BUFFERS

CHEM 251 SDSU

PH CHANGES

- The pH of a solution can be easily changed:
  - Addition of acid or base
  - Dilution of solution - change $[H^+]$
- Numerous chemical reactions/equilibria change with changes in pH.
- These changes can have a negative effect on an analysis or reaction.

SOLUTION PH VALUES

- We previously saw that the pH of various 36 mM solutions to be:
  - H_2CO_3: pH = 3.90
  - $NaHCO_3$: pH = 8.34
  - Na_2CO_3: pH = 11.43
- What would be the pH of a solution of 20 mM H_2CO_3 and 16 mM $NaHCO_3$?
- What about a solution of 16 mM H_2CO_3 and 20 mM $NaHCO_3$?

BUFFERS

- Buffers are used to maintain a near constant pH value.
- Buffers are made from a combination of an acid (or base) and its conjugate salt.
- The ratio of these compounds will determine the pH and keep it constant as solution conditions change.
- The effective pH range of a buffer is related to the pK_a of the acid (base).
- Buffers will not infinitely maintain a pH value, they can be exhausted.
- Carbonic acid (H_2CO_3) and bicarbonate (HCO_3^-) act as a buffer in blood.

BUFFER RANGE

- From the Henderson-Hasselbach equation we see that the pH of a buffer will depend directly on the pK_a
- Changes in the ratio of $[A^-]$ to [HA] will alter the pH of the buffer

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

[A-]/[HA]	pH =
100:1	$pK_a + 2$
10:1	$pK_a + 1$
1:1	pK_a
1:10	$pK_a - 1$
1:100	$pK_a - 2$

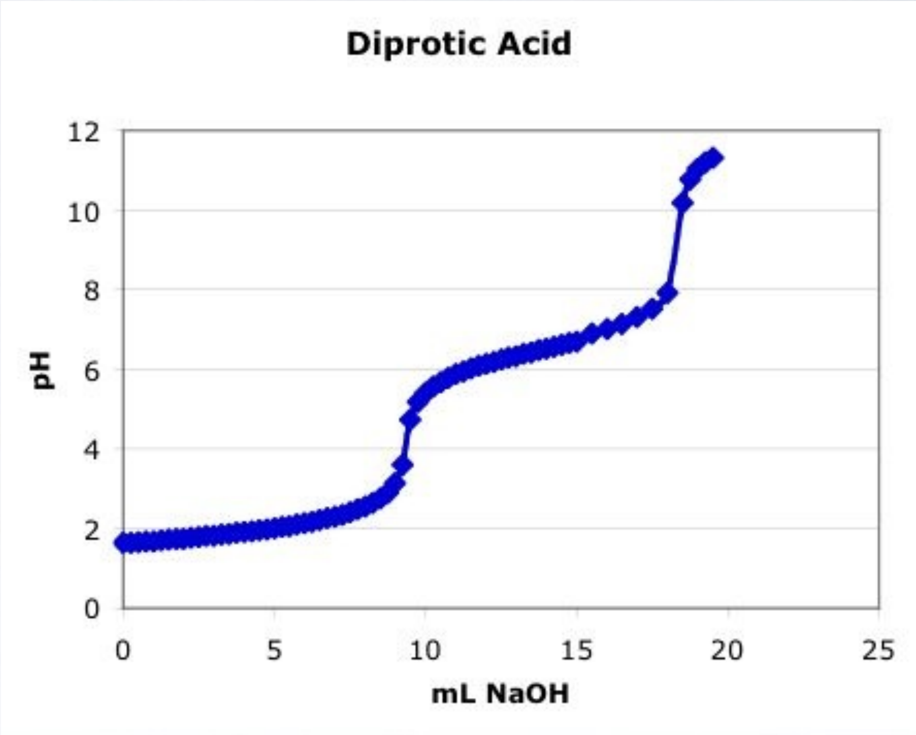
QUESTION

Which weak acid/base would be the best choice to prepare a buffer with a pH of 5.22?

2-Nitrophenol, pK_a = 7.230
3-Nitrobenzoic acid, pK_a = 3.449
Trimethylamine, pK_a = 9.799
Acetic acid, pK_a = 4.756

BUFFERS IN TITRATIONS

- When titrating a weak acid with a strong base a buffer will be naturally formed as some of the weak acid is consumed
- This causes a slow change in the pH when the it is near the pK_a of the acid



$$\mathbf{H_2A} + NaOH \rightleftharpoons Na^+ + \mathbf{HA^-} + H_2O$$

$$\mathbf{HA^-} + NaOH \rightleftharpoons Na^+ + \mathbf{A^{2-}} + H_2O$$