**General Chemistry 2**

**Worksheet**

Organic Chemistry Tutor

1. The average rate of appearance of [NH3] is 0.215 M/s. Determine the average rate of disappearance of [H2].

N2(g) + 3H2(g) -----> 2NH3(g)

A. -0.645 M/s C. -0.143 M/s

B. -0.323 M/s D. -0.430 M/s

2. Which of the statements shown below is correct given the following rate law expression:

Rate = k[A]2[B][C]0

A. The rate of the reaction doubles as the concentration of [A] doubles.

B. The rate of the reaction decreases by half as the concentration of [C] doubles.

C. The rate increases by a factor of 3 as the concentration of [B] triples in value.

D. The rate of the reaction increases by a factor of 4 as the concentration of [B] and [C] increases by a factor of 2 simultaneously.

3. Use the following experimental data to determine the rate law expression and the rate constant k for the following chemical equation:

2NO(g) + O2(g) -----> N2O4(g)

|  |  |  |
| --- | --- | --- |
| [NO] | [O2] | Reaction Rate |
| 0.100 M | 0.100 M | 1.25 x 10-4 M/s |
| 0.200 M | 0.100 M | 5.00 x 10-4 M/s |
| 0.100 M | 0.200 M | 2.50 x 10-4 M/s |

A. Rate = k[NO][O2], k = 0.0125 M-2 s-1

B. Rate = k[NO2]2, k = 0.0125 M-2 s-1

C. Rate = k[O2], k = 0.00125 M-2 s-1

D. Rate = k[NO]2[O2], k = 0.125 M-2 s-1

4. Which of the following will give a straight-line plot in the graph of ln[A] versus time?

A. Zero Order C. Second Order

B. First Order D. Third Order

5. Which of the following units of the rate constant k correspond to a first order reaction?

A. M s-1 C. M-1 s-1

B. s-1 D. M-2 s-1

6. The initial concentration of a reactant is 0.453 M for a zero-order reaction. Calculate the final concentration of the reactant after 64.4 seconds if the rate constant k is 0.00137 M/s.

A. 0.541 M C. 0.365 M

B. 0.444 M D. 0.174 M

7. The initial concentration of a reactant is 0.738 M for a zero-order reaction. The rate constant k is 0.0352 M/min. Calculate the time it takes for the final concentration of the reactant to decrease to 0.255 M.

A. 20.7 min C. 6.51 min

B. 13.7 min D. 1.37 min

8. Calculate the rate constant k for a second-order reaction if the half-life is 243 seconds. The initial concentration of the reactant is 0.325 M.

A. 6.69 x 10-4 M-1 s-1 C. 1.34 x 10-3 M-1 s-1

B. 4.23 x 10-5 M-1 s-1 D. 1.27 x 10-2 M-1 s-1

9. A reaction has a rate constant of 1.46 x 10-3 s-1 at 298 K and 4.33 x 10-2 s-1 at 421 K. Calculate the activation energy of this reaction.

A. 4.32 kJ/mol C. 71.2 kJ/mol

B. 34.9 kJ/mol D. 28.7 kJ/mol

10. Which of the following particles is equivalent to an electron?

A. Beta Particle C. Positron

B. Alpha Particle D. Gamma Particle

11. Identify the missing element.

A. Th C. U

B. Rn D. Po

12. The half-life of Cs-137 is 30.0 years. Calculate the rate constant k for the first-order decomposition of isotope Cs-137.

A. 1.35 x 10-1 yr-1 C. 4.42 x 10-2 yr-1

B. 2.31 x 10-2 yr-1 D. 5.21 X 10-1 Yr-1

13. The half-life of Iodine-131 is about 8.03 days. How long will it take for a 200. g sample to decay to 25.0 grams?

A. 4.73 days C. 24.1 days

B. 16.1 days D. 32.1 days

14. Which of the following shows the correct equilibrium expression for the reaction shown below?

CuO(s) + H2(g) ----> Cu(s) + H2O(g)

A. KP = C. KP = [H2O][H2]

B. KP = D. KP =

15. Calculate Kp for the following reaction at 298 K. Kc = 2.41 x 10-2.

CO(g) + 3H2(g) -----> CH4(g) + H2O(g)

A. 14.4 C. 4.03 x 10-5

B. 5.89 x 10-1 D. 1.44 x 10-8

16. Use the information below to calculate the missing equilibrium constant Kc of the net reaction.

2CO(g) ----> 2C(s) + O2(g) K1 = 1.43 x 10-1

½CO2(g) -----> ¼O2(g) + ½CO(g) K2 = 2.35 x 10-2

C(s) + O2(g) -----> CO2(g) K = ?

A. 3240 C. 239

B. 1680 D. 4790

17. At equilibrium, the partial pressures of Xe, Cl2, and XeCl4 were found to be 215 mm Hg, 315 mm Hg, and 723 mm Hg respectively. Calculate KP.

Xe(g) + 2Cl2(g) -----> XeCl4(g)

A. 19.6 C. 8.11

B. 1.07 x 10-2 D. 3.39 x 10-5

18. A reaction mixture initially contains 0.75 M of [HI]. At equilibrium, the concentration of [I2] was found to be 0.300 M. Calculate the equilibrium concentration of HI in the mixture.

2HI(g) -----> H2(g) + I2(g)

A. 0.150 M C. 0.600 M

B. 0.450 M D. 0.300 M

19. The partial pressures of N2O, O2, and N2O4 are currently 0.134 atm, 0.265 atm, and 0.483 atm respectively. Determine if the reaction is at equilibrium or if it will shift to the right or to the left. KP = 56.8

2N2O(g) + O2(g) -----> N2O4(g)

A. The reaction will shift to the right.

B. The reaction will shift to the left.

C. The reaction is at equilibrium.

D. None of the above.

20. Which of the following statements is correct?

A. The reaction shifts to the right if Q > K.

B. The reaction is product favored when K << 1.

C. Increasing the temperature for an endothermic reaction causes the equilibrium constant K to decrease.

D. The presence of an inert gas has no effect on the equilibrium constant K.

21. Which of the following is a weak acid?

A. HNO3 C. H2SO4

B. HNO2 D. HI

22. Which of the following salts will decrease the pH of an aqueous solution?

A. NaNO2 C. KCl

B. NH4Br D. NaF

23. The pH of a solution is 3.78. Determine the [H3O+] concentration.

A. 2.75 x 10-2 M C. 1.66 x 10-4 M

B. 5.83 x 10-3 M D. 8.73 x 10-5 M

24. Calculate the pH of a 0.25 M HC2H3O2 solution. The Ka of acetic acid is 1.8 x 10-5.

A. 2.37 C. 4.37

B. 2.67 D. 5.35

25. Calculate the pH of the solution made by dissolving 30.5 g of NaF in enough water to make a 650 mL solution. The Ka of HF is 6.8 x 10-4.

A. 1.12 C. 8.61

B. 5.30 D. 10.7

26. A solution contains a mixture of 0.755 M HF and 0.125 M NaF. Calculate the pH of the solution. The Ka of HF is 6.8 x 10-4.

A. 4.25 C. 3.95

B. 3.17 D. 2.39

27. Which of the following is a buffer solution?

A. HF and HCN

B. HI and KI

C. HCl and NaCl

D. HC2H3O2 and NaC2H3O2

28. Which of the following is a Lewis acid?

A. BH3 C. FeCl3

B. AlCl3 D. All of the above

29. Write the equilibrium expression for Ksp based on the following reaction:

CaF2(s) ![Shape, rectangle

Description automatically generated]() Ca2+(aq) + 2F-(aq)

A. Ksp = [Ca2+][F-] C. Ksp = [Ca2+]2[F-]

B. Ksp = [Ca2+][F-]2 D. Ksp = [CaF2]

30. Calculate the molar solubility of Mg(OH)2. The Ksp of Mg(OH)2 is 1.8 x 10-11.

Mg(OH)2(s) ![Shape, rectangle

Description automatically generated]() Mg2+(aq) + 2OH-(aq)

A. 1.65 x 10-4 M C. 4.24 x 10-7 M

B. 1.99 x 10-5 M D. 8.12 x 10-10 M

31. A saturated solution of PbCl2 contains

0.0159 M of [Pb2+] and 0.0317 M of [Cl-]. Calculate the Kspof PbCl2.

PbCl2(s) ![Shape, rectangle

Description automatically generated]() Pb2+(aq) + 2Cl-(aq)

A. 3.24 x 10-7 C. 1.60 x 10-5

B. 4.99 x 10-11 D. 7.12 x 10-8

32. For which of the following reactions is ΔS positive?

A. 2SO2(g) + O2(g) -----> 2SO3(g)

B. CaO(s) + CO2(g) -----> CaCO3(s)

C. H2O(g) -----> H2O(l)

D. 2C(s) + O2(g) -----> 2CO(g)

33. Calculate ΔG using the following information at 340 K.

ΔH = -64.2 kJ/mol ΔS = 105 J/mol K

A. -28.5 kJ/mol C. 31.2 kJ/mol

B. -99.9 kJ/mol D. -32.9 kJ/mol

34. Which of the conditions shown below will cause a reaction to be spontaneous for all temperatures?

A. ΔS = positive, ΔH = positive

B. ΔS = positive, ΔH = negative

C. ΔS = negative, ΔH = negative

D. ΔS = negative, ΔH = positive

35. Keq is 1.83 x 10-12 for a particular reaction at 372 K. Calculate ΔG for this reaction. Is this reaction spontaneous at this temperature?

A. ΔG = +45.2 kJ/mol, Spontaneous

B. ΔG = -77.2 kJ/mol, Nonspontaneous

C. ΔG = -125 kJ/mol, Spontaneous

D. ΔG = +83.6 kJ/mol, Nonspontaneous

36. Which of the following statements is/are correct?

I. Oxidation occurs at the anode.

II. Reduction occurs at the anode.

III. Oxidation occurs at the cathode.

IV. Reduction occurs at the cathode.

A. I and IV C. I Only

B. II and III D. II Only

37. What is the coefficient of Zn(s) when the following redox reaction is balanced under acidic conditions?

Zn(s) + BrO2-(aq) -----> Zn2+(aq) + Br-(aq)

A. 1 C. 3

B. 2 D. 4

38. Which of the following statements is/are true?

I. E > 0 for a spontaneous reaction.

II. E < 0 for a spontaneous reaction.

III. E = 0 at equilibrium.

A. I Only C. I and III

B. II Only D. II and III

39. Calculate the cell potential of a reaction if ΔG = -41.3 kJ/mol and n = 2.

A. +0.415 V C. +0.214 V

B. -0.317 V D. -0.214 V

40. Calculate the cell potential of the reaction using the information shown below at 298 K under nonstandard concentration values.

2Al(s) + 3Cu2+(aq) ---> 2Al3+(aq) + 3Cu(s) E0 = 2.00 V

[Al3+] = 1.5 x 10-5 M, [Cu2+] = 35.4 M

A. E = +1.68 V C. E = +2.09 V

B. E = +1.92 V D. E = +2.14 V

41. Given the following information, determine the rate constant k. The initial concentrations of [SO2] and [O2] are 0.175 M and 0.225 M respectively. The initial reaction rate was measured to be 2.24 x 10-4 M/s.

2SO2(g) + O2(g) -----> 2SO3(g)

**Rate = k[SO2]2[O2]**

A. 3.25 x 10-2 M-2 s-1 C. 2.53 x 10-2 M-2 s-1

B. 5.69 x 10-3 M-2 s-1 D. 1.83 x 10-2 M-2 s-1

42. Which of the following statements is correct?

**Rate = k[A][B]2[C]0**

A. The reaction is zero-order overall.

B. The reaction is first-order overall.

C. The reaction is second-order overall.

D. The reaction is third-order overall.

43. Which of the following statements is correct?

A. The half-life of a zero-order reaction is inversely proportional to the initial concentration.

B. The half-life of a first-order reaction does not depend on the initial concentration.

C. The half-life of a second-order reaction is proportional to the initial concentration.

D. All of the above statements are correct.

44. The initial concentration of a reactant is 0.942 M for a second-order reaction. It takes 135 seconds for the concentration to decrease to 0.147 M. Calculate the rate constant k.

A. 4.25 x 10-2 M-1 s-1 C. 1.49 x 10-2 M-1 s-1

B. 5.89 x 10-3 M-1 s-1` D. 4.77 x 10-4 M-1 s-1

45. Use the following experimental data to determine the rate law expression and the rate constant k for the following chemical equation:

**A + B + C -----> D**

|  |  |  |  |
| --- | --- | --- | --- |
| [A] | [B] | [C] | Reaction Rate |
| 0.200 M | 0.200 M | 0.200 M | 3.60 x 10-3 M/s |
| 0.400 M | 0.200 M | 0.200 M | 7.20 x 10-3 M/s |
| 0.200 M | 0.400 M | 0.200 M | 1.44 x 10-2 M/s |
| 0.200 M | 0.200 M | 0.400 M | 3.60 x 10-3 M/s |

A. Rate = k[A][B][C] k = 0.45 M-2 s-1

B. Rate = k[A][B]2 k = 0.45 M-2 s-1

c. Rate = k[A][C] k = 0.09 M-2 s-1

D. Rate = k[B] k = 0.09 M-2 s-1

46. A substance decomposes according to a first-order reaction. If there were 50.0 g of the substance initially, how much would remain after 2.5 hours if the rate constant k is 1.74 x 10-3 min-1?

A. 12.4 g C. 38.5 g

B. 23.4 g D. 42.9 g

47. How long will it take for a substance to decompose by 85% if the rate constant k for the reaction is 3.75 x 10-3 min-1?

A. 124 min C. 399 min

B. 237 min D. 506 min

48. A reaction has a rate constant of 0.23 min-1 at 298 K. Calculate the rate constant at 375 K if the activation energy for the reaction is 23.74 kJ/mol.

A. 0.00346 min-1 C. 1.64 min-1

B. 0.457 min-1 D. 0.0236 min-1

49. The slope of a 1/[A] vs time straight-line plot is 1.44 x 10-2 M-1 s-1. Calculate the final concentration of [A] after 233 seconds if the initial concentration is 0.744 M.

A. 0.213 M C. 0.449 M

B. 0.341 M D. 0.547 M

50. Which of the following statements is incorrect?

A. The rate constant k is dependent on temperature.

B. The rate constant k is dependent on concentration.

C. The rate constant k is dependent on the presence of a catalyst.

D. A catalyst decreases the activation energy.

51. Which of the following statements is/are correct?

I. The rate of a reaction increases with increasing temperature.

II. The rate of a reaction decreases with increasing initial concentration of reactants.

III. The rate of a reaction decreases in the presence of a catalyst.

A. II Only C. I and II

B. I Only D. II and III

52. Which of the following statements is correct?

A. The activation energy of the forward reaction is greater than the activation energy of the reverse reaction for an endothermic reaction.

B. The activation energy of the forward reaction is greater than activation energy of the reverse reaction for an exothermic reaction.

C. The forward activation energy is the difference between the energy of the products and the transition state.

D. The activation energy of a reaction is inversely proportional to the initial concentration of the reactants.

53. Which of the following statements is incorrect?

A. A homogeneous catalyst is present in the same phase as the reactant molecules.

B. A catalyst lowers the activation energy of a reaction.

C. A catalyst speeds up a reaction while remaining unchanged.

D. A heterogeneous catalyst is present in the same phase as the reactant molecules.

54. Which of the following species is a catalyst?

A + B -----> C (slow)

C + D -----> E + B (fast)

A + D -----> E (net reaction)

A. A C. C

B. B D. D

55. Which of the following species is an intermediate?

A + B -----> C (slow)

C + D -----> E + B (fast)

A + D -----> E (net reaction)

A. A C. C

B. B D. D

56. Which of the following rate law expressions correctly describes the slow step of the elementary reaction shown below?

A + B -----> C (slow)

C + D -----> E + B (fast)

A + D -----> E (net reaction)

A. Rate = k[A][D] C. Rate = k[C][D]

B. Rate = k[A][B] D. Rate = k[A]2

57. Which of the following rate law expressions correctly describes the fast step of the elementary reaction shown below?

A + B -----> C (slow)

C + D -----> E + B (fast)

A + D -----> E (net reaction)

A. Rate = k[A][D] C. Rate = k[C][D]

B. Rate = k[A][B] D. Rate = k[A][C]

58. Which of the following rate law expressions correctly describes the net reaction shown below?

A + B -----> C (slow)

C + D -----> E + B (fast)

A + D -----> E (net reaction)

A. Rate = k[A][D] C. Rate = k[C][D]

B. Rate = k[A][B] D. Rate = k[A][C]

59. Which of the following processes best describes the reaction shown below?

A. Alpha Decay C. Electron Capture

B. Positron Production D. Beta Emission

60. The half-life of Sr-90 is about 28.8 days. What mass of the isotope will be found remaining if a 22.5 g sample is allowed to decay for 75.1 days?

A. 3.69 g C. 4.71 g

B. 1.88 g D. 6.93 g

61. Calculate the nuclear binding energy of isotope Fe-56 using the following information:

1g = 6.022 x 1023 amu

|  |  |
| --- | --- |
| Fe-56 | 55.9207 amu |
| Proton | 1.00728 amu |
| Neutron | 1.00867 amu |

A. 3.51 x 10-19 J C. 5.11 x 10-14 J

B. 7.90 x 10-11 J D. 1.76 x 10-13 J

62. Which of the following shows the correct equilibrium expression for the reaction shown below?

Al2(CO3)3(s) -----> Al2O3(s) + 3CO2(g)

A. Kp = C. Kp = [CO2]

B. Kp = D. Kp = [CO2]3

63. Use the information below to calculate the equilibrium constant K of the net reaction.

2S(s) + 2O2(g) -----> 2SO2(g) K1 = 425

SO3(g) -----> ½ O2(g) + SO2(g) K2 = 0.18

S(s) + 3/2 O2(g) -----> SO3(g) K = ?

A. 115 C. 0.125

B. 283 D. 0.000299

64. A reaction mixture initially contains CO and O2 at partial pressures of 0.25 atm and 0.400 atm respectively. At equilibrium, the partial pressure of [CO2] is 0.15 atm. Calculate Kp.

A. 0.153 C. 325

B. 6.92 D. 0.00427

65. 2.00 M of I2 and 2.00 M of Br2 are initially present in a reaction mixture. Calculate the equilibrium concentration of [I2], [Br2], and [IBr] at 725 K. Kc = 100.

I2(g) + Br2(g) -----> 2IBr(g)

A. [I2] = [Br2] = 0.333 M, [IBr] = 3.34 M

B. [I2] = [Br2] = 0.125 M, [IBr] = 0.427 M

C. [I2] = [Br2] = 0.176 M, [IBr] = 2.75 M

D. [I2] = [Br2] = 0.448 M, [IBr] = 3.85 M

66. The initial concentrations of PCl3, Cl2, and PCl5 are 0.485 M, 0.261 M, and 0.399 M respectively.

Kc = 0.500. Calculate the equilibrium concentration of [Cl2].

PCl3(g) + Cl2(g) -----> PCl5(g)

A. 0.711 M C. 0.173 M

B. 0.326 M D. 0.487 M

67. Which of the following statements is incorrect?

A. The equilibrium constant K is dependent on temperature.

B. The equilibrium constant K is dependent on concentration.

C. The reaction shifts to the right when Q < K.

D. The presence of a catalyst does not affect the position of equilibrium.

68. In which direction will the reaction shift if Cl2 is added to the system?

Si(s) + 2Cl2(g) -----> SiCl4(g) ΔH = -641 kJ/mol

A. The reaction will shift to the right.

B. The reaction will shift to the left.

C. The reaction will not shift in any direction.

D. None of the above.

69. In which direction will the reaction shift if SiCl4 is removed from the system?

Si(s) + 2Cl2(g) -----> SiCl4(g) ΔH = -641 kJ/mol

A. The reaction will shift to the right.

B. The reaction will shift to the left.

C. The reaction will not shift in any direction.

D. None of the above.

70. In which direction will the reaction shift if the pressure is increased?

Si(s) + 2Cl2(g) -----> SiCl4(g) ΔH = -641 kJ/mol

A. The reaction will shift to the right.

B. The reaction will shift to the left.

C. The reaction will not shift in any direction.

D. None of the above.

71. In which direction will the reaction shift if the volume is decreased?

Si(s) + 2Cl2(g) -----> SiCl4(g) ΔH = -641 kJ/mol

A. The reaction will shift to the right.

B. The reaction will shift to the left.

C. The reaction will not shift in any direction.

D. None of the above.

72. In which direction will the reaction shift if the temperature is decreased?

Si(s) + 2Cl2(g) -----> SiCl4(g) ΔH = -641 kJ/mol

A. The reaction will shift to the right.

B. The reaction will shift to the left.

C. The reaction will not shift in any direction.

D. None of the above.

73. In which direction will the reaction shift if a catalyst is added to the system?

Si(s) + 2Cl2(g) -----> SiCl4(g) ΔH = -641 kJ/mol

A. The reaction will shift to the right.

B. The reaction will shift to the left.

C. The reaction will not shift in any direction.

D. None of the above.

74. In which direction will the reaction shift if Neon gas is added to the system?

Si(s) + 2Cl2(g) -----> SiCl4(g) ΔH = -641 kJ/mol

A. The reaction will shift to the right.

B. The reaction will shift to the left.

C. The reaction will not shift in any direction.

D. None of the above.

75. In which direction will the reaction shift if SO2 is removed from the system?

H2(g) + SO3(g) --> H2O(g) + SO­2(g) ΔH = -124 kJ/mol

A. The reaction will shift to the right.

B. The reaction will shift to the left.

C. The reaction will not shift in any direction.

D. None of the above.

76. In which direction will the reaction shift if H2 is added to the system?

H2(g) + SO3(g) --> H2O(g) + SO­2(g) ΔH = -124 kJ/mol

A. The reaction will shift to the right.

B. The reaction will shift to the left.

C. The reaction will not shift in any direction.

D. None of the above.

77. In which direction will the reaction shift if the pressure is increased?

H2(g) + SO3(g) --> H2O(g) + SO­2(g) ΔH = -124 kJ/mol

A. The reaction will shift to the right.

B. The reaction will shift to the left.

C. The reaction will not shift in any direction.

D. None of the above.

78. In which direction will the reaction shift if the volume is increased?

H2(g) + SO3(g) --> H2O(g) + SO­2(g) ΔH = -124 kJ/mol

A. The reaction will shift to the right.

B. The reaction will shift to the left.

C. The reaction will not shift in any direction.

D. None of the above.

79. In which direction will the reaction shift if the temperature is increased?

H2(g) + SO3(g) --> H2O(g) + SO­2(g) ΔH = -124 kJ/mol

A. The reaction will shift to the right.

B. The reaction will shift to the left.

C. The reaction will not shift in any direction.

D. None of the above.

80. What effect will the addition of [H2O] have on the concentration of [SO2]?

H2(g) + SO3(g) --> H2O(g) + SO­2(g) ΔH = -124 kJ/mol

A. The concentration of [SO2] will increase.

B. The concentration of [SO2] will decrease.

C. It will have no effect.

D. None of the above.

81. What effect will the addition of [H2O] have on the concentration of [H2]?

H2(g) + SO3(g) --> H2O(g) + SO­2(g) ΔH = -124 kJ/mol

A. The concentration of [H2] will increase.

B. The concentration of [H2] will decrease.

C. It will have no effect.

D. None of the above.

82. Rank the following acids in order of increasing strength:

HF HBr HI HCl

A. HF < HCl < HBr < HI

B. HI < HBr < HCl < HF

C. HF < HBr < HCl < HI

D. HI < HCl < HBr < HF

83. Which of the following compounds is a weak base?

A. NH4Cl C. NaH

B. NaOH D. NH3

84. Rank the following acids in order of decreasing strength:

HClO3 HClO4 HClO2 HClO

A. HClO > HClO2 > HClO3 > HClO4

B. HClO4 > HClO3 > HClO2 > HClO

C. HClO2 > HClO4 > HClO > HClO3

D. HClO3 > HClO > HClO2 > HClO4

85. Which of the following substances is a conjugate acid of HSO3-?

A. H2SO4 C. H2SO3

B. SO32- D. HSO4-

86. Which of the following substances is a conjugate base of HPO42-?

A. H2PO4- C. PO43-

B. H3PO4 D. H2PO3-

87. Which of the following is a correct conjugate acid-base pair?

A. H2SO4 / SO42- C. HNO2 / NO2-

B. H3O+ / OH- D. NO3-/ NO2-

88. Which of the following is not a basic salt?

A. NaCl C. LiH

B. NaNO2 D. LiCN

89. Calculate the pH of a 0.00350 M HCl solution.

A. 2.46 C. 8.11

B. 3.74 D. 11.5

90. Calculate the pH of a 0.00100 M Ba(OH)2 solution.

A. 2.70 C. 11.3

B. 3.00 D. 11.0

91. The pH of a solution is 5.16. Determine the [OH-] concentration.

A. 3.72 x 10-4 M C. 8.44 x 10-8 M

B. 6.92 x 10-6 M D. 1.44 x 10-9 M

92. Calculate the pH of the solution made by dissolving 25.2 g of HF in enough water to make a 455 mL solution. The Ka of HF is 6.8 x 10-4.

A. 1.36 C. 4.74

B. 2.77 D. 5.99

93. Calculate the pH of a 0.125 M NH4Cl solution. The Kb of Ammonia (NH3) is 1.8 x 10-5.

A. 2.82 C. 4.63

B. 9.26 D. 5.08

94. Calculate the unknown concentration of a HCN solution if the pH is 4.92. The Ka of HCN is

4.9 x 10-10.

A. 0.153 M C. 0.401 M

B. 0.295 M D. 0.633 M

95. Calculate the percent ionization of a 0.0500 M HF solution. The Ka of HF is 6.8 x 10-4.

A. 3.47% C. 8.91%

B. 5.44% D. 11.0%

96. Which of the following acids is the strongest?

A. HNO2 Ka = 4.5 x 10-4

B. HF Ka = 6.8 x 10-4

C. HCN Ka = 4.9 x 10-10

D. HClO Ka = 2.0 x 10-11

97. A solution contains a mixture of 0.25 M HC2H3O2and 0.25 M NaC2H3O2. Calculate the pH of the solution. The Ka of acetic acid is 1.8 x 10-5.

A. 2.45 C. 4.74

B. 4.21 D. 5.09

98. A solution is made by mixing 14.5 g of HNO2 and 15.0 g of NaNO2 in 1.00 L of water. Calculate the pH of the solution. The Ka of HNO2 is 4.5 x 10-4.

A. 2.85 C. 3.35

B. 3.19 D. 3.50

99. Calculate the ratio of [NaCN]/[HCN] if the pH of the solution is 8.708. The Ka of HCN is 4.90 x 10-10.

A. 0.100 C. 0.453

B. 0.250 D. 0.615

100. Which of the following mixtures will produce a buffer solution?

A. 50 mL of 0.100 M NaOH and 100 mL of 0.100 M HF.

B. 50 mL of 0.100 M HCl and 50 mL of 0.100 M NH3.

C. 100 mL of 0.100 M HCN and 200 mL of 0.100 M NaOH.

D. 50 mL of 0.100 M NaCl and 100 mL of 0.100 M HCl.

*Use the following information to answer questions 101 through 105.*

74.8 mL of a 0.255 M HF solution was titrated with a 0.100 M NaOH solution. The Ka of HF is

6.8 x 10-4.

101. Calculate the pH of the HF solution before the addition of NaOH.

A. 1.88 C. 2.76

B. 2.45 D. 3.01

102. Calculate the pH of the solution after the addition of 125 mL of 0.100 M NaOH.

A. 2.74 C. 3.45

B. 3.17 D. 3.81

103. Calculate the volume of NaOH needed to reach the equivalence point.

A. 29.3 mL C. 136 mL

B. 80.4 mL D. 191 mL

104. Calculate the pH of the solution at the equivalence point.

A. 5.99 C. 8.01

B. 7.04 D. 9.12

105. Calculate the pH of the solution after the addition of 210 mL of 0.100 M NaOH.

A. 9.81 C. 12.4

B. 11.8 D. 13.1

106. Which of the following statements regarding buffers is incorrect?

A. A buffer is a solution that resist changes in pH.

B. A buffer solution is made up of a weak acid and its conjugate weak base pair.

C. A buffer solution is made up of a strong acid and its conjugate weak base pair.

D. A buffer maintains the pH of a solution by reacting with any hydronium and hydroxide ions that are introduced into the solution.

107. Which of the following is a diprotic acid?

A. HNO2 C. H2SO3

B. H3PO4 D. HF

108. Calculate the pH of the solution after mixing 215 mL of 0.150 M HCl with 250 mL of 0.125 M NaOH.

A. 1.15 C. 6.54

B. 2.67 D. 8.91

109. Which of the following statements is/are true?

I. The pH at the equivalence point is greater than 7 when a weak acid is titrated with a strong base.

II. The pH at the equivalence point is greater than 7 when a weak base is titrated with a strong acid.

III. The pH at the equivalence point is equal to 7 when a strong acid is titrated with a strong base.

A. I Only C. II and III

B. I and III D. II Only

110. Calculate the molar solubility of BaCO3. The Ksp of BaCO3 is 5.1 x 10-9.

BaCO3(s) ![Shape, rectangle

Description automatically generated]() Ba2+(aq) + CO32-(aq)

A. 2.44 x 10-4 M C. 4.28 x 10-6 M

B. 7.14 x 10-5 M D. 1.33 x 10-2 M

111. Calculate the molar solubility of Cu3(PO4)2 in g/L. The Ksp pf Cu3(PO4)2 is 1.3 x 10-37.

A. 4.76 x 10-5 g/L C. 1.64 x 10-8 g/L

B. 6.26 x 10-6 g/L D. 9.12 x 10-10 g/L

112. The Ksp for CaF2 is 3.9 x 10-11. Calculate the concentration of [F-] in a saturated solution of CaF2.

A. 4.27 x 10-4 M C. 3.39 x 10-4 M

B. 2.14 x 10-4 M D. 6.78 x 10-4 M

113. A saturated solution of Ag2SO4 contains 3.28 g/L of [Ag+]. Calculate the Ksp of Ag2SO4.

A. 4.23 x 10-7 C. 2.71 x 10-11

B. 8.11 x 10-12 D. 1.40 x 10-5

114. A saturated solution of BaF2 contains 0.146 M of NaF. The Ksp for BaF2 is 1.0 x 10-6. Calculate the molar solubility of BaF2 in this solution.

A. 3.71 x 10-4 M C. 4.69 x 10-5 M

B. 7.10 x 10-3 M D. 1.17 x 10-5 M

115. 48.9 g of NiCl2 is dissolved in a 245 mL saturated solution of NiCO3. The Ksp of NiCO3 is 6.60 x 10-9. Calculate the concentration of [CO32-] in g/L.

A. 2.57 x 10-7 g/L C. 1.25 x 10-6 g/L

B. 4.29 x 10-9 g/L D. 5.01 x 10-11 g/L

116. Which of the following statements is correct?

A. If Q > Ksp, precipitation occurs.

B. If Q < Ksp, precipitation occurs.

C. If Q = K, dissolution occurs.

D. None of the above.

117. A solution initially contains 3.81 x 10-4 M of [Ag+] and 4.15 x 10-5 M of [Cl-]. The Ksp of AgCl is 1.8 x 10-10. Determine which of the following actions will occur.

AgCl(s) ![Shape, rectangle

Description automatically generated]() Ag+(aq) + Cl-(aq)

A. The reaction will shift to the right and dissolution will occur.

B. The reaction will shift to the right and precipitation will occur.

C. The reaction will shift to the left and precipitation occur.

D. The reaction will shift to the left and dissolution will occur.

118. Which of the following is true if AgNO3 is added to the solution?

AgCl(s) ![Shape, rectangle

Description automatically generated]() Ag+(aq) + Cl-(aq)

A. The reaction will shift to the right and dissolution will occur.

B. The reaction will shift to the right and precipitation will occur.

C. The reaction will shift to the left and precipitation will occur.

D. The reaction will shift to the left and

dissolution will occur.

119. Which of the following statements is true regarding AgCl if Pb(NO3)2 is added to the solution? The Ksp of PbCl2 is 1.60 x 10-5.

AgCl(s) ![Shape, rectangle

Description automatically generated]() Ag+(aq) + Cl-(aq) ΔH = +65.8 kJ/mol

A. Precipitation will occur.

B. Dissolution will occur.

C. No effect.

D. None of the above.

120. Which of the following is true regarding [Ag+] if the temperature is increased?

AgCl(s) ![Shape, rectangle

Description automatically generated]() Ag+(aq) + Cl-(aq) ΔH = +65.8 kJ/mol

A. The concentration of [Ag+] will increase.

B. The concentration of [Ag+] will decrease.

C. No effect.

D. None of the above.

121. Which of the following is true if MgCl2 is added to the solution?

AgCl(s) ![Shape, rectangle

Description automatically generated]() Ag+(aq) + Cl-(aq) ΔH = +65.8 kJ/mol

A. The reaction will shift to the right and the solubility of AgCl will increase.

B. The reaction will shift to the right and the solubility of AgCl will decrease.

C. The reaction will shift to the left and the solubility of AgCl will decrease.

D. The reaction will shift to the left and the solubility of AgCl will increase.

122. Which of the following is true if the temperature was decreased?

AgCl(s) ![Shape, rectangle

Description automatically generated]() Ag+(aq) + Cl-(aq) ΔH = +65.8 kJ/mol

A. Ksp will increase.

B. Ksp will decrease.

C. Ksp will remain the same.

D. None of the above.

123. What will happen if CaCl2 is added to the solution?

CaF2(s) ![Shape, rectangle

Description automatically generated]() Ca2+(aq) + 2F-(aq) ΔH = +13.4 kJ/mol

A. The pH of the solution will increase.

B. The pH of the solution will decrease.

C. The pH will remain the same.

D. None of the above.

124. What will happen if HCl is added to the solution?

CaF2(s) ![Shape, rectangle

Description automatically generated]() Ca2+(aq) + 2F-(aq) ΔH = +13.4 kJ/mol

A. The solubility of CaF2 will increase.

B. The solubility of CaF2 will decrease.

C. The solubility of CaF2 will remain the same.

D. None of the above.

125. Calculate the change in entropy (ΔS0) for the reaction shown below:

2H2(g) + O2(g) ![Shape, rectangle

Description automatically generated]() 2H2O(g)

Thermodynamic data at 298 K (ΔS0)

|  |  |
| --- | --- |
| H2(g) | 130.6 J/mol K |
| O2(g) | 205.0 J/mol K |
| H2O(g) | 188.7 J/mol K |

A. +88.8 J/mol K C. +147 J/mol K

B. -88.8 J/mol K D. -147 J/mol K

126. Which of the following compounds has the greatest entropy?

A. CaO(s) C. SO2(g)

B. H2O(l) D. SO2(g)

127. Estimate the boiling point of substance A using the following information:

A(l) ![Shape, rectangle

Description automatically generated]() A(g)

ΔH = +44.1 kJ/mol, ΔS = +115 J/mol K

A. 383 K C. 349 K

B. 325 K D. 405 K

*Use the following information to answer questions 128 through 130.*

ΔG0 Thermodynamic data at 298 K

|  |  |
| --- | --- |
| SO2(g) | -300.4 kJ/mol |
| H2S(g) | -33.0 kJ/mol |
| H2O(g) | -228.6 kJ/mol |

3H2(g) + SO2(g) ![Shape, rectangle

Description automatically generated]() H2S(g) + 2H2O(g)

128. Calculate ΔG0 for the reaction shown above at 298 K.

A. +38.80 kJ/mol C. +74.53 kJ/mol

B. -189.8 kJ/mol D. -51.21 kJ/mol

129. Calculate the equilibrium constant K at 298 K for the reaction shown above.

A. 9.26 x 10-1 C. 5.39 x 10-34

B. 1.08 D. 1.85 x 1033

130. Calculate ΔG for the reaction shown above at 298 K using the partial pressure values shown below:

H2 = 0.79 atm SO2 = 0.85 atm

H2S = 0.01 atm H2O = 0.015 atm

A. 142 kJ/mol C. -108 kJ/mol

B. -173 kJ/mol D. -220 kJ/mol

131. Which of the following must be true for an exothermic reaction?

A. If ΔS = +, then ΔG = + at low temperatures.

B. If ΔS = -, then ΔG = + for all temperatures.

C. If ΔS = +, then ΔG = - for all temperatures.

D. If ΔS = +, then ΔG = - at high temperatures.

132. Consider the reaction shown below. What will be the effect on ΔG if the concentration of [H2] is increased?

H2(g) + SO3(g) ![Shape, rectangle

Description automatically generated]() H2O(g) + SO2(g)

A. ΔG will increase C. No Change

B. ΔG will decrease D. None of the above

133. Which of the following species is the reducing agent in the reaction shown below?

Mg(s) + 2HCl(aq) -----> MgCl2(aq) + H2(g)

A. Mg C. H2

B. HCl D. MgCl2

134. Which of the following species is oxidized in the reaction shown below?

Fe2+(aq) + Zn(s) -----> Zn2+(aq) + Fe(s)

A. Fe2+ C. Fe

B. Zn D. Zn2+

135. Which of the following statements are true?

I. Electrons travel from the anode to the cathode.

II. Electrons travel from the cathode to the anode.

III. Cations travel toward the anode.

IV. Cations travel toward the cathode.

A. I and III C. II and III

B. I and IV D. II and IV

136. Determine the oxidation state of Mn in the compound KMnO4.

A. 0 C. +4

B. +2 D. +7

137. Which of the following statements is/are true?

I. Oxidation involves a gain of electrons.

II. Oxidation involves a loss of electrons.

III. Reduction involves a gain of electrons.

A. I Only C. II and III

B. III Only D. II Only

138. What is the sum of all coefficients when the following redox reaction is balanced?

Al(s) + Cu2+(aq) -----> Al3+(aq) + Cu(s)

A. 4 C. 9

B. 6 D. 10

139. Which of the following choices show the correct balanced redox reaction under basic conditions?

I-(aq) + ClO3-(aq) -----> I2(s) + Cl-(aq)

A. 6I-(aq) + ClO3-(aq) + 3H2O(l) ----> Cl-(aq) + 6OH-(aq) + 3I2(s)

B. 2I-(aq) + ClO3-(aq) + 3H2O(l) ----> Cl-(aq) + 6OH-(aq) + 2I2(s)

C. 2I-(aq) + 2ClO3-(aq) + 6H2O(l) ----> 2Cl-(aq) + 12OH-(aq) + I2(s)

D. 4I-(aq) + ClO3-(aq) + 3H2O(l) ----> Cl-(aq) + 6OH-(aq) + 2I2(s)

*Use the following information to answer questions 140 through 146.* The cell notation of the voltaic cell is Zn(s)|Zn2+(aq)||Cu2+(aq)|Cu(s).

Zn2+(aq) + 2e- -----> Zn(s) E0 = -0.760 V

Cu2+(aq) + 2e- -----> Cu(s) E0 = +0.340 V

140. Calculate the net cell potential of this battery using the standard reduction potentials shown above.

A. -0.420 V C. +0.420 V

B. -1.10 V D. +1.10 V

141. Calculate ΔG0 of the voltaic cell mentioned above.

A. -81.0 kJ/mol C. +81.0 kJ/mol

B. -212 kJ/mol D. +212 kJ/mol

142. Calculate the equilibrium constant K of the voltaic cell at 298 K.

A. 3.25 x 1015 C. 1.61 x 1037

B. 4.82 x 1019 D. 1.96 x 1027

143. Which of the following half-reactions will occur at the anode in the voltaic cell?

A. Zn2+(aq) + 2e- -----> Zn(s)

B. Zn(s) -----> Zn2+(aq) + 2e-

C. Cu2+(aq) + 2e- -----> Cu(s)

D. Cu(s) -----> Cu2+(aq) + 2e-

144. Which of the following half-reactions will occur at the cathode?

A. Zn2+(aq) + 2e- -----> Zn(s)

B. Zn(s) -----> Zn2+(aq) + 2e-

C. Cu2+(aq) + 2e- -----> Cu(s)

D. Cu(s) -----> Cu2+(aq) + 2e-

145. Which of the following correctly describes the net reaction?

A. Zn(s) + Cu2+(aq) -----> Zn2+(aq) + Cu(s)

B. Zn(s) + Cu(s) -----> Cu2+(aq) + Zn2+(aq)

C. Cu2+(aq) + Zn2+(aq) -----> Cu(s) + Zn(s)

D. Zn2+(aq) + Cu(s) -----> Zn(s) + Cu2+(aq)

146. Calculate the net cell potential if the concentration of ZnSO4 and CuSO4 in the voltaic cell are 0.001 M and 10.0 M respectively.

A. 0.98 V C. 1.16 V

B. 1.03 V D. 1.22 V

147. Calculate the ratio of [Zn2+]/[Ni2+] when the cell potential of the following reaction is 0.531 V.

Zn(s) + Ni2+(aq) -----> Zn2+(aq) + Ni(s) E0 = 0.480 V

A. 0.0188 C. 12.5

B. 0.512 D. 53.2

148. An electric current of 4.54 A passed through a solution of CuSO4 for 5.00 minutes. Calculate the mass of copper deposited on the cathode.

A. 0.217 g C. 0.449 g

B. 0.369 g D. 0.612 g

149. Calculate the electric current that passed through a solution of NiCl2 if the mass of the cathode increased by 0.124 g in 22.1 minutes.

A. 0.307 A C. 1.01 A

B. 0.714 A D. 1.89 A

150. Which of the following indicators will be most suitable for the titration of a 200 mL 0.75 M HF solution with 0.100 M KOH? Ka = 6.8 x 10-4 for HF. The pKa range for each indicator is provided below.

A. Methyl Orange: 3.2 – 4.4

B. Bromothymol Blue: 6.0 – 7.6

C. Phenolphthalein: 8.2 – 10.0

D. Bromocresol Green: 3.8 – 5.4

**Answers:**

1. B 45. B 89. A 133. A

2. C 46. C 90. C 134. B

3. D 47. D 91. D 135. B

4. B 48. C 92. A 136. D

5. B 49. A 93. D 137. C

6. C 50. B 94. B 138. D

7. B 51. B 95. D 139. A

8. D 52. A 96. B 140. D

9. D 53. D 97. C 141. B

10. A 54. B 98. B 142. C

11. B 55. C 99. B 143. B

12. B 56. B 100. A 144. C

13. C 57. C 101. A 145. A

14. B 58. B 102. C 146. D

15. C 59. C 103. D 147. A

16. D 60. A 104. C 148. C

17. D 61. B 105. B 149. A

18. A 62. D 106. C 150. C

19. B 63. A 107. C

20. D 64. B 108. B

21. B 65. A 109. B

22. B 66. D 110. B

23. C 67. B 111. B

24. B 68. A 112. A

25. C 69. A 113. D

26. D 70. A 114. C

27. D 71. A 115. A

28. D 72. A 116. A

29. B 73. C 117. C

30. A 74. C 118. C

31. C 75. A 119. B

32. D 76. A 120. A

33. B 77. C 121. C

34. B 78. C 122. B

35. D 79. B 123. B

36. A 80. B 124. A

37. B 81. A 125. B

38. C 82. A 126. D

39. C 83. D 127. A

40. D 84. B 128. B

41. A 85. C 129. C

42. D 86. C 130. D

43. B 87. C 131. C

44. A 88. A 132. B