單選題〈1-20 題，每題 2.5 分〉

1. Which one of the following reagents is capable of transforming $Br^-(aq)$ to $Br_2(l)$ under standard-state conditions?
   (A) $I^-(aq)$ (B) $NO_3^-(aq)$ (C) $Ag^+(aq)$ (D) $Al^{3+}(aq)$ (E) $Au^{3+}(aq)$
2. How many coulombs of charge are required to cause reduction of 0.25 mole of Cu^{2+} to Cu?
   (A) 0.25 C (B) 0.50 C (C) 1.2×10^4 C (D) 2.4×10^4 C (E) 4.8×10^4 C
3. Iron objects such as storage tanks and underground pipelines can be protected from corrosion by connecting them through a wire to a piece of
   (A) Pb (B) Ag (C) Sn (D) Mg (E) Cu
4. The maximum number of electrons in a atom with the following set of quantum number ($n = 4, l = +3, m_l = -2, m_s = +1/2$) is
   (A) 0 (B) 1 (C) 2 (D) 3 (E) 4
5. Which element has the following electron configuration $1s^22s^22p^63s^2$?
   (A) Na (B) Mg (C) Al (D) Si (E) Ne
6. How many unpaired electrons does a chromium atom have?
   (A) 1 (B) 2 (C) 4 (D) 5 (E) 6
7. Which element will have the lowest ionization energy?
   (A) Li (B) Na (C) Be (D) K (E) Rb
8. Which element will display an unusually large jump in ionization energy values between the third and the fourth ionization energies?
   (A) Na (B) Mg (C) Al (D) Si (E) P
9. Which bond has the greatest percent ionic characters?
   (A) C-O (B) S-O (C) Na-I (D) Na-Br (E) F-F
10. Which molecule has a Lewis structure that does not obey the octet rule?
    (A) N_2O (B) CS_2 (C) PH_3 (D) CCl_4 (E) NO_2
11. At what temperature will hydrogen molecule have the same kinetic energy as nitrogen molecules have at 298 K?
    (A) 86 K (B) 1032 K (C) 298 K (D) 21 K (E) 4172 K
12. Based on the Graham's law, the relative rates of effusion of H_2 and CO through a fine pinhole is
    (A) 14 (B) 3.74 (C) 0.071 (D) 0.267 (E) none of the above
13. What is the osmotic pressure at 0 °C of an aqueous solution containing 46.0 g of glycerin ($C_3H_8O_3$) per liter?

(A) 22.4 atm (B) 33.6 atm (C) 11.2 atm (D) 5.6 atm (E) none of the above

14. The heat of solution of LiCl is –37 kJ/mol, and the lattice energy of LiCl(s) is 828 kJ/mol. Calculate the total heat of hydration of gas phase Li^+ ions and Cl^- ions
(A)791 kJ (B) 865 kJ (C) –865 kJ (D) –791 kJ (E) none of the above

15. Arrange the following three reactions according to their ΔS°
(1)$H_2O(g) \rightarrow H_2O(l)$ (2)$2NO(g) \rightarrow N_2(g)+O_2(g)$ (3) $MgCO_3(s) \rightarrow MgO(s)+CO_2(g)$
(A) 1 < 2 < 3 (B) 2 < 3 < 1 (C) 3 < 2 < 1 (D) 2 < 1 < 3 (E) 1 < 3 < 2

16. A negative sign for ΔG indicates that at constant T and P
(A) the reaction is exothermic (B) the reaction is endothermic
(C) the reaction is fast (D) the reaction is spontaneous
(E) ΔS must be positive

17. For which type of titration will the *pH* be basic at the equivalence point?
(A) strong acid vs. strong base (B) strong acid vs. weak base
(C) weak acid vs. strong base (D) all of the above
(E) none of the above

18. Which species listed below is present in the greatest concentration in a 0.1 M solution of CH_3COONa?
(A) CH_3COONa (B)CH_3COO^- (C) Na^+ (D) CH_3COOH (E) OH^-

19. A student is asked to prepare a buffer solution at pH=8.6, which one of the following weak acid should he/she choose?
(A) $K_a=2.7\times10^{-3}$ (B) $K_a=4.4\times10^{-6}$ (C) $K_a=2.6\times10^{-9}$ (D) $K_a=3.0\times10^{-11}$

20. A first-order reaction has a rate constant of 7.5×10^{-3} s^{-1}. The time required for the reaction to be 60% complete is
(A) 3.8×10^{-3} s (B) 6.9×10^{-3} s (C) 68 s (D) 120 s (E) 130 s

〈21-45 題，每題 2 分〉

21. A 25 mL solution of potassium hydroxide, KOH, reacts completely with 37 mL of 0.25 M HCl. What is the molarity of the potassium hydroxide solution?
(A) 2.7 M (B) 1.4 M (C) 0.75 M (D) 0.37 M (E) none of the above

22. When a 2.5 g sample of aluminum reacts with 18.5 g of sulfuric acid, H_2SO_4, 15.2 g of aluminum sulfate, $Al_2(SO_4)_3$, is isolated. What is the percentage yield of aluminum sulfate?

(A) 136% (B) 89% (C) 96% (D) 92% (E) none of the above

23. The shape of a CH_4 molecule is

(A) linear (B) angular (C) triangular pyramidal (D) planar triangular (E) none of the above

24. How many different first ionization energies are there for a lithium atom in its ground state?

(A) 1 (B) 2 (C) 3 (D) 4 (E) none of the above

25. Consider the reaction $CH_2CH_2 + Cl_2 \rightarrow$ products. Which of the following is a major product?

(A) 1,2-dichloroethane (B) ethane (C) HCl
(D) 1,1-dichloroethane (E) none of the above

26. What is the name of the following molecule?

$CH_2CH_2CH_2CH_3CH_3CH_2CH_2CH_2CHCH_2CH_3$

(A) isodecane (B) 2-butylheptane (C) 5-ethylnonane
(D) isoundecane (E) none of the above

27. The use of hydrogen as a cheap source of energy has not become a reality because

(A) no ready source of hydrogen exists
(B) hydrogen cannot be handled safely
(C) the technology for obtaining hydrogen from petroleum does not exist
(D) no cost effective way has been developed to electrolyze water
(E) none of the above

28. Given the following values of the ΔG_f° in kJ mol^{-1}:

$CH_{4(g)} = -50.8$ $CCl_{4(l)} = -65.3$ $HCl_{(g)} = -95.3$

What is the value of ΔG° for the reaction,

$4Cl_{2(g)} + CH_4 \rightarrow CCl_{4(l)} + 4HCl_{(g)}$?

(A) 282 kJ mol^{-1} (B) -282 kJ mol^{-1} (C) -396 kJ mol^{-1}
(D) -425 kJ mol^{-1} (E) none of the above

29. The K_b of methylamine, CH_3NH_2, is 3.9×10^{-4}. What is the pH of an aqueous solution that is 0.030 M in methylamine and 0.020 M in CH_3NH_3Cl?

(A) 10.8 (B) 8.2 (C) 3.2 (D) 9.7 (E) none of the above

30. Consider the equilibrium, $N_2 + O_2 \leftrightarrow 2NO$. What is the effect of increasing the pressure on the position of the equilibrium?

(A) There is a shift in the position of equilibrium to the right.
(B) There is be no effect.
(C) There is a shift in the position of equilibrium to the left.

(D) The NO concentration decreases.

(E) none of the above

31. The Ka for hydrofluoric acid, HF, is 3.5×10^{-4}. What is the K_b for the fluoride ion, F^-?

(A) 1.7×10^{-11} (B) 4.7×10^{-11} (C) 3.5×10^{10}

(D) 3.5×10^{-10} (E) none of the above

32. Consider the following half-reactions and voltages.

$2H^+_{(aq)} + 2e \rightarrow H_{2(g)}$ $E° = 0.0$ V

$Li^+_{(aq)} + 1e \rightarrow Li_{(s)}$ $E° = -3.05$ V

$O_{2(g)} + 4H^+_{(aq)} + 4e \rightarrow 2H_2O_{(l)}$ $E° = 1.23$ V

$F_{2(g)} + 2e \rightarrow 2F^-_{(aq)}$ $E° = 2.87$ V

What is the product produced at the cathode when a current is passed through an aqueous solution of LiF?

(A) lithium (B) fluorine (C) hydrogen (D) oxygen

(E) none of the above

33. How much charge is required to deposit 19.3 g of Fe from molten $FeCl_3$?

(A) 5.00×10^4 C (B) 1.00×10^5 C (C) 3.60×10^5 C

(D) 7.45 C (E) none of the above

34. Consider the electrochemical cell,

$Cu_{(s)}|Cu^{2+}(0.25M)||Co^{3+}(0.75\ M)|Co^{2+}(1.25\ M)$.

If E° for the cell is 1.47 V, what is E(volts) for the cell?

(A) 1.45 V (B) 1.57 V (C) 1.63 V (D) 1.31 V (E) none of the above

35. Which of the following objects is chiral?

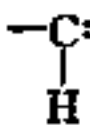
(A) pencil (B) screw (C) nail (D) thimble (E) none of the above

36. What is the systematic name for the molecule, $CH_3(CH_2)_4CO_2H$?

(A) hexane acid (B) pentanoic acid (C) hexanoic acid

(D) methylpentanoic acid (E) none of the above

37. The functional group that has the structure,



is

(A) an aldehyde (B) a ketone (C) an alcohol

(D) an alkene (E) none of the above

38. Which step in a chain reaction has the highest activation energy?

(A) initiation (B) propagation (C) termination

(D) continuation (E) none of the above

39. Study the reactions on the following list and select the reaction where bromide ions act as catalysts.

(A) $2Br^-_{(aq)} + PbCl_{2(s)} \rightarrow PbBr_{2(s)} + 2Cl^-_{(aq)}$

(B) $Br_2 + CH_2CH_2 \rightarrow CH_2BrCH_2Br$

(C) $2Na + Br_2 \rightarrow 2NaBr$

(D) $Br_2 + NaOH \rightarrow NaBr + HBrO$

(E) none of the above

40. What will be the equilibrium constant expression for the gas phase reaction, $PCl_3 + Cl_2 \leftrightarrow PCl_5$?

(A) $[PCl_5][PCl_3][Cl_2]$ (B) $[PCl_3][Cl_2]/[PCl_5]$

(C) $[PCl_5]/[PCl_3][Cl_2]$ (D) $[PCl_3][Cl_2]$

(E) none of the above

41. The mineral most important in the function of hemoglobin is

(A) Mg (B) Fe (C) Ca (D) Zn (E) none of the above

42. The major function of starch in the diet is

(A) protein synthesis (B) a source of energy (C) an aid to enzyme action

(D) cell wall function (E) none of the above

43. Which of the following protein side chains is classified as hydrophobic?

(A) $-CH_2CH(CH_3)_2$ (B) $-CH_2OH$ (C) $-(CH_2)_4NH_2$

(D) $-CH_2COOH$ (E) none of the above

44. Uranyl nitrate, $UO_2(NO_3)_2$, decomposes when heated to produce uranium(VI) oxide, nitrogen dioxide and oxygen. Write a balanced chemical equation for this reaction. What is the coefficient for oxygen in this equation?

(A) 1 (B) 2 (C) 3 (D) 4 (E) none of the above

45. The mass of a uranium-238 nucleus is 238.0003 u. The mass of a proton and neutron are 1.00728 u and 1.00867 u, respectivwely. What is the mass defect for the uranium-238 nucleus?

(A) 1.9353 u (B) 1.8572 u (C) 1.9987 u (D) 2.0341 u

(E) none of the above