CHEM 110 Third Midterm Test Bank

1. Which is the correct equilibrium constant expression for the following reaction?
$Fe_2O_3(s) + 3H_2(g) \rightleftharpoons 2Fe(s) + 3H_2O(g)$

A. $K_c = [Fe_2O_3][H_2]^3/[Fe]^2[H_2O]^3$
B. $K_c = [H_2]/[H_2O]$
C. $K_c = [H_2O]^3/[H_2]^3$
D. $K_c = [Fe]^2[H_2O]^3/[Fe_2O_3][H_2]^3$
E. $K_c = [Fe][H_2O]/[Fe_2O_3][H_2]$

2. The equilibrium constant expression for the reaction $2BrF_5(g) \rightleftharpoons Br_2(g) + 5F_2(g)$ is

A. $K_c = [Br_2][F_2]/[BrF_5]$
B. $K_c = [Br_2][F_2]^5/[BrF_5]^2$
C. $K_c = [Br_2][F_2]^2/[BrF_5]^5$
D. $K_c = [BrF_5]^2/[Br_2][F_2]^5$
E. $K_c = 2[BrF_5]^2/([Br_2] \times 5[F_2]^5)$

3. Consider the two gaseous equilibria

$SO_2(g) + (1/2)O_2(g) \rightleftharpoons SO_3(g)$ K_1
$2SO_3(g) \rightleftharpoons SO_2(g) + O_2(g)$ K_2

The values of the equilibrium constants K_1 and K_2 are related by

A. $K_2 = K_1^2$
B. $K_2^{-2} = K_1$
C. $K_2 = 1/K_1^2$
D. $K_2 = 1/K_1$
E. none of these

4. Carbon tetrachloride reacts at high temperatures with oxygen to produce two toxic gases, phosgene and chlorine.
$CCl_4(g) + (1/2)O_2(g) \rightleftharpoons COCl_2(g) + Cl_2(g)$, $K_c = 4.4 \times 10^9$ at 1,000 K

Calculate K_c for the reaction $2CCl_4(g) + O_2(g) \rightleftharpoons 2COCl_2(g) + 2Cl_2(g)$.

A. 4.4×10^9
B. 8.8×10^9
C. 1.9×10^{10}
D. 1.9×10^{19}
E. 2.3×10^{-10}

5. When the following reaction is at equilibrium, which of these relationships is *always* true?
$2NOCl(g) \rightleftharpoons 2NO(g) + Cl_2(g)$

A. $[NO][Cl_2] = [NOCl]$
B. $[NO]^2[Cl_2] = [NOCl]^2$
C. $[NOCl] = [NO]$
D. $2[NO] = [Cl_2]$
E. $[NO]^2[Cl_2] = K_c[NOCl]^2$

6. Calculate K_p for the reaction $2NOCl(g) \rightleftharpoons 2NO(g) + Cl_2(g)$ at 400°C if K_c at 400°C for this reaction is 2.1×10^{-2}.

A. 2.1×10^{-2}
B. 1.7×10^{-3}
C. 0.70
D. 1.2
E. 3.8×10^{-4}

7. On analysis, an equilibrium mixture for the reaction $2H_2S(g) \rightleftharpoons 2H_2(g) + S_2(g)$ was found to contain 1.0 mol H_2S, 4.0 mol H_2, and 0.80 mol S_2 in a 4.0 L vessel. Calculate the equilibrium constant, K_c, for this reaction.

A. 1.6
B. 3.2
C. 12.8
D. 0.64
E. 0.8

8. 2.50 mol NOCl was placed in a 2.50 L reaction vessel at 400°C. After equilibrium was established, it was found that 28% of the NOCl had dissociated according to the equation $2NOCl(g) \rightleftharpoons 2NO(g) + Cl_2(g)$.

   Calculate the equilibrium constant, K_c, for the reaction.

   A. 0.021
   B. 0.039
   C. 0.169
   D. 26
   E. 47

9. 1.25 moles of NOCl were placed in a 2.50 L reaction chamber at 427°C. After equilibrium was reached, 1.10 moles of NOCl remained. Calculate the equilibrium constant, K_c, for the reaction $2NOCl(g) \rightleftharpoons 2NO(g) + Cl_2(g)$.

   A. 3.0×10^{-4}
   B. 1.8×10^{3}
   C. 1.4×10^{-3}
   D. 5.6×10^{-4}
   E. 4.1×10^{-3}

10. The brown gas NO_2 and the colorless gas N_2O_4 exist in equilibrium, $2NO_2 \rightleftharpoons N_2O_4$. In an experiment, 0.625 mole of N_2O_4 was introduced into a 5.00 L vessel and was allowed to decompose until equilibrium was reached. The concentration of N_2O_4 at equilibrium was 0.0750 M. Calculate K_c for the reaction.

    A. 7.5
    B. 0.125
    C. 0.0750
    D. 0.10
    E. 0.050

11. Calculate K_c for the reaction $2HI(g) \rightleftharpoons H_2(g) + I_2(g)$ given that the concentrations of each species at equilibrium are as follows:
    $[HI] = 0.85$ mol/L, $[I_2] = 0.60$ mol/L, $[H_2] = 0.27$ mol/L.

    A. 5.25
    B. 0.22
    C. 4.5
    D. 0.19
    E. 1.6×10^{2}

12. Phosgene, $COCl_2$, a poisonous gas, decomposes according to the equation $COCl_2(g) \rightleftharpoons CO(g) + Cl_2(g)$. Calculate K_p for this reaction if $K_c = 0.083$ at 900°C.

    A. 0.125
    B. 8.0
    C. 6.1
    D. 0.16
    E. 0.083

13. K_p for the reaction of $SO_2(g)$ with O_2 to produce $SO_3(g)$ is 3×10^{24}. Calculate K_c for this equilibrium at 25°C. (The relevant reaction is $2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$.)

    A. 3×10^{24}
    B. 5×10^{21}
    C. 2×10^{20}
    D. 5×10^{22}
    E. 7×10^{25}

14. Equilibrium is established for the reaction $2X(s) + Y(g) \rightleftharpoons 2Z(g)$ at 500K, $K_c = 100$. Determine the concentration of Z in equilibrium with 0.2 mol X and 0.50 M Y at 500K.

    A. 3.2 M
    B. 3.5 M
    C. 4.5 M
    D. 7.1 M
    E. none of these

15. At 35°C, the equilibrium constant for the reaction $2NOCl(g) \rightleftharpoons 2NO(g) + Cl_2(g)$ is $K_c = 1.6 \times 10^{-5}$. An equilibrium mixture was found to have the following concentrations of Cl_2 and NOCl: $[Cl_2] = 1.2 \times 10^{-2}$ M; $[NOCl] = 2.8 \times 10^{-1}$ M. Calculate the concentration of NO(g) at equilibrium.

A. 1.0×10^{-4} M
B. 1.0×10^{-2} M
C. 2.8×10^{-1} M
D. 2.4×10^{-2} M
E. 1.6×10^{-3} M

16. Sodium carbonate, $Na_2CO_3(s)$, can be prepared by heating sodium bicarbonate, $NaHCO_3(s)$.

$$2NaHCO_3(s) \rightleftharpoons Na_2CO_3(s) + CO_2(g) + H_2O(g) \quad K_p = 0.23 \text{ at } 100°C$$

If a sample of $NaHCO_3$ is placed in an evacuated flask and allowed to achieve equilibrium at 100°C, what will the total gas pressure be?

A. 0.46 atm
B. 0.96 atm
C. 0.23 atm
D. 0.48 atm
E. 0.11 atm

17. 15.00 g of solid ammonium hydrogen sulfide is introduced into a 500.-mL flask at 25°C, the flask is sealed, and the system is allowed to reach equilibrium. What is the partial pressure of ammonia in this flask if $K_p = 0.108$ at 25°C for $NH_4HS(s) \rightleftharpoons NH_3(g) + H_2S(g)$?

A. 0.657 atm
B. 1.25 atm
C. 0.329 atm
D. 14.4 atm
E. 2.50 atm

18. Consider the following reactions and their associated equilibrium constants:

$A + 2B \rightleftharpoons C \qquad K_1$
$C \rightleftharpoons D + E \qquad K_2$

For the reaction $A + 2B \rightleftharpoons D + E$, having equilibrium constant K_c,

A. $K_c = K_1 + K_2$
B. $K_c = K_1/K_2$
C. $K_c = K_1 - K_2$
D. $K_c = (K_1)(K_2)$
E. $K_c = K_2/K_1$

19. Consider the following equilibria:

$2SO_3(g) \rightleftharpoons 2SO_2(g) + O_2(g) \quad K_c = 2.3 \times 10^{-7}$
$2NO_3(g) \rightleftharpoons 2NO_2(g) + O_2(g) \quad K_c = 1.4 \times 10^{-3}$

Calculate the equilibrium constant for the reaction
$SO_2(g) + NO_3(g) \rightleftharpoons SO_3(g) + NO_2(g)$.

A. 78
B. 1.3×10^{-2}
C. 1.6×10^{-4}
D. 3.2×10^{-10}
E. 6.1×10^{3}

20. At 700 K, the reaction $2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$ has the equilibrium constant $K_c = 4.3 \times 10^6$, and the following concentrations are present: $[SO_2] = 0.10$ M; $[SO_3] = 10.$ M; $[O_2] = 0.10$ M.

Is the mixture at equilibrium? If not at equilibrium, in which direction (as the equation is written), *left to right* or *right to left*, will the reaction proceed to reach equilibrium?

A. Yes, the mixture is at equilibrium.
B. No, *left to right*
C. No, *right to left*
D. There is not enough information to be able to predict the direction.

21. At 700 K, the reaction $2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$ has the equilibrium constant $K_c = 4.3 \times 10^6$, and the following concentrations are present: $[SO_2] = 0.010$ M; $[SO_3] = 10.$M; $[O_2] = 0.010$ M.

Is the mixture at equilibrium? If not at equilibrium, in which direction (as the equation is written), *left to right* or *right to left*, will the reaction proceed to reach equilibrium?

A. Yes, the mixture is at equilibrium.
B. No, *left to right*
C. No, *right to left*
D. There is not enough information to be able to predict the direction.

22. For the following reaction at equilibrium, which choice gives a change that will shift the position of equilibrium to favor formation of more products?

$2NOBr(g) \rightleftharpoons 2NO(g) + Br_2(g)$, $\Delta H°_{rxn} = 30$ kJ/mol

A. Increase the total pressure by decreasing the volume.
B. Add more NO.
C. Remove Br_2
D. Lower the temperature.
E. Remove NOBr selectively.

23. For the following reaction at equilibrium, which one of the changes below would cause the equilibrium to shift to the *left*?

$2NOBr(g) \rightleftharpoons 2NO(g) + Br_2(g)$, $\Delta H°_{rxn} = 30$ kJ/mol

A. Increase the container volume.
B. Remove some NO.
C. Remove some Br_2 .
D. Add more NOBr.
E. Decrease the temperature.

24. For the following reaction at equilibrium in a reaction vessel, which one of these changes would cause the Br_2 concentration to *decrease*?

$2NOBr(g) \rightleftharpoons 2NO(g) + Br_2(g)$, $\Delta H°_{rxn} = 30$ kJ/mol

A. Increase the temperature.
B. Remove some NO.
C. Add more NOBr.
D. Compress the gas mixture into a smaller volume.

25. For the following reaction at equilibrium in a reaction vessel, which one of these changes would cause the Br_2 concentration to *increase*?

$2NOBr(g) \rightleftharpoons 2NO(g) + Br_2(g)$, $\Delta H°_{rxn} = 30$ kJ/mol

A. Lower the temperature.
B. Remove some NO.
C. Remove some NOBr.
D. Compress the gas mixture into a smaller volume.

26. For the equilibrium reaction $2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$, $\Delta H°_{rxn} = -198$ kJ/mol. Which one of these factors would cause the equilibrium constant to *increase*?

A. Decrease the temperature.
B. Add SO_2 gas.
C. Remove O_2 gas.
D. Add a catalyst.
E. none of these

27. The reaction $2SO_3(g) \rightleftharpoons 2SO_2(g) + O_2(g)$ is endothermic. If the temperature is increased,

A. more SO_3 will be produced.
B. K_c will decrease.
C. no change will occur in K_c .
D. K_c will increase.
E. the pressure will decrease.

28. For the reaction at equilibrium $2SO_3 \rightleftharpoons 2SO_2 + O_2$ ($\Delta H°_{rxn}$ = 198 kJ/mol), if we increase the reaction temperature, the equilibrium will

A. shift to the right.
B. shift to the left.
C. not shift.
D. The question cannot be answered because the equilibrium constant is not given.

29. Which of these situations will result if some $CH_4(g)$ is removed from the reaction $CO(g) + 3H_2(g) \rightleftharpoons CH_4(g) + H_2O(g)$ at equilibrium?

A. H_2O will be consumed.
B. More CH_4 and H_2O will be produced.
C. K_p will decrease.
D. More CO will be produced.
E. No change will occur.

30. For the common allotropes of carbon (graphite and diamond), $C(gr) \rightleftharpoons C(dia)$ with equilibrium constant K = 0.32. The molar volumes of graphite and diamond are, respectively, 5.30 cm^3/mol and 3.42 cm^3/mol; ΔH_f of diamond is 1.90 kJ/mol. These data suggest that the formation of diamond is favored at

A. low temperatures and low pressures.
B. high temperatures and low pressures.
C. low temperatures and high pressures.
D. high temperatures and high pressures.

31. In which of these gas-phase equilibria is the yield of products increased by increasing the total pressure on the reaction mixture?

A. $CO(g) + H_2O(g) \rightleftharpoons CO_2(g) + H_2(g)$
B. $2NO(g) + Cl_2(g) \rightleftharpoons 2NOCl(g)$
C. $2SO_3(g) \rightleftharpoons 2SO_2(g) + O_2(g)$
D. $PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$

32. Consider this gas phase equilibrium system:
$PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$ $\Delta H°_{rxn}$ = +87.8 kJ/mol

Which of these statements is *false*?

A. Increasing the system volume shifts the equilibrium to the right.
B. Increasing the temperature shifts the equilibrium to the right.
C. A catalyst speeds up the approach to equilibrium and shifts the position of equilibrium to the right.
D. Decreasing the total pressure of the system shifts the equilibrium to the right.
E. Increasing the temperature causes the equilibrium constant to increase.

33. The reaction $2NO(g) \rightleftharpoons N_2(g) + O_2(g)$ is exothermic, $\Delta H°_{rxn}$ = -180 kJ/mol.
Which one of these statements is *true*?

A. K_p at 1,000 K is less than K_p at 2,000 K.
B. K_p at 1,000 K is larger than K_p at 2,000 K.
C. The K_p's at 1000 K and 2000 K are the same.
D. K_p depends on total pressure as well as temperature.

34. Consider this reaction at equilibrium:
$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$, $\Delta H°_{rxn}$ = -198 kJ/mol

If the volume of the system is compressed at constant temperature, what change will occur in the position of the equilibrium?

A. a shift to produce more SO_2
B. a shift to produce more O_2
C. no change
D. a shift to produce more SO_3

35. Consider this reaction at equilibrium at a total pressure P_1:
$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$

Suppose the volume of this system is compressed to one-half its initial volume and then equilibrium is reestablished. The new equilibrium total pressure will be

A. twice P_1.
B. three times P_1.
C. 3.5 P_1.
D. less than twice P_1
E. unchanged.

36. For the reaction $2NOCl(g) \rightleftharpoons 2NO(g) + Cl_2(g)$, $K_c = 8.0$ at a certain temperature.

What concentration of NOCl must be put into an empty 4.00 L reaction vessel in order that the equilibrium concentration of NOCl be 1.00 M?

A. 1.26 M
B. 2.25 M
C. 2.50 M
D. 3.52 M
E. 11.0 M

37. The equilibrium constants (expressed in atm) for the chemical reaction
$N_2(g) + O_2(g) \rightleftharpoons 2NO(g)$ are $K_p = 1.1 \times 10^{-3}$ and 3.6×10^{-3} at 2,200 K and 2,500 K, respectively.
Which one of these statements is *true*?

A. The reaction is exothermic, $\Delta H^\circ < 0$.
B. The partial pressure of NO(g) is less at 2,200 K than at 2,500 K.
C. K_p is less than K_c by a factor of (RT).
D. The total pressure at 2,200 K is the same as at 2,500 K.
E. Higher total pressure shifts the equilibrium to the left.

38. When the substances in the equation below are at equilibrium, at pressure P and temperature T, the equilibrium can be shifted to favor the products by

$$CuO(s) + H_2(g) \rightleftharpoons H_2O(g) + Cu(s) \quad \Delta H^\circ_{rxn} = -2.0 \text{ kJ/mol}$$

A. increasing the pressure by means of a moving piston at constant T.
B. increasing the pressure by adding an inert gas such as nitrogen.
C. decreasing the temperature.
D. allowing some gases to escape at constant P and T.
E. adding a catalyst.

39. 50.0 g of N_2O_4 is introduced into an evacuated 2.00 L vessel and allowed to come to equilibrium with its decomposition product, $N_2O_4(g) \rightleftharpoons 2NO_2(g)$. For this reaction $K_c = 0.133$. Once the system has reached equilibrium, 5.00 g of NO_2 is injected into the vessel, and the system is allowed to equilibrate once again. Calculate the mass of NO_2 in the final equilibrium mixture.

A. 17.8 g
B. 12.4 g
C. 14.7 g
D. 19.7 g
E. 15.5 g

40. Calculate the pH of a 1.6 M KOH solution.

A. 1.60
B. -0.20
C. 0.20
D. 14.20
E. 13.80

41. The pH of coffee is approximately 5.0. How many times greater is the $[H_3O^+]$ in coffee than in tap water having a pH of 8.0?

A. 0.62
B. 1.6
C. 30
D. 1,000
E. 1.0×10^4

42. The OH^- concentration in a 1.0×10^{-3} M $Ba(OH)_2$ solution is

A. 0.50×10^{-3} M.
B. 1.0×10^{-3} M.
C. 2.0×10^{-3} M.
D. 1.0×10^{-2} M.
E. 0.020 M.

43. In the reaction $HSO_4^-(aq) + OH^-(aq) \rightleftharpoons SO_4^{2-}(aq) + H_2O(l)$, the conjugate acid-base pairs are

	pair 1	*pair 2*
Row 1	HSO_4^- and SO_4^{2-};	H_2O and OH^-.
Row 2	HSO_4^- and H_3O^+;	SO_4^{2-} and OH^-.
Row 3	HSO_4^- and OH^-;	SO_4^{2-} and H_2O.
Row 4	HSO_4^- and H_2O;	OH^- and SO_4^{2-}.
Row 5	HSO_4^- and OH^-;	SO_4^{2-} and H_3O^+.

A. Row 1
B. Row 2
C. Row 3
D. Row 4
E. Row 5

44. What is the pH of a 0.20 M solution of NH_4Cl? [$K_b(NH_3) = 1.8 \times 10^{-5}$]

A. 3.74
B. 4.98
C. 6.53
D. 9.02
E. 10.25

45. Identify the conjugate base of HCO_3^- in the reaction

$$CO_3^{2-} + HSO_4^- \rightleftharpoons HCO_3^- + SO_4^{2-}$$

A. HSO_4^-
B. CO_3^{2-}
C. OH^-
D. H_3O^+
E. SO_4^{2-}

46. Morphine, $C_{17}H_{19}NO_3$, is often used to control severe post-operative pain. What is the pH of the solution made by dissolving 25.0 mg of morphine in 100. mL of water at 25°C? (For morphine, $K_b = 1.62 \times 10^{-6}$.)

A. 9.57
B. 9.08
C. 3.79
D. 9.87
E. 4.43

47. One liter of an aqueous solution contains 6.02×10^{20} H_3O^+ ions. Therefore, its H_3O^+ ion concentratic is

A. 0.0100 mole per liter.
B. 0.00100 mole per liter.
C. 1.00 mole per liter.
D. 6.02×10^{20} mole per liter.
E. 6.02×10^{23} mole per liter.

48. Consider the weak acid CH_3COOH (acetic acid). If a 0.048 M CH_3COOH solution is 5.2% ionized, determine the [H_3O^+] concentration at equilibrium.

A. 0.25 M
B. 9.2×10^{-3} M
C. 0.048 M
D. 0.052 M
E. 2.5×10^{-3} M

49. Calculate the pH of a 3.5×10^{-3} M HNO_3 solution.

A. -2.46
B. 0.54
C. 2.46
D. 3.00
E. 3.46

50. The OH^- concentration in a 7.5×10^{-3} M $Ca(OH)_2$ solution is

A. 7.5×10^{-3} M.
B. 1.5×10^{-2} M.
C. 1.3×10^{-12} M.
D. 1.0×10^{-7} M.
E. 1.0×10^{-14} M.

51. What mass of ammonium chloride must be added to 250. mL of water to give a solution with pH = 4.85? [$K_b(NH_3) = 1.8 \times 10^{-5}$]

C

A. 4.7 g
B. 75 g
C. 2.3×10^{-3} g
D. 19 g
E. 10. g

52. A 0.10 M NH_3 solution is 1.3% ionized. Calculate the H^+ ion concentration.

$NH_3 + H_2O \rightleftharpoons NH_4^+ + OH^-$

A. 1.3×10^{-3} M
B. 7.7×10^{-2} M
C. 7.7×10^{-12} M
D. 0.13 M
E. 0.10 M

53. Calculate the pH of a beer in which the hydrogen ion concentration is 6.3×10^{-5} M.

A. 4.2
B. 4.8
C. 5.63
D. 9.8
E. 14.0

54. Calculate the hydrogen ion concentration in a solution of fruit juice having a pH of 4.25.

A. 1.0×10^{-14} M
B. 5.6×10^{-5} M
C. 4.0×10^{-25} M
D. 2.5×10^{-4} M
E. 5.6×10^{-4} M

55. What is the pH of a 0.014 M $Ca(OH)_2$ solution?

A. 1.85
B. 1.55
C. 12.15
D. 12.45
E. 15.85

56. What is the pH of a solution prepared by mixing 100. mL of 0.0500 M HCl with 300. mL of 0.500 M HF? [$K_a(HF) = 7.1 \times 10^{-4}$]

A. 1.47
B. 1.90
C. 1.30
D. 1.63
E. 2.82

57. What mass of sodium nitrite must be added to 350. mL of water to give a solution with pH = 8.40? [$K_a(HNO_2) = 5.6 \times 10^{-4}$]

A. 68 g
B. 1.7×10^{-4} g
C. 0.039 g
D. 8.3 g
E. 24 g

58. Which solution will have the lowest pH?

A. 0.10 M HCN
B. 0.10 M HNO_3
C. 0.10 M NaCl
D. 0.10 M H_2CO_3
E. 0.10 M NaOH

59. Calculate the pH of a 0.10 M HCN solution that is 0.0070% ionized.

A. 1.00
B. 0.00070
C. 3.15
D. 5.15
E. 7.00

60. Which is *not* a characteristic property of acids?

A. tastes sour
B. turns litmus from blue to red
C. reacts with metals to yield CO_2 gas
D. neutralizes bases
E. reacts with carbonates to yield CO_2 gas

61. Calculate the concentration of oxalate ion ($C_2O_4^{2-}$) in a 0.175 M solution of oxalic acid ($C_2H_2O_4$). [For oxalic acid, $K_{a1} = 6.5 \times 10^{-2}$, $K_{a2} = 6.1 \times 10^{-5}$.]

A. 0.11 M
B. 6.1×10^{-5} M
C. 4.0×10^{-6} M
D. 0.0791 M
E. 0.175 M

62. A 0.14 M HNO_2 solution is 5.7% ionized. Calculate the H^+ ion concentration.

A. 8.0×10^{-3} M
B. 0.057 M
C. 0.13 M
D. 0.14 M
E. 0.80 M

63. What is the OH^- ion concentration in a 5.2×10^{-4} M HNO_3 solution?

A. 1.9×10^{-11} M
B. 1.0×10^{-7} M
C. 5.2×10^{-4} M
D. zero
E. 1.0×10^{-4} M

64. Diet cola drinks have a pH of about 3.0, while milk has a pH of about 7.0. How many times greater is the H_3O^+ concentration in diet cola than in milk?

A. 2.3 times higher in diet cola than in milk
B. 400 times higher in diet cola than in milk
C. 0.43 times higher in diet cola than in milk
D. 1,000 times higher in diet cola than in milk
E. 10,000 times higher in diet cola than in milk

65. What is the pH of a 0.0055 M HA (weak acid) solution that is 8.2% ionized?

A. 2.26
B. 3.35
C. 4.52
D. 8.21
E. 10.65

66. Which one of these salts will form a *basic* solution upon dissolving in water?

A. NaI
B. NaF
C. NH_4NO_3
D. LiBr
E. $Cr(NO_3)_3$

67. The pH of a $Ba(OH)_2$ solution is 10.00. What is the H^+ ion concentration of this solution?

A. 4.0×10^{-11} M
B. 1.6×10^{-10} M
C. 1.3×10^{-5} M
D. 1.0×10^{-10} M
E. 10 M

68. Calculate the pH of a 0.14 M HNO_2 solution that is 5.7% ionized.

A. 0.85
B. 1.70
C. 2.10
D. 11.90
E. 13.10

69. The pH of tomato juice is about 4.5. Calculate the concentration of hydrogen ions in this juice.

A. 3. × 10^{-10} M
B. 3. × 10^{-5} M
C. 5. × 10^{-4} M
D. 4 M
E. 3. × 10^{10} M

70. Predict the direction in which the equilibrium will lie for the reaction

$H_2CO_3 + F^- \rightleftharpoons HCO_3^- + HF$.

$K_{a1}(H_2CO_3) = 4.2 \times 10^{-7}$; $K_a(HF) = 7.1 \times 10^{-4}$

A. to the right
B. to the left
C. in the middle

71. What is the pH of a solution prepared by mixing 10.0 mL of a strong acid solution with pH = 2.00 and 10.0 mL of a strong acid solution with pH = 6.00?

C

A. 2.0
B. 2.3
C. 4.0
D. 6.0
E. 8.0

72. Predict the direction in which the equilibrium will lie for the reaction

$H_2SO_3(aq) + HCO_3^-(aq) \rightleftharpoons HSO_3^-(aq) + H_2CO_3(aq)$.

$K_{a1}(H_2SO_3) = 1 \times 10^{-2}$; $K_{a1}(H_2CO_3) = 4.2 \times 10^{-7}$

A. to the right
B. to the left
C. in the middle

73. Calculate the pH of a buffer solution prepared by dissolving 0.20 mole of sodium cyanate (NaCNO) and 1.0 mole of cyanic acid (HCNO) in enough water to make 1.0 liter of solution. [$K_a(HCNO) = 2.0 \times 10^{-4}$]

A. 0
B. 3.0
C. 3.7
D. 4.4
E. 5.0

74. Will a precipitate form (*yes* or *no*) when 50.0 mL of 1.2×10^{-3} M $Pb(NO_3)_2$ are added to 50.0 mL of 2.0×10^{-4} M Na_2S? If so, identify the precipitate.

A. Yes, the precipitate is PbS.
B. Yes, the precipitate is $NaNO_3$.
C. Yes, the precipitate is Na_2S.
D. Yes, the precipitate is $Pb(NO_3)_2$.
E. No, a precipitate will not form.

75. The molar solubility of tin(II) iodide is 1.28×10^{-2} mol/L. What is K_{sp} for this compound?

A. 8.4×10^{-6}
B. 1.28×10^{-2}
C. 4.2×10^{-6}
D. 1.6×10^{-4}
E. 2.1×10^{-6}

76. You have 500.0 mL of a buffer solution containing 0.30 M acetic acid (CH_3COOH) and 0.20 M sodium acetate (CH_3COONa). What will the pH of this solution be after the addition of 20.0 mL of 1.00 M NaOH solution? [$K_a = 1.8 \times 10^{-5}$]

A. 4.65
B. 4.71
C. 4.56
D. 4.84
E. 5.07

77. Find the concentration of Pb^{2+} ions in a solution made by adding 5.00 g of lead(II) iodide to 500. mL of 0.150 M KI. [For PbI_2, $K_{sp} = 1.39 \times 10^{-8}$.]

A. 3.04×10^{-4} M
B. 1.54×10^{-7} M
C. 6.18×10^{-7} M
D. 1.52×10^{-4} M
E. 9.27×10^{-8} M

78. Will a precipitate (ppt) form when 300. mL of 2.0×10^{-5} M $AgNO_3$ are added to 200. mL of 2.5×10^{-9} M NaI? Answer *yes* or *no*, and identify the precipitate if there is one.

A. Yes, the ppt is $AgNO_3(s)$.
B. Yes, the ppt is $NaNO_3(s)$.
C. Yes, the ppt is NaI(s).
D. Yes, the ppt is AgI(s).
E. No, a precipitate will not form.

79. Calculate the pH of the solution resulting from the addition of 10.0 mL of 0.10 M NaOH to 50.0 mL of 0.10 M HCN ($K_a = 4.9 \times 10^{-10}$) solution.

A. 5.15
B. 8.71
C. 5.85
D. 9.91
E. 13.0

80. Calculate the pH of a buffer solution that contains 0.25 M benzoic acid ($C_6H_5CO_2H$) and 0.15 M sodium benzoate (C_6H_5COONa). [$K_a = 6.5 \times 10^{-5}$ for benzoic acid]

A. 3.97
B. 4.83
C. 4.19
D. 3.40
E. 4.41

81. Calculate the silver ion concentration in a saturated solution of silver(I) sulfate ($K_{sp} = 1.4 \times 10^{-5}$).

A. 1.5×10^{-2} M
B. 2.4×10^{-2} M
C. 3.0×10^{-2} M
D. 1.4×10^{-5} M
E. none of these

82. You are asked to go into the lab and prepare an acetic acid - sodium acetate buffer solution with a pH of 4.00 ± 0.02. What molar ratio of CH_3COOH to CH_3COONa should be used?

A. 0.18
B. 0.84
C. 1.19
D. 5.50
E. 0.10

83. The molar solubility of manganese(II) carbonate is 4.2×10^{-6} M. What is K_{sp} for this compound?

A. 4.2×10^{-6}
B. 8.4×10^{-6}
C. 3.0×10^{-16}
D. 1.8×10^{-11}
E. 2.0×10^{-3}

84. What volume of 0.0500 M sodium hydroxide should be added to 250. mL of 0.100 M HCOOH to obtain a solution with a pH of 4.50? [K_a(HCOOH) = 1.7×10^{-4}]

A. 540 mL
B. 420 mL
C. 80. mL
D. 340 mL
E. 500. mL

85. The solubility of lead(II) iodide is 0.064 g/100 mL at 20°C. What is the solubility product for lead(II) iodide?

A. 1.1×10^{8}
B. 3.9×10^{-6}
C. 1.1×10^{-11}
D. 2.7×10^{-12}
E. 1.4×10^{-3}

86. Will a precipitate of magnesium fluoride form when 200. mL of 1.9×10^{-3} M $MgCl_2$ are added to 300 mL of 1.4×10^{-2} M NaF? (K_{sp} (MgF_2) = 6.9×10^{-9})

A. Yes, $Q > K_{sp}$
B. No, $Q < K_{sp}$
C. No, $Q = K_{sp}$
D. Yes, $Q < K_{sp}$

87. Calculate the concentration of chloride ions in a saturated lead(II) chloride ($K_{sp} = 2.4 \times 10^{-4}$) solution.

A. 2.4×10^{-4} M
B. 4.8×10^{-4} M
C. 3.9×10^{-2} M
D. 1.2×10^{-1} M
E. 7.8×10^{-7} M

88. Calculate the minimum concentration of Cr^{3+} that must be added to 0.095 M NaF in order to initiate a precipitate of chromium(III) fluoride. (For CrF_3, $K_{sp} = 6.6 \times 10^{-11}$.)

A. 0.023 M
B. 0.032 M
C. 7.7×10^{-8} M
D. 2.9×10^{-9} M
E. 6.9×10^{-10} M

89. Which response has *both* answers correct? Will a precipitate form when 250 mL of 0.33 M Na_2CrO_4 are added to 250 mL of 0.12 M $AgNO_3$? ($K_{sp}(Ag_2CrO_4) = 1.1 \times 10^{-12}$) What is the concentration of the silver ion *remaining* in solution?

A. Yes, $[Ag^+] = 2.9 \times 10^{-6}$ M.
B. Yes, $[Ag^+] = 0.060$ M.
C. Yes, $[Ag^+] = 1.3 \times 10^{-4}$ M.
D. No, $[Ag^+] = 0.060$ M.
E. No, $[Ag^+] = 0.105$ M.

90. Calculate the concentration of fluoride ions in a saturated barium fluoride ($K_{sp} = 1.7 \times 10^{-6}$) solution.

A. 7.6×10^{-3} M
B. 1.5×10^{-2} M
C. 3.4×10^{-5} M
D. 1.7×10^{-6} M
E. 3.4×10^{-6} M

91. Which one of the following is a buffer solution?

A. 0.40 M HCN and 0.10 KCN
B. 0.20 M CH_3COOH
C. 1.0 M HNO_3 and 1.0 M $NaNO_3$
D. 0.10 M KCN
E. 0.50 M HCl and 0.10 NaCl

92. You have 500.0 mL of a buffer solution containing 0.20 M acetic acid (CH_3COOH) and 0.30 M sodium acetate (CH_3COONa). What will the pH of this solution be after the addition of 20.0 mL of 1.00 M NaOH solution? [$K_a = 1.8 \times 10^{-5}$]

A. 4.41
B. 4.74
C. 4.56
D. 4.92
E. 5.07

93. Find the concentration of calcium ions in a solution made by adding 3.50 g of calcium fluoride to 750. mL of 0.125 M NaF. [For CaF_2, $K_{sp} = 3.95 \times 10^{-11}$.]

A. 3.16×10^{-10} M
B. 2.53×10^{-9} M
C. 4.29×10^{-4} M
D. 6.32×10^{-10} M
E. 2.15×10^{-4} M

94. What volume of 0.200 M potassium hydroxide should be added to 300. mL of 0.150 M propanoic acid (C_2H_5COOH) to obtain a solution with a pH of 5.25? [$K_a(C_2H_5COOH) = 1.34 \times 10^{-5}$]

A. 32 mL
B. 210mL
C. 160mL
D. 65mL
E. 13mL

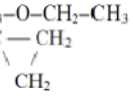
95. The general formula for *alkenes* is

A. C_nH_{2n+2}
B. $C_{2n}H_{2n}$
C. C_nH_{n+2}
D. C_nH_{2n}
E. C_nH_{2n-2}

96. The general formula of an *alkane* is

A. C_nH_{2n}
B. C_nH_{2n+2}
C. C_nH_{2n-2}
D. C_nH_{2n+4}
E. C_nH_{2n-4}

97. Which one of these formulas is that of an *unsaturated* hydrocarbon?

A. $CH_3–CH_2–CH_3$
B. $CH_3–CH=CH_2$
C. $CH_3–CH_2–OH$
D. $CH_3–O–CH_2–CH_3$
E. 

98. Which of these molecules is *unsaturated*?

A. C_3H_8
B. CH_3OH
C. C_5H_{10}
D. CH_4
E. C_4H_{10}

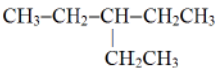
99. The formula $CH_3CH_2CH_2CH_2CH_2CH=CH_2$ represents

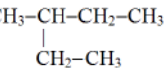
A. an alkane.
B. an alkyne.
C. an alcohol.
D. an unsaturated hydrocarbon.
E. a CFC.

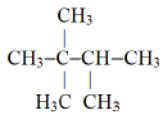
100. How many structural isomers are there of C_4H_{10}?

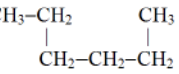
A. 4
B. 6
C. 2
D. 8
E. 10

101. Which of these species are *structural isomers* of C_6H_{14}?

I. 

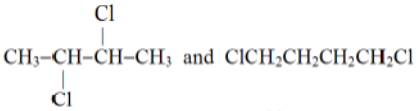
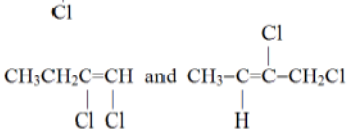
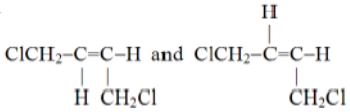
II. 

III. 

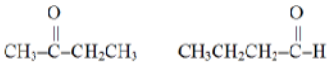
IV. 

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

102. Which of these pairs are *geometric isomers*?

A. $CH_3CH_2–O–CH_2CH_3$ and $CH_3CH_2CH_2CH_2OH$
B. 
C. 
D. 

103.The two molecules represented below are examples of



A.isomers
B.isotopes
C.alcohols
D.carboxylic acids
E.unsaturated hydrocarbons

104.The two molecules represented below are examples of

A.geometric isomers.
B.structural isomers.
C.optical isomers.
D.stereoisomers.
E.none of these

105.Which of these species is an aromatic compound?

A.C_2H_2
B.C_6H_{12}
C.$C_6H_4Br_2$
D.C_5H_{10}
E.$C_2H_4Br_2$

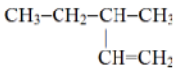
106.The compound that has a triple bond between one pair of carbon atoms is called a/an

A.alkane.
B.chlorofluorocarbon.
C.alkyne.
D.alkene.
E.alcohol.

107.The alkane with six carbon atoms is called

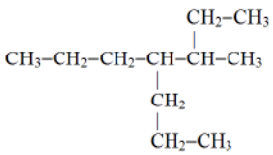
A.butane.
B.hexane.
C.heptane.
D.butene.
E.none of these.

108.Which of these is the systematic name for the compound represented below?



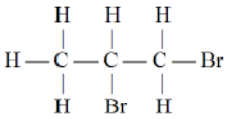
A.2-ethylbutane
B.3-methylpentene
C.3-methyl-1-pentene
D.3-methyl-1-hexene
E.2-methylhexane

109.The systematic name for the compound represented below is



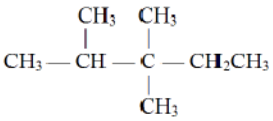
A.4,5-diethylheptane.
B.3-propyl-4-ethylhexane
C.3-ethyl-4-propylhexane.
D.3-methyl-4-propylheptane.
E.2-ethyl-4-propylhexane.

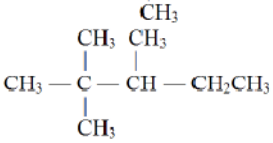
110. Which of these is the systematic name for the compound represented below?

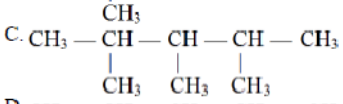


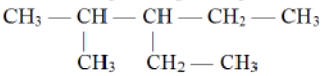
A. 2,3-dibromopentane
B. 1,2-dibromopentane
C. 2,3-dibromopropane
D. 1,2-propane dibromide
E. 1,2-dibromopropane

111. The correct structure for 2,3,3-trimethylpentane is

A.


B.


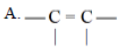
C.


D.


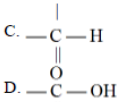
112. Organic compounds with the general formula R-O-R (where R is an alkyl group) are called

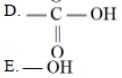
A. alkenes.
B. alcohols.
C. ethers.
D. aldehydes.
E. organic acids.

113. Which one of these structures represents a *carboxyl* functional group

A.


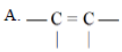
B.

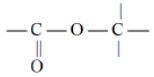

C.


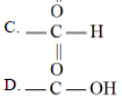
D.


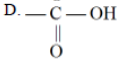
E.


114. Which one of these structures represents an *ester* functional group?

A.


B.


C.


D.


115. Which one of these choices is the formula for a *ketone*?

A. CH_3CHO
B. CH_3OCH_3
C. CH_3COCH_3
D. CH_3COOH
E. $HC{\equiv}CH$

116. The name for the compound with the formula $CH_3CH_2CH_2CH_2OH$ is

A. propanol.
B. propane.
C. butanol.
D. pentane.
E. pentanol.

117. Which type of organic compound does *not* contain a carbonyl group?

A. ethers
B. carboxylic acids
C. ketones
D. aldehydes
E. esters

118. A protein is

A. a polysaccharide.
B. a saturated ester of glycerol.
C. one of the units making up a nucleic acid.
D. a polymer of amino acids.
E. an aromatic hydrocarbon.

119. An *amino acid* is a compound that contains at least

A. one amino group and one amide group.
B. two amino groups and one carboxylic acid group.
C. one hydroxyl group and one methyl group.
D. one carboxylic acid group and one amino group.
E. one methyl group and one amide group.

120. A *peptide bond* (also called an *amide bond*) joins two amino acids together. What atoms are linked by this bond?

A. C — O
B. C — H
C. C — N
D. N — S
E. S — C

121. Which one of these choices is the general structural formula of an amino acid?

A. $R{-}CH_2{-}\overset{\displaystyle O}{\overset{\|}{C}}{-}NH_2$

B. $R{-}CH_2{-}NH_2$

C. $R{-}\underset{\displaystyle NH_2}{\underset{|}{CH}}{-}OH$

D. $R{-}\underset{\displaystyle COOH}{\underset{|}{CH}}{-}NH_2$

122. The functional group

$-\overset{\displaystyle O}{\overset{\|}{C}}{-}\underset{\displaystyle H}{\underset{|}{N}}-$

found in proteins is called a (an)

A. amide.
B. carboxylic acid.
C. amine.
D. amino acid.
E. dipeptide.

1.C
2.B
3.C
4.D
5.E
6.D
7.B
8.A
9.D
10.A
11.B
12.B
13.E
14.D
15.B
16.B
17.C
18.D
19.A
20.B
21.C
22.C
23.E

51.A
52.C
53.A
54.B
55.D
56.D
57.D
58.B
59.D
60.C
61.B
62.A
63.A
64.E
65.B
66.B
67.D
68.C
69.B
70.B
71.B
72.A
73.B
74.A
75.A
76.B
77.C

51.A
52.C
53.A
54.B
55.D
56.D
57.D
58.B
59.D
60.C
61.B
62.A
63.A
64.E
65.B
66.B
67.D
68.C
69.B
70.B
71.B
72.A
73.B
74.A
75.A
76.B
77.C

78.D
79.B
80.A
81.C
82.D
83.D
84.B
85.A
86.A
87.E
88.C
89.A
90.B
91.A
92.E
93.B
94.C
95.D
96.B
97.B
98.C
99.D
100.C
101.D
102.D
103.A
104.B

105.C
106.C
107.B
108.C
109.D
110.E
111.A
112.C
113.D
114.B
115.C
116.C
117.A
118.D
119.D
120.C
121.D
122.A