST} = [OH^-]_{xs} + [H_3O^+]_{ST}$

$[OH^-]_{ST} = 3.16 \times 10^{-2}\,M + 0.180\,M = 0.212\,M\ OH^-$

4.Now convert concentration into grams!

Na = 23.0
O = 16.0
H = 1.0
40.0

$$\frac{0.212\ \text{mol}\ OH^-}{1\ L} \times 0.0400\ L \times \frac{40.0\ g\ NaOH}{1\ mol} = \boxed{0.339\ g\ NaOH}$$

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

PLO's: P5