Acids, Bases + Salts Answers

1. C
2. C
3. B
4. A
5. B
6. B
7. C
8. B
9. B
10. B
11. D
12. C
13. B
14. A
15. C
16. C
17. a) <-> $H_2C_2O_4 + SO_4^{2-}$
c) $HC_2O_4^-/H_2C_2O_4$; HSO_4^-/SO_4^{2-}
d) Reactants ($KaHSO_4^- < KaH_2C_2O_4$)
18. see answer
19. D
20. See answer
21. See answer
22. C
23. D
24. C
25. B
26. B
27. C
28. C
29. D
30. D
31. <-> $C_2O_4^{2-} + H_3O^+$
32. D
33. D
34. C
35. A
36. C
37. A
38. A
39. B
40. B
41. C
42. Test#1 = electrical conductivity
Test#2 = pH test
Test#3 = reaction with Mg (metal)
43. B
44. A
45. B
46. A
47. C
48. B
49. D
50. D
51. D
52. D
53. D
54. C
55. D
56. D
57. D
58. A
59. B
60. C
61. A
62. A
63. D
64. B
65. A
66. a) $H_2AsO_4^-$
b) $H_2SeO_4^-$
c) H_2SO_3
d) a<b<c
67. a) i) $HF + Cl^-$
b) Products favored because HCl is a stronger acid than HF
68. see answer
69. see answer
70. A
71. D
72. C
73. See answer
74. D
75. C
76. C
77. D
78. B
79. D
80. C
81. B
82. D
83. C

84. B
85. A
86. B
87. D
88. B
89. B
90. B
91. D
92. D
93. A
94. a) below 25°C, $Kw<1x10^{-14}$, rxn shifts left
b) pH = pOH = 7.17
c) neutral, because $[H^+] = [OH^-]$
95. a) below 25°C, $Kw<1x10^{-14}$, rxn shifts left
b) see #95c
c) $Kw = 2.9x10^{-15}$
96. a) at low temp = shift left, the $[H_3O^+]$ drops = pH increases
b) $Kw = 2.5x10^{-15}$
97. a) pOH = 7.265
b) $Kw = 2.95x10^{-15}$
98. C
99. B
100. pOH = 7.085
101. D
102. C
103. B
104. C
105. B
106. A
107. D
108. A
109. B
110. A
111. C
112. D
113. A
114. B
115. B
116. C
117. D
118. D
119. C
120. A
121. See answer
122. pH = 10.34
123. pH = 13.70
124. D
125. B
126. C
127. A
128. D
129. 2.3g NaOH
130. D
131. A
132. D
133. B
134. A
135. D
136. C
137. C
138. D
139. A
140. A
141. A
142. D
143. D
144. B
145. A
146. pH = 11.48
147. pH = 8.68
148. pH = 1.97
149. pH = 9.88
150. pH = 3.67
151. pH = 10.30
152. pH = 7.39
153. pH = 11.50
154. pH = 11.79
155. pH = 4.74
156. pH = 12.36
157. $[NH_3] = 0.279M$
158. pH = 4.25
159. A
160. C
161. D
162. C
163. A
164. C
165. C
166. $Kb = 3.6x10^{-4}$

167. $Ka = 1.5x10^{-2}$; acid = H_2SO_3
168. $Ka = 9.1x10^{-8}$; acid = H_2S
169. $Kb = 1.5x10^{-10}$; $X^- = C_6H_5COO^-$
170. $Ka = 5.9x10^{-2}$
171. $Ka = 2.8x10^{-9}$
172. $Kb = 2.4x10^{-12}$
173. $Ka = 2.4x10^{-11}$
174. A
175. B
176. A
177. C
178. D
179. A
180. B
181. B
182. B
183. D
184. C
185. C
186. B
187. See answer
188. See answer
189. C
190. C
191. B
192. B
193. B
194. C
195. A
196. D
197. B
198. B
199. B
200. D
201. See answer
202. D
203. B
204. A
205. C
206. C
207. D
208. C
209. C
210. A
211. C
212. D
213. D
214. D
215. C
216. B
217. D
218. C
219. B
220. B
221. C
222. A
223. A
224. D
225. A
226. A
227. C
228. C
229. D
230. D
231. C
232. C
233. C
234. A
235. A
236. C
237. D
238. D
239. D
240. D
241. B
242. C
243. B
244. D
245. D
246. B
247. A
248. A
249. B
250. D
251. D
252. C
253. A
254. a) $[HInd]=[Ind^-]$
b) $Ka = 4x10^{-6}$
c) yellow, yellow, yellow
yellow, blue, green

255. a) Ka = 5.0×10^{-8}
b) orange, yellow, amber
yellow, orange, amber
blue, red, purple
256. D
257. a) WA/SB
b) because of buffering effect
c) Thymol blue, Thymophthalien
258. C
259. D
260. C
261. D
262. C
263. C
264. A
265. A
266. D
267. B
268. C
269. B
270. A
271. A
272. A
273. D
274. C
275. A
276. $[Ba(OH)_2] = 0.0426M$
277. [NaOH] = 0.567M
278. D
279. D
280. B
281. B
282. D
283. A) 0.0125L NaOH
b) $H_3O^+ + OH^- <-> 2H_2O$
c) vol of base will not change, because strong acid results in rxn going to completion (1:1 ratio)
284. A) SA/SB graph
b) equivalence point pH >7
c) SB/WA graph
285. A
286. B
287. D
288. A
289. B
290. C
291. D
292. B
293. B
294. D
295. C
296. $NH^{4+} + OH^- \rightarrow H_2O + NH_3$
297. C
298. C
299. B
300. B
301. pH = 2.0
302. C
303. D
304. B
305. C
306. A
307. B
308. A
309. D
310. D
311. B
312. C
313. D
314. D
315. B
316. D
317. B
318. A
319. a) HB, initial pH >1, buffering action
b) see answer
c) Phenophthalien
320. A) B, pH >7; A, pH = 7
b) SA/SB produces a neutral salt, WA/SB produces a basic salt
c) volume of SB will be equal
321. B
322. A
323. B
324. B
325. a) to resist pH change
b) add = amounts of WA to its CB
326. B
327. D
328. A

329. C
330. B
331. A
332. B
333. D
334. C
335. B
336. B
337. B
338. B
339. A
340. A
341. B
342. D
343. D
344. B
345. A
346. A
347. B
348. A
349. A
350. D
351. a) prevents CO_2 loss from upsetting blood pH
b) pH = 6.8-7.8
c) pH would decrease
352. see answer
353. see answer
354. see answer
355. A
356. A
357. D
358. C
359. D
360. C
361. B
362. a) $Ba(OH)_2$ basic
b) ignore
c) 2LiOH basic
363. a)$Ti(OH)_2$ basic
b) ignore
c) 2RbOH basic
364. a) $H_2PO_4^-$
b) MgO
c) SO_2
365. a) ignore
b) CaO
c) NO_2
366. C
367. D
368. B
369. A
370. B
371. D
372. D
373. C
374. D
375. D
376. B
377. D
378. C
379. C
380. A
381. B
382. C
383. A
384. D
385. C
386. A
387. A
388. A
389. $[H^+]$ in HCl = 0.10M
$[H^+]$ in $H_2CO_3 = 6.55x10^{-4}M$; HCl has greater electrical conductivity
390. pH = 3.35
391. B
392. A
393. A
394. B
395. C
396. D
397. B
398. A
399. A
400. a) pH = 6.70
b) amber, due to pH = 6.70
401. C
402. D
403. B
404. B
405. A

Prescribed Learning Outcomes - Chemistry 12

Acid / Base Section

J: Acids, Bases, and Salts (Properties and Definitions)

J1: Identify acids and bases through experimentation
J2: List general properties of acids and bases
J3: Write balanced equations representing the neutralization of acids by bases in solution
J4: Define *Arrhenius acids* and *bases*
J5: Write names and formulae of some common acids and bases and outline some of their common properties, uses, and commercial names
J6: Define *Brönsted-Lowry acids and bases*
J7: Identify Brönsted-Lowry acids and bases in an equation
J8: Write balanced equations representing the reaction of acids or bases with water
J9: Identify an H_3O^+ ion as a protonated H_2O molecule that can be represented in shortened form as $H^+_{(aq)}$
J10: Define *conjugate acid-base pair*
J11: Identify the conjugate of a given acid or base
J12: Show that in any Brönsted-Lowry acid-base equation there are two conjugate pairs present

K: Acids, Bases, and Salts (Strong and Weak Acids and Bases)

K1: Relate electrical conductivity in a solution to the concentration of ions
K2: Classify an acid or base in solution as either weak or strong by comparing conductivity
K3: Define a *strong acid* and a *strong base*
K4: Define a *weak acid* and a *weak base*
K5: Write equations to show what happens when strong and weak acids and bases are dissolved in water (dissociation , ionization)
K6: Compare the relative strengths of acids or bases by using a table of relative acid strengths
K7: Identify and explain why the strongest acid in aqueous solutions is H_3O^+ and the strongest base in aqueous solutions is OH^-
K8: Predict whether products or reactants are favoured in an acid-base equilibrium by comparing the strength of the two acids (or two bases)
K9: Compare the relative concentrations of H_3O^+ (or OH^-) between two acids (or between two bases) using their relative positions on an acid strength table
K10: Define amphiprotic
K11: Identify chemical species that are amphiprotic
K12: Describe situations in which H_2O would act as an acid or base

L: Acids, Bases, and Salts (K_w , pH , pOH)

L1: Write equations representing the ionization of water using either H_3O^+ and OH^- or H^+ and OH^-
L2: Write the equilibrium expression for the ion product constant of water, K_w
L3: Predict the effect of the addition of an acid or base to the equilibrium system:

$$2\,H_2O_{(l)} \Leftrightarrow H_3O^+_{(aq)} + OH^-_{(aq)}$$

L4: State the relative concentrations of H_3O^+ and OH^- in acid, base, and neutral solutions
L5: State the value of K_w at 25°C
L6: Describe the variation of the value of K_w with temperature
L7: Calculate the concentration of H_3O^+ (or OH^-) given the other, using K_w
L8: Describe the pH scale with reference to everyday solutions
L9: Define *pH* and *pOH*
L10: Define pK_w , give its value at 25°C, and its relation to pH and pOH
L11: Perform calculations relating pH, pOH, $[H_3O^+]$, and $[OH^-]$
L12: Calculate H_3O^+, or OH^- from pH and pOH

M: Acids, Bases, and Salts (K_a and K_b Problem Solving)

M1: Write K_a and K_b equilibrium expressions
M2: Relate the magnitude of K_a or K_b to the strength of the acid or base
M3: Given the K_a , K_b , and initial concentration, calculate any of the following:
- H_3O^+ - OH^- - pH - pOH

M4: Calculate the value of K_b for a base given the value of K_a for its conjugate acid (or vice versa)
M5: Calculate the value of K_a or K_b given the pH and initial concentration

N: Acids, Bases, and Salts (Hydrolysis of Salts)

N1:
Write a dissociation equation for a salt in water
N2:
Write net ionic equations representing the hydrolysis of salts
N3:
Predict qualitatively whether a salt solution would be acidic, basic, or neutral
N4:
Determine whether an amphiprotic ion will act as a base or an acid in solution

O: Acids, Bases, and Salts (Indicators)

O1:
Describe an indicator as a mixture of a weak acid and its conjugate base, each with distinguishing colours
O2:
Describe the term *transition point* of an indicator, including the conditions that exist in the equilibium system
O3:
Describe the shift in equilibrium and resulting colour changes as an acid or a base is added to an indicator
O4:
Predict the approximate pH at the transition point using the K_a value of an indicator
O5:
Predict the approximate K_a value for an indicator given the approximate pH range of the colour change

P: Acids, Bases, and Salts (Neutralizations of Acids and bases)

P1:
Demonstrate an ability to design and perform a neutralization experiment involving the following:

- primary standards

- standardized solutions

- titration curves

- indicators selected so the end point coincides with the equivalence point

P2:
Calculate from titration data the concentration of an acid or base

P3:
Calculate the volume of an acid or base of known molarity needed to neutralize a known volume of a known molarity base or acid

P4:
Write formula, complete ionic, and net ionic neutralization equations for:

- a strong acid by a strong base

- a weak acid by a strong base

- a strong acid by a weak base

P5:
Calculate the pH of a solution formed when a strong acid is mixed with a strong base

P6:
Contrast the equivalence point (stoichiometric point) of a strong acid-strong base titration with the equivalence point of a titration involving a weak acid-strong base or strong acid-weak base

Q: Acids, Bases, and Salts (Buffer Solutions)

Q1:
Describe the tendency of buffer solutions to resist changes in pH

Q2:
Describe the composition of an acidic buffer and a basic buffer

Q3:
Outline a procedure to prepare a buffer solution

Q4:
Identify the limitations in buffering systems

Q5:
Describe qualitatively how the buffer equilibrium shifts as small quantities of acid or base are added to the buffer

Q6:
Describe common buffer systems present in industrial, environmental, or biological systems

R: Acids, Bases, and Salts (Acid Rain)

R1:
Write equations representing the formation of acidic solutions or basic solutions from non-metal and metal oxides

R2:
Describe the pH conditions required for rain to be called acid rain

R3:
Relate the pH of normal rain water to the presence of dissolved CO_2

R4:

J01: Identify acids and bases through experimentation

1. Which of the following tests could be used to distinguish between 1.0 M HCl and 1.0 M NaOH?

   I. electrical conductivity
   II. reaction with zinc to produce hydrogen gas
   III. reaction with red litmus paper turning blue

   A. III only
   B. I and II only
   C. II and III only
   D. I, II and III

J02: List general properties of acids and bases

2. The property common to both 0.10 M HCl and 0.10 M NaOH is that both solutions
   A. taste bitter
   B. have a pH > 7
   C. conduct electricity
   D. react with magnesium to produce hydrogen gas

3. Which of the following is generally true of acids, but **not** for bases?
   A. pH > 7
   B. releases protons in solution
   C. conducts electrical current well in solution
   D. feels slippery

4. Which of the following best describes an acidic solution?

	Litmus Colour	Reaction with Zn
A.	red	reaction
B.	red	no reaction
C.	blue	no reaction
D.	blue	reaction

J03: Write balanced equations representing the neutralization of eacids by bases in solution

5. Which of the following represents the complete neutralization of H_3PO_4 by NaOH?
   A. $H_3PO_4 + NaOH \rightarrow H_2O + NaH_2PO_4$
   B. $H_3PO_4 + 3NaOH \rightarrow 3H_2O + Na_3PO_4$
   C. $H_3PO_4 + 2NaOH \rightarrow 2H_2O + Na_2HPO_4$
   D. $H_3PO_4 + NaOH \rightarrow H_2O + NaH + HPO_4$

6. Which of the following represents the complete neutralization of H_2CO_3 by NaOH?
   A. $H_2CO_3 + NaOH \rightarrow H_2O + NaHCO_3$
   B. $H_2CO_3 + 2NaOH \rightarrow 2H_2O + Na_2CO_3$
   C. $H_2CO_3 + NaOH \rightarrow H_3O^+ + NaCO_3^-$
   D. $H_2CO_3 + 2NaOH \rightarrow 2H_2O + Na_2O + CO_2$

7. Which of the following represents the neutralization reaction between $Ca(OH)_{2(s)}$ and $HCl_{(aq)}$?
   A. $H_2O_{(l)} \rightarrow H^+_{(aq)} + OH^-_{(aq)}$
   B. $Ca^{+2}_{(aq)} + 2Cl^-_{(aq)} \rightarrow CaCl_{2(s)}$
   C. $Ca(OH)_{2(s)} + 2HCl_{(aq)} \rightarrow CaCl_{2(aq)} + 2H_2O_{(l)}$
   D. $Ca^{+2}_{(aq)} + 2OH^-_{(aq)} + 2H^+_{(aq)} + 2Cl^-_{(aq)} \rightarrow CaCl_{2(s)} + 2H_2O_{(l)}$

8. When a small solid sample is added to a solution of H_2SO_4, a precipitate forms and the solution becomes less acidic. Which of the following substances could have caused these results?
   A. $MgSO_4$ B. $Ba(OH)_2$ C. $Cu(OH)_2$ D. $Ba(NO_3)_2$

J04: Define Arrhenius acids and bases

9. An Arrhenius base is defined as a compound that
   A. accepts OH^- in solution
   B. releases OH^- in solution
   C. accepts protons in solution
   D. releases protons in solution

10. A substance which produces hydroxide ions in solution is a definition of which of the following?
   A. an Arrhenius acid
   B. an Arrhenius base
   C. a Bronsted-Lowry acid
   D. a Bronsted-Lowry base

J05: Write names and formulae of some common acids and bases and outline some of their common properties, uses, and commercial names

11. Which of the following is a common base found in drain cleaners?
   A. bleach B. vinegar C. milk of magnesia D. sodium hydroxide

J06: Define Bronsted-Lowry acids and bases

J07: Identify Bronsted-Lowry acids and bases in an equation

12. Consider the following Bronsted-Lowry equilibrium:

$$C_6H_5NH_{2\,(aq)} + H_2O_{(l)} \leftrightarrows C_6H_5NH_3^+{}_{(aq)} + OH^-_{(aq)}$$

The substances acting as acids and bases from left to right are:
   A. acid, base, acid, base
   B. acid, base, base, acid
   C. base, acid, acid, base
   D. base, acid, base, acid

13. In which of the following is HSO_3^- acting as a Bronsted-Lowry acid?
   A. $HSO_3^- + H_2O \rightarrow H_2SO_3 + OH^-$
   B. $NH_3 + HSO_3^- \rightarrow NH_4^+ + SO_3^{-2}$
   C. $HSO_3^- + HPO_4^{-2} \rightarrow H_2SO_3 + PO_4^{-3}$
   D. $H_2C_2O_4 + HSO_3^- \rightarrow HC_2O_4^- + H_2SO_3$

14. Select the equation that best represents the reaction of CH_3NH_2 acting as a base with water.
   A. $CH_3NH_{2\,(aq)} + H_2O_{(l)} \leftrightarrows CH_3NH_3^+{}_{(aq)} + OH^-_{(aq)}$
   B. $CH_3NH_{2\,(aq)} + H_2O_{(l)} \leftrightarrows CH_3NH^-_{(aq)} + H_3O^+_{(aq)}$
   C. $CH_3NH_{2\,(aq)} + H_2O_{(l)} \leftrightarrows CH_3NH_2OH^-_{(aq)} + H^+_{(aq)}$
   D. $CH_3NH_{2\,(aq)} + H_2O_{(l)} \leftrightarrows CH_3^+{}_{(aq)} + NH_{3\,(aq)} + OH^-_{(aq)}$

15. Consider the following equilibrium:

$$HCO_3^- + H_2PO_4^- \leftrightarrows HPO_4^{-2} + H_2CO_3$$

What are the Bronsted-Lowry acids in this equilibrium?
   A. HCO_3^- and H_2CO_3
   B. HCO_3^- and HPO_4^{-2}
   C. $H_2PO_4^-$ and H_2CO_3
   D. $H_2PO_4^-$ and HPO_4^{-2}

16. Consider the following equilibrium:

$$HCO_3^- + H_2C_6H_5O_7^- \leftrightarrows$$

What are the Bronsted-Lowry acids in this equilibrium?
   A. $H_3C_6H_5O_7$ and H_2CO_3
   B. HCO_3^- and $HC_6H_5O_7^{-2}$
   C. $H_2C_6H_5O_7^-$ and H_2CO_3
   D. $H_2C_6H_5O_7^-$ and CO_3^{-2}

17. a. Write an equation to represent the predominant reaction when $HC_2O_4^-$ is mixed with HSO_4^-.

c. Identify a conjugate acid-base pair.

d. Predict whether the equilibrium will favour the formation of reactants or products. Explain.

18. a. Write an equation to represent the predominant reaction when HCO_3^- is mixed with HSO_3^-.

b. Justify your statement by comparing K_a values.

c. Identify a conjugate acid-base pair.

d. Predict whether the equilibrium will favour the formation of reactants or products. Explain.

J08: Write balanced equations representing the reaction of acids or bases with water

19. The predominant acid-base reaction between H_2O_2 and H_2O is

A. $H_2O_2 + H_2O \rightarrow 3OH^- + H^+$

B. $H_2O_2 + H_2O \rightarrow O_2^{-2} + H_2O$

C. $H_2O_2 + H_2O \rightarrow H_3O_2^+ + OH^-$

D. $H_2O_2 + H_2O \rightarrow HO_2^- + H_3O^+$

J09: Identify an H_3O^+ ion as a protonated H_2O molecule that can be represented in shortened form as H^+ (aq)

J10: Define conjugate acid-base pair

20. The two reactants in an acid/base reaction are HSO_3^- (aq) and HSO_4^- (aq).

a. Write the equation for the above reaction.

b. Define the term conjugage acid/base pair.

c. Write the formulas for a conjugate acid/base pair for the above reaction.

21. The two reactants in an acid/base reaction are HSO_3^- (aq) and $HC_2O_4^-$ (aq).

a. Write the equation for the above reaction.

b. Define the term conjugage acid/base pair.

c. Write the formulas for a conjugate acid/base pair for the above reaction.

J11: Identify the conjugate of a given acid or base

22. The conjugate base of an acid is produced by
A. adding a proton to the acid.
B. adding an electron to the acid.
C. removing a proton from the acid.
D. removing an electron from the acid.

23. The conjugage acid of $C_6H_5NH_2$ is
A. $C_6H_5NH^-$ B. $C_6H_5NH_3$ C. $C_6H_5NH_2^+$ D. $C_6H_5NH_3^+$

24. The conjugage base of HBO_3^{-2} is
A. $H_2BO_3^-$ B. BO_3^{-2} C. BO_3^{-3} D. $H_2BO_3^{-2}$

25. What is the conjugate base of $H_2PO_4^-$?
A. OH- B. HPO_4^{-2} C. PO_4^{-3} D. H_3PO_4

26. What is the conjugate acid of HPO_4^{-2}?
A. H_3O^+ B. $H_2PO_4^-$ C. PO_4^{-3} D. H_3PO_4

27. Identify a conjugate pair from the equilibrium provided:

$$PO_4^{-3} + HCO_3^- \leftrightarrows HPO_4^{-2} + CO_3^{-2}$$

A. CO_3^{-2} and PO_4^{-3}
B. PO_4^{-3} and HCO_3^-
C. PO_4^{-3} and HPO_4^{-2}
D. HCO_3^- and HPO_4^{-2}

J12: Show that in any Bronsted-Lowry acid-base equation there are two conjugate pairs present

28. Consider the following equilibrium:

$$H_2C_2O_{4\,(aq)} + HPO_4^{-2}{}_{(aq)} \leftrightarrows H_2PO_4^-{}_{(aq)} + HC_2O_4^-{}_{(aq)}$$

In the above equilibrium, a conjugage pair is
A. $HC_2O_4^-$ and HPO_4^{-2}
B. $HC_2O_4^-$ and $H_2PO_4^-$
C. HPO_4^{-2} and $H_2PO_4^-$
D. $H_2C_2O_4$ and $H_2PO_4^-$

29. Consider the following equilibrium:

$$H_2C_2O_{4\,(aq)} + HPO_4^{-2}{}_{(aq)} \leftrightarrows H_2PO_4^-{}_{(aq)} + HC_2O_4^-{}_{(aq)}$$

In the above equilibrium, the two acids are
A. $HC_2O_4^-$ and HPO_4^{-2}
B. $HC_2O_4^-$ and $H_2PO_4^-$
C. HPO_4^{-2} and $H_2PO_4^-$
D. $H_2C_2O_4$ and $H_2PO_4^-$

30. Consider the following reaction:

$$H_2SO_3 + CH_3NH_2 \leftrightarrows HSO_3^- + CH_3NH_3^+$$

Which of the following describes a conjugate acid-base pair in the equilibrium above?

	Acid	Base
A.	HSO_3^-	H_2SO_3
B.	$CH_3NH_3^+$	HSO_3^-
C.	H_2SO_3	$CH_3NH_3^+$
D.	$CH_3NH_3^+$	CH_3NH_2

31. An solution of $HC_2O_4^{-1}{}_{(aq)}$ turns blue litmus paper red. Write a balanced equation to represent the equilibrium between the $HC_2O_4^{-1}$ and H_2O.

K01: Relate electrical conductivity in a solution to the concentration of ions

32. Which of the following acids will have the lowest conductivity?
A. 0.010 M HCl
B. 0.010 M HNO_2
C. 0.010 M H_2SO_3
D. 0.010 M H_3BO_3

33. Which of the following will have the lowest electrical conductivity?
A. 1.00 M HCl
B. 1.00 M $LiNO_2$
C. 1.00 M NaH_2PO_4
D. 1.00 M H_2SO_3

34. Which of the following is correct if the four solutions listed are compared to one another?

	Concentration	Relative Conductivity	Ionization
A. strong acid	0.50 M	highest	complete
B. weak acid	0.50 M	lowest	complete
C. strong base	1.0 M	highest	complete
D. weak base	1.0 M	lowest	complete

35. Which of the following 1.0 M solutions will have the highest electrical conductivity?
A. HI B. HF C. HCN D. HNO_2

36. Which of the following 1.0 M solutions will have the lowest electrical conductivity?
A. H_2CO_3 B. HCOOH C. HCN D. HNO_2

37. Which of the following 1.0 M solutions will have the lowest electrical conductivity?
A. H_2CO_3 B. NH_4Cl C. NaCN D. HNO_3

38. Which of the following solutions will show the greatest electrical conductivity?
A. 0.1 M HCl
B. 0.5 M H_2CO_3
C. 0.5 M H_3BO_3
D. 0.1 M $H_2C_2O_4$

39. Which of the following saturated salt solutions would have the greatest electrical conductivity?
A. PbS B. $CsNO_3$ C. Ag_2CrO_4 D. $Ba_3(PO_4)_2$

K02: Classify an acid or base in solution as either weak or strong by comparing conductivity

40. When comparing equal volumes of 0.10 M HNO_3 with 0.10 M HNO_2, what would be observed?
A. The pH values would be the same.
B. The electrical conductivities would be the different.
C. The effects on blue litmus paper would be the different.
D. The amount of NaOH needed for neutralization would be different.

41. Which of the following solutions would typically show the greatest electrical conductivity?
A. 1.0 M HNO_2
B. 0.8 M NH_3
C. 0.5 M $NaCH_3COO$
D. 0.1 M KOH

42. Describe two lab tests and how their outcomes could be used to distinguish between a strong acid and weak acid of equal molar concentrations.

Test #1: _____

Outcome: _____

_____

Test #2: _____

Outcome: _____

_____

K03: Define a strong acid and a strong base

43. Which of the following is a property of 1.0 M HCl but not a property of 1.0 M CH_3COOH?
A. turns litmus paper red
B. ionizes completely
C. has a pH less than 7.0
D. produces H_3O^+ in solution

K04: Define a weak acid and a weak base

44. Which of the following statements applies to 1.0 M $NH_{3\,(aq)}$ but not to 1.0 M $NaOH_{\,(aq)}$?
A. partially ionizes
B. is a weak acid
C. has a pH greater than 7.0
D. has $[H_3O^+] > [OH^-]$

45. Which of the following best describes a weak acid?
A. Its 0.10 M solution will have a pH = 1.00.
B. It may be very soluble, but only partially ionized.
C. It must be very soluble and completely ionized.
D. It must be of low solubility and completely ionized.

K05: Write equations to show what happens when strong and weak acids and bases are dissolved in water

46. An acid is added to water and an new equilibrium is established. The new equilibrium can be described by
A. pH < pOH and $K_w = 1 \times 10^{-14}$
B. pH < pOH and $K_w < 1 \times 10^{-14}$
C. pH > pOH and $K_w = 1 \times 10^{-14}$
D. pH > pOH and $K_w > 1 \times 10^{-14}$

47. KOH is added to water and a new equilibrium is established. The new equilibrium can be described by
A. pH < pOH and $K_w = 1 \times 10^{-14}$
B. pH < pOH and $K_w < 1 \times 10^{-14}$
C. pH > pOH and $K_w = 1 \times 10^{-14}$
D. pH > pOH and $K_w > 1 \times 10^{-14}$

48. Which of the following represents the predominant reaction between NH_3 and H_2O?
A. $NH_3 + H_2O \leftrightarrows NH_3O + H_2$
B. $NH_3 + H_2O \leftrightarrows NH_4^+ + OH^-$
C. $NH_3 + H_2O \leftrightarrows NH_5^{+2} + O^{-2}$
D. $NH_3 + H_2O \leftrightarrows H_3O^+ + NH_2^-$

49. Which equation best describes the interaction of a weak base with water?
A. $NaOH_{(aq)} \rightarrow Na^+_{(aq)} + OH^-_{(aq)}$
B. $CH_3CH_2OH_{(l)} \rightarrow CH_3CH_2OH_{(aq)}$
C. $HPO_4^{-2}{}_{(aq)} + H_2O_{(l)} \leftrightarrows PO_4^{-3}{}_{(aq)} + H_3O^+_{(aq)}$
D. $N_2H_{4\,(aq)} + H_2O_{(l)} \leftrightarrows N_2H_5^+{}_{(aq)} + OH^-_{(aq)}$

K06: Compare the relative strengths of acids or bases by using a table of relative acid strengths

50. Consider the following equilibrium:

$$H_2C_2O_{4\,(aq)} + HPO_4^{-2}{}_{(aq)} \leftrightarrows H_2PO_4^-{}_{(aq)} + HC_2O_4^-{}_{(aq)}$$

In the above equilibrium, the strongest acid is
A. $HC_2O_4^-$ B. $H_2PO_4^-$ C. HPO_4^{-2} D. $H_2C_2O_4$

51. The strength of the acids HCl, H_2SO_3 and H_3PO_4 from weakest to strongest is
A. $HCl < H_3PO_4 < H_2SO_3$
B. $HCl < H_2SO_3 < H_3PO_4$
C. $H_2SO_3 < H_3PO_4 < HCl$
D. $H_3PO_4 < H_2SO_3 < HCl$

52. The strength of the ions $HC_2O_4^-$, HSO_3^- and $H_2PO_4^-$ from weakest to strongest **acid** is
A. $HC_2O_4^- < H_2PO_4^- < HSO_3^-$
B. $HC_2O_4^- < HSO_3^- < H_2PO_4^-$
C. $HSO_3^- < H_2PO_4^- < HC_2O_4^-$
D. $H_2PO_4^- < HSO_3^- < HC_2O_4^-$

53. Which of the following is the weakest base?
A. F^- B. HS^- C. CN^- D. IO_3^-

54. Which of the following is the weakest acid?
A. HSO_3^- B. $H_2PO_4^-$ C. HCO_3^- D. $HC_2O_4^-$

55. Which of the following is the weakest base?
A. HSO_3^- B. $H_2PO_4^-$ C. HCO_3^- D. $HC_2O_4^-$

K07: Identify and explain why the strongest acid in aqueous solutions is H_30^+ and the strongest base in aqueous solution is OH^-

56. Aqua regia is a concentrated aqueous solution of HCl and HNO_3. The strongest acid in aqua regia is
A. HCl B. H_2O C. HNO_3 D. H_3O^+

57. Which of the following is the strongest base that can exist in an aqueous solution?
A. NH_2^- B. PO_4^{-3} C. H_3O^+ D. OH^-

K08: Predict whether products or reactants are favoured in an acid-base equalibrium by comparing the strength of two acids or bases

58. Which of the following reactions favours the formation of products?

A. $HNO_2 + F^- \leftrightarrows HF + NO_2^-$

B. $H_2CO_3 + IO_3^- \leftrightarrows HIO_3 + HCO_3^-$

C. $NH_4^+ + C_2O_4^{-2} \leftrightarrows HC_2O_4^- + NH_3$

D. $HCN + HCOO^- \leftrightarrows HCOOH + CN^-$

59. In which of the following are reactants favoured?

A. $HNO_2 + CN^- \leftrightarrows NO_2^- + HCN$

B. $H_2S + HCO_3^- \leftrightarrows HS^- + H_2CO_3$

C. $H_3PO_4 + NH_3 \leftrightarrows H_2PO_4^- + NH_4^+$

D. $CH_3COOH + PO_4^{-3} \leftrightarrows CH_3COO^- + HPO_4^{-2}$

60. Consider the following equilibrium:

$$HF_{(aq)} + HPO_4^{-2}{}_{(aq)} \leftrightarrows F^-_{(aq)} + H_2PO_4^-{}_{(aq)}$$

For the above equilibrium, identify the weaker acid and determine whether reactants or products are favored.

Weaker Acid	Side favored
A. HF	products
B. HF	reactants
C. $H_2PO_4^-$	products
D. $H_2PO_4^-$	reactants

61. Consider the following equilibrium:

$$HF_{(aq)} + HPO_4^{-2}{}_{(aq)} \leftrightarrows F^-_{(aq)} + H_2PO_4^-{}_{(aq)}$$

For the above equilibrium, identify the stronger acid and determine whether reactants or products are favored.

Stronger Acid	Side favored
A. HF	products
B. HF	reactants
C. $H_2PO_4^-$	products
D. $H_2PO_4^-$	reactants

62. Consider the following equilibrium:

$$H_2SO_3{}_{(aq)} + H_2PO_4^-{}_{(aq)} \leftrightarrows HSO_3^-{}_{(aq)} + H_3PO_4{}_{(aq)}$$

For the above equilibrium, identify the stronger acid and determine whether reactants or products are favored.

Stronger Acid	Side favored
A. H_2SO_3	products
B. H_2SO_3	reactants
C. H_3PO_4	products
D. H_3PO_4	reactants

63. Consider the following equilibrium:

$$HCO_3^- + H_2PO_4^- \leftrightarrows H_2CO_3 + HPO_4^{-2}$$

Which of the following statements is true?

A. Products are favored because $H_2PO_4^-$ is a stronger acid than H_2CO_3

B. Products are favored because $H_2PO_4^-$ is a stronger acid than HPO_4^{-2}

C. Reactants are favored because HCO_3^- is a stronger base than H_2CO_3

D. Reactants are favored because H_2CO_3 is a stronger acid than $H_2PO_4^-$

64. An acid-base reaction occurs between $H_2PO_4^-$ and $HC_2O_4^-$. Write the equation for the equilibrium that results.

A. $H_2PO_4^- + HC_2O_4^- \leftrightarrows H_3PO_4 + H_2C_2O_4$

B. $H_2PO_4^- + HC_2O_4^- \leftrightarrows H_3PO_4 + C_2O_4^{-2}$

C. $H_2PO_4^- + HC_2O_4^- \leftrightarrows HPO_4^{-2} + H_2C_2O_4$

D. $H_2PO_4^- + HC_2O_4^- \leftrightarrows HPO_4^{-2} + C_2O_4^{-2}$

65. Consider the following equilibrium:

$$H_3AsO_4 + HSeO_3^- \leftrightarrows H_2AsO_4^- + H_2SeO_3$$

Reactants are favored in this equilibrium. Which of the following describes the relative strengths of the acids?

Stronger Acid	Weaker Acid
A. H_2SeO_3	H_3AsO_4
B. $HSeO_3^-$	$H_2AsO_4^-$
C. H_3AsO_4	H_2SeO_3
D. $H_2AsO_4^-$	$HSeO_3^-$

66. Consider the following acid-base equilibria and their K_{eq}:

(A) $H_2AsO_4^{-1} + HSO_3^- \leftrightarrows HAsO_4^{-2} + H_2SO_3 \quad K_{eq} = 4.2 \times 10^{-3}$
(B) $HSeO_4^{-1} + H_2AsO_4^{-1} \leftrightarrows HAsO_4^{-2} + H_2SeO_4 \quad K_{eq} = 1.2 \times 10^{1}$
(C) $H_3AsO_4 + HSO_3^- \leftrightarrows H_2AsO_4^{-1} + H_2SO_3 \quad K_{eq} = 7.9 \times 10^{4}$

a. Write the formula of the weaker acid in equation (A) _____

b. Write the formula of the weaker acid in equation (B) _____

c. Write the formula of the weaker acid in equation (C) _____

d. List the acids from the equilibria above in order from **weakest acid to strongest acid.**

67. Consider the acids HCl and HF.

a. Only one of the following reactions occurs. Complete the equation of the reaction which does occur.

i) $HCl + F^- \rightarrow$ _____

ii) $HF + Cl^- \rightarrow$ _____

b. For the reaction that occurs, are the reactants or products favored? Explain.

68. An acid-base reaction occurs between HSO_3^- and HCO_3^-

a. Write the equation for the equilibrium that results.

b. Identify one conjugate acid-base pair in the reaction.

c. State whether reactants or products are favored and explain how you arrived at your answer.

69. a. Write the equation to represent the reaction that results when NH_4^+ ions are mixed with HCO_3^- ions.

b. Identify the two bases in the reaction in part a)

c. Predict whether the reaction will favour the reactants or products. Justify your answer.

Prediction: _____

Justification: _____

K09: Compare the relative concentrations of H_30^+ or OH^- between two acids or bases using their relative positions on an acid strength table

70. Which of the following 1.0 M solutions will have the lowest $[H_3O^+]$?

A. H_2S B. HNO_2 C. H_2CO_3 D. CH_3COOH

71. The ionization of water can be represented by:
   A. $2H_2O_{(l)} \rightarrow 2H_{2(g)} + O_{2(g)}$
   B. $H_2O_{(l)} \rightarrow 2H^+_{(aq)} + O^{-2}_{(aq)}$
   C. $2H_2O_{(l)} \rightarrow H_3O_{(aq)} + OH_{(aq)}$
   D. $2H_2O_{(l)} \rightarrow H_3O^+_{(aq)} + OH^-_{(aq)}$

72. Given a 1.0 M solution of HI, which sequence best describes the equilibrium concentration of the substances in the solution?
   A. $[H_3O^+] > [I^-] > [OH^-] > [HI]$
   B. $[HI] > [H_3O^+] > [I^-] > [OH^-]$
   C. $[H_3O^+] = [I^-] > [OH^-] > [HI]$
   D. $[H_3O^+] > [HI] > [I^-] > [OH^-]$

K10: Define amphiprotic

73. The ion $H_2PO_4^-$ is an amphiprotic anion.

   a. Define the term **amphiprotic**.

   b. Write a balanced equation for the reaction when $H_2PO_4^-$ reacts with HCO_3^-.

K11: Identify chemical species that are amphiprotic

74. Which of the following are amphiprotic in aqueous solutions?

   I. H_3BO_3
   II. $H_2BO_3^-$
   III. HBO_3^{-2}
   IV. BO_3^{-3}

   A. I only B. IV only C. I and II only D. II and III only

K12: Describe situations in which H_20 would act as an acid or base

75. Water will act as an acid when it reacts with which of the following:

   I. CN^-
   II. NH_3
   III. $HClO_4$
   IV. CH_3COO^-

   A. I and IV only
   B. II and III only
   C. I, II, and IV only
   D. II, III and IV only

76. In which of the following reactions is water behaving as a Bronsted-Lowry acid?
   A. $2H_2O \rightarrow 2H_2 + O_2$
   B. $HCl + H_2O \rightarrow H_3O^+ + Cl^-$
   C. $NH_3 + H_2O \rightarrow NH_4^+ + OH^-$
   D. $NH_4^+ + H_2O \rightarrow NH_3 + H_3O^+$

77. Water has the greatest tendency to act as an acid with which of the following?
   A. Cl^- B. NO_2^- C. $H_2PO_4^-$ D. CH_3COO^-

78. Water has the greatest tendency to act as an acid with which of the following?
   A. HSO_3^- B. HCO_3^- C. $H_2PO_4^-$ D. $HC_2O_4^-$

79. Water has the greatest tendency to act as a base with which of the following?
   A. HSO_3^- B. HCO_3^- C. $H_2PO_4^-$ D. $HC_2O_4^-$

L01: Write equations representing the ionization of water using either H_30^+ and OH^- or H^+ and OH^-

L02: Write the equilibrium expression for the ion product constant of water, K_w

80. Which of the following relationships is used to calculate K_w at 30°C?
   A. $K_w = pH + pOH$
   B. $K_w = -\log [H_3O^+]$
   C. $K_w = [H_3O^+][OH^-]$
   D. $K_w = [H_3O^+] + [OH^-]$

81. Consider the following equilibrium at 25 °C:

$$2H_2O_{(l)} \leftrightarrows H_3O^+_{(aq)} + OH^-_{(aq)}$$

What happens to $[OH^-]$ and pH as 0.1 M HCl is added?

	$[OH^-]$	pH
A.	decreases	increases
B.	decreases	decreases
C.	increases	increases
D.	increases	decreases

82. Consider the following equilibrium:

$$2H_2O_{(l)} \leftrightarrows H_3O^+_{(aq)} + OH^-_{(aq)}$$

What changes occur to $[H_3O^+]$ and pH when NaOH is added?

	$[H_3O^+]$	pH
A.	increases	increases
B.	increases	decreases
C.	decreases	decreases
D.	decreases	increases

83. What happens to the ion concentrations in water when a small amount of $HCl_{(aq)}$ is added?

A. $[H_3O^+] = [OH^-] = 1.0 \times 10^{-7}$ M
B. $[H_3O^+]$ and $[OH^-]$ both increase
C. $[H_3O^+]$ increases and $[OH^-]$ decreases
D. $[H_3O^+]$ increases and $[OH^-]$ stays unchanged

84. Consider the ionization of water:

$$2H_2O_{(l)} \leftrightarrows H_3O^+_{(aq)} + OH^-_{(aq)}$$

What happens to the pH when 0.1 M NaOH is added to the water?

A. pH increases since $[H_3O^+]$ increases
B. pH increases since $[H_3O^+]$ decreases
C. pH decreases since $[H_3O^+]$ increases
D. pH decreases since $[H_3O^+]$ decreases

L04: State the relative concentrations of H_30^+ and OH^- in acid, base and neutral solutions

$H_2SO_4 + H_2O \rightleftarrows H_3O^+ + HSO_4^-$; $HSO_4^- \rightleftarrows H^+ + SO_4^{-2}$

85. In a solution of 0.10 M H_2SO_4, the ions present in order of decreasing concentration are

A. $[H_3O^+] > [HSO_4^-] > [SO_4^{-2}] > [OH^-]$
B. $[H_3O^+] > [SO_4^{-2}] > [HSO_4^{-2}] > [OH^-]$
C. $[OH^-] > [HSO_4^-] > [SO_4^{-2}] > [H_3O^+]$
D. $[SO_4^{-2}] > [HSO_4^-] > [OH^-] > [H_3O^+]$

86. Consider the following equilibrium:

$$2H_2O_{(l)} + \text{energy} \leftrightarrows H_3O^+_{(aq)} + OH^-_{(aq)}$$

The temperature is decreased and a new equilibrium is established. The new equilibrium can be described by

A. pH = pOH and $K_w > 1.0 \times 10^{-14}$
B. pH = pOH and $K_w < 1.0 \times 10^{-14}$
C. pH > pOH and $K_w = 1.0 \times 10^{-14}$
D. pH < pOH and $K_w = 1.0 \times 10^{-14}$

87. Consider the following equilibrium:

$$2H_2O_{(l)} + \text{energy} \leftrightarrows H_3O^+_{(aq)} + OH^-_{(aq)}$$

A few drops of HCl are added and a new equilibrium is established. The new equilibrium can be described by

A. pH = pOH and $K_w > 1.0 \times 10^{-14}$
B. pH = pOH and $K_w < 1.0 \times 10^{-14}$
C. pH > pOH and $K_w = 1.0 \times 10^{-14}$
D. pH < pOH and $K_w = 1.0 \times 10^{-14}$

88. Which of the following is true for pure water?

A. $[H_3O^+] = 0.0$ M
B. $[H_3O^+] = [OH^-]$
C. $[H_3O^+] > [OH^-]$
D. $[H_3O^+] < [OH^-]$

89. Which of the following is true for pure water at 5° C in which the pH = 7.53?

A. $[H_3O^+] = K_w$
B. $[H_3O^+] = [OH^-]$
C. $[H_3O^+] > [OH^-]$
D. $[H_3O^+] < [OH^-]$

90. Which of the following is true for pure water at 75° C in which the pH = 6.83?
A. $[H_3O^+] = K_w$
B. $[H_3O^+] = [OH^-]$
C. $[H_3O^+] > [OH^-]$
D. $[H_3O^+] < [OH^-]$

91. Which of the following statements is true for an acidic solution at 25°C?
A. pH > 7.0
B. pOH < 7.0
C. $[H_3O^+] < [OH^-]$
D. $[H_3O^+] > [OH^-]$

L05: State the value of K_w at 25° C

L06: Describe the variation of the value of K_w with temperature

92. Consider the following equilibrium:

$$2H_2O_{(l)} + \text{energy} \leftrightarrows H_3O^+_{(aq)} + OH^-_{(aq)}$$

The $[OH^-]$ will decrease and the K_w will decrease when
A. a strong acid is added
B. a strong base is added
C. the temperature is increased
D. the temperature is decreased

93. The ionization of water is endothermic. How is K_w related to the temperature of water?
A. K_w increases as temperature increases.
B. K_w decreases as temperature increases.
C. K_w increases as temperature decreases.
D. K_w remains constant as temperature decreases.

94. The ionization of pure water is shown by the reaction:

$$2H_2O_{(l)} + 57.1\ kJ \leftrightarrows H_3O^+_{(aq)} + OH^-_{(aq)}$$

At a certain temperature the K_w of the water is 4.6×10^{-15}.

a. Is the temperature above or below 25°C? Explain your answer using the words exothermic or endothermic and Le Chatelier's Principle.

b. Calculate the pH and pOH of this water

c. Is the water acidic, basic or neutral? Explain your answer.

95. The ionization of pure water is shown by the reaction:

$$2H_2O_{(l)} + 57.1\ kJ \leftrightarrows H_3O^+_{(aq)} + OH^-_{(aq)}$$

At a certain temperature the pH of the water is 7.27.

a. Is the temperature above or below 25°C? Explain your answer using the words exothermic or endothermic and Le Chatelier's Principle.

b. Is the water acidic, basic or neutral? Explain your answer.

c. Calculate the K_w of water at this temperature.

96. Consider the following equilibrium:

$$energy + 2H_2O_{(l)} \leftrightarrows H_3O^+_{(aq)} + OH^-_{(aq)}$$

a. Explain how pure water can have a pH = 7.30.

b. Calculate the value of K_w for the sample of water with a pH of 7.30.

97. At 10°C, the pH of pure water is 7.265.

a. Determine the pOH of water at 10°C.

b. Calculate Kw of pure water at 10°C.

L07: Calculate the concentration of H_3O^+ or OH^- given the other , using K_w

98. What is the $[OH^-]$ of a solution with $[H_3O^+] = 9.3 \times 10^{-2}$?

A. 9.3×10^{-16} M B. 8.6×10^{-13} M C. 1.1×10^{-13} M D. 9.3×10^{-2} M

99. What is the [OH-] in 0.025 M HCl?

A. 1.60 M B. 4.0×10^{-13} M C. 2.5×10^{-2} M D. 12.40 M

100. At 20°C the ionization constant of water (K_w) is 6.76×10^{-15}. Calculate the pOH of water at 20°C.

L08: Describe the pH scale with reference to everyday solutions

101. Which of the following household products could have a pH = 12.00?

A. soda pop B. tap water C. lemon juice D. oven cleaner

102. Which of the following household products could have a pH = 3.00?
A. ammonia B. tap water C. lemon juice D. oven cleaner

103. Which of the following household products could have a pH = 7.00?
A. soda pop B. tap water C. lemon juice D. oven cleaner

104. Which of the following is a typical pH value for dishwashing solutions?
A. 2.0 B. 4.0 C. 10.0 D. 14.0

L09: Define pH and pOH

L10: Define pK_w, give its value at 25° C and its relation to pH and pOH

105. Consider the following statements about water at 60°C:

I. The pH of water at 60°C < 7.00
II The pOH of water at 60°C >7.00
III. The pH = pOH of water at 60°C.

Which of the above statements are true?
A. I and II B. I and III C. I, II and III D. III only

106. Which of the following is a definition of pK_w?
A. $pK_w = -\log K_w$
B. $pK_w = pH - pOH$
C. $pK_w = 7.0$ at 25° C
D. $pK_w = [H_3O^+][OH^-]$

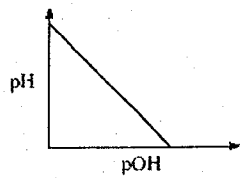
107. What is the value of pK_w for water at 25°C?
A. 1.0×10^{-14}
B. 1.0×10^{-7}
C. 7.00
D. 14.00

L11: Perform calculations relating pH, pOH, $[H_3O^+]$ and $[OH^-]$

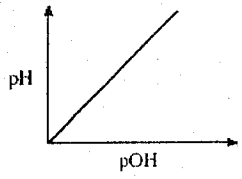
108. When the $[H_3O^+]$ in a solution is increased to twice the original concentration, the change in pH could be from
A. 1.7 to 1.4 B. 2.0 to 4.0 C. 5.0 to 2.5 D. 8.5 to 6.5

109. Which of the following graphs describes the relationship between pH and pOH in pure water?

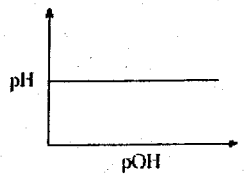
A.



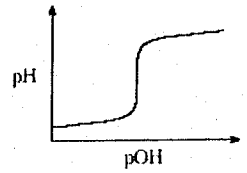
B.



C.

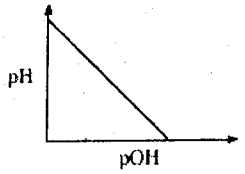


D.

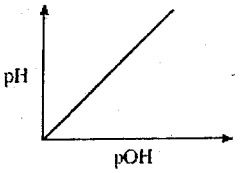


110. Which of the following graphs describes the relationship between pH and pOH in an aqueous solution?

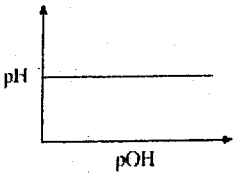
A.



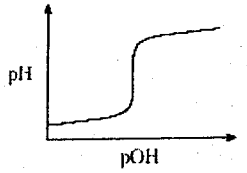
B.



C.



D.



111. What is the $[Sr(OH)_2]$ in a solution with the pH = 11.00?

A. 2.0×10^{-11} M B. 1.0×10^{-11} M C. 5.0×10^{-4} M D. 1.0×10^{-3} M

112. What is the pH of a 0.10 M $Sr(OH)_2$ solution?

A. 0.70 B. 1.00 C. 13.00 D. 13.30

113. What is the pOH of a solution prepared by adding 0.50 moles of NaOH to 0.50 L of water?

A. 0.00 B. 0.30 C. 14.00 D. 13.70

114. The pH of 0.10 M HNO_3 is

A. 0.79 B. 1.00 C. 1.26 D. 13.00

115. How many moles of HI are needed to prepare 3.0 L of an HI solution with a pH of 1.00?

A. 0.030 mol B. 0.30 mol C. 3.0 mol D. 30. mol

116. Calculate the pOH of a 0.050 M HBr solution.

A. 0.30 B. 1.30 C. 12.70 D. 13.70

117. What is the pH of a 0.50 M NaOH solution?

A. 0.30 B. 1.30 C. 12.70 D. 13.70

118. What is the pH of a 0.0050 M $Sr(OH)_2$ solution?

A. 2.00 B. 2.30 C. 12.70 D. 12.00

119. Which of the following equations can be used to calculate pOH?

A. pOH = -log Kw
B. pOH = pKw + pH
C. pOH = pKw - pH
D. pOH = $-\log[H_3O^+]$

120. What is the pOH of 0.05 M $Sr(OH)_2$?

A. 1.0 B. 1.3 C. 12.7 D. 13.0

121. Complete the following table:

$[H_3O^+]$	$[OH^-]$	pH	pOH
5×10^{-4} M			
		12.4	
	8.25×10^{-8} M		
			10.369

122. Calculate the pH of a saturated solution of $Mg(OH)_2$.

123. Calculate the pH of 0.25 M $Sr(OH)_2$.

L12: Perform calculations relating pH, pOH, $[H_3O^+]$ and $[OH^-]$

124. In order to change the pH of a solution from 2.0 to 4.0 the $[H_3O^+]$ must

A. increase by a factor of 2
B. decrease by a factor of 2
C. increase by a factor of 100
D. decrease by a factor of 100

125. What is the $[H_3O^+]$ in a solution with a pOH = 5.20?

A. 1.4×10^{-14} M B. 1.6×10^{-9} M C. 6.3×10^{-6} M D. 7.1×10^{-1} M

126. What is the pOH of a solution made be adding 50.0 mL of 0.50 M NaOH to 250.0 mL of water?

A. 0.30 B. 1.00 C. 1.08 D. 12.92

127. Which of the following 1.0×10^{-3} M solutions has a pH of 3.00?

A. HCl B. HCN C. NaOH D. K_2SO_4

128. What is the pOH of 0.2 M HNO_3?

A. 5×10^{-14} B. 0.2 C. 0.7 D. 13.3

129. A sample of pure NaOH (s) is dissolved in water to make 10.0 L of solution and a pH = 11.75 results. Calculate the mass of pure NaOH that was dissolved.

130. Which of the following solutions will have the lowest [OH-]?

A. NaF B. NaCl C. $NaHCO_3$ D. NaH_2PO_4

M1: Write K_a and K_b equilibrium

131. The relationship $\frac{[H_2P_2O_7^{-2}][H_3O^+]}{[H_3P_2O_7^-]}$ is the

A. K_a for $H_3P_2O_7^-$ B. K_b for $H_3P_2O_7^-$ C. K_a for $H_2P_2O_7^{-2}$ D. K_b for $H_2P_2O_7^{-2}$

132. The relationship $\frac{[H_3BO_3][OH^-]}{[H_2BO_3^-]}$ is the expression for

A. K_a for H_3BO_3 B. K_b for H_3BO_3 C. K_a for $H_2BO_3^-$ D. K_b for $H_2BO_3^-$

133. The K_a expression for HTe^- is

A. $K_a = \frac{[H_2Te][OH^-]}{[HTe^-]}$

B. $K_a = \frac{[Te^{-2}][H_3O^+]}{[HTe^-]}$

C. $K_a = \frac{[HTe^-][H_3O^+]}{[H_2Te]}$

D. $K_a = \frac{[HTe^-][OH^-]}{[Te^{-2}]}$

134. The K_b expression for HSe^- is

A. $K_b = \frac{[H_2Se][OH^-]}{[HSe^-]}$

B. $K_b = \frac{[HSe^-][OH^-]}{[Se^{-2}]}$

C. $K_b = \frac{[HSe^-][H_3O^+]}{[H_2Se]}$

D. $K_b = \frac{[Se^{-2}][H_3O^+]}{[HSe^-]}$

135. Consider the following acid equilibrium:

$$HCN_{(aq)} + H_2O_{(l)} \leftrightarrows H_3O^+_{(aq)} + CN^-_{(aq)}$$

When writing the K_a expression for HCN, why is $H_2O_{(l)}$ not included in the expression?

A. The concentration of $H_2O_{(l)}$ is too large.
B. The concentration of $H_2O_{(l)}$ is too small.
C. The concentration of $H_2O_{(l)}$ does not exist.
D. The concentration of $H_2O_{(l)}$ is relatively constant.

136. Consider the following equilibrium:

$$CH_3NH_{2\,(aq)} + H_2O_{(l)} \leftrightarrows CH_3NH_3^+{}_{(aq)} + OH^-_{(aq)}$$

Which of the following is true?

A. $K_{eq} = \frac{[CH_3NH_3^+][OH^-]}{[CH_3NH_2][H_2O]}$

B. $K_a = \frac{[CH_3NH_3^+][OH^-]}{[CH_3NH_2]}$

C. $K_b = \frac{[CH_3NH_3^+][OH^-]}{[CH_3NH_2]}$

D. $K_{sp} = [CH_3NH_3^+][OH^-]$

137. Consider the following equilibrium:

$$CH_3NH_{2\,(aq)} + H_2O_{(l)} \leftrightarrows CH_3NH_3^+{}_{(aq)} + OH^-_{(aq)}$$

Which of the following is true?

A. $K_b = \frac{[CH_3NH_3^+][OH^-]}{[CH_3NH_2][H_2O]}$

B. $K_a = \frac{[CH_3NH_3^+][OH^-]}{[CH_3NH_2][H_2O]}$

C. $K_b = \frac{[CH_3NH_3^+][OH^-]}{[CH_3NH_2]}$

D. $K_b = \frac{[CH_3NH_2][H_2O]}{[CH_3NH_3^+][OH^-]}$

138. What is the K_a expression for H_3PO_4?

A. $K_a = \frac{[PO_4^{-3}]}{[H^+]^3}$

B. $K_a = \frac{[H_3O^+][PO_4^{-3}]}{[H_3PO_4]}$

C. $K_a = \frac{[H_3O^+]^3[PO_4^{-3}]}{[H_3PO_4]}$

D. $K_a = \frac{[H_3O^+][H_2PO_4^-]}{[H_3PO_4]}$

M2: Relate the magnitude of K_a or K_b to the strength of the acid or base

139. Which of the following 1.0 M solutions will have the lowest pH?
A. HCl B. HCN C. H_3PO_4 D. $H_2C_2O_4$

140. Which of the following 1.0 M solutions will have the highest pOH?
A. HCl B. HCN C. H_3PO_4 D. $H_2C_2O_4$

141. Which of the following 1.0 M solutions will have the lowest pH?
A. $HClO_4$ B. HCN C. H_3PO_4 D. H_2CO_3

142. Which of the following will be the most basic?
A. 1.0 M NO_3^- B. 1.0 M SO_4^{-2} C. 1.0 M CO_3^{-2} D. 1.0 M PO_4^{-3}

143. Which of the following will be the most acidic?
A. 1.0 M NO_2^- B. 1.0 M SO_3^{-2} C. 1.0 M CO_3^{-2} D. 1.0 M SO_4^{-2}

144. Which of the following Ka values represents the acid with the strongest conjugate base?
A. $K_a = 9.5 \times 10^{-9}$ B. $K_a = 4.2 \times 10^{-12}$ C. $K_a = 2.0 \times 10^{-5}$ D. $K_a = 7.8 \times 10^{-3}$

145. Which of the following will have the smallest K_b value?
A. IO_3^- B. NH_3 C. CN^- D. HPO_4^{-2}

M3: Given the K_a, K_b and initial concentration, calculate any of the following: H_30^+, OH^-, pH or pOH

146. Calculate the pH in 0.50 M NH_3.

147. Calculate the pH in 0.050 M $Al_2(C_2O_4)_3$.

148. Calculate the pH of 0.25 M HNO_2

149. Calculate the pH of 0.25 M $NaHCO_3$

150. Calculate the pH of 0.50 M H_2S.

151. Calculate the pH of 0.25 M Na_2HPO_4

152. Calculate the pH of a saturated SrF_2 solution.

153. Calculate the pH of a 0.50 M KCN.

154. Calculate the pH of a 0.50 M NaC_6H_5O.

155. Calculate the pH of a 0.60 M NH_4I. Start by writing the equation for the predominant equilibrium reaction.

156. Calculate the pH of 3.0 M Na_2CO_3. Start by wrting the equation for the predominnat equilibrium reaction.

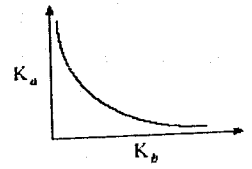
157. What concentration of NH_3 would be required to provide a solution with a pH of 11.35?

158. Calculate the pH of a 0.025 M $Ca(H_2PO_4)_2$ solution.

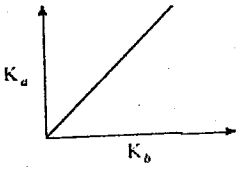
M4: Calculate the value of K_b for a base given the value of K_a, or vice versa

159. Which of the following graphs describes the relationship between K_a and K_b for all conjugage pairs?

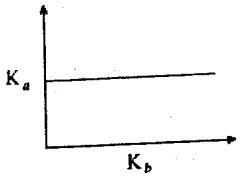
A.



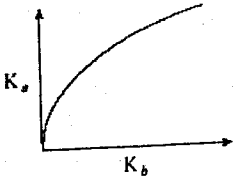
B.



C.



D.



160. What is the value of K_b for $HC_2O_4^-$?

A. 6.4×10^{-5} B. 5.9×10^{-2} C. 1.7×10^{-13} D. 1.6×10^{-10}

161. What is the value of K_b for $HC_6H_5O_7^{-2}$?

A. 1.7×10^{-5} B. 4.1×10^{-7} C. 2.1×10^{-8} D. 5.9×10^{-10}

162. What is the value of K_b for $H_2C_6H_5O_7^-$?

A. 1.7×10^{-5} B. 7.1×10^{-4} C. 1.4×10^{-11} D. 5.9×10^{-10}

163. What is the K_b value for $H_2PO_4^-$?

A. 1.3×10^{-12} B. 6.2×10^{-8} C. 1.6×10^{-7} D. 7.5×10^{-3}

164. What is the K_b value for HPO_4^{-2}?

A. 1.3×10^{-12} B. 6.2×10^{-8} C. 1.6×10^{-7} D. 7.5×10^{-3}

165. Since the ionization of water is endothermic, which of the following is true at 40°C?

A. $K_w = \frac{K_a}{K_b}$

B. $K_w = \frac{K_b}{K_a}$

C. $K_w > 1.0 \times 10^{-14}$

D. $K_w < 1.0 \times 10^{-14}$

M5: Calculate the value of K_b or K_a, given the pH and initial concentration

166. A 0.0200 M solution of methylamine, CH_3NH_2, has a pH = 11.40. Calculate the K_b for methylamine.

167. A 0.20 M solution of a weak acid HA has a pH = 1.32. Use calcaulations and the table of "Relative Strengths of Bronsted-Lowry Acids and Bases" from the Data Booklet to determine the identity of the acid.

168. A 0.20 M solution of a weak acid HA has a pH = 3.87. Use calcaulations and the table of "Relative Strengths of Bronsted-Lowry Acids and Bases" from the Data Booklet to determine the identity of the acid.

169. A 0.20 M solution of a weak base NaX has a pH = 8.744. Use calcaulations and the table of "Relative Strengths of Bronsted-Lowry Acids and Bases" from the Data Booklet to determine the identity of the NaX.

170. A 2.00 M diprotic acid has a pH of 0.50. Calculate its K_a value.

171. A 0.360 M diprotic acid has a pH of 4.50. Calculate its K_a value.

172. A 0.875 M solution of an unknown base has a pH of 8.16. Calculate the K_b of the weak base.

173. A unknown solution has a concentration of 0.560 M has a pH of 5.44. Calculate the unknown solution's K_a or K_b.

N1: Write a dissociation equation for a salt in water

174. Which of the following represents the dissociation equation of a salt in water?

A. $KCl_{(s)} \rightarrow K^+_{(aq)} + Cl^-_{(aq)}$

B. $Ca^{+2}_{(aq)} + SO_4^{-2}{}_{(aq)} \rightarrow CaSO_{4\,(s)}$

C. $HCl_{(aq)} + KOH_{(aq)} \rightarrow KCl_{(aq)} + H_2O_{(l)}$

D. $2Na^+_{(aq)} + 2H_2O_{(l)} \rightarrow 2NaOH_{(aq)} + H_{2\,(g)}$

175. What is the dissociation equation for Na_2CO_3 in water?

A. $Na_2CO_{3\,(s)} \rightarrow Na^{+2}_{(aq)} + CO_3^{-2}{}_{(aq)}$

B. $Na_2CO_{3\,(s)} \rightarrow 2Na^+_{(aq)} + CO_3^{-2}{}_{(aq)}$

C. $CO_3^{-2}{}_{(aq)} + H_2O_{(l)} \rightarrow HCO_3^-{}_{(aq)} + OH^-_{(aq)}$

D. $Na_2CO_{3\,(s)} + 2\,H_2O_{(l)} \rightarrow 2NaOH_{(aq)} + H_2CO_{3\,(aq)}$

176. Which of the following equations describes the dissociation of the salt, ammonium chloride, in water?

A. $NH_4Cl_{(s)} \leftrightarrows NH_4^+{}_{(aq)} + Cl^-_{(aq)}$

B. $NH_4^+{}_{(aq)} + Cl^-_{(aq)} \leftrightarrows NH_4Cl_{(s)}$

C. $Cl^-_{(aq)} + H_2O_{(l)} \leftrightarrows HCl_{(aq)} + OH^-_{(aq)}$

D. $NH_4^+{}_{(aq)} + H_2O_{(l)} \leftrightarrows H_3O^+_{(aq)} + NH_{3\,(l)}$

N2: Write a net ionic equations representing the hydrolysis of salts

177. Which of the following is the net ionic equation describing the hydrolysis of KCN?

A. $K^+_{(aq)} + H_2O_{(l)} \leftrightarrows KOH_{(aq)} + H^+_{(aq)}$

B. $KCN_{(aq)} + H_2O_{(l)} \leftrightarrows K^+_{(aq)} + CN^-_{(aq)}$

C. $CN^-_{(aq)} + H_2O_{(l)} \leftrightarrows HCN_{(aq)} + OH^-_{(aq)}$

D. $CN^-_{(aq)} + H_2O_{(l)} \leftrightarrows 2H^+_{(aq)} + CNO^-_{(aq)}$

178. Which of the following is the net ionic equation describing the hydrolysis of KHC_2O_4?

A. $KHC_2O_{4\,(aq)} + H_2O_{(l)} \leftrightarrows H_2C_2O_{4\,(aq)} + KOH_{(aq)}$

B. $KHC_2O_{4\,(aq)} + H_2O_{(l)} \leftrightarrows KC_2O_4^-{}_{(aq)} + H_3O^+_{(aq)}$

C. $HC_2O_4^-{}_{(aq)} + H_2O_{(l)} \leftrightarrows H_2C_2O_{4\,(aq)} + OH^-_{(aq)}$

D. $HC_2O_4^-{}_{(aq)} + H_2O \leftrightarrows C_2O_4^{-2}{}_{(aq)} + H_3O^+_{(aq)}$

179. Which of the following represents the equilibrium constant expression for the hydrolysis reaction that occurs in $NaF_{(aq)}$?

A. $K_b = \dfrac{[HF][OH^-]}{[F^-]}$

B. $K_a = \dfrac{[H_3O^+][F^-]}{[HF]}$

C. $K_{eq} = \dfrac{[Na^+][F^-]}{[NaF]}$

D. $K_w = [H_3O^+][OH^-]$

180. Which of the following represents the equilibrium constant expression for the hydrolysis reaction that occurs in $NH_4NO_{3(aq)}$?

A. $K_b = \dfrac{[NH_3][OH^-]}{[NH_4^+]}$

B. $K_a = \dfrac{[H_3O^+][NH_3]}{[NH_4^+]}$

C. $K_{eq} = \dfrac{[NH_4^+][NO_3^-]}{[NH_4NO_3]}$

D. $K_b = \dfrac{[HNO_3][OH^-]}{[NO_3^-]}$

181. Which of the following describes the net ionic equation for the hydrolysis of a $NaNO_2$ solution?

A. $NaNO_{2\,(s)} \leftrightarrows Na^+_{(aq)} + NO_2^-{}_{(aq)}$

B. $NO_2^-{}_{(aq)} + H_2O_{(l)} \leftrightarrows HNO_{2\,(aq)} + OH^-_{(aq)}$

C. $Na^+{}_{(aq)} + 2H_2O\,(l) \leftrightarrows H_3O^+_{(aq)} + NaOH_{(aq)}$

D. $NaNO_{2\,(s)} + H_2O_{(l)} \leftrightarrows NaOH + HNO_{2\,(aq)}$

182. Which of the following describes the net ionic equation for the hydrolysis of a $NaCH_3COO$ solution?

A. $NaCH_3COO_{(s)} \leftrightarrows Na^+_{(aq)} + CH_3COO^-_{(aq)}$

B. $CH_3COO^-_{(aq)} + H_2O_{(l)} \leftrightarrows HCH_3COO_{(aq)} + OH^-_{(aq)}$

C. $Na^+_{(aq)} + 2H_2O_{(l)} \leftrightarrows H_3O^+_{(aq)} + NaOH_{(aq)}$

D. $NaCH_3COO_{(s)} + H_2O_{(l)} \leftrightarrows NaOH + HCH_3COO_{(aq)}$

183. What is the equilibrium expression for the predominant equilibrium in $NaHCO_{3\,(aq)}$?

A. $K_a = \dfrac{[HCO_3^-]}{[H_3O^+]\,[CO_3^{-2}]}$

B. $K_b = \dfrac{[HCO_3^-]}{[H_2CO_3]\,[OH^-]}$

C. $K_a = \dfrac{[H_3O^+]\,[CO_3^{-2}]}{[HCO_3^-]}$

D. $K_b = \dfrac{[H_2CO_3]\,[OH^-]}{[HCO_3^-]}$

184. Consider the following reaction:

$$NO_2^-{}_{(aq)} + H_2O_{(l)} \leftrightarrows HNO_{2\,(aq)} + OH^-_{(aq)}$$

This reaction represents which of the following?

A. the titration of NO_2^-

B. the ionization of HNO_2

C. the hydrolysis of $NaNO_2$

D. the dissociation of $NaNO_2$

185. Which of the following is the net ionic equation that describes the hydrolysis that occurs in a K_2CO_3 solution?

A. $CO_3^{-2}{}_{(aq)} + 2H_2O_{(l)} \leftrightarrows H_2CO_{3\,(aq)} + H_3O+_{(aq)}$

B. $K_2CO_{3\,(aq)} + 2H_2O_{(l)} \leftrightarrows H_2CO_{3\,(aq)} + 2\,KOH_{(aq)}$

C. $CO_3^{-2}{}_{(aq)} + H_2O_{(l)} \leftrightarrows HCO_3^-{}_{(aq)} + OH^-_{(aq)}$

D. $K_2CO_{3\,(aq)} + 2H_2O_{(l)} \leftrightarrows H_2CO_{3\,(aq)} + 2\,K^+_{(aq)} + 2\,OH^-_{(aq)}$

186. Which of the following salt solutions is acidic?

A. KBr B. $FeCl_3$ C. $Li_2C_2O_4$ D. $NaHCO_3$

187. For each of the following salts:

- write out all hydrolysis equilibria that the salts would participate in
- calculate the appropriate K_a or K_b for each hydrolysis
- predict whether the solution will be acidic, basic or neutral

a. $Fe(NO_3)_3$

b. $NaNO_2$

c. $Ca(HC_2O_4)_2$

d. NH_4IO_3

188. For each of the following salts:
- write out all hydrolysis equilibria that the salts would participate in
- calculate the appropriate K_a or K_b for each hydrolysis
- predict whether the solution will be acidic, basic or neutral

a. $AlBr_3$

b. K_2SO_3

c. $Ca(H_2PO_4)_2$

d. NH_4CN

N3: Predict qualitatively whether a salt solution is acidic, basic or neutral

189. Which of the following solutions has a pH less than 7.00?
A. NaCl B. LiOH C. NH_4NO_3 D. KCH_3COO

190. Which of the following solutions has a pH less than 7.00?
A. NaCN B. $LiNO_3$ C. NH_4Cl D. KF

191. In a solution of 0.10 M NaCN, the order of ion concentration, from highest to lowest is
A. $[Na^+] > [OH^-] > [CN^-] > [H_3O^+]$
B. $[Na^+] > [CN^-] > [OH^-] > [H_3O^+]$
C. $[H_3O^+] > [OH^-] > [CN^-] > [Na^+]$
D. $[OH^-] > [Na^+] > [CN^-] > [H_3O^+]$

192. Which of the following salts will dissolve to produce a basic solution?
A. $KHSO_4$ B. NH_4CN C. $Al(NO_3)_3$ D. NH_4CH_3COO

193. In an aqueous solution of NaCl, the pH is
A. less than 7 and the solution is acidic
B. equal to 7 and the solution is neutral
C. greater than 7 and the solution is basic
D. greater than 7 and the solution is acidic

194. In an aqueous solution of NaCN, the pH is
A. less than 7 and the solution is acidic
B. equal to 7 and the solution is neutral
C. greater than 7 and the solution is basic
D. greater than 7 and the solution is acidic

195. Dissolving $NaCH_3COO$ in water will produce a solution which is
A. basic with pH > 7
B. basic with pH < 7
C. acidic with pH > 7
D. acidic with pH < 7

196. Which of the following salt solutions will be neutral?
A. 1.0 M NH_4Cl B. 1.0 M HNO_2 C. 1.0 M K_2CO_3 D. 1.0 M $LiClO_4$

197. Which of the following salt solutions will be acidic?
A. $KClO_4$ B. NH_4Br C. $NaHPO_4$ D. CaC_2O_4

198. Which of the following salt solutions will be acidic?
A. KI B. $FeBr_3$ C. $Na_3C_6H_5O_7$ D. $CaSO_4$

199. Which of the following salt solutions will be acidic?
A. KBr B. $CrBr_3$ C. Na_3BO_3 D. $Ca(CH_3COO)_2$

200. Which of the following solutions has the lowest pH?
A. 0.1 M NaCN B. 0.1 M Na_2CO_3 C. 0.1 M Na_3PO_4 D. 0.1 M NH_4NO_3

201. Consider the salt ammonium acetate, NH_4CH_3COO.

a. Write the dissociation equation of NH_4CH_3COO .

b. Write the hydrolysis equations which occur.

c. Explain why a solution of NH_4CH_3COO has a pH = 7.00. Support your answer with calculations

N4: Determine whether an amphiprotic ion will act as a base or an acid in solution

202. Water will act as an acid with which of the following?

I. H_2CO_3
II. HCO_3^-
III. CO_3^{-2}

A. I only
B. III only
C. I and II only
D. II and III only

203. Which of the following represents the predominant reaction between HCO_3^- and water?

A. $2HCO_3^- \rightarrow H_2O + CO_2$
B. $HCO_3^- + H_2O \rightarrow H_2CO_3 + OH^-$
C. $HCO_3^- + H_2O \rightarrow CO_3^{-2} + H_3O^+$
D. $2HCO_3^- + H_2O \rightarrow H_3O^+ + CO_3^{-2} + OH^- + CO_2$

204. Water will act as an acid when it reacts with which of the following:

I. NO_2^-
II. NO_3^-
III. $HC_2O_4^-$
IV. HCO_3^-

A. I and IV only
B. II and III only
C. I, II, and IV only
D. II, III and IV only

205. Which of the following will form a basic aqueous solution?

A. HSO_3^- B. HSO_4^- C. HPO_4^{-2} D. $HC_2O_4^-$

206. Which of the following will form a basic aqueous solution?

A. HSO_3^- B. HSO_4^- C. HCO_3^- D. $HC_2O_4^-$

207. Which of the following 1.0 M salt solutions will be acidic?

A. NaCl B. $NaHCO_3$ C. $(NH_4)_2SO_3$ D. $NaHC_2O_4$

208. What is the equilibrium constant expression representing the predominant reaction for the hydrolysis of $NaHC_2O_{4\,(aq)}$?

A. $K_w = [H_3O^+]\,[OH^-]$

B. $K_{eq} = \dfrac{[Na^+]\,[HC_2O_4^-]}{[NaHC_2O_4]}$

C. $K_a = \dfrac{[H_3O^+]\,[C_2O_4^{-2}]}{[HC_2O_4^-]}$

D. $K_b = \dfrac{[H_2CO_3][OH^-]}{[HC_2O_4^-]}$

209. What is the equilibrium constant expression representing the predominant reaction for the hydrolysis of $NaHSO_{3\,(aq)}$?

A. $K_w = [H_3O^+]\,[OH^-]$

B. $K_{eq} = \dfrac{[Na^+]\,[HSO_3^-]}{[NaHSO_3]}$

C. $K_a = \dfrac{[H_3O^+]\,[SO_3^{-2}]}{[HSO_3^-]}$

D. $K_b = \dfrac{[H_2SO_3][OH^-]}{[HSO_3^-]}$

210. Which of the following salts will produce a solution with the highest pH?

A. 1.0 M Na_2HPO_4 B. 1.0 M $NaHSO_4$ C. 1.0 M $NaHSO_3$ D. 1.0 M NaH_2PO_4

211. Consider the following equilibrium:

$$HPO_4^{-2}{}_{(aq)} + H_2O_{(l)} \leftrightarrows ?$$

What is the equilibrium expression?

A. $K_a = \frac{[H_3O^+][PO_4^{-3}]}{[HPO_4^{-2}]}$

B. $K_a = \frac{[HPO_4^{-2}]}{[H_3O^+][PO_4^{-3}]}$

C. $K_b = \frac{[H_2PO_4^-][OH^-]}{[HPO_4^{-2}]}$

D. $K_b = \frac{[HPO_4^{-2}]}{[H_2PO_4^-][OH^-]}$

212. The $HC_2O_4^-{}_{(aq)}$ ion will act as
A. a base since $K_a < K_b$
B. a base since $K_a > K_b$
C. a acid since $K_a < K_b$
D. a acid since $K_a > K_b$

213. The $H_2PO_4^-{}_{(aq)}$ ion will act as
A. a base since $K_a < K_b$
B. a base since $K_a > K_b$
C. a acid since $K_a < K_b$
D. a acid since $K_a > K_b$

214. What is the equilibrium expression for the predominant equilibrium in $NaHCO_3{}_{(aq)}$?

A. $K_a = \frac{[HCO_3^-]}{[H_3O^+][CO_3^{-2}]}$

B. $K_b = \frac{[HCO_3^-]}{[H_2CO_3][OH^-]}$

C. $K_a = \frac{[H_3O^+][CO_3^{-2}]}{[HCO_3^-]}$

D. $K_b = \frac{[H_2CO_3][OH^-]}{[HCO_3^-]}$

215. Which of the following amphiprotic ions will act predominantly as a base in solution?
A. HSO_3^- B. HSO_4^- C. HPO_4^{-2} D. $H_2PO_4^-$

O1: Describe an indicator as a mixture of a weak acid and its conjugate base, each with distinguishing colours

216. A chemical indicator in solution consists of
A. a weak acid and its conjugate acid
B. a weak acid and its conjugate base
C. a strong acid and its conjugate acid
D. a strong acid and its conjugate base

217. What do a chemical indicator and a buffer solution typically both contain?
A. a strong acid and its conjugate acid
B. a strong acid and its conjugate base
C. a weak acid and its conjugate acid
D. a weak acid and its conjugate base

218. Which term does the following statement best describe? *A mixture of a weak acid and its conjugate base, each with distinguishing colours?*
A. buffer
B. titration
C. indicator
D. primary standard

O2: Describe the term transition point of an indicator, including the conditions that exist in the equilibrium system

219. The pH at which an indicator changes color is known as its
A. standard point B. transition point C. equivilence point D. stoichiometric endpoint

220. What is true about the transition point of all indicators described by the following equilibrium:

$$HIn + H_2O \leftrightarrows H_3O^+ + In^-$$

A. $pH = K_a$
B. $[HIn] = [In^-]$
C. $[H_3O^+] = [OH^-]$
D. $pH = pOH$

O3: Describe the shift in equilibrium and resulting colour changes as an acid or base is added to an indicator

221. What color would 1.0 M HCl be in an indicator mixture consisting of phenol red and thymophthalein?
A. red B. blue C. yellow D. colorless

222. What color would 0.10 M NaOH be in an indicator mixture consisting of phenol red and bromcresol green?
A. purple B. blue C. yellow D. green

223. What color would 0.10 M NaOH be in an indicator mixture consisting of phenol red and alizarin yellow ?
A. red B. orange C. yellow D. colorless

224. When the indicator thymol blue is added to 0.10 M solution of an unknown acid, the solution is red. The acid could be
A. HF B. H_2S C. HCN D. HNO_3

225. When the indicator alazarin yellow is added to 0.010 M solution of an unknown compound, the solution is red. The unknown compound could could be
A. NaOH B. KIO_3 C. HCN D. HNO_3

226. At pH = 4.0 methyl red will be
A. red and [HInd] > [Ind^-]
B. red and [HInd] < [Ind^-]
C. yellow and [HInd] > [Ind^-]
D. yellow and [HInd] < [Ind^-]

227. Methyl red is orange in a 0.10 M solution of an acid. The acid could be
A. HI B. NaOH C. C_6H_5OH D. NH_3

228. Thymol blue is green in a 0.72 M solution of an unknown solution. The unknown solution could be
A. HI B. NaOH C. HCN D. NaHCOO

229. Which would produce a yellow solution at pH = 4.0?
A. methyl red B. methyl violet C. indigo carmen D. chlorophenol red

230. Which would produce an orange solution at pH = 6.0?
A. methyl red B. thymol blue C. phenol red D. chlorophenol red

231. Which would produce a green solution at pH = 6.8?
A. bromcresol green B. thymol blue C. bromthymol blue D. indigo carmine

232. The chemical indicator bromthymol blue changes from yellow to blue as a result of the addition of
A. 1.0 M HCl B. 1.0 M HNO_2 C. 1.0 M K_2CO_3 D. 1.0 M NH_4Cl

233. The chemical indicator thymol blue changes from yellow to blue as a result of the addition of
A. 1.0 M HCl B. 1.0 M HNO_2 C. 1.0 M K_2CO_3 D. 1.0 M NH_4Cl

234. The chemical indicator bromcresol green changes from blue to yellow as a result of the addition of
A. 1.0 M HCl B. 1.0 M $NaNO_2$ C. 1.0 M K_2CO_3 D. 1.0 M LiCl

235. The chemical indicator phenol red changes from red to yellow as a result of the addition of
A. 1.0 M HI B. 1.0 M $NaNO_2$ C. 1.0 M K_2CO_3 D. 1.0 M LiCl

236. Consider the following equilibrium for the chemical indicator phenol red, HInd, at a pH = 7.3 (orange).

$$\underset{\text{yellow}}{HInd} + H_2O \leftrightarrows H_3O^+ + \underset{\text{red}}{Ind^-}$$

When some HCl is added, what stress is imposed on the equilibrium and what colour change occurs?

Stress	Indicator Colour Change
A. increased [H_3O^+]	turns red
B. decreased [H_3O^+]	turns red
C. increased [H_3O^+]	turns yellow
D. decreased [H_3O^+]	turns yellow

237. The indicator phenol red will be red in which of the following solutions?
A. 1.0 M HF B. 1.0 M HBr C. 1.0 M NH_4Cl D. 1.0 M Na_2CO_3

238. The indicator phenol red will be red in which of the following solutions?
A. 1.0 M $NaHSO_4$ B. 1.0 M H_2SO_3 C. 1.0 M NH_4NO_3 D. 1.0 M Na_2HPO_4

239. The indicator phenolphthalein can be described by the following equilibrium equation:

$$\underset{\text{colorless}}{HIn} + H_2O \leftrightarrows H_3O^+ + \underset{\text{pink}}{In^-}$$

HCl is added to a slighly pink sample of this indicator. After equilibrium has been re-established, how do the [H_3O^+] and the colour of the solution compare with the original equilibrium?

[H_3O^+]	Colour of solution
A. decreases	turns more pink
B. decreases	turns colourless
C. increases	turns more pink
D. increases	turns colourless

240. The indicator phenolphthalein can be described by the following equilibrium equation:

$$\underset{\text{colorless}}{HIn} + H_2O \leftrightarrows H_3O^+ + \underset{\text{pink}}{In^-}$$

NH_4Cl is added to a slighly pink sample of this indicator. After equilibrium has been re-established, how do the $[H_3O^+]$ and the colour of the solution compare with the original equilibrium?

	$[H_3O^+]$	Colour of solution
A.	decreases	turns more pink
B.	decreases	turns colourless
C.	increases	turns more pink
D.	increases	turns colourless

241. Consider the following indicator equilibrium:

$$\underset{\text{(yellow)}}{HIn} + H_2O \leftrightarrows H_3O^+ + \underset{\text{(blue)}}{In^-}$$

What is the result of adding CH_3COOH to this indicator?

	Equilibrium Shift	Colour
A.	left	blue
B.	left	yellow
C.	right	blue
D.	right	yellow

242. Consider the following indicator equilibrium:

$$\underset{\text{(yellow)}}{HIn} + H_2O \leftrightarrows H_3O^+ + \underset{\text{(blue)}}{In^-}$$

What is the result of adding Na_2CO_3 to this indicator?

	Equilibrium Shift	Colour
A.	left	blue
B.	left	yellow
C.	right	blue
D.	right	yellow

243. Consider the equilibirum for the indicator, thymolphthalein (HThy):

$$HThy + H_2O \leftrightarrows H_3O^+ + Thy^-$$

What happens when NaOH is added to a sample of this indicator in water?

	Equilibrium	Colour
A.	shifts left	turns blue
B.	shifts right	turns blue
C.	shifts left	turns colourless
D.	shifts right	turns colourless

O4: Predict the approximate pH at the transition point using the K_a value of an indicator

244. A chemical indicator has a $K_a = 1.0 \times 10^{-6}$. Determine the identity of this indicator.
A. phenol red
B. bromthymol blue
C. methyl red
D. chlorophenol red

245. Which of the following chemical indicators has a $K_a = 2.5 \times 10^{-5}$?
A. methyl orange B. phenolphthalein C. thymolphthalein D. bromcresol green

246. Which of the following chemical indicators has a $K_a = 7.9 \times 10^{-10}$?
A. methyl orange B. phenolphthalein C. thymolphthalein D. bromcresol green

247. Which of the following chemical indicators has a $K_a = 1.6 \times 10^{-4}$?
A. methyl orange B. phenolphthalein C. thymolphthalein D. bromcresol green

248. A chemical indicator has a $K_a = 4.0 \times 10^{-6}$. What is the pH at the transition point and what is the identity of the indicator?

	pH	Indicator
A.	5.4	methyl red
B.	5.4	bromcresol green
C.	8.6	phenophthalien
D.	8.6	thymol blue

249. A chemical indicator has a $K_a = 1.6 \times 10^{-7}$. What is the pH at the transition point and what is the identity of the indicator?

	pH	Indicator
A.	6.8	chlorophenol red
B.	6.8	bromthymol blue
C.	6.8	phenol red
D.	7.2	thymol blue

250. An indicator changes colour when 4.0 M HCl is added. If the indicator has a $K_a = 1 \times 10^{-10}$, identify the indicator and the pH at its transition point.

Indicator	pH
A. phenolphthalein	4.0
B. phenolphthalein	10.0
C. thymolphthalein	4.0
D. thymolphthalein	10.0

251. Which indicator below has a $K_a = 1.0 \times 10^{-6}$?

A. methyl red B. phenophthalein C. bromthymol blue D. chlorophenol red

O5: Predict the approximate K_a value of an indicator given the approximate pH range of the colour change

252. An indicator is blue at pH of 7.8 and yellow at a pH of 5.6. Identify the indicator and determine its K_a.

Indicator	K_a
A. thymol blue	1×10^{-2}
B. thymol blue	2×10^{-9}
C. bromthymol blue	2×10^{-7}
D. bromcresol green	3×10^{-5}

253. What is one of the Ka values for thymol blue?

A. 2×10^{-9} B. 2×10^{-7} C. 1×10^{-7} D. 6×10^{-2}

254. An indicator is often used during acid-base titrations.

a. Define the term ***transition point*** for an indicator.

b. Calculate the K_a value for methyl red.

c. A mixture of indicators is made by combining equal amounts of methyl orange and bromthymol blue. Complete the following table showing the colour of each indicator and the mixture at the pH's indicated.

pH	Colour of methyl orange	Colour of bromthymol blue	Colour of mixture
pH = 5			
pH = 9			

255. An indicator is often used during acid-base titrations.

a. Calculate the K_a value for phenol red.

b. A mixture of indicators is made by combining equal amounts of methyl orange, phenol red and chlorophenol red. Complete the following table showing the colour of each indicator and the mixture at the pH's indicated.

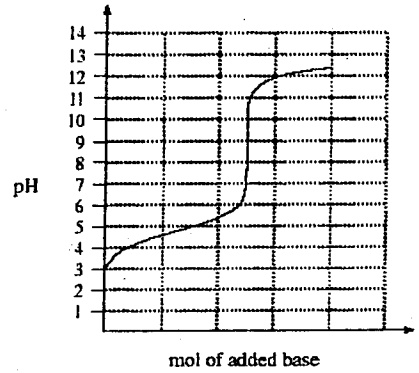
pH	Colour of thymol blue	Colour of phenol red	Colour of mixture
pH = 1.4			
pH = 7.8			
pH = 10.0			

P1: Demonstrate an ability to design and perform a neutralization experiment involving the following:

- primary standard
- standardized solutions
- titration curves
- indicators selected so the end point coincides with the equivalence point

256. Pure sodium hydrogen phthalate is used to standardize a solution of NaOH for use in an acid-base titration. What term is used to describe the sodium hydrogen phthalate?
   A. endpoint acid
   B. titrant acid
   C. equivilence acid
   D. primary standard

257. Consider the following titration curve:



   a. What type of titration would generate this type of graph?

   b. Explain why the equivalence point pH is not 7.00

   c. Besides phenolphthalein, which indicator would be a good choice for this titration?

258. In acid-base titrations, the solution of known concentration is called a (an)
   A. basic solution
   B. acidic solution
   C. standard solution
   D. indicating solution

259. *At a certain point in a strong acid-strong base titration, the moles of H^+ are equal to the moles of OH^-.* This is a definition of which of the following?
   A. end point B. titration point C. transition point D. equivalence point

260. When performing a titration experiment, the indicator must always have
   A. a distinct colour change a pH = 7.0
   B. the ability to change from colourless to pink
   C. a transition point that is close to the equivilence point
   D. an equivalence point that is close to the stoichiometric point

261. Which of the following is **not** a good use for an acid/base titration curve?
   A. to determine the concentration of the base
   B. to select a suitable indicator for the titration
   C. to determine whether the acid is weak or strong
   D. to selects a suitable primary standard for the titration

262. A weak acid is titrated with a strong base using the indicator phenophthalein to detect the end point. What is the approximate pH at the transition point?
   A. 7.0 B. 8.0 C. 9.0 D. 10.0

263. What term describes the chemical that is used to detect the equivilence point of an acid-base titration?
   A. buffer B. standard C. indicator D. primary standard

264. Which of the following is a piece of equipment typically used in acid-base titrations?
   A. burette B. test tube C. litmus paper D. graduated cylinder

P2: Calculate from titration data the concentration of an acid or base

265. The following data were recorded when titrating 25.00 mL of CH_3COOH with 0.200 M $Ba(OH)_2$.

	Volume of $Ba(OH)_2$ added		
	Trial #1	Trial #2	Trial #3
Initial reading	4.03 mL	17.51 mL	32.03 mL
Final reading	17.51 mL	32.03 mL	45.55 mL

Calculate the $[CH_3COOH]$

A. 0.216 M B. 0.108 M C. 0.370 M D. 0.185 M

266. During a titration, what volume of 0.500 M KOH would be necessary to completely neutralize 10.0 mL of 2.00 M CH_3COOH?

A. 10.0 mL B. 20.0 mL C. 25.0 mL D. 40.0 mL

267. During a titration, what volume of 0.500 M $Ba(OH)_2$ would be necessary to completely neutralize 10.0 mL of 2.00 M CH_3COOH?

A. 10.0 mL B. 20.0 mL C. 25.0 mL D. 40.0 mL

268. The complete neutralization of 15.0 mL of KOH requires 0.0250 moles of H_2SO_4. The [KOH] was

A. 3.75×10^{-4} M B. 1.67 M C. 3.33 M D. 0.833 M

269. How many moles of KOH are necessary to completely neutralize 42.0 mL of 3.00 M HCl?

A. 0.0140 moles B. 0.126 moles C. 0.252 moles D. 3.00 moles

270. How many moles of $Ba(OH)_2$ are required to react completely with 100.0 mL of 0.250 M HNO_3

A. 0.0125 moles B. 0.0250 moles C. 0.0500 moles D. 1.25 moles

271. A 10.0 mL sample of H_2SO_3 is completely neutralized by titration with 18.6 mL of 0.10 M NaOH. Calculate the concentration of the acid.

A. 0.093 M B. 0.19 M C. 0.37 M D. 0.74 M

272. During a titration, 25.0 mL of $H_3PO_{4\,(aq)}$ is completely neutralized by 42.6 mL of 0.20 M NaOH. Calculate the concentration of the acid.

A. 0.11 M B. 0.17 M C. 0.34 M D. 1.0 M

273. A 20.0 mL sample of HCl is titrated with 25.0 mL of 0.20 M $Sr(OH)_2$. What is the concentration of the acid?

A. 0.13 M B. 0.20 M C. 0.25 M D. 0.50 M

274. A 25.0 mL sample of H_2SO_3 is titrated with 20.0 mL of 0.150 M NaOH. Calculate the concentration of the H_2SO_3.

A. 0.00300 M B. 0.120 M C. 0.0600 M D. 0.240 M

275. A 25.0 mL sample of a diprotic weak acid is titrated with 20.2 mL of 0.10 M NaOH. What is the concentration of the acid?

A. 0.040 M B. 0.080 M C. 0.16 M D. 0.12 M

276. A titration was performed by adding 0.115 M HCl to a 25.00 mL sample of $Ba(OH)_2$. Calculate the $[Ba(OH)_2]$ from the following data:

	Trial #1	Trial #2	Trial #3
Inital volume of HCl (mL)	4.00	22.45	3.45
Final volume of HCl (mL)	22.45	42.85	22.00

277. A solution of $NaOH_{(aq)}$ was standardized by titration using oxalic acid ($H_2C_2O_{4(s)}$) as the primary standard. The following data was collected:

Mass of $H_2C_2O_{4(s)}$ used = 1.02 g
Volume of $NaOH_{(aq)}$ used = 40.0 mL

Calculate the concentration of the $NaOH_{(aq)}$.

P3: Calculate the volume of an acid or base of known molarity needed to neutralize a known volume of a known molarity base or acid

278. Calculate the volume of 0.500 M NaOH required to completely neutralize 25.0 mL of 0.450 M H_2SO_4.
A. 9.00 mL B. 11.3 mL C. 22.5 mL D. 45.0 mL

279. Calculate the volume of 0.300 M HNO_3 needed to completely neutralize 25.0 mL of 0.250 M $Sr(OH)_2$.
A. 10.4 mL B. 15.0 mL C. 20.8 mL D. 41.7 mL

280. What volume of 0.100 M H_2SO_4 is needed to titrate 25.0 mL of 0.200 M NaOH?
A. 12.5 mL B. 25.0 mL C. 50.0 mL D. 100.0 mL

281. What volume of 0.500 M NaOH is required to neutralize 25.0 mL of a 0.250 M HBr?
A. 5.00 mL B. 12.5 mL C. 20.0 mL D. 25.0 mL

282. What volume of 0.250M KOH is required to titrate 2.30×10^{-3} mol of the weak acid $H_2C_2O_4$?
A. 1.15 mL B. 4.60 mL C. 9.20 mL D. 18.4 mL

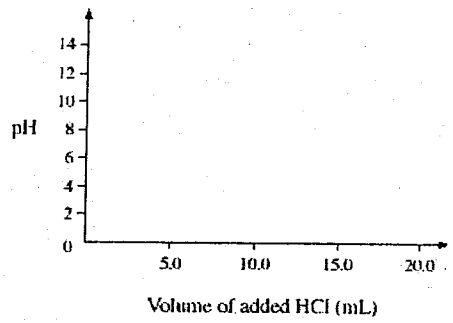
283. A 250.0 mL sample of HCl with a pH of 2.000 is completely neutralized with 0.200 M NaOH.

a. What volume of NaOH is required to reach the stoichiometric point?

b. Write the net ionic equation for the neutralization.

c. If the HCl were titrated with 0.200 M $NH_{3(aq)}$ instead of 0.200 M NaOH, how would the volume of base required to reach the equivilence point compare with the volume calculated in part a) ? Explain your answer.

284. a. In the space below, sketch the titration curve for the reaction when 0.10 M HCl is added to 10.0 mL of 0.10 M NaOH.



b. Describe two changes in the titration curve that would occur from using 0.10 M CH_3COOH in place of the HCl

c. Draw the new titration curve with dotted line.

P4: Write formula, complete ionic, and net ionic neutralization equations for weak and strong acids by weak and strong bases

285. Which of the following would be the net ionic equation for the reaction between HCl and KOH?

A. $H^+ + OH^- \leftrightarrows H_2O$

B. $HCl + KOH \leftrightarrows H_2O + KCl$

C. $H^+ + Cl^- + K^+ + OH^- \leftrightarrows H_2O + KCl$

D. $H^+ + Cl^- + K^+ + OH^- \leftrightarrows H_2O + Cl^- + K^+$

286. Which of the following is the net ionic equation for the neutralization of CH_3COOH with $NaOH_{(aq)}$?

A. $CH_3COO^-_{(aq)} + OH^-_{(aq)} \rightarrow CH_3COOH_{(aq)} + O^{-2}_{(aq)}$

B. $CH_3COOH_{(aq)} + OH^-_{(aq)} \rightarrow CH_3COO^-_{(aq)} + H_2O_{(l)}$

C. $CH_3COOH_{(aq)} + NaOH_{(aq)} \rightarrow NaCH_3COO^-_{(aq)} + H_2O_{(l)}$

D. $CH_3COOH^-_{(aq)} + H^+_{(aq)} + Na^+_{(aq)} + OH^-_{(aq)} \rightarrow Na^+ + CH_3COO^-_{(aq)} + H_2O_{(l)}$

287. Write the net ionic equation for the neutralization of $HF_{(aq)}$ with $Sr(OH)_{2\,(aq)}$.

A. $HF_{(aq)} + OH^-_{(aq)} \rightarrow H_2O_{(l)} + F^-_{(aq)}$

B. $HF_{(aq)} + H_2O_{(l)} \rightarrow H_3O^+_{(aq)} + F^-_{(aq)}$

C. $2HF_{(aq)} + Sr(OH)_{2\,(aq)} \rightarrow SrF_{2\,(s)} + 2\,H_2O_{(l)}$

D. $2HF_{(aq)} + Sr^{+2}_{(aq)} + 2\,OH^-_{(aq)} \rightarrow SrF_{2\,(s)} + 2H_2O_{(l)}$

288. Write the net ionic equation for the neutralization of $HCH_3COO_{(aq)}$ with $Sr(OH)_{2\,(aq)}$.

A. $HCH_3COO_{(aq)} + OH^-_{(aq)} \rightarrow H_2O_{(l)} + CH_3COO^-_{(aq)}$

B. $HCH_3COO_{(aq)} + H_2O_{(l)} \rightarrow H_3O^+_{(aq)} + CH_3COO^-_{(aq)}$

C. $2HCH_3COO_{(aq)} + Sr(OH)_{2\,(aq)} \rightarrow Sr(CH_3COO)_{2\,(aq)} + 2\,H_2O_{(l)}$

D. $2H^+_{(aq)} + 2\,CH_3COO^-_{(aq)} + Sr^{+2}_{(aq)} + 2\,OH^-_{(aq)} \rightarrow Sr(CH_3COO)_{2\,(aq)} + 2H_2O_{(l)}$

289. Write the net ionic equation for the neutralization of $HBr_{(aq)}$ with $Sr(OH)_{2\,(aq)}$.

A. $HBr_{(aq)} + OH^-_{(aq)} \rightarrow H_2O_{(l)} + Br^-_{(aq)}$

B. $H^+_{(aq)} + OH^-_{(aq)} \rightarrow H_2O_{(l)}$

C. $2HBr_{(aq)} + Sr(OH)_{2\,(aq)} \rightarrow SrBr_{2\,(aq)} + 2\,H_2O_{(l)}$

D. $2H^+_{(aq)} + 2\,Br^-_{(aq)} + Sr^{+2}_{(aq)} + 2\,OH^-_{(aq)} \rightarrow SrBr_{2\,(aq)} + 2H_2O_{(l)}$

290. What is the net ionic equation for the neutralization of 0.1 M $Sr(OH)_2$ (aq) with 0.1 M H_2SO_4 (aq)?

A. $H^+_{(aq)} + OH^-_{(aq)} \rightarrow H_2O_{(l)}$

B. $Sr^{+2}_{(aq)} + SO_4^{-2}{}_{(aq)} \rightarrow SrSO_{4\,(s)}$

C. $Sr^{+2}_{(aq)} + 2OH^-_{(aq)} + 2H^+_{(aq)} + SO_4^{-2}{}_{(aq)} \rightarrow SrSO_{4\,(s)} + 2\,H_2O_{(l)}$

D. $Sr(OH)_{2\,(aq)} + H_2SO_{4\,(aq)} \rightarrow SrSO_{4\,(s)} + 2H_2O_{(l)}$

291. What is the formula equation for the neutralization of 0.1 M $Sr(OH)_2$ (aq) with 0.1 M H_2SO_4 (aq)?

A. $H^+_{(aq)} + OH^-_{(aq)} \rightarrow H_2O_{(l)}$

B. $Sr^{+2}_{(aq)} + SO_4^{-2}{}_{(aq)} \rightarrow SrSO_{4\,(s)}$

C. $Sr^{+2}_{(aq)} + 2OH^-_{(aq)} + 2H^+_{(aq)} + SO_4^{-2}{}_{(aq)} \rightarrow SrSO_{4\,(s)} + 2\,H_2O_{(l)}$

D. $Sr(OH)_{2\,(aq)} + H_2SO_{4\,(aq)} \rightarrow SrSO_{4\,(s)} + 2H_2O_{(l)}$

292. Which net ionic equation best describes the reaction between NaOH and H_2S?

A. $OH^-_{(aq)} + H^+_{(aq)} \leftrightarrows H_2O_{(l)}$

B. $2OH^-_{(aq)} + H_2S_{(aq)} \leftrightarrows 2H_2O_{(l)} + S^{-2}_{(aq)}$

C. $2NaOH_{(aq)} + H_2S_{(aq)} \leftrightarrows 2H_2O_{(l)} + Na_2S_{(aq)}$

D. $2Na^+_{(aq)} + 2OH^-_{(aq)} + 2H^+_{(aq)} + S^{-2}_{(aq)} \leftrightarrows 2H_2O_{(l)} + 2Na^+_{(aq)} + S^{-2}_{(aq)}$

293. The strong acid, $HNO_{3\,(aq)}$ is titrated with the weak base, $NH_{3\,(aq)}$. What is the net ionic equation for this reaction?

A. $H^+_{(aq)} + OH^- \leftrightarrows H_2O_{(l)}$

B. $H^+_{(aq)} + NH_{3\,(aq)} \leftrightarrows NH_4^+{}_{(aq)}$

C. $HNO_{3\,(aq)} + NH_{3\,(aq)} \leftrightarrows NH_4NO_{3\,(aq)}$

D. $H^+_{(aq)} + NO_3^-{}_{(aq)} + NH_{3\,(aq)} \leftrightarrows NH_4^+{}_{(aq)} + NO_3^-{}_{(aq)}$

294. Which of the following is the complete ionic equation for the titration of $HCl_{(aq)}$ with $KOH_{(aq)}$?

A. $H^+_{(aq)} + OH^-_{(aq)} \rightarrow H_2O_{(l)}$

B. $HCl_{(aq)} + KOH_{(aq)} \rightarrow KCl_{(aq)} + H_2O_{(l)}$

C. $H^+_{(aq)} + Cl^-_{(aq)} + K^+_{(aq)} + OH^-_{(aq)} \rightarrow KCl_{(aq)} + H_2O_{(l)}$

D. $H^+_{(aq)} + Cl^-_{(aq)} + K^+_{(aq)} + OH^-_{(aq)} \rightarrow K^+_{(aq)} + Cl^-_{(aq)} + H_2O_{(l)}$

295. What is the net ionic equation for the titration of $H_3PO_{4\,(aq)}$ with $Sr(OH)_{2\,(aq)}$?

A. $H^+_{(aq)} + OH^-_{(aq)} \rightarrow H_2O_{(l)}$

B. $6H^+_{(aq)} + 6OH^-_{(aq)} \rightarrow 6H_2O_{(l)}$

C. $2H_3PO_{4\,(aq)} + 3Sr^{+2}_{(aq)} + 6OH^-_{(aq)} \rightarrow Sr_3(PO_4)_{2\,(s)} + 6H_2O_{(l)}$

D. $6H^+_{(aq)} + 2PO_4^{-3}{}_{(aq)} + 3Sr^{+2}_{(aq)} + 6OH^-_{(aq)} \rightarrow 3Sr^{+2}_{(aq)}\ 2PO_4^{-3}{}_{(aq)} + 6H_2O_{(l)}$

296. Write the net ionic equation for the acid-base reaction that occurs between $NaOH_{(aq)}$ and $NH_4Cl_{(aq)}$.

P5: Calculate the pH of a solution formed when a strong acid is mixed with a strong base

297. What is the pH of the solution formed when 0.060 moles of NaOH is added to 1.00 L of 0.050 M HCl?

A. 2.00 B. 7.00 C. 12.00 D. 12.78

298. What is the pH of the solution formed when 500.0 mL of 0.070 M NaOH is added to 500.0 mL L of 0.050 M HCl?

A. 2.00 B. 0.020 C. 12.00 D. 12.78

299. A 10.0 mL sample of 0.093 M H_2SO_4 added to 18.6 mL of 0.10 M NaOH. Calculate the pH of the solution that is made.

A. 0.0 B. 7.00 C. 3.03 D. 10.97

300. The $[H_3O^+]$ results when 25.0 mL of 1.0 M HCl is mixed with 15.0 mL of 0.30 M KOH?

A. 0.020 M B. 0.51 M C. 0.70 M D. 0.82 M

301. Calculate the pH of a solution prepared by mixing 15.0 mL of 0.50 M HCl with 35.0 mL of 0.10 M $Ba(OH)_2$.

P6: Contrast the equivilence point (or stoichiometric point) of a strong acid-strong base titration with the equivilence point of a titration involving a weak acid-strong base or weak base-strong acid

302. Which statement describes the pH of the equivilence point of a titration of 0.200 M CH_3COOH by 0.200 M KOH?

A. The pH = 7 because the CH_3COOH and KOH neutralize each other.

B. The pH = 7 because the no hydrolysis of products is possible.

C. The pH > 7 because the KCH_3COO hydrolizes to form OH^-.

D. The pH < 7 because the KCH_3COO hydrolizes to form H_3O^+.

303. Which statement describes the pH of the equivilence point of a titration of 0.200 M NH_3 by 0.200 M HI?

A. The pH = 7 because the NH_3 and HI neutralize each other.

B. The pH = 7 because the no hydrolysis of products is possible.

C. The pH > 7 because the NH_4^+ hydrolizes to form OH^-.

D. The pH < 7 because the NH_4^+ hydrolizes to form H_3O^+.

304. What is the $[H_3O^+]$ at the equivilence point for the titration between HBr and KOH?
A. 1.0×10^{-9} M B. 1.0×10^{-7} M C. 1.0×10^{-5} M D. 0.0 M

305. What is the pH at the equivilence point for the titration between HF and KOH?
A. 6.25 B. 7.00 C. 7.75 D. 0.0

306. What is the pH at the equivilence point for the titration between HBr and NH_3?
A. 6.25 B. 7.00 C. 7.75 D. 0.0

307. At the equivilence point, the titration of HCl with NH_3 will form a solution which is
A. basic with pH >7
B. acidic with pH < 7
C. acidic with pH > 7
D. neutral with pH = 7

308. At the equivilence point, the titration of HCN with NaOH will form a solution which is
A. basic with pH >7
B. acidic with pH < 7
C. basic with pH < 7
D. neutral with pH = 7

309. At the equivilence point, the titration of HCl with NaOH will form a solution which is
A. basic with pH >7
B. acidic with pH < 7
C. basic with pH < 7
D. neutral with pH = 7

310. Which of the following titrations would have a pH >7 at the equivilence point?
A. HI with KOH
B. $HClO_4$ with NH_3
C. HCl with $Sr(OH)_2$
D. HCOOH with NaOH

311. Which of the following titrations would have a pH < 7 at the equivilence point?
A. HI with KOH
B. $HClO_4$ with NH_3
C. HCl with $Sr(OH)_2$
D. HCOOH with NaOH

312. The pH at the stoichiometric point for the complete neutralization of a strong acid by a weak base will be
A. equal to 7.0
B. equal to 0.00
C. less than 7.0
D. greater than 7.0

313. The pH at the stoichiometric point for the complete neutralization of a weak acid by a strong base will be
A. equal to 7.0
B. equal to 0.00
C. less than 7.0
D. greater than 7.0

314. When a weak acid is titrated with a strong base, what could the pH value be at the equivilence point?
A. 0.0 B. 5.8 C. 7.0 D. 8.6

315. When a strong acid is titrated with a weak base, what could the pH value be at the equivilence point?
A. 0.0 B. 5.8 C. 7.0 D. 8.6

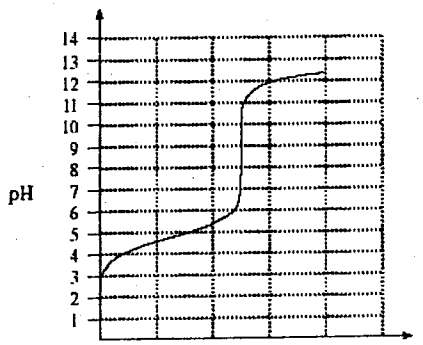
316. Which of the following titrations always results in pH = 7.0 at the equivilence point?
A. A weak acid is titrated with a weak base.
B. A weak acid is titrated with a strong base.
C. A strong acid is titrated with a weak base.
D. A strong acid is titrated with a strong base.

317. What is always true about the pH at the equivilence point when a weak acid is titrated with a strong base?
A. pH < 6.8 B. pH > 7.0 C. pH = 7.0 D. pH = 8.8

318. What is always true about the pH at the equivilence point when a weak base is titrated with a strong acid?
A. pH < 7.0
B. pH > 7.0
C. pH = 7.0
D. the pH does not change anymore, even if more strong base is added

319. A 10.0 mL sample of a 0.10 M strong acid HA is titrated with a 0.25 M KOH.
A 10.0 mL sample of a 0.10 M weak acid HB is titrated with the same 0.25 M KOH.

For one of these titrations a graph is generated that looks like:



a. Which titration generated the above graph? Explain your answer.

The titration between _____ and KOH.

Explanation:

b. Would the titration involving HA require a larger volume of 0.25 M KOH than the titration involving HB? Explain your answer. (Assume both acids are monoprotic)

b. Select one indicator which could be used for both titrations. _____

320. The following two experiments were conducted:

Titration A: A strong acid was titrated with a 0.20 M strong base.

Titration B: A weak acid was titrated with a 0.20 M strong base.

a. How does the pH at the equilivence point of Titration B compare with the pH at the equivilence point of Titration A?

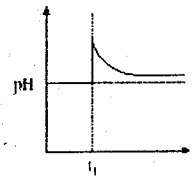
b. Explain your answer

c. How will the volume of strong base needed to reach equivilence point in Titration B compare with the volume of strong base needed to reach equivilence point in Titration A?

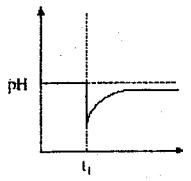
Q1: Describe the tendency of buffer solutions to resist changes in pH

321. Which of the following graphs best describes the effect on the pH of a buffer solution with a small amount of acid is added at time t_1?

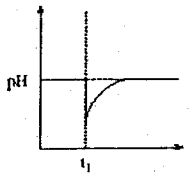
A.



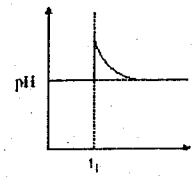
B.



C.

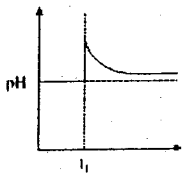


D.

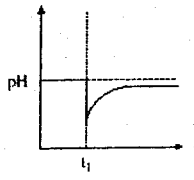


322. Which of the following graphs best describes the effect on the pH of a buffer solution with a small amount of base is added at time t_1?

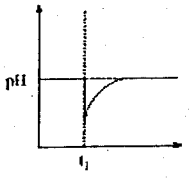
A.



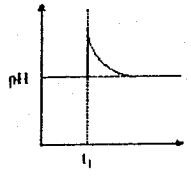
B.



C.



D.



323. What typically happens to the pH of a buffer solution when a small amount of acid is added?
A. The pH increases slightly.
B. The pH decreases slightly.
C. The pH always remains the same.
D. The pH first increases then decreases to its original value.

324. What happens to the pH of a buffer solution if a small amount of base is added?
A. The pH remains constant
B. The pH increases slightly
C. The pH decreases slightly
D. The pH decreases significantly

325. a. What is the main function of a buffer solution?

b. Describe how you would prepare a buffer solution.

Q2: Describe the composition of an acidic buffer and a basic buffer

326. Which of the following would form a buffer solution when equal moles are mixed together?
A. HCl and NaCl
B. HCN and NaCN
C. KNO_3 and KOH
D. Na_2SO_4 and NaOH

327. Equal moles of which of the following chemicals could be used to make a buffer solution that has a pH >7.0?
A. HF and NaF B. HCl and NaCl C. KBr and $NaNO_3$ D. HCN and NaCN

328. Equal moles of which of the following chemicals could be used to make a buffer solution with a pH <7.0?
A. HF and NaF B. HCl and NaCl C. KBr and $NaNO_3$ D. HCN and NaCN

329. Which of the following pairs of chemicals could be used to make a buffer solution?
A. NH_3 and H_2O B. HCl and NaCl C. NH_3 and NH_4Cl D. CH_3COOH and HCl

330. Which of the following pairs of chemicals could be used to make a buffer solution?
A. NH_3 and HCl B. HCN and NaCN C. NH_3 and NaOH D. HCOOH and HCl

331. Which of the following could tpically be used to prepare a buffer solution?
A. H_2S and NaHS
B. H_2S and ZnS
C. HNO_3 and $NaNO_3$
D. HNO_2 and $NaNO_3$

Q3: Outline a procedure to prepare a buffer solution

332. A buffer solution can be prepared by dissolving equal moles of
A. a weak base and a strong acid
B. a weak acid and its conjugate base
C. a strong acid and its conjugate base
D. a strong base and its conjugate acid

333. Which of the following acids could **not** be present in a buffer solution?
A. HF B. HNO_2 C. H_2SO_3 D. $HClO_4$

334. Which of the following acids could **not** be present in a buffer solution?
A. HF B. HCN C. HI D. H_2S

Q4: Identify the limitations in buffering systems

335. If 1.00 moles of HCN and 1.00 moles of NaCN are added to 1.00 L of water, what pH will the buffer remain relatively constant at?
A. 7.00 B. 9.31 C. 4.69 D. 0.00

336. If 1.00 moles of HF and 1.00 moles of NaF are added to 1.00 L of water, what pH will the buffer remain relatively constant at?
A. 7.00 B. 3.46 C. 10.54 D. 0.00

337. If 1.00 moles of CH_3COOH and 1.00 moles of $NaCH_3COO$ are added to 1.00 L of water, what pH will the buffer remain relatively constant at?
A. 7.00 B. 4.74 C. 9.26 D. 0.00

338. If 1.00 moles of NH_4NO_3 and 1.00 moles of NH_3 are added to 1.00 L of water, what pH will the buffer remain relatively constant at?
A. 7.00 B. 9.25 C. 4.75 D. 0.00

339. Consider the following buffer equilibrium:

$$HF_{(aq)} + H_2O_{(l)} \leftrightarrows H_3O^+_{(aq)} + F^-_{(aq)}$$

What would limit the buffering action if HCl were added?
A. $[F^-]$ B. [HF] C. $[H_2O]$ D. $[H_3O^+]$

340. Consider the following buffer equilibrium:

$$HF_{(aq)} + H_2O_{(l)} \leftrightarrows H_3O^+_{(aq)} + F^-_{(aq)}$$

What would limit the buffering action if KOH were added?
A. $[F^-]$ B. [HF] C. $[H_2O]$ D. $[H_3O^+]$

341. Consider the following buffer equilibrium:

$$HCN + H_2O \leftrightarrows CN^- + H_3O^+$$

When 25 mL of 0.200 M KOH are added, the pH rises dramatically. Why?
A. The KOH becomes part of the buffer solution.
B. The KOH exceeds the buffer capacity.
C. The KOH reacts with the HCN instead of the H_3O^+, causing a shift left instead of a shift right.
D. The KOH is a strong base and forces the CN^- to act as an acid.

Q5: Describe qualitatively how the buffer equilibrium shifts as small quantities of acid or base are added to the buffer

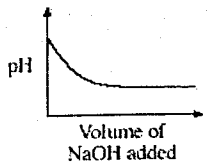
342. Consider the following buffer equilibrium:

$$HCN + H_2O \leftrightarrows CN^- + H_3O^+$$

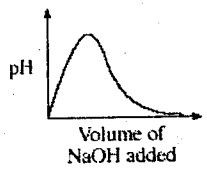
When a few drops of KOH are added the buffer, the equilibrium
A. shifts left and the $[CN^-]$ decreases
B. shifts right and the $[CN^-]$ decreases
C. shifts left and the $[CN^-]$ increases
D. shifts right and the $[CN^-]$ increases

343. Which of the following graphs describes the relationship between the pH of a buffer and the volume of NaOH added to the buffer?

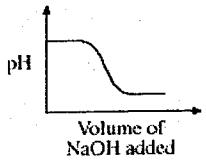
A.



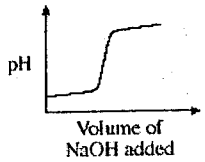
B.



C.

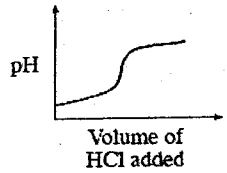


D.

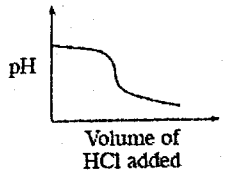


344. Which of the following graphs best describes the changes in pH when HCl is added to a buffer solution?

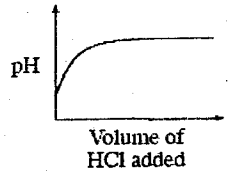
A.



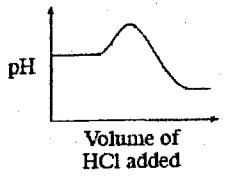
B.



C.



D.



345. Acid is added to a buffer solution. When equilibrium is reestablished the buffering effect has resulted in $[H_3O^+]$

A. increasing slightly
B. decreasing slightly
C. increasing considerably
D. decreasing considerably

346. A few drops of KOH are added to a buffer solution. When equilibrium is reestablished the buffering effect has resulted in pH

A. increasing slightly
B. decreasing slightly
C. increasing considerably
D. decreasing considerably

347. Consider the buffer equilibrium:

$$\underset{\text{high concentration}}{HNO_{2\,(aq)}} + H_2O_{(l)} \leftrightarrows \underset{\text{low concentration}}{H_3O^+_{(aq)}} + \underset{\text{high concentration}}{NO_2^-{}_{(aq)}}$$

What happens when a small amount of $HCl_{(aq)}$ is added to the equilibrium system?

A. the pH increases slightly
B. the pH decreases slightly
C. the equilibrium shifts to the right
D. the equilibrium does not shift due to the levelling effect

348. Consider the buffer equilibrium:

$$\underset{\text{high concentration}}{HNO_{2\,(aq)}} + H_2O_{(l)} \leftrightarrows \underset{\text{low concentration}}{H_3O^+_{(aq)}} + \underset{\text{high concentration}}{NO_2^-{}_{(aq)}}$$

What happens when a small amount of $KOH_{(aq)}$ is added to the equilibrium system?

A. the pH increases slightly
B. the pH decreases slightly
C. the equilibrium shifts to the right
D. the equilibrium does not shift due to the levelling effect

349. Consider the buffer equilibrium:

$$\underset{\text{high concentration}}{HNO_{2\,(aq)}} + H_2O_{(l)} \leftrightarrows \underset{\text{low concentration}}{H_3O^+_{(aq)}} + \underset{\text{high concentration}}{NO_2^-{}_{(aq)}}$$

What happens when a small amount of $Na_2CO_{3\,(aq)}$ is added to the equilibrium system?

A. the pH increases slightly
B. the pH decreases slightly
C. the equilibrium shifts to the left
D. the equilibrium does not shift due to the levelling effect

350. Consider the following buffer equilibrium:

$$H_2CO_{3\,(aq)} + H_2O_{(l)} \leftrightarrows H_3O^+_{(aq)} + HCO_3^-{}_{(aq)}$$

What happens when a small amount of NaOH (aq) is added?

A. $[H_3O^+]$ increases, then the equilibrium shifts to the left.
B. $[H_3O^+]$ decreases, then the equilibrium shifts to the left.
C. $[H_3O^+]$ increases, then the equilibrium shifts to the right.
D. $[H_3O^+]$ decreases, then the equilibrium shifts to the right.

351. In the human bloodstream, a buffer exists that is made of H_2CO_3 and $NaHCO_3$.

a. Explain what the purpose for this buffer is:

b. Approximately what pH level would this buffer operate at? Assume that there are equal moles of H_2CO_3 and $NaHCO_3$.

c. When a person exercises strenuously, the muscles produce lactic acid as a waste product. After strenuous exercise, that acid would make its way into the blood stream. What would happen to the pH of the blood?

352. A scientist wants a buffer solution that will work at a pH level of 3.75.

a. Describe what would be required to make a suitable buffer solution.

b. Which weak acid and conjugate base would work? _____ and its conjugate base _____

c. Explain what would happen if a few drops of NaOH would be added to this buffer. Would the pH change? If so, how much and would it increase or decrease?

pH would _____

Explanation:

353. Consider the following buffer equilibrium:

$$\underset{\text{high concentration}}{HF_{(aq)}} + H_2O_{(l)} \leftrightarrows \underset{\text{low concentration}}{H_3O^+_{(aq)}} + \underset{\text{high concentration}}{F^-_{(aq)}}$$

Using LeChatelier's Principle, explain what happens to the pH of the buffer solution when a small amount of NaOH is added.

If equal moles of HF and F^- are used, what will be the approximate pH level that this buffer will work at?

354. State the sequence of events that occur when a small amount of HCl (aq) is added to a buffer such as:

$$NH_{3\,(aq)} + H_2O_{(l)} \leftrightarrows NH_4^+{}_{(aq)} + OH^-{}_{(aq)}$$

Be sure to describe the stress, the shift and the effect on the pH what occur.

Stress: _____

Shift: _____

_____

Effect on pH _____

R1: Write equations representing the formation of acidic solutions or basic solutions from non-metal and metal oxides (anhydrides)

355. Which of the following will dissolve in water to produce an acidic solution?
A. CO_2 B. CaO C. MgO D. Na_2O

356. Which of the following will dissolve in water to produce an acidic solution?
A. SO_2 B. CaO C. BaO D. Rb_2O

357. What reaction occurs when sodium oxide dissolves in water?
A. $NaO_{(s)} \rightarrow Na^{+2}{}_{(aq)} + O^{-2}{}_{(aq)}$
B. $Na_2O_{(s)} \rightarrow 2Na^+{}_{(aq)} + O^{-2}{}_{(aq)}$
C. $NaO_{(s)} + H_2O_{(l)} \rightarrow NaOH_{(aq)}$
D. $Na_2O_{(s)} + H_2O_{(l)} \rightarrow 2NaOH_{(aq)}$

358. What reaction occurs when strontium oxide dissolves in water?
A. $SrO_{(s)} \rightarrow Sr^{+2}{}_{(aq)} + O^{-2}{}_{(aq)}$
B. $Sr_2O_{(s)} \rightarrow 2Sr^+{}_{(aq)} + O^{-2}{}_{(aq)}$
C. $SrO_{(s)} + H_2O_{(l)} \rightarrow Sr(OH)_{2\,(aq)}$
D. $SrO_{(s)} + H_2O_{(l)} \rightarrow H_2SrO_{2\,(aq)}$

359. What reaction occurs when carbon dioxide dissolves in water?
A. $CO_{2\,(g)} \rightarrow C^{+4}{}_{(aq)} + 2O^{-2}{}_{(aq)}$
B. $CO_{2\,(g)} \rightarrow CO^{+2}{}_{(aq)} + O^{-2}{}_{(aq)}$
C. $CO_{2\,(g)} + 2H_2O_{(l)} \rightarrow C(OH)_{4\,(aq)}$
D. $CO_{2\,(g)} + H_2O_{(l)} \rightarrow H_2CO_{3\,(aq)}$

360. What is produced when MgO is added to water?
A. the metal Mg
B. the acid HMgO
C. the base $Mg(OH)_2$
D. the amphiprotic species H_2MgO

361. What is produced when Se_2O_3 is added to water?
A. $Se_2O_{3\,(s)} + H_2O_{(l)} \rightarrow 2Se_{(s)} + 2O_{2\,(g)} + H_{2\,(g)}$
B. $Se_2O_{3\,(s)} + H_2O_{(l)} \rightarrow H_2Se_2O_{4\,(aq)}$
C. $Se_2O_{3\,(s)} + 3H_2O_{(l)} \rightarrow 2Se(OH)_{3\,(aq)}$
D. $2Se_2O_{3\,(s)} + 4H_2O_{(l)} \rightarrow 4SeH_{2\,(g)} + 5O_{2\,(g)}$

362. For each of the following, predict whether the anhydride will form an acidic or basic solution, and provide the equation to support your answer.

Prediction

a. $BaO + H_2O \rightarrow$ _____

b. $Cl_2O_7 + H_2O \rightarrow$ _____

c. $Li_2O + H_2O \rightarrow$ _____

363. For each of the following, predict whether the anhydride will form an acidic or basic solution, and provide the equation to support your answer.

Prediction

a. $TiO_2 + H_2O \rightarrow$ _____

b. $Cl_2O_5 + H_2O \rightarrow$ _____

c. $Rb_2O + H_2O \rightarrow$ _____

364. For each of the following, provide the anhydride that mixed with water to produce the solution.

a. $H_3PO_4 \rightarrow H_2O +$ _____

b. $Mg(OH)_2 \rightarrow H_2O +$ _____

c. $H_2SO_3 \rightarrow H_2O +$ _____

365. For each of the following, provide the anhydride that mixed with water to produce the solution.

a. $HClO_4 \rightarrow H_2O +$ _____

b. $Ca(OH)_2 \rightarrow H_2O +$ _____

c. $HNO_3 \rightarrow H_2O +$ _____

R2: Describe the pH conditions required for rain to be called acid rain

366. What would be a reasonable $[H_3O^+]$ value for a sample of rainwater to be classified as *acid rain*?
A. 1.58×10^{-8} M B. 3.16×10^{-7} M C. 6.31×10^{-5} M D. 1.00×10^{-1} M

R3: Relate the pH of normal rain water to the presence of dissolved CO_2

367. Which of the following dissolves in water to produce a basic solution?
A. O_2 B. SO_2 C. NO_2 D. MgO

368. The pH of normal rainwater is
A. less than 7.00 due to dissolved $NO_{2\,(g)}$
B. less than 7.00 due to dissolved $CO_{2\,(g)}$
C. greater than 7.0 due to dissolved $CO_{2\,(g)}$
D. equal to 7.00 due to dissolved $NO_{2\,(g)}$ and $CO_{2\,(g)}$

369. Carbon dioxide gas in the atmosphere dissolves in normal rainwater. This causes normal rainwater to
A. be slightly acidic
B. become acid rain
C. become a buffered solution
D. have a pH slightly greater than 7.0

370. What pH would most likely result when CO_2 dissolves naturally in rainwater?
A. 3.5 B. 6.5 C. 7.0 D. 7.5

R4: Describe sources of NO_x and SO_x

371. A gas which is produced by internal combustion engines and contributes to the formation of acid rain is
A. CO_2 B. O_3 C. H_2O D. NO_2

372. A common source of NO_2 is
A. a fuel cell
B. a lead smelter
C. an aluminum smelter
D. an automobile engine

373. What is a common source of $SO_{2\,(g)}$?
A. a fuel cell
B. a car battery
C. a lead smelter
D. corrosion of iron

374. Which of the following is a major source of $NO_{2\,(g)}$ which contributes to the problem of acid rain?
A. a fuel cell
B. an air conditioner
C. a nuclear power plant
D. the automobile engine

R5: Discuss general environmental problems associated with acid rain

R5: Discuss general environmental problems associated with acid rain

375. Identify an environmental problem associated with acid rain.
A. increasing the pH of lake
B. depletion of the ozone layer
C. chemical decomposition of rainwater
D. chemical erosion of limestone structures

R6: Review

376. The property common to both 0.10 M NH_3 and 0.10 M NaOH is that both solutions
A. dissociate 100%
B. have a pH > 7
C. turn blue litmus paper red
D. react with magnesium to produce hydrogen gas

377. A substance which absorbs hydrogen ions in solution is a definition of which of the following?
A. an Arrhenius acid
B. an Arrhenius base
C. a Bronsted-Lowry acid
D. a Bronsted-Lowry base

384. When comparing 0.1 0 M HPO_4^{-2} and 0.10 M $HC_2O_4^-$ as acids, which of the following is true?

A. $HC_2O_4^-$ is weaker and its pH is larger
B. HPO_4^{-2} is stronger and its pH is larger
C. HPO_4^{-2} is weaker and its pH is smaller
D. $HC_2O_4^-$ is stronger and its pH is smaller

385. Consider the following equilibrium:

$$2H_2O_{(l)} + \text{energy} \leftrightarrows H_3O^+_{(aq)} + OH^-_{(aq)}$$

A few drops of NaOH are added and a new equilibrium is established. The new equilibrium can be described by

A. pH = pOH and $K_w > 1.0 \times 10^{-14}$
B. pH = pOH and $K_w < 1.0 \times 10^{-14}$
C. pH > pOH and $K_w = 1.0 \times 10^{-14}$
D. pH < pOH and $K_w = 1.0 \times 10^{-14}$

386. At 20°C the ionization constant of water (K_w) is 6.76×10^{-15}. Calculate the pOH and pH of water at 20°C.

	pH	pOH
A.	7.085	7.085
B.	7.000	7.000
C.	7.085	6.915
D.	6.915	7.085

387. Which of the following solutions will have a pH = 1.00?

I. 0.10 M HCl
II. 0.10 M HNO_2
III. 0.10 M NaOH

A. I only B. III only C. I and II only D. I, II and III

388. Which of the following solutions would have a pH = 2.00?

A. 0.010 M HCl
B. 0.010 M HCN
C. 0.010 M H_2SO_4
D. 0.010 M NaOH

378. Consider the following Bronsted-Lowry equilibrium:

$$C_6H_5NH_{2\,(aq)} + H_2PO_4^-{}_{(aq)} \leftrightarrows C_6H_5NH_3^+{}_{(aq)} + HPO_4^{-2}{}_{(aq)}$$

The substances acting as acids and bases from left to right are:

A. acid, base, acid, base
B. acid, base, base, acid
C. base, acid, acid, base
D. base, acid, base, acid

379. Which of the following will have the lowest electrical conductivity?

A. 1.00 M $HClO_4$
B. 1.00 M NaCN
C. 1.00 M $H_2C_2O_4$
D. 1.00 M $NaHCO_3$

380. In a 1.0 M HF solution, the concentrations of HF, F^- and OH^-, from highest to lowest is

A. $[HF] > [F^-] > [OH^-]$
B. $[F^-] > [HF] > [OH^-]$
C. $[OH^-] > [HF] > [F^-]$
D. $[OH^-] > [F^-] > [HF]$

381. The strength of the ions $HC_2O_4^-$, HSO_3^- and $H_2PO_4^-$ from weakest to strongest **base** is

A. $HC_2O_4^- < H_2PO_4^- < HSO_3^-$
B. $HC_2O_4^- < HSO_3^- < H_2PO_4^-$
C. $HSO_3^- < H_2PO_4^- < HC_2O_4^-$
D. $H_2PO_4^- < HSO_3^- < HC_2O_4^-$

382. Which of the following is the strongest acid that can exist in an aqueous solution?

A. O^{-2} B. NH_2^- C. H_3O^+ D. $HClO_4$

383. Consider the following equilibrium:

$$H_3AsO_4 + HSeO_4^- \leftrightarrows H_2AsO_4^- + H_2SeO_4$$

Reactants are favored in this equilibrium. Which of the following describes the relative strengths of the acids and bases?

	Stronger Acid	Stronger Base
A.	H_2SeO_4	$H_2AsO_4^-$
B.	H_2SeO_4	$HSeO_3^-$
C.	H_3AsO_4	$H_2AsO_4^-$
D.	H_3AsO_4	$HSeO_3^-$

389. Using calculations, show why the electrical conductivity of 1.0 M H_2CO_3 will be less than that for 0.10 M HCl.

390. Calculate the pH of a 0.010 M NH_4CN solution.

391. Consider the following equilibrium:

$$2H_2O_{(l)} \leftrightarrows H_3O^+_{(aq)} + OH^-_{(aq)}$$

What changes occur to $[H_3O^+]$ and pH when $NaHSO_3$ is added?

	$[H_3O^+]$	pH
A.	increases	increases
B.	increases	decreases
C.	decreases	decreases
D.	decreases	increases

392. In an aqueous solution of $Fe(NO_3)_3$, the pH is
A. less than 7 and the solution is acidic
B. equal to 7 and the solution is neutral
C. greater than 7 and the solution is basic
D. greater than 7 and the solution is acidic

393. The $HCO_3^-{}_{(aq)}$ ion will act as
A. a base since $K_a < K_b$
B. a base since $K_a > K_b$
C. a acid since $K_a < K_b$
D. a acid since $K_a > K_b$

394. Consider the following indicator equilibrium:

$$HIn + H_2O \leftrightarrows H_3O^+ + In^-$$

Which of the following is true about the transition point of this indicator?
A. pH = 7.0
B. [HIn] = [In^-]
C. [HIn] > [In^-]
D. moles of H_3O^+ = moles of In^-

395. What color would 0.10 M HCl be in an indicator mixture consisting of phenol red and bromcresol green?
A. purple B. blue C. yellow D. green

396. When the indicator thymol blue is added to 0.010 M solution of an unknown acid, the solution is orange. The acid could be
A. HF B. H_2S C. HCN D. HNO_3

400. At 45.0 °C, $K_w = 4.00 \times 10^{-14}$ for pure water.

a. Calculate the pH of water at 45.0 °C.

b. A mixture of the indicators Thymol Blue and Chlorophenol Red is added to the water. What is the resulting colour of the mixture? Explain.

Resulting color _____
Explaination:

401. A 20.0 mL sample of H_2SO_4 is titrated with 25.0 mL of 0.20 M $Sr(OH)_2$. What is the concentration of the acid?
A. 0.13 M B. 0.20 M C. 0.25 M D. 0.50 M

402. At the equivilence point, the titration of HCl with $Ba(OH)_2$ will form a solution which is
A. basic with pH >7
B. acidic with pH < 7
C. basic with pH < 7
D. neutral with pH = 7

403. What is always true about the pH at the equivilence point when a weak acid is titrated with a strong base?
A. pH < 7.0
B. pH > 7.0
C. pH = 7.0
D. the pH does not change anymore, even if more strong base is added

404. Which of the following pairs of chemicals could be used to make a buffer solution?
A. HNO_3 and $NaNO_3$ B. HCN and NaCN C. HI and NaI D. $NaClO_4$ and $HClO_4$

397. Consider the following equilibrium for the chemical indicator phenol red, HInd, at a pH = 7.3 (orange).

$$\underset{\text{yellow}}{HInd} + H_2O \leftrightarrows H_3O^+ + \underset{\text{red}}{Ind^-}$$

When some Na_2CO_3 is added, what stress is imposed on the equilibrium and what colour change occurs?

Stress	Indicator Colour Change
A. increased $[H_3O^+]$	turns red
B. decreased $[H_3O^+]$	turns red
C. increased $[H_3O^+]$	turns yellow
D. decreased $[H_3O^+]$	turns yellow

398. The indicator phenolphthalein can be described by the following equilibrium equation:

$$\underset{\text{colorless}}{HIn} + H_2O \leftrightarrows H_3O^+ + \underset{\text{pink}}{In^-}$$

NaCN is added to a slighly pink sample of this indicator. After equilibrium has been re-established, how do the $[H_3O^+]$ and the colour of the solution compare with the original equilibrium?

$[H_3O^+]$	Colour of solution
A. decreases	turns more pink
B. decreases	turns colourless
C. increases	turns more pink
D. increases	turns colourless

399. A chemical indicator has a $K_a = 1.6 \times 10^{-4}$. What is the pH at the transition point and what is the identity of the indicator?

pH	Indicator
A. 3.8	methyl orange
B. 3.8	bromcresol green
C. 10.2	phenophthalien
D. 10.2	thymophthalien

405. Consider the following buffer equilibrium:

$$HF_{(aq)} + H_2O_{(l)} \leftrightarrows H_3O^+_{(aq)} + F^-_{(aq)}$$

What would limit the buffering action if KCH_3COO were added?

A. $[F^-]$ B. $[HF]$ C. $[H_2O]$ D. $[H_3O^+]$