1. Which of the following square planar complex ions can have cis-trans isomers?
   (A) $[\text{Pt(NH}_3\text{)}_4]^{2+}$    (B) $[\text{Ni(NH}_3\text{)}_4]^{2+}$    (C) $[\text{Pt(NH}_3\text{)}_2\text{Cl}_2]$    (D) $[\text{Pt(NH}_3\text{)}\text{Cl}_3]^{-}$
   (E) $[\text{Ni(NH}_3\text{)}_3\text{Cl}]^{+}$

2. The measured voltage of the cell
   $$\text{Pt(s)} | \text{H}_2 (1.0 \text{ atm}) | \text{H}^+(\text{aq}) \parallel \text{Ag}^+(1.0 \text{ M}) | \text{Ag(s)}$$
   is 1.02 V at 25°C. Given $E^{\circ}_{\text{cell}}$ is 0.80 V, calculate the pH of the solution.
   (A) 1.86    (B) 1.69    (C) 3.72    (D) 3.89    (E) 7.43

3. Vaporization is a process for which:
   (A) $\Delta G$ is negative when vaporization occurs in an open container.
   (B) $\Delta H^o$ and $\Delta S^o$ are negative.
   (C) $\Delta H^o$ is positive and $\Delta S^o$ is negative.
   (D) $\Delta G^o$ is negative at low temperature, but positive at high temperature.
   (E) $\Delta H^o$ is negative, and $\Delta S^o$ is positive.

4. The half-reaction occurring at the cathode during electrolysis of aqueous copper iodide solution is:
   (A) $\text{I}_2 + 2e^- \rightarrow 2\text{I}^-$
   (B) $\text{Cu} \rightarrow \text{Cu}^{2+} + 2e^-$
   (C) $\text{Cu}^{2+} + 2e^- \rightarrow \text{Cu}$
   (D) $2\text{I}^- \rightarrow \text{I}_2 + 2e^-$
   (E) $2e^- + 2\text{H}_2\text{O} \rightarrow \text{H}_2 + 2\text{OH}^-$
5. How many coulombs of charge are required to cause reduction of 0.20 mol of Cr\(^{3+}\) to Cr?
   (A) 0.60 C  (B) 3.0 C  (C) \(2.9 \times 10^4\) C  (D) \(5.8 \times 10^4\) C  (E) \(9.65 \times 10^4\) C

6. The molar solubility of MgCO\(_3\) is \(1.8 \times 10^{-4}\) mol/L. What is K\(_{sp}\) for this compound?
   (A) \(1.8 \times 10^{-4}\)  (B) \(3.6 \times 10^{-4}\)  (C) \(1.3 \times 10^{-7}\)  (D) \(3.2 \times 10^{-8}\)  (E) \(2.8 \times 10^{-14}\)

7. Calculate the H\(^+\) ion concentration in \(8.8 \times 10^{-4}\) M Ca(OH)\(_2\).
   (A) \(8.8 \times 10^{-4}\) M  (B) \(1.8 \times 10^{-3}\) M  (C) \(2.2 \times 10^{-11}\) M  (D) \(1.1 \times 10^{-11}\) M  (E) \(5.7 \times 10^{-12}\) M

8. Arrange the acids HOCl, HClO\(_3\), and HClO\(_2\) in order of increasing acid strength.
   (A) HOCl < HClO\(_3\) < HClO\(_2\)
   (B) HOCl < HClO\(_2\) < HClO\(_3\)
   (C) HClO\(_2\) < HOCl < HClO\(_3\)
   (D) HClO\(_3\) < HOCl < HClO\(_2\)
   (E) HClO\(_3\) < HClO\(_2\) < HOCl

9. Which of the following is a basic anhydride?
   (A) NO\(_2\)  (B) H\(_2\)O  (C) K\(_2\)O  (D) NaCl  (E) SO\(_2\)

10. Which of the following will act as a Lewis acid?
    (A) NH\(_3\)  (B) NH\(_4^+\)  (C) H\(_2\)O  (D) BF\(_3\)  (E) F\(^-\)

11. In which one of the following substances will the individual molecules experience both London forces and dipole-dipole forces?
    (A) HCl  (B) BCl\(_3\)  (C) Br\(_2\)  (D) H\(_2\)  (E) CO\(_2\)

12. Which one of the following hydrocarbons does not have structural isomers?
    (A) C\(_7\)H\(_{16}\)  (B) C\(_6\)H\(_{14}\)  (C) C\(_5\)H\(_{10}\)  (D) C\(_4\)H\(_8\)  (E) C\(_3\)H\(_8\)

13. According to the VSEPR theory, the geometry of the SO\(_3\) molecule is:
    (A) pyramidal  (B) tetrahedral  (C) trigonal planar  (D) distorted tetrahedron  (E) square planar
14. The correct name for $K_2S$ is __________.
   (A) potassium sulfate  (B) potassium disulfide  (C) potassium bisulfide  
   (D) potassium sulfide  (E) dipotassium sulfate

15. Which one of the following is not true concerning automotive air bags?
   (A) They are inflated as a result of a decomposition reaction  
   (B) They are loaded with sodium azide initially  
   (C) The gas used for inflating them is oxygen  
   (D) The two products of the decomposition reaction are sodium and nitrogen  
   (E) A gas is produced when the air bag activates.

16. An aqueous ethanol solution (400 mL) was diluted to 4.00 L, giving a concentration of 0.0400 M. The concentration of the original solution was __________ M.
   (A) 0.400  (B) 0.200  (C) 2.00  (D) 1.60  (E) 4.00

17. A tin atom has 50 electrons. Electrons in the __________ subshell experience the lowest effective nuclear charge.
   (A) 1s  (B) 3p  (C) 3d  (D) 5s  (E) 5p

18. The electron configuration of the $S^{2-}$ ion is __________.
   (A) $[\text{Ar}]3S^{2}3p^{6}$  (B) $[\text{Ar}]3S^{2}3p^{2}$  (C) $[\text{Ne}]3S^{2}3p^{2}$  
   (D) $[\text{Ne}]3S^{2}3p^{6}$  (E) $[\text{Kr}]3S^{2}2p^{-6}$

19. The molecular geometry of the $\text{H}_3\text{O}^+$ ion is __________.
   (A) linear  (B) tetrahedral  (C) bent  (D) trigonal pyramidal  (E) octahedral

20. Which of the following has dispersion forces as its only intermolecular force?
   (A) $\text{CH}_4$  (B) $\text{HCl}$  (C) $\text{C}_6\text{H}_{13}\text{NH}_2$  (D) $\text{NaCl}$  (E) $\text{CH}_3\text{Cl}$

21. The effect of a catalyst on an equilibrium is to __________.
   (A) increase the rate of the forward reaction only  
   (B) increase the equilibrium constant so that products are favored  
   (C) slow the reverse reaction only  
   (D) increase the rate at which equilibrium is achieved without changing the composition of the equilibrium mixture  
   (E) shift the equilibrium to the right
22. The reduction half reaction occurring in the standard hydrogen electrode is

(A) \( H_2(g, 1 \text{ atm}) \rightarrow 2H^+(aq, 1 \text{M}) + 2e^- \)
(B) \( 2H^+(aq) + 2OH^- \rightarrow H_2O (l) \)
(C) \( O_2(g) + 4H^+(aq) + 4e^- \rightarrow 2H_2O (l) \)
(D) \( 2H^+(aq, 1 \text{M}) + 2e^- \rightarrow H_2(g, 1 \text{ atm}) \)
(E) \( 2H^+(aq, 1 \text{M}) + Cl^-(aq) \rightarrow 2HCl (aq) \)

23. Hybridization of Xe in \( \text{XeF}_4 \) is __________ and in \( \text{XeF}_2 \) is __________.

(A) \( sp^3d^2, sp^3d^2 \)
(B) \( sp^3d, sp^3d^2 \)
(C) \( sp^3d^2, sp^3d \)
(D) \( sp^3, sp^3d \)
(E) \( sp^3, sp^3d^2 \)

24. The hydrometallurgical process used in refining gold ore entails converting metallic gold to a water-soluble complex. The formula of the complex is

(A) \( \text{Au(NH}_3)_2^+ \)
(B) \( \text{Au(CN)}_4^{3-} \)
(C) \( \text{Au(CN)}_2^- \)
(D) \( \text{Au(CO)}_4^{2-} \)
(E) \( \text{Au(CO)}_4^+ \)

25. The correct name for \( [\text{Ni(NH}_3)_6]^3(\text{NO}_3)_3 \) is __________.

(A) dinitrohexaamminenickel (II)
(B) hexaamminenickel (III) trinitrate
(C) dinitrohexaamminenickelate (III)
(D) hexaamminenickel (II) nitrate
(E) hexaamminenickel (III) nitrate