單一選擇題 (第 1、2 二題各 2 分，其餘每題 3 分)

1. All of the following have resonance structures except
(A) $CH_3CO_2^-$ (B) SO_2 (C) NO_3^- (D) H_2NNH_2 (E) O_3

2. Which of the following has the highest lattice energy?
(A) KI (B) MgO (C) NaCl (D) BaO (E) CaO

3. What is the shape of IF_4^+?
(A) square planar (B) trigonal bipyramidal (C) seesaw (D) tetrahedral (E) T-shaped

4. All of the following are paramagnetic except
(A) O_2^+ (B) O_2^- (C) N_2^{2+} (D) O_2 (E) N_2^{2-}

5. The overall nucleosynthesis of ^{60}Co results from bombardment of a certain element with 2 neutrons along with β emission. Identify the starting element.
(A) ^{58}Fe (B) ^{59}Co (C) ^{60}Fe (D) ^{59}Fe (E) ^{58}Ni

6. For the oxides CrO, Cr_2O_3, and CrO_3, which of the following is true?
(A) CrO is basic, Cr_2O_3 is amphoteric, and CrO_3 is acidic. (B) All the oxides are basic.
(C) CrO and Cr_2O_3 are acidic and CrO_3 is basic. (D) All the oxides are acidic.
(E) CrO is acidic, and Cr_2O_3 and CrO_3 are basic.

7. 25. The products of the reaction of $Al_4C_3(s)$ with water are
(A) $Al(OH)_3(s)$ and $C_2H_4(g)$ (B) $Al_2O_3(s)$ and $CH_4(g)$ (C) $Al(OH)_3(s)$ and $CH_4(g)$
(D) $Al_2O_3(s)$ and $C_2H_2(g)$ (E) $Al(OH)_3(s)$ and $C_2H_2(g)$

8. For a 0.10 M solution of a weak acid, HA, with pKa = 10, which of the following is true?
(A) $[HA] = [H_3O^+]$ (B) $[HA] \cong 0$ (C) [HA] = Ka (D) $[HA] = [A^-]$ (E) $[HA] \neq [H_3O^+]$

9. Which of the following are allotropes?
(A) boron carbide and carbon (B) silicon, carbon, and C_{60} (C) graphite, diamond, and C60
(D) carbon monoxide and carbon dioxide (E) silicon carbide, diamond, and C_{60}

10. When ammonium chloride is added to $NH_3(aq)$,
(A) the pH of the solution decreases. (B) the pH of the solution increases.
(C) the equilibrium concentration of $NH_3(aq)$ decreases. (D) the K_b increases.
(E) the pH of the solution does not change.

11. The three quantum numbers for an electron in a hydrogen atom in a certain state are $n = 4$, $\ell = 2$, $m_\ell = 1$. The electron is located in what type of orbital?
(A) 3d (B) 4s (C) 4p (D) 3p (E) 4d

(背面仍有題目,請繼續作答)

12. In the most plausible Lewis structure of $XeOF_2$, there are
(A) 2 single bonds, 1 double bond, and 2 lone pairs of electrons around Xe.
(B) 2 single bonds, 1 double bond, and 3 lone pairs of electrons around Xe.
(C) 3 single bonds and 2 lone pairs of electrons around Xe.
(D) 3 single bonds and 1 lone pair of electrons around Xe.
(E) 2 single bonds, 1 double bond, and 1 lone pair of electrons around Xe.

13. Which one of the following statements is incorrect?
(A) For a one-dimensional particle in a box, the separation between neighboring energy levels decreases as the length of the container increases.
(B) For a one-dimensional particle in a box, as the mass of the particle becomes larger the separation between neighboring energy levels increases.
(C) For a one-dimensional particle in a box, the separation between neighboring energy levels becomes zero when the walls of the box are infinitely far apart.
(D) Argon atoms in a cylinder can be treated as though their translational energy was not quantized.
(E) A billiard ball on a table has a completely negligible zero-point energy.

14. The pH of 0.80 M benzenesulfonic acid is 0.51. What is the percent ionization of benzenesulfonic acid?
(A) 5.0% (B) 51% (C) 39% (D) 64% (E) 25%

15. Which of the following is true?
(A) An electron in an s-orbital has a zero probability of being found at the nucleus.
(B) A p-orbital has a spherical boundary surface.
(C) An electron in a p-orbital has zero probability of being found at the nucleus.
(D) A 2s orbital has one nodal plane.
(E) An s-orbital becomes more dense as the distance from the nucleus increases.

16. The rate law for the following mechanism is

$ClO^-(aq) + H_2O(l) \rightarrow HOCl(aq) + OH^-(aq)$ K, fast
$I^-(aq) + HOCl(aq) \rightarrow HOI(aq) + Cl^-(aq)$ k_1, slow
$HOI(aq) + OH^-(aq) \rightarrow OI^-(aq) + H_2O(l)$ k_2, fast

(A) rate = $k_1 \cdot K[ClO^-][I^-]$ (B) rate = $k_1 \cdot K[ClO^-][I^-][OH^-]^{-1}$ (C) rate = $k_1 \cdot k_2 \cdot K[ClO^-][I^-]$
(D) rate = $k_1[I^-][HOCl]$ (E) rate = $k_1 \cdot K[ClO^-][I^-][OH^-]$

17. Rhodium lies below cobalt in the periodic table. What is the d-electron configuration of $[Rh(CN)_6]^{3-}$?
(A) t_{2g}^5 (B) t_{2g}^6 (C) $t_{2g}^5e_g^2$ (D) $t_{2g}^4e_g^1$ (E) $t_{2g}^4e_g^2$

18. If $\Delta G° = -27.1$ kJ at 25℃ for the reaction: $CH_3COO^-(aq) + H_3O^+(aq) \rightarrow CH_3COOH(aq) + H_2O(aq)$ calculate the value of the equilibrium constant for this reaction at 298 K.
(A) 1.01 (B) 1.78×10^{-5} (C) 1.15×10^{-11} (D) 9.89×10^{-1} (E) 5.63×10^4

19. Consider the following reaction: $2HI(g) \rightarrow H_2(g) + I_2(g)$
At 298 K, $K_c = 1.3 \times 10^{-3}$, whereas at 783 K, $K_c = 2.2 \times 10^{-2}$. Which of the following is true?
(A) The reaction is exothermic. (B) At 783 K, more HI(g) is produced. (C) At 298 K, $K_p = 3.2 \times 10^{-2}$
(D) $K_p = K_c$ at both temperatures. (E) At 298 K, the reaction is likely to be spontaneous.

20. The standard voltage of the cell: $Pt \mid H_2(g) \mid H^+(aq) \parallel Cl^-(aq) \mid AgCl(s) \mid Ag(s)$ is 0.22 V at 25℃.
Calculate the equilibrium constant for the reaction below.
$2AgCl(s) + H_2(g) \rightarrow 2Ag(s) + 2H^+(aq) + 2Cl^-(aq)$
(A) 2.7×10^7 (B) 1.7×10^3 (C) 5.2×10^3 (D) 7.4 (E) 3.7

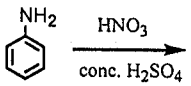
21. Calculate the standard entropy of fusion of ethanol at its melting point, 159 K. The standard molar enthalpy of fusion (in $J \cdot K^{-1} \cdot mol^{-1}$)of ethanol at its melting point is 5.02 $kJ \cdot mol^{-1}$.
(A) +5.02 [1] (B) −44.0 (C) −31.6 J (D) −5.02 (E) +31.6

22. Calculate $\Delta G°$ for the decomposition of mercury(II) oxide at 298 K.
$2HgO(s) \rightarrow 2Hg(l) + O_2(g)$
Assume $\Delta H_f°$ of HgO(s) is $-90.8\ kJ \cdot mol^{-1}$; S° of HgO(s), Hg(l), and $O_2(g)$ are 70.3, 76.0, and 205.1 $J \cdot K^{-1} \cdot mol^{-1}$, respectively.
(A) −46.2 kJ (B) −4.5 kJ (C) +246.2 kJ (D) −17.1 kJ (E) +117.1 kJ

23. The atomic radius of zinc is 137 pm. Estimate its density, given that the metal has a face-centered-close-packed structure. (Zn = 63.5)
(A) 4.49 $g.cm^{-3}$ (B) 14.0 $g.cm^{-3}$ (C) 7.47 $g.cm^{-3}$ (D) 19.2 $g.cm^{-3}$ (E) 10.2 $g.cm^{-3}$

24. If 2.00 mol of an ideal gas at 300 K and 3.00 atm expands from 6.00 L to 18.00 L and a final pressure of 1.20 atm, isothermally and reversibly, which of the following is correct?
(A) w = −5.48 kJ, q = −5.48 kJ, ΔU = −11.0 kJ (B) w = −5.48 kJ, q = +5.48 kJ, ΔU = 0
(C) w = −3.65 kJ, q = +3.65 kJ, ΔU = 0 (D) w = +3.65 kJ, q = +3.65 kJ, ΔU = +7.30 kJ
(E) w = +5.48 kJ, q = +5.48 kJ, ΔU = +11.0 kJ

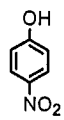
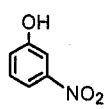
25. Name the following compound. 
(A) 1-methyl-3,3-dichlorocyclohexane (B) 1-methyl-5,5-dichlorocyclohexane
(C) 1,1-dichloro-5-methylcyclohexane (D) dichlorocyclohexane-3-methyl
(E) 1,1-dichloro-3-methylcyclohexe

26. What major product(s) is (are) obtained from the following reaction?

(A) ortho-nitroaniline (B) meta-nitroaniline (C) para-nitroaniline
(D) ortho-nitroaniline and para-nitroaniline (E) ortho-, meta-, and para-nitroaniline

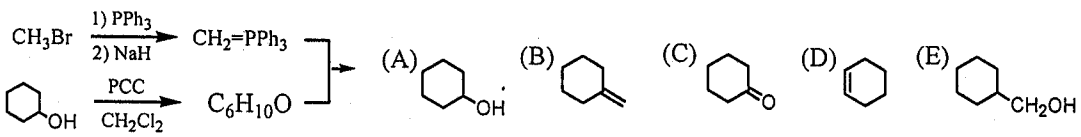
(背面仍有題目,請繼續作答)

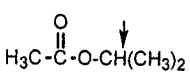
27. When ethene is bubbled through bromine water, the solution is decolorized. Which of the following is true regarding this reaction?
(A) Br_2 acts as a nucleophile. (B) Br_2 acts as an electrophile.
(C) The first step is the removal of a hydrogen atom to form $(C_2H_3)^-$.
(D) The Br^- ion attacks at the same face of the bromonium ion.
(E) Br_2 attacks the carbons of the double bond in one step.

28. If 2-bromooctane rotates the plane of polarized light to the right while the product rotates the plane of polarized light to the left, which of the following is true?
(A) This is an example of an electrophilic substitution. (B) The reaction occurs by an S_N1 mechanism.
(C) This is an example of an elimination reaction. (D) This is an example of an addition reaction.
(E) The reaction occurs by an S_N2 mechanism.

29. Which of the following compounds is the strongest acid?
(A)  (B)  (C)  (D)  (E) C_2H_5OH

30. Predict the product of the reaction of acetic acid with dimethylamine.
(A) CH_3CONH_2 (B) $CH_3CON(CH_3)_2$ (C) no reaction occurs
(D) $CH_3CONH(CH_3)_2^+$ (E) $CH_3CONHCH_3$

31. Predict the product of the following reactions.


32. What is the splitting pattern for indicated hydrogen atom in the ^1H NMR spectrum? 
(A) singlet (B) doublet (C) triplet (D) quartet (E) septet

33. Which of the following compounds give a singlet with 3 hydrogens at about 2.0 ppm in the ^1H-NMR spectrum?
(A) $HCO_2CH(CH_3)_2$ (B) $CH_3OCH_2CH_3$ (C) $CH_3CH(OH)CH_2CHO$
(D) $CH_3COCH_2CH_3$ (E) $CH_3CH{=}CHCH_3$

34. What is the most likely structure for compound X that has the molecular formula, C_5H_8O, and an IR spectrum with a peak at 1710 cm^{-1}, but no peak at 1650 cm^{-1}?
(A)  (B)  (C)  (D) $CH_3CH{=}CHCH_2CHO$ (E) $CH_3CH{=}CHCH_2CH_3$