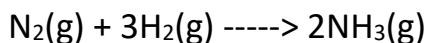


# **General Chemistry 2**

## **Worksheet**

Organic Chemistry Tutor

1. The average rate of appearance of  $[\text{NH}_3]$  is 0.215 M/s. Determine the average rate of disappearance of  $[\text{H}_2]$ .



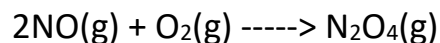
- A. -0.645 M/s  
B. -0.323 M/s  
C. -0.143 M/s  
D. -0.430 M/s

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

$$\text{Rate} = k[\text{A}]^2[\text{B}][\text{C}]^0$$

- A. The rate of the reaction doubles as the concentration of  $[\text{A}]$  doubles.  
B. The rate of the reaction decreases by half as the concentration of  $[\text{C}]$  doubles.  
C. The rate increases by a factor of 3 as the concentration of  $[\text{B}]$  triples in value.  
D. The rate of the reaction increases by a factor of 4 as the concentration of  $[\text{B}]$  and  $[\text{C}]$  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:



$[\text{NO}]$	$[\text{O}_2]$	Reaction Rate
0.100 M	0.100 M	$1.25 \times 10^{-4}$ M/s
0.200 M	0.100 M	$5.00 \times 10^{-4}$ M/s
0.100 M	0.200 M	$2.50 \times 10^{-4}$ M/s

- A. Rate =  $k[\text{NO}][\text{O}_2]$ ,  $k = 0.0125 \text{ M}^{-2} \text{ s}^{-1}$   
B. Rate =  $k[\text{NO}_2]^2$ ,  $k = 0.0125 \text{ M}^{-2} \text{ s}^{-1}$   
C. Rate =  $k[\text{O}_2]$ ,  $k = 0.00125 \text{ M}^{-2} \text{ s}^{-1}$   
D. Rate =  $k[\text{NO}]^2[\text{O}_2]$ ,  $k = 0.125 \text{ M}^{-2} \text{ s}^{-1}$

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

- A. Zero Order  
B. First Order  
C. Second Order  
D. Third Order

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

- A.  $\text{M s}^{-1}$   
B.  $\text{s}^{-1}$   
C.  $\text{M}^{-1} \text{ s}^{-1}$   
D.  $\text{M}^{-2} \text{ s}^{-1}$

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.  $6.69 \times 10^{-4} \text{ M}^{-1} \text{ s}^{-1}$                       C.  $1.34 \times 10^{-3} \text{ M}^{-1} \text{ s}^{-1}$   
B.  $4.23 \times 10^{-5} \text{ M}^{-1} \text{ s}^{-1}$                       D.  $1.27 \times 10^{-2} \text{ M}^{-1} \text{ s}^{-1}$

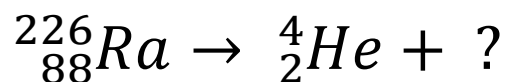
9. A reaction has a rate constant of  $1.46 \times 10^{-3} \text{ s}^{-1}$  at 298 K and  $4.33 \times 10^{-2} \text{ s}^{-1}$  at 421 K. Calculate the activation energy of this reaction.

- 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

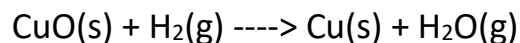
12. The half-life of Cs-137 is 30.0 years. Calculate the rate constant  $k$  for the first-order decomposition of isotope Cs-137.

- A.  $1.35 \times 10^{-1} \text{ yr}^{-1}$                       C.  $4.42 \times 10^{-2} \text{ yr}^{-1}$   
B.  $2.31 \times 10^{-2} \text{ yr}^{-1}$                       D.  $5.21 \times 10^{-1} \text{ yr}^{-1}$

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?



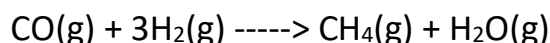
A.  $K_P = \frac{[\text{H}_2\text{O}][\text{Cu}]}{[\text{CuO}][\text{H}_2]}$

C.  $K_P = [\text{H}_2\text{O}][\text{H}_2]$

B.  $K_P = \frac{[\text{H}_2\text{O}]}{[\text{H}_2]}$

D.  $K_P = \frac{[\text{H}_2]}{[\text{H}_2\text{O}]}$

15. Calculate  $K_P$  for the following reaction at 298 K.  
 $K_C = 2.41 \times 10^{-2}$ .



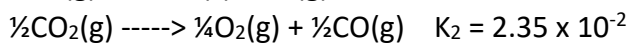
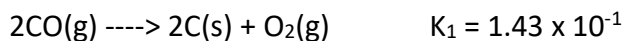
A. 14.4

C.  $4.03 \times 10^{-5}$

B.  $5.89 \times 10^{-1}$

D.  $1.44 \times 10^{-8}$

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



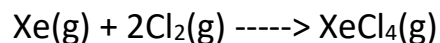
A. 3240

C. 239

B. 1680

D. 4790

17. At equilibrium, the partial pressures of Xe,  $\text{Cl}_2$ , and  $\text{XeCl}_4$  were found to be 215 mm Hg, 315 mm Hg, and 723 mm Hg respectively. Calculate  $K_P$ .



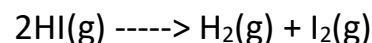
A. 19.6

C. 8.11

B.  $1.07 \times 10^{-2}$

D.  $3.39 \times 10^{-5}$

18. A reaction mixture initially contains 0.75 M of  $[\text{HI}]$ . At equilibrium, the concentration of  $[\text{I}_2]$  was found to be 0.300 M. Calculate the equilibrium concentration of HI in the mixture.



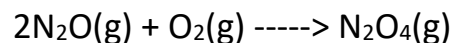
A. 0.150 M

C. 0.600 M

B. 0.450 M

D. 0.300 M

19. The partial pressures of  $\text{N}_2\text{O}$ ,  $\text{O}_2$ , and  $\text{N}_2\text{O}_4$  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.  $K_P = 56.8$



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  $K \ll 1$ .
- 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.  $\text{HNO}_3$
- B.  $\text{HNO}_2$
- C.  $\text{H}_2\text{SO}_4$
- D.  $\text{HI}$

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

- A.  $\text{NaNO}_2$
- B.  $\text{NH}_4\text{Br}$
- C.  $\text{KCl}$
- D.  $\text{NaF}$

23. The pH of a solution is 3.78. Determine the  $[\text{H}_3\text{O}^+]$  concentration.

- A.  $2.75 \times 10^{-2} \text{ M}$
- B.  $5.83 \times 10^{-3} \text{ M}$
- C.  $1.66 \times 10^{-4} \text{ M}$
- D.  $8.73 \times 10^{-5} \text{ M}$

24. Calculate the pH of a 0.25 M  $\text{HC}_2\text{H}_3\text{O}_2$  solution. The  $K_a$  of acetic acid is  $1.8 \times 10^{-5}$ .

- A. 2.37
- B. 2.67
- C. 4.37
- D. 5.35

25. Calculate the pH of the solution made by dissolving 30.5 g of  $\text{NaF}$  in enough water to make a 650 mL solution. The  $K_a$  of  $\text{HF}$  is  $6.8 \times 10^{-4}$ .

- A. 1.12
- B. 5.30
- C. 8.61
- D. 10.7

26. A solution contains a mixture of 0.755 M  $\text{HF}$  and 0.125 M  $\text{NaF}$ . Calculate the pH of the solution. The  $K_a$  of  $\text{HF}$  is  $6.8 \times 10^{-4}$ .

- A. 4.25
- B. 3.17
- C. 3.95
- D. 2.39

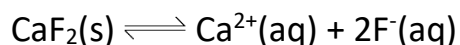
27. Which of the following is a buffer solution?

- A.  $\text{HF}$  and  $\text{HCN}$
- B.  $\text{HI}$  and  $\text{KI}$
- C.  $\text{HCl}$  and  $\text{NaCl}$
- D.  $\text{HC}_2\text{H}_3\text{O}_2$  and  $\text{NaC}_2\text{H}_3\text{O}_2$

28. Which of the following is a Lewis acid?

- A.  $\text{BH}_3$                       C.  $\text{FeCl}_3$   
B.  $\text{AlCl}_3$                       D. All of the above

29. Write the equilibrium expression for  $K_{sp}$  based on the following reaction:



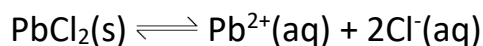
- A.  $K_{sp} = [\text{Ca}^{2+}][\text{F}^{-}]$                       C.  $K_{sp} = [\text{Ca}^{2+}]^2[\text{F}^{-}]$   
B.  $K_{sp} = [\text{Ca}^{2+}][\text{F}^{-}]^2$                       D.  $K_{sp} = [\text{CaF}_2]$

30. Calculate the molar solubility of  $\text{Mg}(\text{OH})_2$ . The  $K_{sp}$  of  $\text{Mg}(\text{OH})_2$  is  $1.8 \times 10^{-11}$ .



- A.  $1.65 \times 10^{-4} \text{ M}$                       C.  $4.24 \times 10^{-7} \text{ M}$   
B.  $1.99 \times 10^{-5} \text{ M}$                       D.  $8.12 \times 10^{-10} \text{ M}$

31. A saturated solution of  $\text{PbCl}_2$  contains 0.0159 M of  $[\text{Pb}^{2+}]$  and 0.0317 M of  $[\text{Cl}^{-}]$ . Calculate the  $K_{sp}$  of  $\text{PbCl}_2$ .



- A.  $3.24 \times 10^{-7}$                       C.  $1.60 \times 10^{-5}$   
B.  $4.99 \times 10^{-11}$                       D.  $7.12 \times 10^{-8}$

32. For which of the following reactions is  $\Delta S$  positive?

- A.  $2\text{SO}_2(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2\text{SO}_3(\text{g})$   
B.  $\text{CaO}(\text{s}) + \text{CO}_2(\text{g}) \rightarrow \text{CaCO}_3(\text{s})$   
C.  $\text{H}_2\text{O}(\text{g}) \rightarrow \text{H}_2\text{O}(\text{l})$   
D.  $2\text{C}(\text{s}) + \text{O}_2(\text{g}) \rightarrow 2\text{CO}(\text{g})$

33. Calculate  $\Delta G$  using the following information at 340 K.

$$\Delta H = -64.2 \text{ kJ/mol} \qquad \Delta S = 105 \text{ J/mol K}$$

- 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.  $\Delta S = \text{positive}$ ,  $\Delta H = \text{positive}$   
B.  $\Delta S = \text{positive}$ ,  $\Delta H = \text{negative}$   
C.  $\Delta S = \text{negative}$ ,  $\Delta H = \text{negative}$   
D.  $\Delta S = \text{negative}$ ,  $\Delta H = \text{positive}$

35.  $K_{eq}$  is  $1.83 \times 10^{-12}$  for a particular reaction at 372 K. Calculate  $\Delta G$  for this reaction. Is this reaction spontaneous at this temperature?

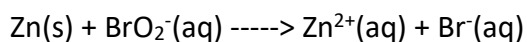
- A.  $\Delta G = +45.2 \text{ kJ/mol}$ , Spontaneous  
B.  $\Delta G = -77.2 \text{ kJ/mol}$ , Nonspontaneous  
C.  $\Delta G = -125 \text{ kJ/mol}$ , Spontaneous  
D.  $\Delta G = +83.6 \text{ kJ/mol}$ , Nonspontaneous

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
- B. II and III
- C. I Only
- D. II Only

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



- A. 1
- B. 2
- C. 3
- D. 4

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

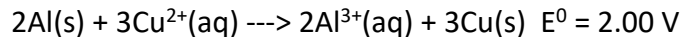
- I.  $E > 0$  for a spontaneous reaction.
- II.  $E < 0$  for a spontaneous reaction.
- III.  $E = 0$  at equilibrium.

- A. I Only
- B. II Only
- C. I and III
- D. II and III

39. Calculate the cell potential of a reaction if  $\Delta G = -41.3 \text{ kJ/mol}$  and  $n = 2$ .

- A. +0.415 V
- B. -0.317 V
- C. +0.214 V
- D. -0.214 V

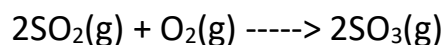
40. Calculate the cell potential of the reaction using the information shown below at 298 K under nonstandard concentration values.



$$[\text{Al}^{3+}] = 1.5 \times 10^{-5} \text{ M}, \quad [\text{Cu}^{2+}] = 35.4 \text{ M}$$

- A.  $E = +1.68 \text{ V}$
- B.  $E = +1.92 \text{ V}$
- C.  $E = +2.09 \text{ V}$
- D.  $E = +2.14 \text{ V}$

41. Given the following information, determine the rate constant  $k$ . The initial concentrations of  $[\text{SO}_2]$  and  $[\text{O}_2]$  are 0.175 M and 0.225 M respectively. The initial reaction rate was measured to be  $2.24 \times 10^{-4} \text{ M/s}$ .



$$\text{Rate} = k[\text{SO}_2]^2[\text{O}_2]$$

- A.  $3.25 \times 10^{-2} \text{ M}^{-2} \text{ s}^{-1}$
- B.  $5.69 \times 10^{-3} \text{ M}^{-2} \text{ s}^{-1}$
- C.  $2.53 \times 10^{-2} \text{ M}^{-2} \text{ s}^{-1}$
- D.  $1.83 \times 10^{-2} \text{ M}^{-2} \text{ s}^{-1}$

42. Which of the following statements is correct?

$$\text{Rate} = k[\text{A}][\text{B}]^2[\text{C}]^0$$

- 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.  $4.25 \times 10^{-2} \text{ M}^{-1} \text{ s}^{-1}$       C.  $1.49 \times 10^{-2} \text{ M}^{-1} \text{ s}^{-1}$   
B.  $5.89 \times 10^{-3} \text{ M}^{-1} \text{ s}^{-1}$       D.  $4.77 \times 10^{-4} \text{ M}^{-1} \text{ s}^{-1}$

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]	Reaction Rate
0.200 M	0.200 M	0.200 M	$3.60 \times 10^{-3} \text{ M/s}$
0.400 M	0.200 M	0.200 M	$7.20 \times 10^{-3} \text{ M/s}$
0.200 M	0.400 M	0.200 M	$1.44 \times 10^{-2} \text{ M/s}$
0.200 M	0.200 M	0.400 M	$3.60 \times 10^{-3} \text{ M/s}$

- A. Rate =  $k[A][B][C]$      $k = 0.45 \text{ M}^{-2} \text{ s}^{-1}$   
B. Rate =  $k[A][B]^2$        $k = 0.45 \text{ M}^{-2} \text{ s}^{-1}$   
C. Rate =  $k[A][C]$          $k = 0.09 \text{ M}^{-2} \text{ s}^{-1}$   
D. Rate =  $k[B]$              $k = 0.09 \text{ M}^{-2} \text{ s}^{-1}$

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  $1.74 \times 10^{-3} \text{ min}^{-1}$ ?

- 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  $3.75 \times 10^{-3} \text{ min}^{-1}$ ?

- A. 124 min                                    C. 399 min  
B. 237 min                                    D. 506 min

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

- A.  $0.00346 \text{ min}^{-1}$                       C.  $1.64 \text{ min}^{-1}$   
B.  $0.457 \text{ min}^{-1}$                         D.  $0.0236 \text{ min}^{-1}$

49. The slope of a  $1/[A]$  vs time straight-line plot is  $1.44 \times 10^{-2} \text{ M}^{-1} \text{ s}^{-1}$ . 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
- B. I Only

- C. I and II
- D. II and III

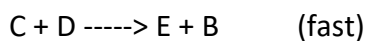
52. Which of the following statements is correct?

- 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?

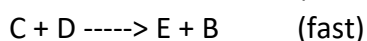
- A. A homogeneous catalyst is present in the same phase as the reactant molecules.
- B. A catalyst lowers the activation energy of a reaction.
- C. A catalyst speeds up a reaction while remaining unchanged.
- D. A heterogeneous catalyst is present in the same phase as the reactant molecules.

54. Which of the following species is a catalyst?



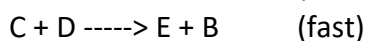
- A. A  
B. B
- C. C  
D. D

55. Which of the following species is an intermediate?



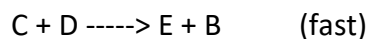
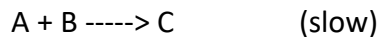
- A. A  
B. B
- C. C  
D. D

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



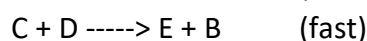
- A. Rate =  $k[A][D]$   
B. Rate =  $k[A][B]$
- C. Rate =  $k[C][D]$   
D. Rate =  $k[A]^2$

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



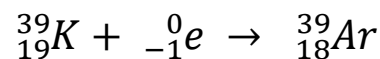
- A. Rate =  $k[A][D]$   
B. Rate =  $k[A][B]$
- C. Rate =  $k[C][D]$   
D. Rate =  $k[A][C]$

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



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

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



- A. Alpha Decay  
B. Positron Production
- C. Electron Capture  
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:

$$1\text{g} = 6.022 \times 10^{23} \text{ amu}$$

Fe-56	55.9207 amu
Proton	1.00728 amu
Neutron	1.00867 amu

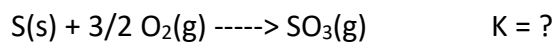
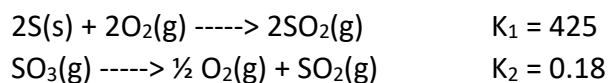
- A.  $3.51 \times 10^{-19}$  J                                      C.  $5.11 \times 10^{-14}$  J  
 B.  $7.90 \times 10^{-11}$  J                                      D.  $1.76 \times 10^{-13}$  J

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



- A.  $K_p = \frac{[\text{CO}_2][\text{Al}_2\text{O}_3]}{[\text{Al}_2(\text{CO}_3)_3]}$                                       C.  $K_p = [\text{CO}_2]$   
 B.  $K_p = \frac{[\text{Al}_2(\text{CO}_3)_3]}{[\text{CO}_2][\text{Al}_2\text{O}_3]}$                                       D.  $K_p = [\text{CO}_2]^3$

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

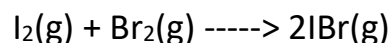


- A. 115    C. 0.125  
 B. 283    D. 0.000299

64. A reaction mixture initially contains CO and O<sub>2</sub> at partial pressures of 0.25 atm and 0.400 atm respectively. At equilibrium, the partial pressure of [CO<sub>2</sub>] is 0.15 atm. Calculate K<sub>p</sub>.

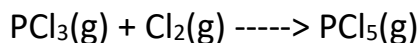
- A. 0.153    C. 325  
 B. 6.92    D. 0.00427

65. 2.00 M of I<sub>2</sub> and 2.00 M of Br<sub>2</sub> are initially present in a reaction mixture. Calculate the equilibrium concentration of [I<sub>2</sub>], [Br<sub>2</sub>], and [IBr] at 725 K. K<sub>c</sub> = 100.



- A. [I<sub>2</sub>] = [Br<sub>2</sub>] = 0.333 M, [IBr] = 3.34 M  
 B. [I<sub>2</sub>] = [Br<sub>2</sub>] = 0.125 M, [IBr] = 0.427 M  
 C. [I<sub>2</sub>] = [Br<sub>2</sub>] = 0.176 M, [IBr] = 2.75 M  
 D. [I<sub>2</sub>] = [Br<sub>2</sub>] = 0.448 M, [IBr] = 3.85 M

66. The initial concentrations of  $\text{PCl}_3$ ,  $\text{Cl}_2$ , and  $\text{PCl}_5$  are 0.485 M, 0.261 M, and 0.399 M respectively.  $K_c = 0.500$ . Calculate the equilibrium concentration of  $[\text{Cl}_2]$ .

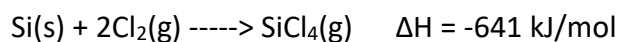


- A. 0.711 M                      C. 0.173 M  
B. 0.326 M                      D. 0.487 M

67. Which of the following statements is incorrect?

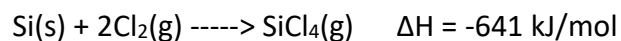
- A. The equilibrium constant  $K$  is dependent on temperature.  
B. The equilibrium constant  $K$  is dependent on concentration.  
C. The reaction shifts to the right when  $Q < K$ .  
D. The presence of a catalyst does not affect the position of equilibrium.

68. In which direction will the reaction shift if  $\text{Cl}_2$  is added to the system?



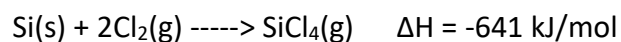
- A. The reaction will shift to the right.  
B. The reaction will shift to the left.  
C. The reaction will not shift in any direction.  
D. None of the above.

69. In which direction will the reaction shift if  $\text{SiCl}_4$  is removed from the system?



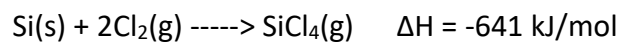
- A. The reaction will shift to the right.  
B. The reaction will shift to the left.  
C. The reaction will not shift in any direction.  
D. None of the above.

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



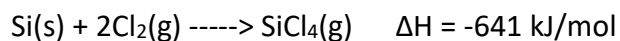
- A. The reaction will shift to the right.  
B. The reaction will shift to the left.  
C. The reaction will not shift in any direction.  
D. None of the above.

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



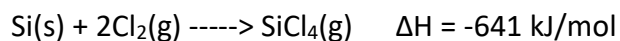
- A. The reaction will shift to the right.  
B. The reaction will shift to the left.  
C. The reaction will not shift in any direction.  
D. None of the above.

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



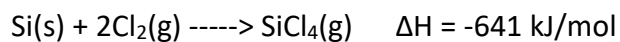
- A. The reaction will shift to the right.
- B. The reaction will shift to the left.
- C. The reaction will not shift in any direction.
- D. None of the above.

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



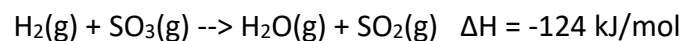
- A. The reaction will shift to the right.
- B. The reaction will shift to the left.
- C. The reaction will not shift in any direction.
- D. None of the above.

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



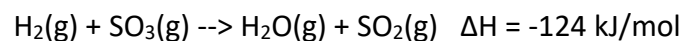
- A. The reaction will shift to the right.
- B. The reaction will shift to the left.
- C. The reaction will not shift in any direction.
- D. None of the above.

75. In which direction will the reaction shift if  $\text{SO}_2$  is removed from the system?



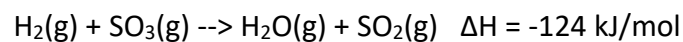
- A. The reaction will shift to the right.
- B. The reaction will shift to the left.
- C. The reaction will not shift in any direction.
- D. None of the above.

76. In which direction will the reaction shift if  $\text{H}_2$  is added to the system?



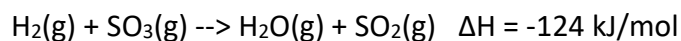
- A. The reaction will shift to the right.
- B. The reaction will shift to the left.
- C. The reaction will not shift in any direction.
- D. None of the above.

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



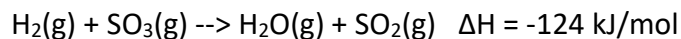
- A. The reaction will shift to the right.
- B. The reaction will shift to the left.
- C. The reaction will not shift in any direction.
- D. None of the above.

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



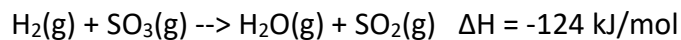
- A. The reaction will shift to the right.
- B. The reaction will shift to the left.
- C. The reaction will not shift in any direction.
- D. None of the above.

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



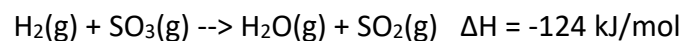
- A. The reaction will shift to the right.
- B. The reaction will shift to the left.
- C. The reaction will not shift in any direction.
- D. None of the above.

80. What effect will the addition of  $[\text{H}_2\text{O}]$  have on the concentration of  $[\text{SO}_2]$ ?



- A. The concentration of  $[\text{SO}_2]$  will increase.
- B. The concentration of  $[\text{SO}_2]$  will decrease.
- C. It will have no effect.
- D. None of the above.

81. What effect will the addition of  $[\text{H}_2\text{O}]$  have on the concentration of  $[\text{H}_2]$ ?



- A. The concentration of  $[\text{H}_2]$  will increase.
- B. The concentration of  $[\text{H}_2]$  will decrease.
- C. It will have no effect.
- D. None of the above.

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

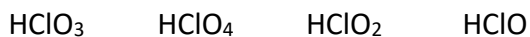
HF                  HBr                  HI                  HCl

- A.  $\text{HF} < \text{HCl} < \text{HBr} < \text{HI}$
- B.  $\text{HI} < \text{HBr} < \text{HCl} < \text{HF}$
- C.  $\text{HF} < \text{HBr} < \text{HCl} < \text{HI}$
- D.  $\text{HI} < \text{HCl} < \text{HBr} < \text{HF}$

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

- A.  $\text{NH}_4\text{Cl}$
- B.  $\text{NaOH}$
- C.  $\text{NaH}$
- D.  $\text{NH}_3$

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



- A.  $\text{HClO} > \text{HClO}_2 > \text{HClO}_3 > \text{HClO}_4$
- B.  $\text{HClO}_4 > \text{HClO}_3 > \text{HClO}_2 > \text{HClO}$
- C.  $\text{HClO}_2 > \text{HClO}_4 > \text{HClO} > \text{HClO}_3$
- D.  $\text{HClO}_3 > \text{HClO} > \text{HClO}_2 > \text{HClO}_4$

85. Which of the following substances is a conjugate acid of  $\text{HSO}_3^-$ ?

- A.  $\text{H}_2\text{SO}_4$
- B.  $\text{SO}_3^{2-}$
- C.  $\text{H}_2\text{SO}_3$
- D.  $\text{HSO}_4^-$

86. Which of the following substances is a conjugate base of  $\text{HPO}_4^{2-}$ ?

- A.  $\text{H}_2\text{PO}_4^-$
- B.  $\text{H}_3\text{PO}_4$
- C.  $\text{PO}_4^{3-}$
- D.  $\text{H}_2\text{PO}_3^-$

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

- A.  $\text{H}_2\text{SO}_4 / \text{SO}_4^{2-}$
- B.  $\text{H}_3\text{O}^+ / \text{OH}^-$
- C.  $\text{HNO}_2 / \text{NO}_2^-$
- D.  $\text{NO}_3^- / \text{NO}_2^-$

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

- A.  $\text{NaCl}$
- B.  $\text{NaNO}_2$
- C.  $\text{LiH}$
- D.  $\text{LiCN}$

89. Calculate the pH of a 0.00350 M  $\text{HCl}$  solution.

- A. 2.46
- B. 3.74
- C. 8.11
- D. 11.5

90. Calculate the pH of a 0.00100 M  $\text{Ba}(\text{OH})_2$  solution.

- A. 2.70
- B. 3.00
- C. 11.3
- D. 11.0

91. The pH of a solution is 5.16. Determine the  $[\text{OH}^-]$  concentration.

- A.  $3.72 \times 10^{-4} \text{ M}$
- B.  $6.92 \times 10^{-6} \text{ M}$
- C.  $8.44 \times 10^{-8} \text{ M}$
- D.  $1.44 \times 10^{-9} \text{ M}$

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  $K_a$  of HF is  $6.8 \times 10^{-4}$ .

- A. 1.36  
B. 2.77  
C. 4.74  
D. 5.99

93. Calculate the pH of a 0.125 M  $\text{NH}_4\text{Cl}$  solution. The  $K_b$  of Ammonia ( $\text{NH}_3$ ) is  $1.8 \times 10^{-5}$ .

- A. 2.82  
B. 9.26  
C. 4.63  
D. 5.08

94. Calculate the unknown concentration of a HCN solution if the pH is 4.92. The  $K_a$  of HCN is  $4.9 \times 10^{-10}$ .

- A. 0.153 M  
B. 0.295 M  
C. 0.401 M  
D. 0.633 M

95. Calculate the percent ionization of a 0.0500 M HF solution. The  $K_a$  of HF is  $6.8 \times 10^{-4}$ .

- A. 3.47%  
B. 5.44%  
C. 8.91%  
D. 11.0%

96. Which of the following acids is the strongest?

- A.  $\text{HNO}_2$   $K_a = 4.5 \times 10^{-4}$   
B. HF  $K_a = 6.8 \times 10^{-4}$   
C. HCN  $K_a = 4.9 \times 10^{-10}$   
D.  $\text{HClO}$   $K_a = 2.0 \times 10^{-11}$

97. A solution contains a mixture of 0.25 M  $\text{HC}_2\text{H}_3\text{O}_2$  and 0.25 M  $\text{NaC}_2\text{H}_3\text{O}_2$ . Calculate the pH of the solution. The  $K_a$  of acetic acid is  $1.8 \times 10^{-5}$ .

- A. 2.45  
B. 4.21  
C. 4.74  
D. 5.09

98. A solution is made by mixing 14.5 g of  $\text{HNO}_2$  and 15.0 g of  $\text{NaNO}_2$  in 1.00 L of water. Calculate the pH of the solution. The  $K_a$  of  $\text{HNO}_2$  is  $4.5 \times 10^{-4}$ .

- A. 2.85  
B. 3.19  
C. 3.35  
D. 3.50

99. Calculate the ratio of  $[\text{NaCN}]/[\text{HCN}]$  if the pH of the solution is 8.708. The  $K_a$  of HCN is  $4.90 \times 10^{-10}$ .

- A. 0.100  
B. 0.250  
C. 0.453  
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  $\text{NH}_3$ .
- 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  $K_a$  of HF is  $6.8 \times 10^{-4}$ .

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

- A. 1.88
- B. 2.45
- C. 2.76
- D. 3.01

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

- A. 2.74
- B. 3.17
- C. 3.45
- D. 3.81

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

- A. 29.3 mL
- B. 80.4 mL
- C. 136 mL
- D. 191 mL

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

- A. 5.99
- B. 7.04
- C. 8.01
- D. 9.12

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

- A. 9.81
- B. 11.8
- C. 12.4
- 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.  $\text{HNO}_2$
- B.  $\text{H}_3\text{PO}_4$
- C.  $\text{H}_2\text{SO}_3$
- D.  $\text{HF}$

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

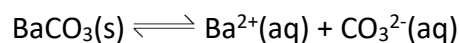
- A. 1.15
- B. 2.67
- C. 6.54
- D. 8.91

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
- B. I and III
- C. II and III
- D. II Only

110. Calculate the molar solubility of  $\text{BaCO}_3$ . The  $K_{\text{sp}}$  of  $\text{BaCO}_3$  is  $5.1 \times 10^{-9}$ .



- A.  $2.44 \times 10^{-4} \text{ M}$
- B.  $7.14 \times 10^{-5} \text{ M}$
- C.  $4.28 \times 10^{-6} \text{ M}$
- D.  $1.33 \times 10^{-2} \text{ M}$

111. Calculate the molar solubility of  $\text{Cu}_3(\text{PO}_4)_2$  in g/L. The  $K_{\text{sp}}$  pf  $\text{Cu}_3(\text{PO}_4)_2$  is  $1.3 \times 10^{-37}$ .

- A.  $4.76 \times 10^{-5} \text{ g/L}$
- B.  $6.26 \times 10^{-6} \text{ g/L}$
- C.  $1.64 \times 10^{-8} \text{ g/L}$
- D.  $9.12 \times 10^{-10} \text{ g/L}$

112. The  $K_{sp}$  for  $\text{CaF}_2$  is  $3.9 \times 10^{-11}$ . Calculate the concentration of  $[\text{F}^-]$  in a saturated solution of  $\text{CaF}_2$ .

- A.  $4.27 \times 10^{-4} \text{ M}$                       C.  $3.39 \times 10^{-4} \text{ M}$   
B.  $2.14 \times 10^{-4} \text{ M}$                       D.  $6.78 \times 10^{-4} \text{ M}$

113. A saturated solution of  $\text{Ag}_2\text{SO}_4$  contains 3.28 g/L of  $[\text{Ag}^+]$ . Calculate the  $K_{sp}$  of  $\text{Ag}_2\text{SO}_4$ .

- A.  $4.23 \times 10^{-7}$                       C.  $2.71 \times 10^{-11}$   
B.  $8.11 \times 10^{-12}$                       D.  $1.40 \times 10^{-5}$

114. A saturated solution of  $\text{BaF}_2$  contains 0.146 M of  $\text{NaF}$ . The  $K_{sp}$  for  $\text{BaF}_2$  is  $1.0 \times 10^{-6}$ . Calculate the molar solubility of  $\text{BaF}_2$  in this solution.

- A.  $3.71 \times 10^{-4} \text{ M}$                       C.  $4.69 \times 10^{-5} \text{ M}$   
B.  $7.10 \times 10^{-3} \text{ M}$                       D.  $1.17 \times 10^{-5} \text{ M}$

115. 48.9 g of  $\text{NiCl}_2$  is dissolved in a 245 mL saturated solution of  $\text{NiCO}_3$ . The  $K_{sp}$  of  $\text{NiCO}_3$  is  $6.60 \times 10^{-9}$ . Calculate the concentration of  $[\text{CO}_3^{2-}]$  in g/L.

- A.  $2.57 \times 10^{-7} \text{ g/L}$                       C.  $1.25 \times 10^{-6} \text{ g/L}$   
B.  $4.29 \times 10^{-9} \text{ g/L}$                       D.  $5.01 \times 10^{-11} \text{ g/L}$

116. Which of the following statements is correct?

- A. If  $Q > K_{sp}$ , precipitation occurs.  
B. If  $Q < K_{sp}$ , precipitation occurs.  
C. If  $Q = K$ , dissolution occurs.  
D. None of the above.

117. A solution initially contains  $3.81 \times 10^{-4} \text{ M}$  of  $[\text{Ag}^+]$  and  $4.15 \times 10^{-5} \text{ M}$  of  $[\text{Cl}^-]$ . The  $K_{sp}$  of  $\text{AgCl}$  is  $1.8 \times 10^{-10}$ . Determine which of the following actions will occur.



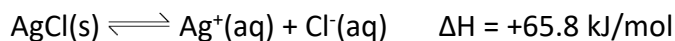
- A. The reaction will shift to the right and dissolution will occur.  
B. The reaction will shift to the right and precipitation will occur.  
C. The reaction will shift to the left and precipitation occur.  
D. The reaction will shift to the left and dissolution will occur.

118. Which of the following is true if  $\text{AgNO}_3$  is added to the solution?



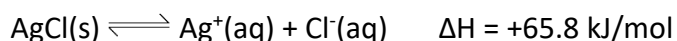
- A. The reaction will shift to the right and dissolution will occur.
- B. The reaction will shift to the right and precipitation will occur.
- C. The reaction will shift to the left and precipitation will occur.
- D. The reaction will shift to the left and dissolution will occur.

119. Which of the following statements is true regarding  $\text{AgCl}$  if  $\text{Pb}(\text{NO}_3)_2$  is added to the solution? The  $K_{sp}$  of  $\text{PbCl}_2$  is  $1.60 \times 10^{-5}$ .



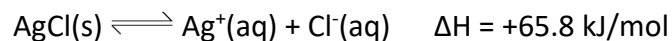
- A. Precipitation will occur.
- B. Dissolution will occur.
- C. No effect.
- D. None of the above.

120. Which of the following is true regarding  $[\text{Ag}^+]$  if the temperature is increased?



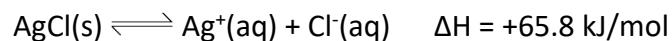
- A. The concentration of  $[\text{Ag}^+]$  will increase.
- B. The concentration of  $[\text{Ag}^+]$  will decrease.
- C. No effect.
- D. None of the above.

121. Which of the following is true if  $\text{MgCl}_2$  is added to the solution?



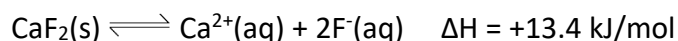
- A. The reaction will shift to the right and the solubility of  $\text{AgCl}$  will increase.
- B. The reaction will shift to the right and the solubility of  $\text{AgCl}$  will decrease.
- C. The reaction will shift to the left and the solubility of  $\text{AgCl}$  will decrease.
- D. The reaction will shift to the left and the solubility of  $\text{AgCl}$  will increase.

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



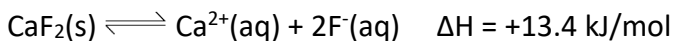
- A.  $K_{sp}$  will increase.
- B.  $K_{sp}$  will decrease.
- C.  $K_{sp}$  will remain the same.
- D. None of the above.

123. What will happen if  $\text{CaCl}_2$  is added to the solution?



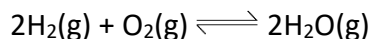
- A. The pH of the solution will increase.
- B. The pH of the solution will decrease.
- C. The pH will remain the same.
- D. None of the above.

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



- A. The solubility of  $\text{CaF}_2$  will increase.
- B. The solubility of  $\text{CaF}_2$  will decrease.
- C. The solubility of  $\text{CaF}_2$  will remain the same.
- D. None of the above.

125. Calculate the change in entropy ( $\Delta S^0$ ) for the reaction shown below:



Thermodynamic data at 298 K ( $\Delta S^0$ )

$\text{H}_2(\text{g})$	130.6 J/mol K
$\text{O}_2(\text{g})$	205.0 J/mol K
$\text{H}_2\text{O}(\text{g})$	188.7 J/mol K

- A. +88.8 J/mol K
- B. -88.8 J/mol K
- C. +147 J/mol K
- D. -147 J/mol K

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

- A.  $\text{CaO}(\text{s})$
- B.  $\text{H}_2\text{O}(\text{l})$
- C.  $\text{SO}_2(\text{g})$
- D.  $\text{SO}_2(\text{g})$

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



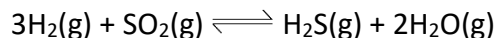
$$\Delta H = +44.1 \text{ kJ/mol}, \quad \Delta S = +115 \text{ J/mol K}$$

- A. 383 K
- B. 325 K
- C. 349 K
- D. 405 K

Use the following information to answer questions 128 through 130.

$\Delta G^0$  Thermodynamic data at 298 K

$\text{SO}_2(\text{g})$	-300.4 kJ/mol
$\text{H}_2\text{S}(\text{g})$	-33.0 kJ/mol
$\text{H}_2\text{O}(\text{g})$	-228.6 kJ/mol



128. Calculate  $\Delta G^0$  for the reaction shown above at 298 K.

- A. +38.80 kJ/mol
- B. -189.8 kJ/mol
- C. +74.53 kJ/mol
- D. -51.21 kJ/mol

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

- A.  $9.26 \times 10^{-1}$                       C.  $5.39 \times 10^{-34}$   
B. 1.08                                  D.  $1.85 \times 10^{33}$

130. Calculate  $\Delta G$  for the reaction shown above at 298 K using the partial pressure values shown below:

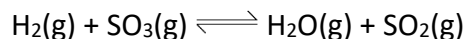


- A. 142 kJ/mol                      C. -108 kJ/mol  
B. -173 kJ/mol                      D. -220 kJ/mol

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

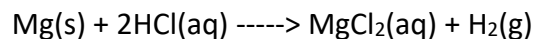
- A. If  $\Delta S = +$ , then  $\Delta G = +$  at low temperatures.  
B. If  $\Delta S = -$ , then  $\Delta G = +$  for all temperatures.  
C. If  $\Delta S = +$ , then  $\Delta G = -$  for all temperatures.  
D. If  $\Delta S = +$ , then  $\Delta G = -$  at high temperatures.

132. Consider the reaction shown below. What will be the effect on  $\Delta G$  if the concentration of  $[H_2]$  is increased?



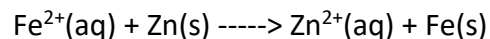
- A.  $\Delta G$  will increase                      C. No Change  
B.  $\Delta G$  will decrease                      D. None of the above

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



- A. Mg    C.  $H_2$   
B. HCl                                        D.  $MgCl_2$

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



- A.  $Fe^{2+}$                                       C. Fe  
B. Zn                                         D.  $Zn^{2+}$

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  $KMnO_4$ .

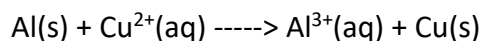
- A. 0    C. +4  
B. +2    D. +7

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.

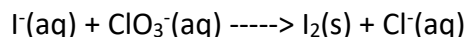
- A. I Only
- B. III Only
- C. II and III
- D. II Only

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



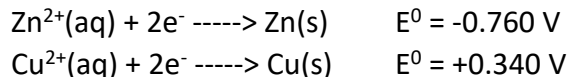
- A. 4
- B. 6
- C. 9
- D. 10

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



- A.  $6\text{I}^{-}(\text{aq}) + \text{ClO}_3^{-}(\text{aq}) + 3\text{H}_2\text{O}(\text{l}) \rightarrow \text{Cl}^{-}(\text{aq}) + 6\text{OH}^{-}(\text{aq}) + 3\text{I}_2(\text{s})$
- B.  $2\text{I}^{-}(\text{aq}) + \text{ClO}_3^{-}(\text{aq}) + 3\text{H}_2\text{O}(\text{l}) \rightarrow \text{Cl}^{-}(\text{aq}) + 6\text{OH}^{-}(\text{aq}) + 2\text{I}_2(\text{s})$
- C.  $2\text{I}^{-}(\text{aq}) + 2\text{ClO}_3^{-}(\text{aq}) + 6\text{H}_2\text{O}(\text{l}) \rightarrow 2\text{Cl}^{-}(\text{aq}) + 12\text{OH}^{-}(\text{aq}) + \text{I}_2(\text{s})$
- D.  $4\text{I}^{-}(\text{aq}) + \text{ClO}_3^{-}(\text{aq}) + 3\text{H}_2\text{O}(\text{l}) \rightarrow \text{Cl}^{-}(\text{aq}) + 6\text{OH}^{-}(\text{aq}) + 2\text{I}_2(\text{s})$

Use the following information to answer questions 140 through 146. The cell notation of the voltaic cell is  $\text{Zn(s)}|\text{Zn}^{2+}(\text{aq})||\text{Cu}^{2+}(\text{aq})|\text{Cu(s)}$ .



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

- A. -0.420 V
- B. -1.10 V
- C. +0.420 V
- D. +1.10 V

141. Calculate  $\Delta G^{\circ}$  of the voltaic cell mentioned above.

- A. -81.0 kJ/mol
- B. -212 kJ/mol
- C. +81.0 kJ/mol
- D. +212 kJ/mol

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

- A.  $3.25 \times 10^{15}$
- B.  $4.82 \times 10^{19}$
- C.  $1.61 \times 10^{37}$
- D.  $1.96 \times 10^{27}$

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

- A.  $\text{Zn}^{2+}(\text{aq}) + 2\text{e}^{-} \rightarrow \text{Zn}(\text{s})$
- B.  $\text{Zn}(\text{s}) \rightarrow \text{Zn}^{2+}(\text{aq}) + 2\text{e}^{-}$
- C.  $\text{Cu}^{2+}(\text{aq}) + 2\text{e}^{-} \rightarrow \text{Cu}(\text{s})$
- D.  $\text{Cu}(\text{s}) \rightarrow \text{Cu}^{2+}(\text{aq}) + 2\text{e}^{-}$

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

- A.  $\text{Zn}^{2+}(\text{aq}) + 2\text{e}^{-} \rightarrow \text{Zn}(\text{s})$
- B.  $\text{Zn}(\text{s}) \rightarrow \text{Zn}^{2+}(\text{aq}) + 2\text{e}^{-}$
- C.  $\text{Cu}^{2+}(\text{aq}) + 2\text{e}^{-} \rightarrow \text{Cu}(\text{s})$
- D.  $\text{Cu}(\text{s}) \rightarrow \text{Cu}^{2+}(\text{aq}) + 2\text{e}^{-}$

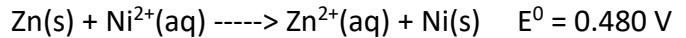
145. Which of the following correctly describes the net reaction?

- A.  $\text{Zn}(\text{s}) + \text{Cu}^{2+}(\text{aq}) \rightarrow \text{Zn}^{2+}(\text{aq}) + \text{Cu}(\text{s})$
- B.  $\text{Zn}(\text{s}) + \text{Cu}(\text{s}) \rightarrow \text{Cu}^{2+}(\text{aq}) + \text{Zn}^{2+}(\text{aq})$
- C.  $\text{Cu}^{2+}(\text{aq}) + \text{Zn}^{2+}(\text{aq}) \rightarrow \text{Cu}(\text{s}) + \text{Zn}(\text{s})$
- D.  $\text{Zn}^{2+}(\text{aq}) + \text{Cu}(\text{s}) \rightarrow \text{Zn}(\text{s}) + \text{Cu}^{2+}(\text{aq})$

146. Calculate the net cell potential if the concentration of  $\text{ZnSO}_4$  and  $\text{CuSO}_4$  in the voltaic cell are 0.001 M and 10.0 M respectively.

- A. 0.98 V
- B. 1.03 V
- C. 1.16 V
- D. 1.22 V

147. Calculate the ratio of  $[\text{Zn}^{2+}]/[\text{Ni}^{2+}]$  when the cell potential of the following reaction is 0.531 V.



- A. 0.0188
- B. 0.512
- C. 12.5
- D. 53.2

148. An electric current of 4.54 A passed through a solution of  $\text{CuSO}_4$  for 5.00 minutes. Calculate the mass of copper deposited on the cathode.

- A. 0.217 g
- B. 0.369 g
- C. 0.449 g
- D. 0.612 g

149. Calculate the electric current that passed through a solution of  $\text{NiCl}_2$  if the mass of the cathode increased by 0.124 g in 22.1 minutes.

- A. 0.307 A
- B. 0.714 A
- C. 1.01 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?  $K_a = 6.8 \times 10^{-4}$  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 |        |

