系所組別： 地科系、化工系、材料系、環工系

考試科目： 普通化學

考試日期：0711，節次：1

※ 考生請注意：本試題 ☑可 ☐不可 使用計算機

說明：1. 答案一律寫在答案卷上，否則不計分。
2. 請依序作答、並標明題號。
3. 常數： $c = 2.998 \times 10^8$ m/s, $h = 6.626 \times 10^{-34}$ J s, $F = 96485$ C/mol,
$R = 8.314$ J/mol K $= 0.082$ atm L/mol K

一、選擇題：(每題 3 分，共 60 分，答錯不倒扣)

1. What type of structure does the IF_3 molecule have?
(A) pyramidal (B) tetrahedral (C) T-shaped (D) trigonal planar (E) octahedral

2. Which of the following is paramagnetic?
(A) B_2 (B) C_2 (C) H_2 (D) N_2 (E) At least two of the above are paramagnetic.

3. The density of diatomic gas is 1.696 g/L at STP. Identify the gas. (H:1, N:14, O:16, F:19, Cl:35.5)
(A) H_2 (B) N_2 (C) O_2 (D) F_2 (E) Cl_2

4. Consider the reaction: $2NOBr(g) \rightleftharpoons 2NO(g) + Br_2(g)$. A 1.0 L vessel was initially filled with pure NOBr at a pressure of 4.0 atm and 300 K. At equilbirum, the partial pressure of NOBr was 2.50 atm. Determine the value of K_p for the reaction.
(A) 0.14 (B) 0.18 (C) 0.27 (D) 0.45 (E) none of these

5. What is the pH of a 0.2 *M* solution of NH_4Cl? K_b for NH_3 is 1.8×10^{-5}.
(A) 2.7 (B) 5.0 (C) 7.0 (D) 9.0 (E) 11.3

6. Which one of the following equations represents the formation reaction of $CH_3OH(l)$?
(A) $C(g) + 2H_2(g) + \frac{1}{2}O_2(g) \rightarrow CH_3OH(l)$ (B) $C(g) + 4H(g) + O(g) \rightarrow CH_3OH(l)$
(C) $C(\text{graphite}) + 4H(g) + O(g) \rightarrow CH_3OH(l)$ (D) $C(\text{diamond}) + 4H(g) + O(g) \rightarrow CH_3OH(l)$
(E) $C(\text{graphite}) + 2H_2(g) + \frac{1}{2}O_2(g) \rightarrow CH_3OH(l)$

7. Consider a weak acid, HX. The value of $\Delta G°$ for the acid's dissociation reaction at 25°C is 42.6 kJ. What is the value of K_a for the acid?
(A) 1.63 (B) 3.41×10^{-8} (C) 4.26×10^5 (D) 2.86×10^{-6} (E) none of these

8. The standard potential for the reaction $A + B \rightleftharpoons C + D$ is 1.50 volts. The equilibrium constant *K* for this reaction at 25°C is:
(A) 2.5×10^{25} (B) 4.0×10^{-26} (C) 25.4 (D) –25.4 (E) not enough information given

9. What mass of copper will be deposited when 18.2 amp are passed through a $CuSO_4$ solution for 45.0 minutes? (O: 16, S: 32, Cu: 63.5)
(A) 16.2 g (B) 33.4 g (C) 40.6 g (D) 81.3 g (E) 163 g

10. For which of the following can we not draw a stable Lewis structure?
(A) PCl_5 (B) OCl_6 (C) SCl_6 (D) All of the above have stable Lewis structures.
(E) None of the above (A-C) has a stable Lewis structures.

(背面仍有題目,請繼續作答)

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11. Consider the molecular orbital description of the NO^- anion. Which of the following statements is false?
(A) NO^- is paramagnetic. (B) NO^- is isoelectronic with CO.
(C) The bond order in NO^- is 2. (D) Statements A through D are false.
(E) The bond energy in NO^+ is greater than the bond energy in NO^-.

12. For which order reaction is the half life $t_{½}$ of the reaction proportional to $1/k$ where k is the rate constant?
(A) zero order (B) first order (C) second order (D) all of the above
(E) none of the above

13. Which one of the following is the strongest intermolecular force experienced by noble gases?
(A) London dispersion forces (B) dipole-dipole interactions (C) hydrogen bonding
(D) ion-ion interactions (E) polar covalent bonds

14. When water is heated, its pH decreases. This means that
(A) the water is no longer neutral (B) $[H^+] > [OH^-]$ (C) $[OH^-] > [H^+]$
(D) (A) and (B) are correct (E) none of these

15. Which of the following complexes shows geometric isomerism?
(A) $[Co(NH_3)_5Cl]SO_4$ (B) $[Co(NH_3)_6]Cl_3$ (C) $[Co(NH_3)_5Cl]Cl_2$ (D) $K[Co(NH_3)_2Cl_4]$
(E) none of these

16. Which of the following is optically active (i.e., chiral)?
(A) $HN(CH_3)_2$ (B) CH_2Cl_2 (C) 2-chloropropane (D) 2-chlorobutane
(E) 3-chloropentane

17. In the **best** Lewis structure for ClO_3^-, what is the formal charge on Cl ?
(A) 0 (B) +1 (C) –1 (D) +2 (E) –2

18. For a chemical reaction to be spontaneous only at high temperatures, which of the following conditions must be met?
(A) $\Delta S° > 0, \Delta H° > 0$ (B) $\Delta S° > 0, \Delta H° < 0$ (C) $\Delta S° < 0, \Delta H° < 0$
(D) $\Delta S° < 0, \Delta H° > 0$ (E) $\Delta G° > 0$

19. A voltaic cell prepared using aluminum and nickel has the following cell notation.
$Al(s) \mid Al^{3+}(aq) \parallel Ni^{2+}(aq) \mid Ni(s)$ Which of the following reactions occurs at the anode?
(A) $Al(s) \rightarrow Al^{3+}(aq) + 3e^-$ (B) $Al^{3+}(aq) + 3e \rightarrow Al(s)$ (C) $Ni(s) \rightarrow Ni^{2+}(aq) + 2e^-$
(D) $Ni^{2+}(aq) + 2e^- \rightarrow Ni(s)$ (E) none of these choices is correct

20. The rate constant for a reaction increases from 10.0 s^{-1} to 100. s^{-1} when the temperature is increased from 300 K to 400 K. Calculate the activation energy for the reaction in kJ/mol. (6%)
(A) 23.0 (B) 12.7 (C) 5.00 (D) 18.3 (E) 45.6

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二、簡答題：(寫出答案即可)(每題 4 分，共 20 分)

1. What is the de Broglie wavelength(in nm) of an electron with mass 9.11×10^{-31} kg moving at 2.00% of the speed of the light.

2. The formation constant K_f for the complex ion $Ag(NH_3)_2^+$ is 1.7 and the solubility product K_{sp} for AgCl is 1.6×10^{-10}. What is the molar solubility of AgCl in 1.0 *M* NH_3?

3. When a 1.50 g sample of glutamic acid (麩氨酸) is dissolved in 100.0 g H_2O, the resulting solution freezes at −0.190°C and the freezing-point depression constant K_f for H_2O is 1.86°C kg/m. What is the molar mass(in g/mol) of glutamic acid?

4. What is the pH at the equivalence point for the titration of 1.0 *M* ethylamine, $C_2H_5NH_2$, by 1.0 *M* perchloric acid, $HClO_4$? (pK_b for $C_2H_5NH_2$ = 3.25)

5. At 25°C a galvanic cell is constructed with copper electrodes and Cu^{2+} in each compartment. In one compartment, the $[Cu^{2+}] = 1.0 \times 10^{-3}$ *M* and in the other compartment, the $[Cu^{2+}]$ = 2.0 *M*. What is the potential(in V) for this cell? The standard reduction potential for Cu^{2+} is +0.34 V.

三、計算及說明題：(計算題需寫出計算過程) (共 20 分)

1. Given the following information:

$Li(s) \rightarrow Li(g)$	heat of sublimation of Li(*s*) = 166 kJ/mol
$HCl(g) \rightarrow H(g) + Cl(g)$	bond energy of HCl = 427 kJ/mol
$Li(g) \rightarrow Li^+(g) + e^-$	ionization energy of Li(*g*) = 520 kJ/mol
$Cl(g) + e^- \rightarrow Cl^-(g)$	electron affinity of Cl(*g*) = –349 kJ/mol
$Li^+(g) + Cl^-(g) \rightarrow LiCl(s)$	lattice energy of LiCl(*s*) = –829 kJ/mol
$H_2(g) \rightarrow 2H(g)$	bond energy of H_2 = 432 kJ/mol

Calculate the net energy change for the reaction $2Li(s) + 2HCl(g) \rightarrow 2LiCl(s) + H_2(g)$. (6%)

2. Calculate the pH in a solution that consists of 1.2 *M* HClO and 2.3 *M* NaClO. (6%) K_a for HClO is 3.5×10^{-8}.

3. Describe the molecular orbital electron configurations of N_2 molecule. (4%)

4. Draw the structure of 2,3-dichloro-*trans*-2-butene compound. (4%)