Review for the General Chemistry Exam
Second Semester Part 2 of 3

Part 12. Acid & Base Equilibria:

160. According to the Brønsted–Lowry definition, which chemical species can function ***both*** as an acid and as a base?

(A) Cl^- (B) SO_4^{2-} (C) NH_4^+

(D) HCO_3^- (E) H_3O^+

161. Which of these compounds is correctly described or classified?

(A) NH_3 – a weak acid in water

(B) CaS – a salt of a weak base and a strong acid

(C) SO_3 – the hydrate of sulfuric acid

(D) NaOH – a strong base

(E) $CuSO_4 \cdot 5H_2O$ – the hydride of $CuSO_4$

162. In the reaction

$$CN^- + H_2O \rightarrow HCN + OH^-$$

which is an acid–base conjugate pair?

(A) H_2O and HCN (C) CN^- and H_2O

(B) H_2O and OH^- (D) HCN and OH^-

163. Which species can act either as an acid or as a base in aqueous solution?

(A) HCO_3^- (B) HNO_2

(C) HIO_4 (D) H_3PO_4

164. The conjugate acid of HPO_4^{2-} is

(A) PO_4^{3-} (B) $H_2PO_4^-$ (C) H_3PO_4

(D) H_3O^+ (E) P_2O_5

165. Given that H**X** is a stronger Brønsted acid than H**Y** in aqueous solution, which is true of a 1 M solution of Na**X**?

(A) It is less basic than a 1 M solution of Na**Y**.

(B) It is more basic than a 1 M solution of Na**Y**.

(C) It yields a neutral solution.

(D) It is more concentrated than a l M solution of Na**Y**.

166. Which of these species is ***most*** likely to be a Lewis acid and is also ***least*** likely to be a Brønsted acid?

(A) NH_4^+ (B) BF_3

(C) H_2O (D) OH^-

167. According to the Lewis definition, an acid is a species

(A) having a hydrogen ion.

(B) donating a pair of electrons.

(C) accepting a pair of electrons.

(D) accepting a hydrogen ion.

168. HCl is a strong acid. What is the pH of 200 mL of 0.002 M HCl?

(A) 2.0 (B) 2.7

(C) 3.4 (D) 4.0

169. What is the pH of a 0.01 M NaOH solution?

(A) 10^{-12} (B) 12 (C) -12

(D) 2 (E) -2

170. When 50. mL of 0.1 M HCl is mixed with 50 mL of 0.20 M NaOH, the resulting hydronium ion concentration will be

(A) 0.050 M. (B) 0.10 M.

(C) 0.20 M. (D) 1×10^{-7} M.

(E) none of these

171. Which series is the correct order of decreasing acid strength for each group of acids?

(A) $H_2S > H_2Te > H_2Se > H_2O$

(B) $HClO_3 > HClO_4 > H_2SO_4 > HNO_3$

(C) $HClO_4 > HClO_3 > HClO_2 > HClO$

(D) HF > HCl > HBr > HI

172. Which particles are present in the greatest number in a dilute sulfuric acid solution?

(A) H_2SO_4 molecules (D) H_3O^+ ions

(B) HSO_4^- ions (E) OH^- ions

(C) SO_4^{2-} ions

173. Which statement is a logical inference from the fact that a 0.10 M solution of potassium acetate, $KC_2H_3O_2$, is less alkaline than a 0.10 M solution of potassium cyanide, KCN?

(A) Hydrocyanic acid is a weaker acid than acetic acid.

(B) Hydrocyanic acid is less soluble in water than acetic acid.

(C) Cyanides are less soluble than acetates.

(D) Acetic acid is a weaker acid than hydrocyanic acid.

174. What is the set of products expected from the hydrolysis of CN^- ion?

(A) HCN and OH^- (C) CN^- and H_2O

(B) HCN and H^+ (D) HCN and H_2O

175. Which salt reacts with water (hydrolyzes) to produce a basic solution?

(A) $NaC_2H_3O_2$ (C) $NaNO_3$

(B) NH_4Cl (D) $BaSO_4$

176. In titrating $NH_{3(aq)}$ with 0.1 M HCl, the equivalence point in pH units will be

(A) lower than 7 due to hydrolysis of NH_4^+

(B) lower than 7 due to hydrolysis of Cl^-

(C) higher than 7 due to hydrolysis of NH_4^+

(D) higher than 7 due to hydrolysis of Cl^-

177. The new species formed by the hydrolysis of KCN are

(A) H^+ ions, CN^- ions and OH^- ions.

(B) CN^- ions and OH^- ions.

(C) HCN molecules and KOH molecules.

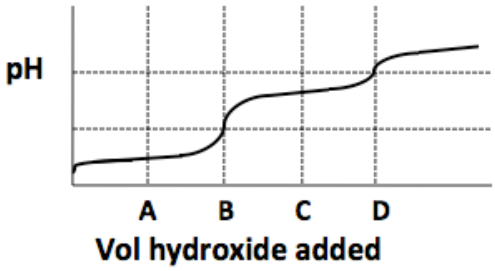
(D) HCN molecules and OH^- ions.

(E) H_3O^+ ions and KOH molecules.

178. A 25.0-mL sample of 0.130 M HCl is mixed with 15.0 mL of 0.240 M of NaOH. The pH of the resulting solution will be nearest

(A) 2.1 (B) 7 (C) 11.9 (D) 13.0

179. A volume of 10.0 mL of 0.10 M H_3PO_4 was titrated with 0.10 M NaOH. The pH response to addition of various amounts of NaOH is shown. At point **A** the ratio of $[H_3PO_4]/[H_2PO_4^-]$ is



(A) 1 (B) 2 (C) 3 (D) 4

180. In the titration of 50.0 mL of 0.100 M benzoic acid (a monoprotic acid) with 50.0 mL of 0.100 M Na0H, the properties of the solution at the equivalence point will correspond exactly to the properties of

(A) a 0.100 M sodium solution.

(B) a 0.0500 M sodium hydroxide solution.

(C) a 0.0500 M benzoic acid solution.

(D) a 0.0500 M sodium benzoate solution.

181. Which pair constitutes a buffer in aqueous solution?

(A) HCl and NaCl

(B) NH_3 and NH_4Cl

(C) HBr and KBr

(D) HNO_3 and NH_4NO_3

182. The addition of a small amount of acid or base will have very little effect on the pH value of a solution containing equal molar concentrations of

(A) NH_4Cl and NaCl

(B) NaOH and HCl

(C) NH_3 and NH_4Cl

(D) NaOH and NaCl

(E) NH_3 and NaCl

183. Which gives an acidic solution in water?

(A) H_2 (B) CH_4 (C) NH_3

(D) CaO (E) SO_2

184. The amide ion, NH_2^- , is a stronger base than the hydroxide ion, OH^-. Which reaction will occur if sodium amide is dissolved in water?

(A) $NH_2^-(aq) + H_2O(l) \rightarrow H_3O^+(aq) + NH^{2-}(aq)$

(B) $NH_2^-(aq) + H_2O(l) \rightarrow NH_2OH(aq) + H^-(aq)$

(C) $NH_2^-(aq) + H_2O(l) \rightarrow OH^-(aq) + NH_3(aq)$

(D) $NH_2^-(aq) + H_2O(l) \rightarrow$ no reaction

185. What is the $[OH^-]$ of a solution which is 0.18 M in ammonium ion and 0.10 M in ammonia? [K_b for Ammonia = 1.8×10^{-5}]

(A) 1.3×10^{-3} (C) 1.3×10^{-5}

(B) 1.0×10^{-3} (D) 1.0×10^{-5}

186. In pure water at 60 °C,

$$[H_3O^+] = [OH^-] = 3.1 \times 10^{-7} \text{ M}.$$

It is reported that an aqueous solution at 60 °C has $[H_3O^+] = 1.0 \times 10^{-7}$ M. Such a solution is

(A) neutral. (B) basic.

(C) acidic. (D) impossible

187. The dissociation constant for monoprotic acid H**X** in water is 1.34×10^{-4}. What is the concentration of $\mathbf{X}^-$ ion in a 0.20 M solution of H**X**?

(A) 5.2×10^{-3} (C) 4.5×10^{-4}

(B) 2.0×10^{-4} (D) 6.4×10^{-4}

188. The dissociation constant for a weak base **B**OH in water was found to be 1.25×10^{-6}. What is the concentration of H^+ in a 3.2 M solution of **B**OH?

(A) 2.0×10^{-3} M (C) 1.6×10^{-11} M

(B) 4.0×10^{-6} M (D) 5.0×10^{-12} M

189. When 0.10 mol of a weak acid H**A** was diluted to one liter, experiment showed the acid to be 1% dissociated. What is the acid dissociation constant, K_a?

$$H\mathbf{A} + H_2O \rightarrow H_3O^+ + \mathbf{A}^-$$

(A) 1×10^{-6} (C) 1×10^{-3}

(B) 1×10^{-5} (D) 1×10^{5}

190. What is the H_3O^+ of a solution which is 0.2 M in $NaC_2H_3O_2$ and 0.1 M in $HC_2H_3O_2$? [$K_a = 1.85 \times 10^{-5}$]

(A) 9.0×10^{-7} (C) 3.6×10^{-6}

(B) 1.8×10^{-6} (D) 9.0×10^{-6}

191. A 0.10 M C_6H_5COOH solution has a pH of 2.59. What is the K_a of this acid?

(A) 6.6×10^{-6} (C) 2.6×10^{-3}

(B) 6.6×10^{-5} (D) 2.6×10^{-2}

192. What is the pH of a 0.1 M NaF solution? [K_a for HF = 7×10^{-4}]

(A) 2.1 (B) 5.9 (C) 8.1 (D) 9.1

193. What is the hydrogen ion concentration of a buffer solution containing 0.10 M NO_2 and 0.20 M HNO_2? [$K_a = 4.5 \times 10^{-4}$]

(A) 2.2×10^{-4} M (C) 9.0×10^{-4} M

(B) 4.5×10^{-4} M (D) 9.5×10^{-3} M

194. Assume that standardized aqueous solutions of each of these are available.

Substance	Ionization Constant
$NaC_2H_3O_2$	$K_b = 5.6 \times 10^{-10}$
RNH_3Cl	$K_a = 5.6 \times 10^{-10}$
RNH_2	$K_b = 1.8 \times 10^{-5}$
$HC_2H_3O_2$	$K_a = 1.8 \times 10^{-5}$

A buffer with a desired pH is 5.0 would be conveniently prepared by appropriate mixtures of

(A) $NaC_2H_3O_2$ and $HC_2H_3O_2$

(B) RNH_3Cl and RNH_2

(C) $HC_2H_3O_2$ and water

(D) $HC_2H_3O_2$ and RNH_2

Part 13. Solubility Equilibria:

195. The addition of solid Na_2SO_4 to an aqueous solution in equilibrium with solid $BaSO_4$ will cause

(A) no change in $[Ba^{2+}]$ in solution.

(B) more $BaSO_4$ to dissolve.

(C) precipitation of more $BaSO_4$.

(D) an increase in the K_{sp} of $BaSO_4$.

196. The solubility of $BaCO_3$ is 7.9×10^{-3} g·L^{-1}. Calculate the solubility product, K_{sp} ignoring hydrolysis. [Molar Mass: $BaCO_3$ 197 g mol^{-1}]

(A) 1.6×10^{-2} (C) 4.0×10^{-5}

(B) 1.6×10^{-9} (D) 6.2×10^{-5}

197. Typical “hard” water contains about 2.0×10^{-3} mol of Ca^{2+} per liter. Calculate the maximum concentration of fluoride ion which could be present in hard water. [K_{sp} for $CaF_2 = 4.0 \times 10^{-11}$]

(A) 1.4×10^{-4} M (C) 4.0×10^{-3} M

(B) 2.0×10^{-3} M (D) 2.0×10^{-8} M

198. What is $[OH^-]$ in a saturated solution of $Mg(OH)_2$ where $[Mg^{2+}] = 1.5 \times 10^{-5}$ M? [K_{sp} for $Mg(OH)_2 = 1.5 \times 10^{-11}$]

(A) 2.2×10^{-10} M (C) 5.0×10^{-4} M

(B) 3.0×10^{-5} M (D) 1.0×10^{-3} M

199. What is the concentration of Ag^+ in a 0.010 M KCl solution saturated with AgCl? [K_{sp} for AgCl = 1.8×10^{-10}]

(A) 1.3×10^{-5} M
(B) 1.0×10^{-7} M
(C) 1.8×10^{-8} M
(D) 1.8×10^{-11} M

200. If two salts, **AX** and $\mathbf{BX_2}$, have the same K_{sp} values of 4.0×10^{-12} at a given temperature, then

(A) their molar solubilities in water are the same.
(B) the salts are more soluble in 0.1 M Na**X** than in water.
(C) the molar solubility of **AX** in water is less than that of $\mathbf{BX_2}$.
(D) addition of Na**X** will not affect the solubilities of the salts.

201. What is the molar concentration of silver ion in a solution containing 1.3×10^{-4} M CrO_4^{2-}, saturated with Ag_2CrO_4?
[K_{sp} for $Ag_2CrO_4 = 9 \times 10^{-12}$]

(A) 1.3×10^{-16}
(B) 7×10^{-16}
(C) 9×10^{-12}
(D) 2.6×10^{-4}
(E) 7×10^{-3}

202. What is the molar solubility of lead sulfate in 1.0×10^{-3} M Na_2SO_4? [K_{sp} for $PbSO_4 = 1.8 \times 10^{-8}$]

(A) 1.8×10^{-2}
(B) 1.3×10^{-4}
(C) 1.8×10^{-5}
(D) 5.0×10^{-6}

Answers:

160. D
161. D
162. B
163. A
164. B
165. A

166. B
167. C
168. B
169. B
170. E

171. C
172. D
173. A
174. A
175. A

176. A
177. D
178. C
179. A
180. D

181. B
182. C
183. E
184. C
185. D

186. B
187. A
188. D
189. B
190. D

191. B
192. C
193. C
194. A
195. C

196. B
197. A
198. D
199. C
200. C

201. D
202. C

Please notify Dr Mattson (brucemattson@creighton.edu) of any mistakes or problems with this review.