What is the dissociation reaction for water? What are the ionic forms of water?

$H_2O \Leftrightarrow H_3O^+ + OH^-$ the two ionic forms are the products of this reaction (H_3O^+ and OH^-)

Acids contain more _________ ion. Bases contain more __________ ion.

Acids contain more H_3O^+. Bases contain more OH^-.

At pH 8, __________ ion is more prevalent than __________ ion.

$H_2O > OH^- > H_3O^+$ Regardless of whether solution is an acid or base, H_2O will always be most prevalent as the acid or base is also in a water solution.

At pH 2, __________ ion is more prevalent than __________ ion.

$H_2O > H_3O^+ > OH^-$

What is the acid-dissociation reaction? What is the equilibrium constant (K_a) of this equation?

$HA + H_2O \Leftrightarrow A^- + H^+$ $K_a = \frac{[H^+][A^-]}{[HA]}$ note that this comes from the "product/reactants" you learned in gen-chem.

Lactic acid has a K_a of 1.3×10^{-4} and Citric Acid has a K_a of 4×10^{-6}. Which is the stronger acid? Why?

Lactic acid is stronger as it has a larger K_a values. <u>Larger K_a = stronger acid</u>

Larger K_a values indicate that the "products over reactants" equation has a larger numerator than denominator since the acid (HA) will dissociate completely, as in the case of a strong acid (K_a >1). Weak acids do not dissociate completely, though.

Acetic acid has a pK_a 4.75 and Ascorbic acid has a pK_a of 11.80. Which is the stronger acid? Why?

Acetic acid is a stronger acid as it has a smaller pK_a. <u>Smaller pK_a = stronger acid.</u>

What is the generic Henderson-Hasselbalch equation?

$pH = pK_a + log\frac{[A^-]}{[HA]}$ pH equals pK_a plus the log of base over acid.

When pH is 8 and pK_a is 5, what is the ratio of conjugate base to weak acid? Weak acid to conjugate base?

$$pH = pK_a + log\frac{[A^-]}{[HA]}$$
$$8 = 5 + log\frac{[A^-]}{[HA]}$$
$$3 = log\frac{[A^-]}{[HA]}$$

Logs are default in base 10. So, in order to equal 3, this log must be of 10^3. So $\frac{[A^-]}{[HA]} = 10^3$. That is the ratio of base to acid (since A^- divided by HA is A^-:HA). The ratio of acid to base, however, is the inverse of the ratio of base to acid. $\frac{1}{10^3} = 10^{-3}$ either is fine. Dr. Muccio will denote them using the latter (10^{-3}).

Here is a pretty solid review of logs.
http://www.chem.tamu.edu/class/fyp/mathrev/mr-log.html

A buffer is a (strong/weak) (acid/base) that resists change in pH when more acid/base is added.

Weak acid

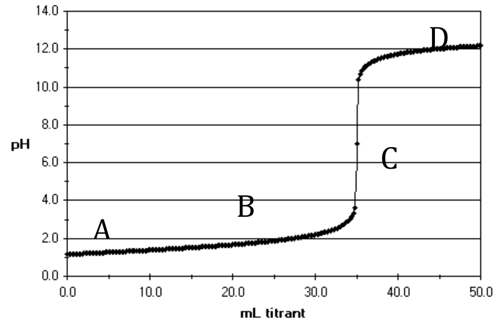
What is the range for effective buffering? pK_a ± _______.

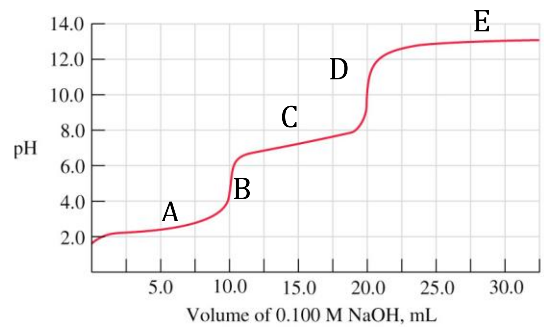
pK_a ± 1

The concentrations of A^- and HA are equal (Maximum buffer capacity) when pH (>,<,=) to pK_a.

A buffer exists when pH = pK_a.

Which of the letters below represent the buffering point?



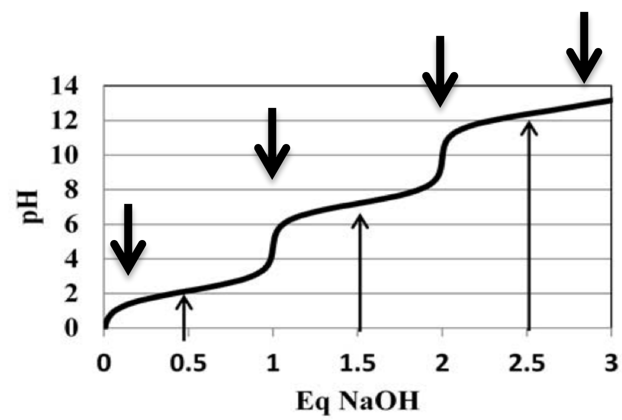


For the graph on the left, B is the buffering point of the given monoprotic acid. For the graph on the right, A and C are the two buffering points of the given diprotic acid. E may at first seem like one, but it is not as there is no third buffering point since we only have 2 inflection points (B and D).

For the graph on the left, what is the approximate pH at the buffering point? The pKa?

1.9ish. Since pH=pK$_a$ at the buffering point, the pK$_a$ is also 1.9ish.

The graph below is the titration of phosphoric acid (H_3PO_4), a triprotic acid (H_3A). Can you determine what is the dominant species at **all** of the arrows?



I will start from far left and work over.

H_3PO_4
H_3PO_4 = $H_2PO_4^-$ (the first buffer point)
$H_2PO_4^-$
$H_2PO_4^-$ = HPO_4^{2-} (the second buffer point)
HPO_4^{2-}
HPO_4^{2-} = PO_4^{3-} (the third and final buffer point)
PO_4^{3-}

Which equilibrium reaction contributes to the intercellular buffering system? What is the pH of that system?

Dihydrogen phosphate/monohydrogen phosphate system. $H_2PO_4 \Leftrightarrow HPO_4^{2-} + H^+$. This system has a pH of 7.2.

Which equilibrium reaction contributes to the blood buffering system? What is the pH of that system? The pKa? What is the “acid” in the reaction? The base? What is the ratio of the acid to base?

Carbon dioxide/bicarbonate equilibrium system. $CO_2 + H_2O \Leftrightarrow H^+ + HCO_3^-$ at a pKa of 6.35 and a pH of 7.4 with a ratio of 10:1.

What is the pKa values for the carbonic acid to bicarb buffer? The bicarb → carbonate buffer? (Bonus: can you draw the titration of the carbonic acid system?)

3.6 and 10.3, respectively

How tightly is blood pH buffered at?

±.05