

**This is BCE#22.**

**I recommend you print out this page and bring it to class. [Click here](#) to show a set of five BCE22 student responses randomly selected from all of the student responses thus far in a new window.**

**John , here are [your responses](#) to the BCE and the [Expert's response](#).**

**Our discussion of acids and bases has prepared you to calculate the pH of the following solutions,**

**strong acids**

**weak acids**

**strong bases**

**weak bases**

**the salt of a strong acid and a strong base**

**the salt of a strong acid and a weak base**

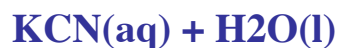
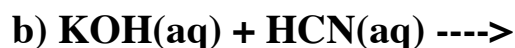
**the salt of a weak acid and a strong base**

**common ion - weak acid and its conjugate base**

**common ion - weak base and its conjugate acid**

**Our next system to consider in aqueous equilibria is the neutralization reaction. Lets look at a neutralization reaction in the context of the different types of acids and bases.**

**1. Predict the products of the following neutralization reactions:**





2. Let get more quantitative with the first neutralization reaction. NOTE: This is solution stoichiometry calculations from CHEM 1314 so watch out! Suppose you are doing a titration (laboratory last week) to determine the concentration of a standardized solution of NaOH. Here is the following data that you collect in the experiment. (NOTE: The endpoint of a titration is when the mol of acid = mol of base)

Volume of standard NaOH solution : 15.00 mL

Concentration of  $\text{HNO}_3$  : 0.424 M

Volume of  $\text{HNO}_3$  solution required to reach the endpoint of the titration : 10.00 mL

a) how many mol of  $\text{HNO}_3$  reacted?

mol  $\text{HNO}_3$  0.00424 93%

$$\text{mol HNO}_3 = 0.0100 \text{ L} * (0.424 \text{ mol HNO}_3 / 1 \text{ L}) = 0.00424 \text{ mol HNO}_3$$

b) how many mol of NaOH reacted?

mol NaOH 0.00424 93%

$$\text{mol NaOH reacting} = \text{mol HNO}_3 \text{ reacting} = 0.00424 \text{ mol}$$

c) concentration of the standard NaOH solution?

0.283 M NaOH 79%

$$\text{molarity of NaOH} = \text{mol NaOH} / \text{liters solution} = 0.00424 \text{ mol NaOH} / 0.015 \text{ L} = 0.283 \text{ M}$$

3. Lets consider a titration where the concentration of NaOH is 0.283 M. In the titration the NaOH is added to a 25.0 mL sample of a 0.424 M  $\text{HNO}_3$  solution.

a) Calculate the pH of the  $\text{HNO}_3$  solution before any base is added.

$$\text{pH} = 0.372$$

71%

$$\text{pH} = -\log [\text{H}^+]$$

In a solution that is 0.424 M  $\text{HNO}_3$  the  $[\text{H}^+] = 0.424 \text{ M}$  because  $\text{HNO}_3$  is a strong acid.

$$\text{pH} = -\log (0.424) = 0.373$$

b) If 5.00 mL of 0.283 M NaOH is added to the 25.0 mL sample of 0.424 M  $\text{HNO}_3$  answer the following questions:

i) How many mol of NaOH have been added when 5.00 mLs of 0.283 M NaOH are added to the acid solution?

$$\text{mol of NaOH added } 0.001415 \quad 93\%$$

$$0.0050 \text{ L} * (0.283 \text{ mol NaOH}/1 \text{ L}) = 0.00142 \text{ mol NaOH added}$$

ii) How many mol of  $\text{HNO}_3$  would react?

$$\text{mol of } \text{HNO}_3 \text{ reacting } 0.001415 \quad 79\%$$

$$\text{mol } \text{HNO}_3 \text{ reacting} = \text{mole of NaOH added} = 0.00142 \text{ mol } \text{HNO}_3$$

iii) How many mol of  $\text{HNO}_3$  remain unreacted?

$$\text{mol of } \text{HNO}_3 \text{ remaining } 0.009185 \quad 79\%$$

The initial number of mol of  $\text{HNO}_3$  are

$$0.0250 \text{ L} * (0.424 \text{ mol } \text{HNO}_3/1 \text{ L}) = 0.0106 \text{ mol } \text{HNO}_3$$

From ii) the mol  $\text{HNO}_3$  reacting are = 0.00142 mol

$$\text{So mol of } \text{HNO}_3 \text{ remaining} = \text{mol } (\text{HNO}_3)_0 - \text{mol } (\text{HNO}_3)_r = 0.0106 \text{ mol} - 0.00142 \text{ mol} = 0.00918 \text{ mol}$$

iv) What is the new concentration of  $\text{HNO}_3$  after addition of NaOH

new  $[\text{HNO}_3]$  0.306 M

57%

$$\begin{array}{r} 14\% \ 0.00918 \\ \hline 0.025 \end{array}$$

The new concentration of  $\text{HNO}_3 = \text{mol HNO}_3/\text{volume solution}$

We have to be careful with this calculation. The mol of  $\text{HNO}_3$  are in iii) but the volume of the solution is the volume of the sample of  $\text{HNO}_3$  initially plus the volume of  $\text{NaOH}$  solution added. So the calculation is...

$$0.00918 \text{ mol HNO}_3 / 0.030 \text{ L} = 0.306 \text{ M HNO}_3$$

v) What is the new pH of the solution

$$\text{pH} = 0.514 \quad 57\%$$

$$\text{pH} = -\log [\text{H}^+]$$

In a solution that is 0.306 M  $\text{HNO}_3$  the  $[\text{H}^+] = 0.306 \text{ M}$  because  $\text{HNO}_3$  is a strong acid.

$$\text{pH} = -\log (0.306) = 0.514$$

Notice after adding some  $\text{NaOH}$  the pH is higher. Since some of the  $\text{HNO}_3$  has been neutralized the pH increases.

4. Is there anything about the questions that you feel you do not understand? List your concerns/questions.

nothing

5. If there is one question you would like to have answered in lecture, what would that question be?

nothing