JASPERSE CHEM 210 PRACTICE TEST 2 VERSION 3
Ch. 14 Chemical Equilibria
Ch. 16 Acid-Base Equilibria

Key Equations:

$[H^+][HO^-] = 1.00 \times 10^{-14}$ $pH = -\log[H^+]$ $[H^+] = 10^{-pH}$ $pH + pOH = 14$

for weak acids in water: $K_a = [H^+]^2/[HA]_{init}$ $[H^{\oplus}] = \sqrt{K_a \times [HA]_{init}}$

for weak based in water: $K_b = [OH^-]^2/[Base]_{init}$ $[HO^{\ominus}] = \sqrt{K_b \times [Base]_{init}}$

(the above weak acid/base equations assume <5% ionization and assume no alternative source of common ions)

$K_aK_b = 10^{-14}$ for a conjugate acid/base pair Quadratic Equation: $x = \dfrac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

1. Which of the following is <u>false</u> about a system at equilibrium:

   a) It's a "dynamic equilibrium": reactants and products are constantly going back and forth
   b) It's a "steady state"; the concentrations stay steady once equilibrium is established
   c) The rate of the forward reaction exactly equals the rate of the reverse reaction
   d) The equilibrium state will be the same, no matter what the direction of approach to the equilibrium. It doesn't matter whether you start from the right side or from the left side.
   e) If a catalyst is present, a different equilibrium state will be achieved then if no catalyst is used

2. Which of the following is <u>true</u> about the following system at equilibrium, given the listed K value:

   $A(g) + 2B(g) \rightleftharpoons C(g) + D(g)$ $K = 139$

   a) Products predominate
   b) Reactants predominate
   c) Roughly equal molar amounts of products and reactants are present
   d) Only products exist
   e) Only reactants exist

3. Which of the following statements are true, regarding the equilibrium constant K for a reaction and the reaction quotient Q:

   1) If Q < K, the reaction is not at equilibrium, and will reach equilibrium by shifting some reactants over to products
   2) If Q > K, the reaction is not at equilibrium, and will reach equilibrium by shifting some reactants over to products
   3) If Q = K, the reaction is already at equilibrium.
   4) If some extra reactants are added to a reaction previously at equilibrium, immediately following the addition Q > K
   5) If some extra reactants are added to a reaction previously at equilibrium, immediately following the addition Q < K

   a) 1 and 4 only
   b) 2, 3, and 4 only
   c) 1, 3, and 5 only
   d) 1, 3, and 4 only
   e) 2, 3, and 5 only

4. Identify the equation that would give the equilibrium expression shown:

$$K_c = [H_2]^2 [O_2] / [H_2O]^2$$

a) $2H_2 (g) + O_2 (g) \rightleftharpoons H_2O (g) + D (g)$
b) $H_2O (g) \rightleftharpoons H_2 (g) + 1/2O_2 (g)$
c) $H_2O (g) \rightleftharpoons 2H (g) + O (g)$
d) $2H_2O (g) \rightleftharpoons 2H_2 (g) + O_2 (g)$

5. For the following reaction, determine whether the system is at equilibrium when [CO] = 0.60 M and $[CO_2]$ = 0.40 M. The system _____ at equilibrium, because _____.

$$C (s) + CO_2 (g) \rightleftharpoons 2 CO (g) \qquad K_c = 168$$

a) Is; the value of Q is 1.50
b) Is not; the value of Q is 0.90
c) Is; the value of Q is 0.90
d) Is not; the value of Q is 01.11
e) More information is needed to answer this question

6. What is the equilibrium constant K_c for the following reaction, given the equilibrium concentrations shown?

$Br_2 (g)$ +	$Cl_2 (g)$ $\rightleftharpoons$	2BrCl (g)
0.20M	0.40M	0.34M

a) 1.4
b) 4.2
c) 0.71
d) 2.2×10^{-3}

7. What is the equilibrium concentration of Cl_2 (g) (in moles/liter), given the K value and the equilibrium concentrations shown for the other chemicals?

$C_2O_2Cl_2 (g)$ $\rightleftharpoons$	2CO (g) +	$Cl_2 (g)$	$K_c = 3.6 \times 10^{-3}$
0.20M	0.40M	???	

a) 4.5×10^{-3}
b) 2.2×10^{3}
c) 1.1×10^{-2}
d) 4.5×10^{-6}
e) none of the above

8. When 1.0 mole each of CO (g) and Br_2 (g) were placed into a 1 L container and allowed to reach equilibrium, the resulting mixture contained 0.60 moles of CO (g). How many moles of Br_2 (g) and $C_2O_2Br_2$ (g) are present at equilibrium?

$$2CO\ (g) + Br_2\ (g) \rightleftharpoons C_2O_2Br_2\ (g)$$

a) 0.60 moles of Br_2 ; 0.40 moles of $C_2O_2Br_2$
b) 0.80 moles of Br_2 ; 0.20 moles of $C_2O_2Br_2$
c) 0.20 moles of Br_2 ; 0.80 moles of $C_2O_2Br_2$
d) 0.40 moles of Br_2 ; 1.20 moles of $C_2O_2Br_2$
e) none of the above

9. 0.400 mol of HI (g) was placed in a 1.00 L flask that had no NO_2 (g) initially. After equilibration occurred, the concentration of HI (g) was found to be 0.328 M. What is the value of K_c for this reaction?

$$2HI\ (g) \rightleftharpoons H_2\ (g) + I_2\ (g)$$

a) 3.95×10^{-3}
b) 1.20×10^{-2}
c) 4.80×10^{-4}
d) 63.5

10. 0.30 mol of AZ (g) was placed in a 1.00 L flask. What is the equilibrium concentration of Z_2 (g) for this reaction?

$$2AZ\ (g) \rightleftharpoons A_2\ (g) + Z_2\ (g) \qquad K_c = 4.80 \times 10^{-5}$$

a) 2.30×10^{8} M
b) 1.52×10^{-4} M
c) 2.08×10^{-3} M
d) 4.14×10^{-6} M
e) 1.71×10^{-11} M

11. What is the effect of increasing the temperature for the following equilibrium?

$$N_2\ (g) + 3H_2\ (g) \rightleftharpoons 2\ NH_3\ (g) \qquad \Delta H^\circ = -92\ kJ$$

a) There will be a shift in the position of equilibrium to the right; K will increase
b) There will be a shift in the position of equilibrium to the left; K will decrease
c) There will be no effect on the equilibrium position; K will not change
d) The concentration of N_2 (g) will decrease
e) None of the above

12. 131 g of 2NOCl (g) (65.5 g/mol) was placed in a 4.00 L flask. What is the equilibrium concentration of Cl_2 (g) for this reaction?

$$2NOCl\ (g) \rightleftharpoons 2\ NO\ (g) + Cl_2\ (g) \qquad K_c = 3.0 \times 10^{-7}$$

a) 2.30×10^{8} M
b) 1.52×10^{-4} M
c) 3.79×10^{-3} M
d) 2.66×10^{-3} M
e) 1.71×10^{-11} M

13. Given the following equilibrium, which of the following statements is <u>true</u>?

$$2SO_2\ (g) + O_2\ (g) \rightleftharpoons 2SO_3\ (g) \qquad \Delta H^\circ = -78\ kJ$$

a) An increase in temperature will cause a shift in the equilibrium position to the right
b) A reduction in volume will cause a shift in the equilibrium position to the left
c) An increase in the concentration of O_2 (g) will cause the concentration of SO_3 (g) to increase
d) An increase in the amount of SO_2 (g) will cause the amount of SO_3 (g) to decrease
e) None of the above

14. Given the following equilibrium, which of the following statements is <u>true</u> if additional F^- is added to the solution?

$$HF\ (aq) + H_2O\ (l) \rightleftharpoons H_3O^+\ (aq) + F^-\ (aq)$$

a) $[H_3O^+]$ will <u>increase</u> and the pH value will <u>increase</u>.
b) $[H_3O^+]$ will <u>increase</u> and the pH value will <u>decrease</u>
c) $[H_3O^+]$ will <u>decrease</u> and the pH value will <u>increase</u>
d) $[H_3O^+]$ will <u>decrease</u> and the pH value will <u>decrease</u>
e) none of the above

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15. The $[H^+]$ and pH of 0.0037 M HBr are:

a) 0.0074 M and 2.43
b) 0.0037 M and 2.43
c) 0.0074 M and 2.13
d) 0.0037 M and 2.13
e) 0.0037 M and –2.13

16. What is the $[H^+]$ concentration of a solution with pH = 3.48?

a) 3.31×10^{-4} M
b) 2.87×10^{-4} M
c) 3.31×10^{-3} M
d) 3.01×10^{-11} M
e) none of the above

17. Calculate the hydronium ion concentration in a 1.8×10^{-3} M aqueous solution of NaOH.

a) 7.8×10^{-4} M
b) 5.5×10^{-13} M
c) 5.6×10^{-12} M
d) 8.3×10^{-13} M
e) none of the above

18. The K_a for $H_2S = 9.1 \times 10^{-8}$. Calculate the pH of a 0.15 M solution of H_2S in water.

a) 5.1
b) 3.9
c) 4.5
d) 7.9
e) none of the above

19. A 0.45 M solution of a newly discovered weak acid HZ has a pH of 2.60. What is the value of K_a for HZ?

a) 1.1×10^{-5} M
b) 1.1×10^{-4} M
c) 2.8×10^{-6} M
d) 1.4×10^{-5} M
e) none of the above

20. The K_b for ethylamine is 4.7×10^{-4}. What is the hydroxide ion concentration in an aqueous solution that is 0.15 M in ethylamine?

a) 6.9×10^{-5} M
b) 8.4×10^{-3} M
c) 2.8×10^{-5} M
d) 7.6×10^{-5} M
e) none of the above

21. The basicity constant K_b for aniline, $C_6H_5NH_2 = 4.3 \times 10^{-10}$. Calculate the pH of a 0.15 M solution of aniline in water.

a) 5.1
b) 8.9
c) 6.8
d) 12.0
e) none of the above

22. The K_a for a newly discovered acid is HZ is 7.0×10^{-4}. What is the value of K_b for the anion Z^-?

a) 1.4×10^{-11}
b) 4.7×10^{-11}
c) 3.5×10^{10}
d) 3.5×10^{-10}
e) 2.8×10^{-11}

23. The K_a for HF is 6.8×10^{-4}. What is the pH of an 0.19 M solution of KF in water?

a) 8.2
b) 5.8
c) 9.6
d) 4.3
e) none of the above

24. What is the conjugate base of CH_3OH?

a) CH_3O^+
b) CH_3O^-
c) $CH_3OH_2^+$
d) CH_3OH^+

25. Given the K_a values shown, which one of the anions shown is the <u>weakest</u> base?

CH_3COOH ($K_a = 1.8 \times 10^{-5}$) HCOOH ($K_a = 1.0 \times 10^{-4}$)
HClO ($K_a = 3.0 \times 10^{-8}$) HF ($K_a = 6.8 \times 10^{-4}$)

a) CH_3COO^-
b) $HCOO^-$
c) ClO^-
d) F^-

26. Are any of the following acidity relationships false?

a) $H_2SO_4 > H_2SO_3$
b) $H_3PO_4 > H_2PO_4^-$
c) $HPO_4^{2-} > H_2PO_4^-$
d) $HBr > HBrO$
e) $HNO_3 > H_2CO_3$

27. For the reaction shown, which of the following statements would be false?

$$HCOOH\ (aq) + Br^-\ (aq) \rightleftharpoons HCOO^-\ (aq) + HBr\ (aq)$$

a) HCOOH and HBr function as the acids
b) HBr is the stronger acid, so the equilibrium will favor the left side
c) $HCOO^-$ would function as a base in the reaction
d) HBr is the stronger acid, so $K > 1$
e) HCOOH and $HCOO^-$ are a conjugate acid/base pair

28. The acid strength decreases in the series $CH_3COOH > HCN > HCO_3^-$. Which of the following statements is true

a) CN^- has a greater love for protons than does CH_3COO^-
b) CN^- has a greater love for protons than does CO_3^{2-}
c) CH_3COO^- has a greater love for protons than does CO_3^{2-}
d) CH_3COO^- would be a stronger base than CO_3^{2-}
e) CH_3COO^- would be a stronger base than CN^-

29. For the reaction shown, which of the following statements would be true, given the listed value for K?

$$HNO_2\ (aq) + CH_3COO^-\ (aq) \rightleftharpoons CH_3COOH\ (aq) + NO_2^-\ (aq) \qquad K = 25$$

a) CH_3COO^- is the weakest acid
b) HNO_2 is the weakest acid
c) CH_3COOH is the weakest acid
d) NO_2^- is the strongest base
e) The solution will contain more HNO_2 than CH_3COOH at equilibrium

30. Three of the following will give an acidic solution in water. Which one would not give an acidic solution in water?

a) $TiCl_4$
b) C_3H_7COOH
c) NH_4Cl
d) $NaNO_3$

31. Which of the following causes it's aqueous solution to be <u>basic</u>?

a) $NaHSO_4$
b) $LiClO_4$
c) KClO
d) $FeBr_3$

32. Which one of the following solutions would have a pH of 7.0?

a) Na_2S
b) $FeCl_3$
c) $NaClO_4$
d) CH_3NH_3Cl
e) None of these

33. Rank the relative pH's for solutions of the following salts, from lowest pH to highest pH, given the following acidity data:

HCN ($K_a = 4.9 \times 10^{-10}$) HF ($K_a = 3.5 \times 10^{-4}$)

Salts: NaOH KCl NH_4Br KCN KF

a) $NH_4Br < KCl < KF < KCN < NaOH$
b) $NH_4Br < KCl < KCN < KF < NaOH$
c) $NaOH < KCN < KF < KCl < NH_4Br$
d) $NH_4Br < KCN < KCl < KF < NaOH$
e) None of the above

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1. E
2. A
3. C
4. D
5. B
6. A
7. A
8. B
9. B
10. C
11. B
12. D
13. C
14. C
15. B
16. A
17. C
18. B
19. D
20. B
21. B
22. A
23. A
24. B
25. D
26. C
27. D
28. A
29. C
30. D
31. C
32. C
33. A