

CHEM 1202 - Homework # 6

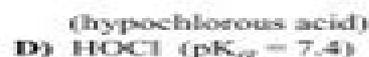
ANSWER KEY

Acids & Bases # 1

Due Tuesday, Nov 9th, 2004 (by Noon)

Check the box to the right if you want your graded homework to be placed out in the public rack outside Prof. Stanley's office. Otherwise you will have to pick up your homework from Prof. Stanley in person:

1. (3 pts) Consider the following weak acids and their  $pK_a$  values:



Which compound is the strongest acid (use letter)? **F**

The strongest acid has the smallest or most negative  $pK_a$  value. Triflic acid's  $pK_a$  of  $-10$  is equal to a  $K_a = 1 \times 10^{10}$ .

Which compound is the weakest acid (use letter)? **D**

The weakest acid has the largest most positive  $pK_a$  value. HOCl acid's  $pK_a$  of 7.4 is equal to  $K_a = 2.5 \times 10^{-8}$ .

Which compound has the strongest conjugate base (use letter)? **D**

The weakest acid has the strongest conjugate base!

2. (5 pts) What are the pH's for the following solutions?

a) 0.001 M HBr = **3**

b) 1 M  $\text{HNO}_3$  = **0**

c)  $1 \times 10^{-12}$  M  $\text{Sr}(\text{OH})_2$  = **7**

d) 10 M NaOH = **15**

e)  $1 \times 10^{-5}$  M KOH = **9**

See Acids & Bases page 19 in your notes!  
 $[\text{OH}^-]_{\text{total}} = [\text{OH}^-]_{\text{acid}} + [\text{OH}^-]_{\text{base}}$   
 $[\text{OH}^-]_{\text{total}} = 1 \times 10^{-7}$ , but  $[\text{OH}^-]_{\text{base}} = 2 \times 10^{-12}$   
 which is so small that you can ignore it

3. (3 pts) Calculate the pH of a 0.001 M solution of acid that has a  $pK_a$  of 5.0. Clearly show all your work and put a box around your answer.



First, convert the  $pK_a$  of 5 into a  $K_a$  value:  $K_a = \text{antilog}(-pK_a) = 1 \times 10^{-5}$ . Now, we can solve for the  $[\text{H}^+]$  and the pH.

$$K_a = \frac{(x)(x)}{(0.001 - x)} = 1 \times 10^{-5} \quad \text{assume that } x \ll 0.001, \quad \frac{x^2}{(0.001)} = 1 \times 10^{-5}, \quad \text{or } x^2 = 1 \times 10^{-8}$$

or  $x = [\text{H}^+] = 1 \times 10^{-4}$ . So the pH =  $-\log(1 \times 10^{-4}) = 4$

**pH = 4**

4. (4 pts) What is the  $K_a$  value of a 1 M solution of sabonic acid (HA) that has a pH of 4? Clearly show all your work and put a box around your answer.



BUT, before you go any further, I've given you the pH of the solution in the problem!! So you don't have to solve for  $x$ , you already know it!! So all we have to do is take the anti-log of pH 4 to get the concentration of the  $\text{H}^+$  (and  $\text{A}^-$ ):

$[\text{H}^+] = \text{antilog}(-4) = 1 \times 10^{-4} \text{ M}$ . Substituting this into the equilibrium expression gives us:

$$K_a = \frac{(1 \times 10^{-4})^2}{1 - 1 \times 10^{-4}} = \frac{1 \times 10^{-8}}{1} = 1 \times 10^{-8} \quad \text{so, } K_a = 1 \times 10^{-8}$$

Note that it is fine to drop the  $x$  in the  $1 - x$  expression because  $x$  is much smaller than 1.

So the answer is:  **$K_a = 1 \times 10^{-8}$**

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**Responsive Education Solutions**



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