單選題（1-20 題，每題 2.5 分）

1. Calculate the pH of a 0.021 *M* NaCN solution. Given K_a(HCN)=4.9×10^{-10}.
   (A)1.68 (B) 3.18 (C) 5.49 (D) 7.00 (E) 10.82
2. The isomerization of cyclopropane follows first order kinetics. The rate constant at 700 K is 6.2×10^{-4} min^{-1}, and the half-life at 760 K is 29.0 min. Calculate the activation energy for this reaction.
   (A) 5.07 kJ/mol (B) 27.0 kJ/mol (C) 50.7 kJ/mol (D) 160 kJ/mol
   (E) 270 kJ/mol
3. For what reaction-order does the half-life get longer as the initial concentration increases?
   (A) zero order (B) first order (C) second order (D) third order
   (E) none of the above
4. Calculate the work done against an atmospheric pressure of 1.0 atm when 7.65 mole of zinc dissolves in excess acid at 30 °C.
   (A) w=+22.4 kJ (B) w=+24.9 kJ (C) w=0 (D) w=–2.52 kJ (E) w=–19.3 kJ
5. Hydrogen peroxide (H_2O_2) decomposes according to the equation: $H_2O_{2(l)} \rightarrow H_2O_{(l)} + 1/2\ O_{2(g)}$. ΔH^0=-98.2 kJ/mol, ΔS^0=70.1 J/mol. What is the value of K_p for this reaction at 25 C?
   (A) 1.3×10^{-21} (B) 20.9 (C) 3.46 10^{17} (D) 7.7×10^{20} (E) 8.6×10^{4}
6. Which statement about ozone and the ozone layer is true?
   (A) Ozone is found in a band of almost pure ozone several *km* thick encircling the Earth.
   (B) The ozone layer encircles Earth and contains more ozone than is found elsewhere.
   (C) Ozone is a compound with the chemical formula CO_2
   (D) In the Earth's atmosphere, ozone exists only in the ozone layer.
   (E) Ozone is used as a coolant in refrigerators and air conditioners.
7. The K_{sp} value for $PbCl_2$ is 2.4×10^{-4}. What is the molar solubility of $PbCl_2$?
   (A) 2.4×10^{-4} mol/L (B)6.2×10^{-2} mol/L (C) 7.7×10^{-3} mol/L
   (D) 3.9×10^{-2} mol/L (E) 6.0×10^{-5} mol/L
8. Which of the following solutions has the highest osmotic pressure at 25 °C?
   (A) 0.2 M KBr (B) 0.2 M ethanol (C) 0.2 M Na_2SO_4 (D) 0.2 M KCl

9. A solution is prepared by dissolving 0.005 mole each of ammonia and pyridine (C_5H_5N) together in enough water to make 200.0 cm^3 of solution.
What is the value of $[OH^-]$? ($K_b(NH_3)=1.8\times 10^{-5}$, $K_b(C_5H_5N)=1.7\times10^{-9}$)
(A) 1.34×10^{-3} M (B) 6.7×10^{-4} M (C) 2.01×10^{-3} M (D) 1.8×10^{-5} M
(E) 1.7×10^{-9} M
10. Which one of the following is the unit for a second-order reaction?
(A) sec^{-1} (B) sec^{-2} (C) $M^{-1}\ sec^{-1}$ (D) $M^{-1}\ sec^{-2}$ (E) $M^{-2}\ sec^{-1}$
11. The triple point of iodine (I_2) is at 0.12 atm and 115 °C. This means that liquid I_2
(A) is more dense than $I_{2(s)}$ (B) cannot exist above 115 °C
(C) is liquid at room temperature
(D) cannot have a vapor pressure less than 0.12 atm
12. The number of atoms in a face-centered cubic unit cell is
(A) 1 (B)2 (C) 3 (D) 4 (E) 8
13. Which of the following molecules have the same shape?
(A) SF_4 and CH_4 (B) CO_2 and H_2O (C) CO_2 and BeH_2 (D) N_2O and NO_2
14. What is the dominant type of intermolecular force present in liquid benzene
(A) ionic (B) dipole-dipole (C) hydrogen bonding (D) dispersion
(E) dipole-induced dipole
15. Consider the electrochemical cell $Zn(s)\,|\,Zn^{2+}$ (1.0 *M*) $\|$ Cu^{+2} (1.0 *M*) $\,|\,$Cu (s). Under which following conditions will the cell voltage change?
(A) the concentration of Zn^{2+} and Cu^{2+} are both decreased to 0.5 *M*
(B) the concentration of Zn^{2+} and Cu^{2+} are both increased to 2.0 *M*
(C) the mass of the anode is doubled
(D) the temperature is raised to 50 °C
(E) the salt bridge concentration is increased
16. Which one is the weakest reducing agent listed below:
(A) Cr^{3+} (B) Cr (C) Mn^{2+} (D) Co (E) MnO_4^-
17. What is the bond order for the CN^- anion?
(A) 1 (B) 1.5 (C) 2 (D)2.5 (E) 3
18. What is the bond order for NO?
(A) 1 (2) 1.5 (C) 2 (D) 2.5 (E) 3
19. Which of the followings are true for a spontaneous redox reaction in the forward direction
(A) $\Delta S>0$ (B) $\Delta G<0$ (C) $E_{redox}<0$ (D) $\Delta H>0$ (E) $\Delta H<0$

20. Which of the following would cause the percent ionization of a weak acid to increase?
(A) addition of a strong acid
(B) addition of a salt containing its conjugate base
(C) diluting with more water
(D) the percent ionization of a weak acid is a constant and cannot be increased

〈21-45 題，每題 2 分〉

21. Ultrapure silicon is produced by
(A) distillation (B) crystallization (C) sublimation
(D) zone refining (E) none of the above
22. Which of the following is false?
(A) Vulcanization is achieved by heating natural rubber with sulfur.
(B) Vulcanized rubber has disulfide linkages between rubber chains.
(C) Vulcanization improves the properties of rubber.
(D) Vulcanization allows rubber to be stretched further.
(E) none of the above
23. Which of the following is false?
(A) The presence of an aromatic ring in the polymer chain makes the polymer stiff and strong.
(B) Polyester molecules are not capable of hydrogen bonding with each other.
(C) Polyesters are formed from dicarboxylic acids and diols.
(D) The molecule eliminated when a polyester is formed is ammonia.
(E) none of the above
24. Which of the following is false?
(A) High density polyethylene is used to make antifreeze bottles.
(B) High density polyethylene has a high degree of branching.
(C) High density polyethylene molecules lie very close together.
(D) High density polyethylene is less flexibe than low density polyethylene.
(E) none of the above
25. A fourteen gram serving of diet margarine contains seventy Calories. How many servings are necessary to supply the basic body requirements of 1750 Cal/day?
(A) 350 (B) 5.8 (C) 25 (D) 18 (E) none of the above

26. Hydrogen bonding between DNA strands occurs between pairs of nitrogen bases. Which of the following is a pair of nitrogen bases where hydrogen bonding in DNA is important?
(A) guanine-thymine (B) cystosine-adenine (C) adenine-thymine
(D) cytosine-thymine (E) none of the above

27. 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

28. Which of the following would represent a termination step in a free radical reaction that had a chain mechanism?
(A) $2Cl \rightarrow Cl_2$ (B) $CH_3 + Cl_2 \rightarrow CH_4 + Cl$
(C) $Cl + CH_4 \rightarrow CH_3 + HCl$ (D) $Cl_2 + H \rightarrow HCl + Cl$.
(E) none of the above

29. Consider the reaction, A + B → products, which has the rate equation, rate = k[A]. The half-life for the reaction is 46.2 hours. How long will it take for the concentration of A to fall from 0.050 M to 0.048 M?
(A) 2.0 h (B) 3.5 h (C) 4.7 h (D) 6.8 h (E) none of the above

30. Consider the rate data for the reaction,
2A + 3B→ products.

Initial [A]	Initial [B]	$-\Delta[A]/\Delta t$
0.025 M	0.025 M	0.0012 mol min^{-1}
0.050 M	0.025 M	0.0024 mol min^{-1}
0.050 M	0.050 M	0.0024 mol min^{-1}

What is the rate equation for this reaction?
(A) k[A] (B) k[A][B] (C) $k[A]^2[B]$ (D) k[B] (E) none of the above

31. 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

32. How much charge is required to deposit 19.3 g of Fe from molten $FeCl_3$?
(A) 5.00×10^4 C (B) 1.00×10^3 C (C) 3.60×10^5 C
(D) 7.45 C (E) none of the above

33. The E° for the reaction, $I_2 + 2Br^- \rightarrow Br_2 + 2I^-$, is -0.55 V.
What is the value of K for this reaction?
(A) 3.8×10^{-18} (B) 2.6×10^{-19} (C) 3.8×10^{18} (D) 6.7×10^{-22}
(E) none of the above

34. Consider the following half-reactions and voltages.
$F_2 + 2e^- \rightarrow F_2$ E° = 2.87 V
$Al_3 + + 3e^- \rightarrow Al$ E° = -1.66 V
What will be the voltage potential for the spontaneous process when the two half-reactions interact in an electrochemical cell?
(A) -3.8 V (B) 3.8 V (C) -1.21 V (D) -2.6 V (E) none of the above

35. A 0.35 M solution of the acid HA has a pH of 4.7. What is the Ka of HA?
(A) 2.4×10^{-6} (B) 4.6×10^{-6} (C) 1.1×10^{-8} (D) 5.3×10^{-9}
(E) none of the above

36. The K_b of aniline, $C_6H_5NH_2$, is 4.3×10^{-10}. What is the pH of a 0.15 M solution of $C_6H_5NH_3Cl$ in water?
(A) 11.3 (B) 8.6 (C) 5.2 (D) 2.7 (E) none of the above

37. Under which condition is a reaction always in equilibrium?
(A) $\Delta H = 0$ (B) $\Delta S = 0$ (C) $\Delta H = -$ (D) $\Delta H = +$ (E) none of the above

38. Given the following values of the $\Delta G_f°$ in kJ mol^{-1}:
$CH_4(g) = -50.8$ $CCl_4(l) = -65.3$ $HCl(g) = -95.3$
What is the value of $\Delta G°$ 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

39. The major source of energy for industrialized nations is
(A) nuclear (B) coal (C) wind (D) solar (E) none of the above

40. Draw the Lewis structure for benzene, C_6H_6(the carbons should be in a six-membered ring). How many single bonds are present?
(A) 9 (B) 11 (C) 7 (D) 5 (E) none of the above

41. What is the name of the hydrocarbon, C_3H_8?
(A) methane (B) propane (C) butane (D) hexane (E) none of the above

42. The shape of the water molecule is
(A) angular (B) planar triangular (C) linear (D) tetrehedral
(E) none of the above

43. Draw an energy level diagram for a nitrogen atom. How many unpaired electrons are present?
(A) 3 (B) 2 (C) 1 (D) 4 (E) none of the above

44. What volume of 0.25 M HCl will react with 39 g of alaminum hydroxide, $Al(OH)_3$? (Assume product is $AlCl_3$.)
(A) 8.0 L (B) 6.0 L (C) 4.0 L (D) 2.0 L (E) none of the above

45. When a 18.7 g sample of oxygen reacts with 5.0 g of ethane, 14.2 g of carbon dioxide is recovered. What is the percentage yield for this reaction?
(A) 44% (B) 97% (C) 91% (D) 86% (E) none of the above