149 **Buffers**

Made Easy

Chapter 17.1-2

150 **What is a Buffer?**

- An aqueous solution that has a highly stable pH even upon addition of small amounts of H^+ or OH^-.
- The solution is able to absorb and neutralize incoming acid or incoming base.
- How??
  - ✓ Because of the presence of significant quantities of both a conjugate weak acid/base pair.
- $HA \leftrightharpoons H^+ + A^-$
- $X\text{-}NH_2 + H_2O \leftrightarrows X\text{-}NH_3^+ + OH^-$

151 **There are two methods to construct a buffer**

1. Dissolve a conjugate WA-salt (or WB-salt) into a solution of WA or WB.
   - ✓ Example: Dissolving $NaC_2H_3O_2$ into a solution of $HC_2H_3O_2$
     - Because acetic acid is weak, the acid is present
     - When sodium acetate salt dissolves it completely dissociates (soluble salt) and creates a significant quantity of acetate ions, the conjugate base of acetic acid
     - Therefore both the weak acid, and the conjugate base are present in the solution
2. Titrate a WA (or WB) partway along.
   - ✓ Neutralization of the weak acid generates the conjugate base. The more weak acid you neutralize, the more weak base is present

152 **The pH of an acetic acid solution is ~ 4.7**
If you added some sodium acetate to acetic acid,

A. The pH would go up
B. The pH would go down
C. The pH would stay the same

154 **The pH of an acetic acid solution is ~ 4.7**
If you added some sodium hydroxide to the acetic acid,

A. The pH would go up
B. The pH would go down
C. The pH would stay the same

156

A. pH = 9.26
B. pH = 7.00
C. pH = 4.74
D. pH = 1.80

158

A. There are no spectator ions.
B. Cl^-
C. Both NH_4^+ and Cl^-
D. NH_4^+

160

A. $NH_{3(aq)} + H_2O_{(L)} \Leftrightarrow NH_4^+{}_{(aq)} + OH^-{}_{(aq)}$
B. $NH_4^+{}_{(aq)} + OH^-{}_{(aq)} \Leftrightarrow NH_{3(aq)} + H_2O_{(L)}$
C. $H_3O^+{}_{(aq)} + OH^-{}_{(aq)} \Leftrightarrow 2H_2O_{(l)}$
D. $NH_4^+{}_{(aq)} + H_2O_{(L)} \Leftrightarrow H_3O^+{}_{(aq)} + NH_{3(aq)}$
E. $H_3O^+{}_{(aq)} + NH_{3(aq)} \Leftrightarrow NH_4^+{}_{(aq)} + H_2O_{(L)}$

162 **A mixture of 0.10 mol of NH_4Cl and 0.12 mole of NH_3 is added to enough water to make 1.0 L of solution.**

163 **A mixture of 0.10 mol of NH_4Cl and 0.12 mole of NH_3 is added to enough water to make 1.0 L of solution. Now, add 250 ml of 0.20 M HCl and calculate the pH.**

165 **Which of the following combinations will result in a buffer? Will the pH of the solution be 7, above 7, or below 7?**

A. 20 ml of 1 M KNO_3 and 20 ml of HNO_3

B. A solution of calcium acetate and acetic acid
C. 100 ml of 0.5 M CH_3NH_2 with 5 g of dissolved $CH_3NH_3NO_3$
D. 20 ml of 1 M NaOH and 20 ml of NaCl

167 **Which of the following combinations will result in a buffer? Will the pH of the solution be 7, above 7, or below 7?**

A. 50 ml of 0.5 M NaOH with 25 ml of 0.5 M HF
B. 20 ml of 1 M HNO_3 and 10 ml of 1 M NaOH
C. 100 ml of 0.5 M CH_3NH_2 with 100 ml of 0.5 M HNO_3
D. 100 ml of 0.5 M CH_3NH_2 with 60 ml of 0.5 M HNO_3

169 **Consider the weak acid ionization reaction represented below.Which of the actions below would shift the equilibrium position toward reactants?**
$HNO_2 \leftrightharpoons H^+ + NO_2^-$

A. adding HCl
B. adding KOH
C. adding H_2O
D. adding $NaNO_2$

171 **Calculate the pH of a 0.025 M HNO_2 solution. $K_a = 4.5 \times 10^{-4}$**

173 **Calculate the pH of a solution made by combining 0.30 mole of sodium nitrite with 0.50 mole of HNO_2 in a 2.0 L solution. $K_a = 4.5 \times 10^{-4}$**

175 **Which of the following combinations can produce a buffer solution? Select all that apply.**

A. HCl / NaCl
B. $HC_2H_3O_2$ / NH_3
C. H_3PO_4 / NaH_2PO_4

D. HNO_3 / $Ca(OH)_2$
E. HCN / NaOH
F. NH_4NO_3 / NH_3

177 **Which of the following combinations can produce a buffer solution? Select all that apply.**

A. KNO_3 / NaOH
B. HCN / NaOH
C. NH_3 / HCl
D. HCl / KOH
E. NH_3NO_3 / NH_3

179 **What is $[H^+]$ of a 0.050 M HF solution dissolved with enough solid NaF to produce a solution 0.20 M NaF K_a (HF) = 6.8×10^{-4}**

A. 1.7 x 10-4 M
B. 3.4×10^{-4} M
C. 6.8×10^{-4} M
D. 1.4×10^{-3} M
E. 2.7×10^{-3} M
F. Cannot be determined without knowing volumes of each, or total volume

181 **Calculate the pH of a 0.50 M solution of sodium acetate ($NaC_2H_3O_2$ or NaAc) in 0.50 M acetic acid ($HC_2H_3O_2$ or HAc). pK_a (HAc) = 4.74**

A. 3.74
B. 4.24
C. 4.74
D. 5.24
E. 5.74

183 **Using equal volumes and concentrations of which of the following combinations would be best to make a buffer with a pH above 7 ?**

A. NaCl and HCl
B. NH_3 and NH_4Cl
C. NaOH and HCl
D. HNO_2 and $NaNO_2$
E. NH_3 and C_5H_5NHCl

185 **Calculate the pH of a 0.50 M solution of sodium acetate ($NaC_2H_3O_2$ or NaAc) in 0.050 M acetic acid ($HC_2H_3O_2$ or HAc). pK_a (HAc) = 4.74**

A. 3.74
B. 4.24
C. 4.74
D. 5.24
E. 5.74

187 **In an NH_4^+/NH_3 buffer, what concentration changes will occur if a small amount of OH^- is added?**

189 **Calculate the pH of a buffer solution containing 0.20 moles sodium acetate and 0.30 moles acetic acid (HAc) pK_a (HAc) = 4.74.**

A. 2.63
B. 4.57
C. 4.74
D. 4.92
E. 5.27
F. not enough information, volume information must be known to calculate a pH.

191

A. All acid-base pairs will function as buffers.
B. $HCHO_2$ and CHO_2^- will not work as a buffer because CHO_2^- is a spectator ion.
C. HCO_3^- and CO_3^{2-} will not work as a buffer because HCO_3^- is a spectator ion.
D. HNO_3 and NO_3^- will not work as a buffer because NO_3^- is a spectator ion.

193 **Calculate the pH of a buffer solution containing 0.25 moles sodium acetate and 0.30 moles acetic acid (HAc) to which 0.20 moles HCl are added. pK_a (HAc) = 4.74.**

195 **Calculate the pH of 2000 ml of a buffer solution containing 0.25 moles sodium acetate and 0.30 moles acetic acid (HAc) to which 0.35 moles HCl are added. pK_a (HAc) = 4.74**