

## Exam Wednesday Night

### Place

UTC 2.102A Last name A-K

UTC 2.112A Last name L-Z

### Time

7:30-9:00

We will start right at 7:30

We will end right at 9:00

get there early

# Makeup Exam Sunday night

Place  
TBD

Time  
6:30-8:00

Anyone who would  
like to can take the  
makeup exam

You cannot take  
both

When are you planning to take the exam

A. Wednesday night

B. Sunday night

## Converting pH and pOH

$$K_w = [\text{H}^+][\text{OH}^-]$$

$$\log(K_w) = \log([\text{H}^+][\text{OH}^-])$$

$$\log(K_w) = \log[\text{H}^+] + \log[\text{OH}^-]$$

$$\log(10^{-14}) = \log[\text{H}^+] + \log[\text{OH}^-]$$

$$-14 = -\text{pH} - \text{pOH}$$

$$14 = \text{pH} + \text{pOH}$$

For the next exam

Which of the following would be more helpful

- A. More worksheets
- B. Suggested back of the book problems
- C. Suggested problems on eduspace
- D. other

## Buffer Both HA and A-



	HA	H <sup>+</sup>	A <sup>-</sup>
I	[HA] <sub>0</sub>	0	[A <sup>-</sup> ] <sub>0</sub>
C	-x	+x	+x
E	[HA] <sub>0</sub> - x	+x	[A <sup>-</sup> ] <sub>0</sub> + x

*really 10<sup>-7</sup>* ←

$$K_a = \frac{[\text{H}^+][\text{A}^-]}{[\text{HA}]} = \frac{(x)([\text{A}^-]_0 + x)}{[\text{HA}]_0 - x} = \frac{(x)([\text{A}^-]_0)}{[\text{HA}]_0} \quad \text{assuming } x \ll C$$

## pH in a buffer solution

$$K_a \approx \frac{[H^+][A^-]_0}{[HA]_0}$$

we have approximated a small change

$$\log(K_a) \approx \log \frac{[H^+][A^-]_0}{[HA]_0} = \log[H^+] + \log \frac{[A^-]_0}{[HA]_0}$$

$$pK_a = pH - \log \frac{[A^-]_0}{[HA]_0}$$

$$\text{pKa} = \text{pH} - \log \frac{[\text{A}^-]_0}{[\text{HA}]_0}$$

initial conjugate base

initial weak acid

$$[\text{A}^-]_0 = [\text{HA}]_0$$

equal acid/base

$$-\log \frac{[\text{A}^-]_0}{[\text{HA}]_0} = 0$$

$$\text{pH} = \text{pKa}$$

$$[\text{A}^-]_0 < [\text{HA}]_0$$

more acid

$$-\log \frac{[\text{A}^-]_0}{[\text{HA}]_0} > 0$$

$$\text{pH} < \text{pKa}$$

$$[\text{A}^-]_0 > [\text{HA}]_0$$

more base

$$-\log \frac{[\text{A}^-]_0}{[\text{HA}]_0} < 0$$

$$\text{pH} > \text{pKa}$$



What is the pOH of a 0.01 M solution of  $\text{HClO}_4$ ?

A. 1

B. 2

C. 7

D. 10

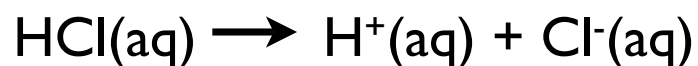
E. 12 ←  $[\text{H}^+] = 10^{-2}$     $\text{pH} = 2$     $\text{pOH} = 12$

## Strong Acids and Bases

"Strong" means one thing

The substance dissociates 100% in water

Strong Acid



$$K_{\text{a}} = \frac{[\text{H}^{\text{+}}][\text{Cl}^{-}]}{[\text{HCl}]} \approx \infty$$

Strong Electrolyte



$$K_{\text{sp}} = [\text{Na}^{\text{+}}][\text{Cl}^{-}] \approx \infty$$

What is the pH of a  $10^{-10}\text{M}$  solution of HCl?

- A. 2
- B. 4
- C. 7
- D. 10
- E. very slightly less than 7

When do we get into problems with approximations

What approximations are we making

Typically that  $[\text{H}^+]_0 = 0$   
no  $\text{H}^+$  at the start

not a problem along as the concentration of acid or base is large enough

what is large enough big compared to  $10^{-7}$

When do we get into problems with approximations

What approximations are we making

That the change is small  
what is required for this

$K$  should be small (weak acid, weak base)  
The initial concentration should be large

$C-x$  is approximately  $C$   
this is a comparison between  $C$  and  $x$

For which of this will our approximations fail?

- A. 0.1 M solution of sodium acetate
- B. 1 M solution of HF
- C.  $10^{-6}$  M solution of benzoic acid
- D. 0.5 M solution of HCl
- E. 0.2 M solution of NaOH

The  $pK_a$  of HF is 3.18. What is the pH of solution of 100 mL of 0.1 M HF and 100 mL of a 0.2 M NaF?

- A. slightly less than 3.18
- B. 3.18
- C. slightly more than 3.18

$$\text{pKa} = \text{pH} - \log \frac{[\text{A}^-]_0}{[\text{HA}]_0}$$

initial conjugate base

initial weak acid

if the initial acid and base are similar in concentration than the pH is close to the pKa

For the pH to be 1 unit different than the pKa  
the difference in concentrations  
must be at least 10 X!