LECTURE 22

1. Predict whether an aqueous solution of each of the following salts has a pH equal to, greater than or less than 7.

(a) $KC_6H_5CO_2$ (c) NH_4Br (e) Li_2CO_3
(b) $NaNO_2$ (d) $MgCl_2$

(a) pH >7, basic
(b) pH >7, basic
(c) pH <7, acidic
(d) pH = 7, neutral
(e) pH >7, basic

2. Phosphate buffers are very useful in biochemical experiments. Your UROP supervisor asks you to make up a phosphate buffer to carry out kinetic assays on an enzyme using the conjugate acid/base pair of HPO_4^{2-} ($K_a = 2.1 \times 10^{-13}$) and PO_4^{3-}, both available from the stock room in the form of potassium salts.

(a) What must be the ratio of the molarities of PO_4^{3-} and HPO_4^{2-} ions in a buffer solution having a pH of 12.0 (report ratio to one significant figure)?

(b) What mass of K_3PO_4 must be added to 2.00 L of 0.100 M K_2HPO_4(aq) to prepare a buffer solution with a pH of 12.0 (report mass to one significant figure)?

(**c**) State the range of pH values for which this phosphate buffer will be an effective in maintaining a constant pH.

(a) The ratio of HPO_4^{2-} to PO_4^{3-} is 5, and the ratio of PO_4^{3-} to HPO_4^{2-} is 0.2

(b) We need to add 9 g of K_3PO_4 to 2.0 L.

(c) The acceptable range, based on our K_a calculations in (a) is 11.68-13.68.

3. A different phosphate buffer is now put to test to see if it will maintain the pH of an enzyme solution if a strong base is added. This buffer solution was prepared to a final volume of 100.0 mL with concentrations of the salts of the conjugate acid/base pairs as following: 0.150 M Na_2HPO_4(aq) and 0.100 M KH_2PO_4(aq). What are the pH and the pH change resulting from the addition of 80.0 mL of 0.0100 M NaOH(aq) to the buffer solution? The pK_a of $H_2PO_4^-$ is 7.21.

Original pH : 7.39 or 7.38
pH after addition of NaOH : 7.45 or 7.44
ΔpH = 0.06

4. A pharmaceutical molecule with antifungal properties is only active when deprotonated and negatively charged (A^-). The protonated state (HA) is inactive. If the pK_a of this drug is 9.0,

(a) calculate the ratio of protonated to deprotonated compound at physiological pH (7.4).
(b) Without doing a calculation, would more or less of the drug be active at pH=7.4 if the pK_a of the drug was 8.0

(a) The ratio of protonated (inactive) compound to deprotonated (active) compound is 40 to 1 at physiological pH.

(b) More

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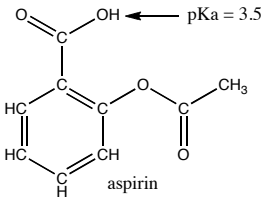
5. If 50.0 mL of a 0.200 M solution of the weak base *N*-ethylmorpholine ($C_6H_{13}NO$) is mixed with 8.00 mL of 1.00 M HCl and then diluted to a final volume of 100.0 mL with water, the result is a buffer with a pH of 7.00. Compute the K_b of *N*-ethylmorpholine.

The K_b is **4.0×10^{-7}**.

6. Absorption of aspirin (acetylsalicylic acid, $C_9H_8O_4$,) into the bloodstream occurs only when the molecule is in its conjugate base form.



aspirin

(a) If a patient takes one tablet of aspirin (325 mg of aspirin), how many milligrams of aspirin are available for immediate absorption in the stomach? The pH of the stomach is 1.6, and the pK_a of aspirin is 3.5.

(b) Would you expect more or less aspirin to be absorbed in the small intestine (pH ≈ 7.5) compared to the stomach? Briefly explain your answer (no calculation is required).

(a) 4 mg

(b) More aspirin will be absorbed in the small intestine. More of the molecule will be in the conjugate base form when the pH is higher.

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