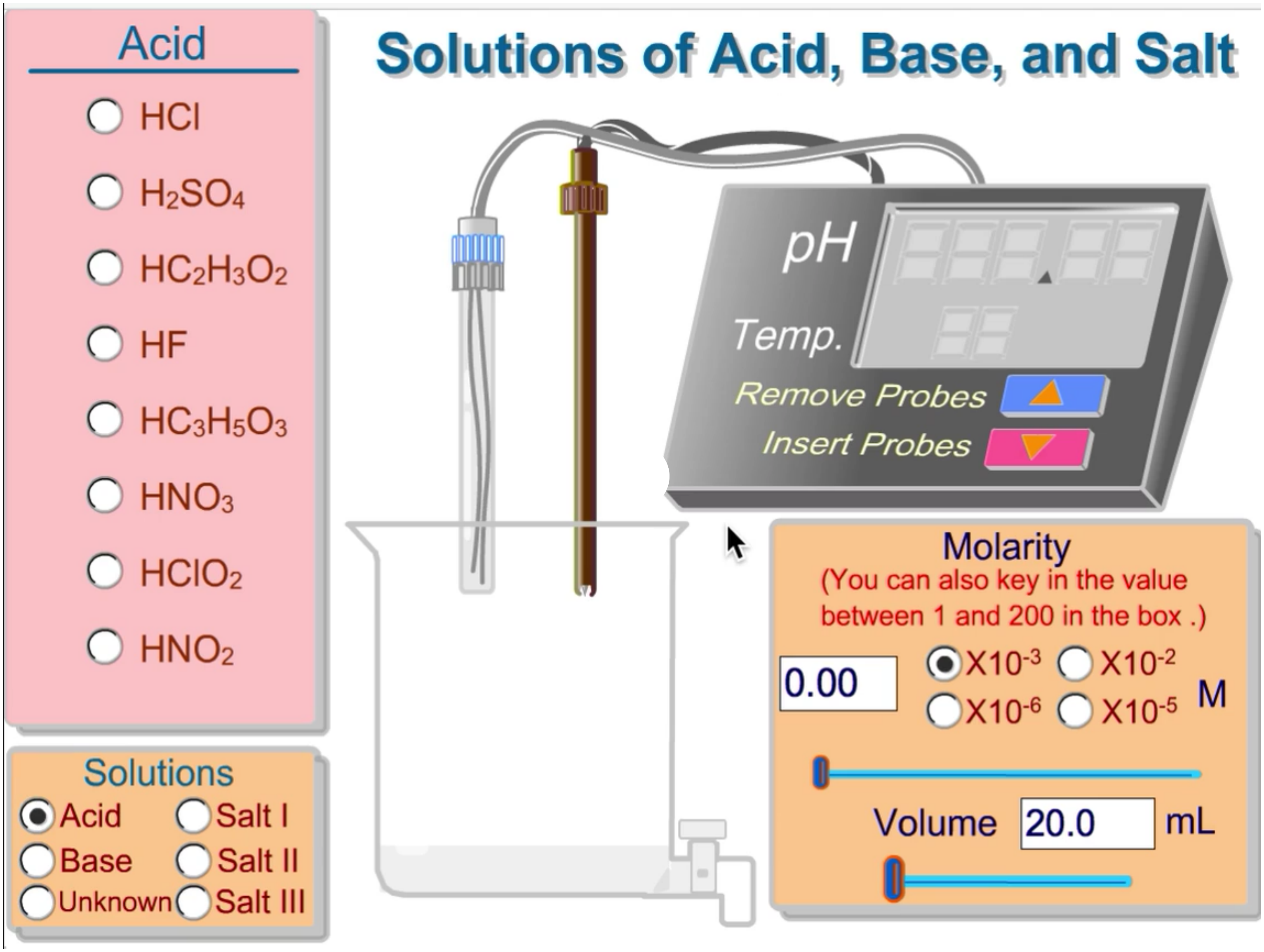
This is BCE#17.

I recommend you print out this page and bring it to class. Click here to show a set of five BCE17 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.

In this BCE you will measure the pH of several aqueous solutions of acids and bases. You will watch a movie of a ph meter simulation developed at Iowa State University by Dr. Greenbowe and his students. Play the movie below. In the movie the concentrtion of each solution is set to 0.100 M. The beaker will be filled with 75 mLs of each solution in turn. You are to record the measured pH and then to calculate the [H$^+$] for each measurement in the table below the movie.



1a. Complete the pH column in the following table.

Solution	**pH**	**Equilibrium [H$^+$] or [OH$^-$]**
0.100 M HCl	0.99 1.00	[H$^+$] = 1.0 x 10^{-1} M

100% 79%

0.100 M HNO_3	0.99 1.00 100%	1E-1 $[H^+] = 1.0 \times 10^{-1}$ M 79%
0.100 M H_2SO_4	0.88 0.88 95%	0.131 $[H^+] = 1.31 \times 10^{-1}$ M 68%
0.100 M $HC_2H_3O_2$	2.87 2.87 95%	1.31E-3 $[H^+] = 1.35 \times 10^{-3}$ M 68%
0.100 M NaOH	13 13.00 100%	1E-1 $[OH^-] = 1.0 \times 10^{-1}$ M 53%
0.100 M NH_3	11.12 11.12 95%	1.32E-3 $[OH^-] = 1.32 \times 10^{-3}$ M 47%

Sample Calculation of $[H^+]$:

We know that pH = - log $[H^+]$, to solve for the $[H^+]$ the negative sign must be moved to the side with pH

- pH = log $[H^+]$

then both sides must be raised to the power of 10,

or $10^{-pH} = 10^{\log[H^+]}$

but $10^{\log[H^+]} = [H^+]$

therefore $[H^+] = 10^{-pH}$

To solve for the $[H^+]$ for 0.100 M HCl we use the measured pH of the solution (pH = 1.00) in the equation $[H^+] = 10^{-pH}$ to determine the equilibrium $[H^+]$.

$[H^+] = 10^{-1}$ so $[H^+] = 1 \times 10^{-1}$ M

To solve for the $[H^+]$ for 0.100 M H_2SO_4 we use the measured pH of the solution (pH = 0.88) in the equation $[H^+] = 10^{-pH}$ to determine the equilibrium $[H^+]$.

$[H^+] = 10^{-0.88}$ so $[H^+] = 1.3 \times 10^{-1}$ M

To solve for the $[H^+]$ for 0.100 M $HC_2H_3O_2$ we use the measured pH of the solution (pH = 2.87) in the equation $[H^+] = 10^{-pH}$ to determine the equilibrium $[H^+]$.

$[H^+] = 10^{-2.87}$ so $[H^+] = 1.3 \times 10^{-3}$ M

To solve for the $[OH^-]$ for 0.100 M NaOH we use the measured pH of the solution (pH = 13.00) in the equation $[H^+] = 10^{-pH}$ to determine the equilibrium $[H^+]$.

$[H^+] = 10^{-13}$ so $[H^+] = 1.0 \times 10^{-13}$ M and

and then recall that $1.0 \times 10^{-14} = [H^+][OH^-]$

or $[OH^-]= 1.0 \times 10^{-14} /[H^+]$

so for 0.100 M NaOH : $[OH^-]= 1.0 \times 10^{-14} /[1.0 \times 10^{-13}] = 1.0 \times 10^{-1}$ M

To solve for the $[OH^-]$ for 0.100 M NH_3 we use the measured pH of the solution (pH = 11.12) in the equation $[H^+] = 10^{-pH}$ to determine the equilibrium $[H^+]$.

$[H^+] = 10^{-11.12}$ so $[H^+] = 7.59 \times 10^{-12}$ M

$[OH^-] = 1.0 \times 10^{-14} / [H^+]$

so for 0.100 M NH_3 : $[OH^-] = 1.0 \times 10^{-14} / [7.59 \times 10^{-12}] = 1.3 \times 10^{-3}$ M

b) Complete the Equilibrium $[H^+]$ or $[OH^-]$ column by using the pH to calculate the $[H^+]$ or $[OH^-]$ for each acid or base.

2a. Each of the acids in the table above has the same concentration, 0.100 M. Did all of the acids have the same pH? No
No, two of the acids (HCl and HNO_3) had the same pH. However, both HCl and HNO_3 had different pH compared to H_2SO_4 and $HC_2H_3O_2$ (which differed between themselves).

b) What do you think might be an explanation for the experimental pHs you observed for this set of acids.

with the exception of HCl and HNO3 each acid dissociated to a different extent
HCl and HNO_3 are both monoprotic strong acids. H_2SO_4 is a diprotic acid, so we would not be surprised that its pH differs from a monoprotic strong acid. However, the pH of H_2SO_4 is even more interesting. The $[H^+]$ suggests that the second proton is not completely dissociated. If it were we would have expected a $[H^+] = 0.200$ M. So something interesting is going on there. Finally the pH of the $HC_2H_3O_2$ solution differs from everyone. $HC_2H_3O_2$ is a monoprotic acid, but the calculated $[H^+]$ suggests that the proton in $HC_2H_3O_2$ does not completely dissociate as was observed in HCl and HNO_3. This affirms that $HC_2H_3O_2$ is a weak acid.

3a. Each of the bases in the table above has the same concentration, 0.100 M. Did all of the bases have the same pH? No
No, two of the bases (NaOH and NH_3) have different pHs.

b) What do you think might be an explanation for the experimental pHs you observed for this set of bases.

each base dissociated to a different extent
NaOH is a strong base, while NH_3 is a weak base. A strong base completely dissociates. A weak base only partially dissociates.

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

nothing

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

nothing