1. What is the oxidation number of chlorine in potassium chlorate, KClO₃?
   a) -1  b) +1  c) +2  d) +5  e) +6

2. The oxidation state of nitrogen given for all of the following species is correct except
   a) N₂H₄  b) NH₂OH  c) N₂O  d) N₂  e) HNO₂

3. Which substance in the reaction below is the oxidizing agent?
   5 Fe²⁺(aq) + MnO₄⁻(aq) + 8H⁺(aq) →
   Mn²⁺(aq) + 5Fe³⁺(aq) + 4H₂O(l)
   a) Fe²⁺  b) MnO₄⁻  c) H⁺  d) Mn²⁺  e) Fe³⁺

4. In the equation
   KMnO₄ + H₂C₂O₄ + H₂SO₄ ——>
   CO₂ + K₂SO₄ + MnSO₄ + H₂O
   the oxidizing agent is
   a) H₂C₂O₄  b) H₂SO₄  c) CO₂  d) MnSO₄  e) KMnO₄

5. Balance the following oxidation-reduction reaction which occurs in basic solution:
   Cr(OH)₃(s) + ClO⁻(aq) → CrO₂⁻(aq) + Cl₂(g)
   When this equation is balanced using the smallest whole-number coefficients, what is the coefficient on H₂O, and on which side of the reaction is H₂O found, product side or reactant side?
   a) 2, reactant side  b) 8, product side  c) 12, reactant side  d) 2, product side  e) 14, product side

6. The following reaction occurs in acidic solutions. What is the sum of the coefficients in the balanced equation?
   (Don’t forget implied coefficients of “1”.)
   As₂S₃ + NO₃⁻ → H₃AsO₄ + HSO₄⁻ + NO
   a) 16  b) 32  c) 43  d) 79  e) 97

7. The following change occurs in acidic solution:
   H₂S + Cr₂O₇²⁻ → S + Cr³⁺
   Complete and balance the foregoing equation. The properly balanced equation shows that for every mole of Cr₂O₇²⁻ that reacts, ___ moles of H⁺ are consumed.
   a) 8  b) 7  c) 5  d) 10  e) 14

8. For the redox reaction
   2Fe²⁺ + Cl₂ → 2Fe³⁺ + 6Cl⁻
   which of the following are the correct half-reactions?
   I. Cl₂ + 2e⁻ → 2Cl⁻
   II. Cl⁻ → Cl²⁻ + e⁻
   III. Cl₂ → 2Cl⁻ + 2e⁻
   IV. Fe²⁺ → Fe³⁺ + e⁻
   V. Fe²⁺ + e⁻ → Fe³⁺
   a) I and V  b) I and IV  c) II and IV  d) II and V  e) III and IV

9. If the following redox reaction is used for a galvanic cell under standard conditions at 25°C, which of the following reactions occurs at the anode?
   Sn²⁺(aq) + 2Ag⁺(aq) → Sn⁴⁺(aq) + 2Ag(s)
   a) Sn²⁺(aq) → Sn⁴⁺(aq) + 2e⁻
   b) 2Ag⁺(aq) + 2e⁻ → 2Ag(s)
   c) Sn²⁺(aq) + 2e⁻ → Sn⁰(aq)
   d) 2Ag(s) → 2Ag⁺(aq) + 2e⁻

10. What is the cell potential for the following galvanic cell at standard conditions and 25°C?
    Ag(s) | Ag⁺(aq) || Br₂(l) | Br⁻(aq) | Pt(s)
    a) 1.89 V  b) 2.69 V  c) 0.29 V  d) -0.51 V  e) 0.51 V
11. Which of the following is the best oxidizing agent under standard conditions at 25°C?

a) Na⁺ (aq)  
b) Ag⁺ (aq)  
c) Pb²⁺ (aq)  
d) Cl₂ (g)  
e) I₂ (s)

12. The Nernst equation is

a) \( \Delta G = \Delta G^\circ + RT \ln Q \)  
b) \( \Delta S_{\text{univ}} = \Delta S_{\text{surr}} + \Delta S_{\text{sys}} \)  
c) \( \Delta G = \Delta H - T \Delta S \)  
d) \( E = E^\circ - \frac{RT}{nF} \ln Q \)  
e) \( pH = pK_a + \log \frac{[\text{base}]}{[\text{acid}]} \)

13. The following galvanic cell has a standard potential at 25°C of 1.94 V. What is the standard reduction potential for Ce³⁺ (aq) at 25°C?

Ce(s) | Ce³⁺ (1M) || Cd²⁺ (1M) | Cd(s)

a) 2.34 V  
b) -2.34 V  
c) 1.57 V  
d) -1.57 V  
e) 1.54 V

14. What is the cell potential of the galvanic cell at 25°C which uses the following reaction?

Zn(s) + 2Fe³⁺ (aq) \rightarrow Zn²⁺ (aq) + 2Fe²⁺ (aq)

(0.015 M) (0.30 M) (1.5 M)

a) 1.53 V  
b) 1.63 V  
c) 1.49 V  
d) 0.09 V  
e) 1.43 V

15. What is the pH of the solution in the anode half cell of the following galvanic cell if the measured cell potential at 25°C is 0.28 V?

Pt(s) | H₂ (1 atm) | H⁺ (?? M) || Pb²⁺ (1 M) | Pb(s)

a) 2.5  
b) 0.14  
c) 6.9  
d) 14  
e) 11.5

16. A galvanic cell is made from a half cell consisting of a Cu(s) electrode in a 0.30 M solution of Cu²⁺ (aq) and a half cell consisting of a Cu(s) electrode in a 0.10 M solution of Cu²⁺ (aq). What is the cell potential at 25°C and which electrode is the cathode?

a) 0.014 V, Cu(s) electrode in the 0.30 M solution of Cu²⁺ (aq)  
b) 0.028 V, Cu(s) electrode in the 0.30 M solution of Cu²⁺ (aq)  
c) -0.014 V, Cu(s) electrode in the 0.10 M solution of Cu²⁺ (aq)  
d) -0.028 V, Cu(s) electrode in the 0.10 M solution of Cu²⁺ (aq)  
e) 0.014 V, Cu(s) electrode in the 0.10 M solution of Cu²⁺ (aq)

17. Using standard reduction potentials, what is the value of the equilibrium constant at 25°C for the following reaction?

4Fe²⁺ (aq) + O₂ (g) + 4H⁺ (aq) \rightarrow 4Fe³⁺ (aq) + 2H₂O(l)

a) 1.0  
b) 1.2 x 10³¹  
c) 69  
d) 2.2  
e) 1 x 10¹³⁵

Answer Key

1. d  6. e  11. d  16. a  
2. b  7. a  12. d  17. b  
3. b  8. b  13. b  
4. e  9. a  14. e  
5. d  10. c  15. c