科目：普通化學 適用：應化系

編號：486

考生注意：
1.依次序作答，只要標明題號，不必抄題。
2.答案必須寫在答案卷上，否則不予計分。
3.限用藍、黑色筆作答；試題須隨卷繳回。

一、單選題：(36% total, 3% each)

1. Consider three 1-L flasks at the same temperature and pressure. Flask A contains CO gas, flask B contains N_2 gas, and flask C contains O_2 gas. Which contains the lowest density?

A) Two of the flasks contain gases at the same density. B) flask A
C) All are the same. D) flask B E) flask C

2. The value of the equilibrium constant *K* is dependent on

I. the temperature of the system. II. the nature of the reactants and products.
III. the concentration of the reactants. IV. the concentration of the products.

A) II and III only B) three of these C) I and II only
D) III and IV only E) none of these

3. For the reaction $CO_2(g) + 2H_2O(g) \rightarrow CH_4(g) + 2O_2(g)$, $\Delta H^\circ = 803$ kJ

Which of the following will increase *K*?

A) increasing the volume of system B) increasing the temperature of system
C) decreasing the number of moles of methane D) all of these E) none of these

4. Which intermolecular force is the strongest?

A) polar covalent bonds B) hydrogen bonding C) dipole-dipole interactions
D) London dispersion forces E) ionic bonding

5. Which of the following is *not* the correct chemical formula for the compound named?

A) Zn_3P_2 zinc phosphide B) HF hydrogen fluoride
C) $BaBr_2$ barium bromide D) Li_2O lithium oxide
E) Fe_2SO_4 iron(II) sulfate

6. Ionic hydrides are formed when hydrogen combines with elements from

I. Group 1A II. Group 2A III. Group 3A

A) I and III only B) I, II, and III C) II and III only D) I and II only E) none of these

7. Which of the following is the best reducing agent?

$Cl_2 + 2e^- \rightarrow 2Cl^-$ $E^\circ = 1.36$ V
$Mg^{2+} + 2e^- \rightarrow Mg$ $E^\circ = -2.37$ V
$2H^+ + 2e^- \rightarrow H_2$ $E^\circ = 0.00$ V

A) H_2 B) Mg C) Mg^{2+} D) Cl^- E) Cl_2

8. Order the following bonds from highest to lowest bond energy: carbon–carbon, silicon–silicon, silicon–oxygen.

A) Si—Si, Si—O, C—C B) C—C, Si—Si, Si—O C) Si—O, Si—Si, C—C

D) C—C, Si—O, Si—Si E) Si—O, C—C, Si—Si

9. Which are alkaline earth halides?

A) PbI_2, $PbBr_2$, CdF_2 B) NaI, KBr, LiF C) MgO, MgS, CaO

D) Al_2O_3, In_2O_3, Ga_2S_3 E) CaF_2, $MgBr_2$, SrI_2

10. For the hypothetical reactions 1 and 2, $K_1 = 10^2$ and $K_2 = 10^{-4}$.

1. $A_2(g) + B_2(g) \rightleftharpoons 2AB(g)$
2. $2A_2(g) + C_2(g) \rightleftharpoons 2A_2C(g)$
3. $A_2C(g) + B_2(g) \rightleftharpoons 2AB(g) + (1/2)C_2(g)$

What is the value for K for reaction 3?

A) 10^{-4} B) 10^{-2} C) 10^4 D) 10^6 E) 10^2

11. For the vaporization of a liquid at a given pressure,

A) ΔG is negative at low temperatures but positive at high temperatures (and zero at some temperature).

B) ΔG is positive at low temperatures but negative at high temperatures (and zero at some temperature).

C) ΔG is negative at all temperatures. D) ΔG is positive at all temperatures.

12. Given a cylinder of fixed volume filled with 1 mol of argon gas, which of the following is correct? (Assume all gases obey the ideal gas law.)

A) If a second mole of argon is added to the cylinder, the ratio T/P will remain constant.

B) A cylinder of identical volume filled with the same *pressure* of helium must contain more atoms of gas because He has a smaller atomic radius than argon.

C) If the temperature of the cylinder is changed from 25°C to 50°C, the pressure inside the cylinder will double.

D) Two of these are correct. E) None of these is correct.

二、簡答題：(64%)

1. Consider the following two unbalanced equations:

$$CH_4 + O_2 \rightarrow CO_2 + H_2O$$

$$H_2 + O_2 \rightarrow H_2O$$

Suppose you carry out each reaction with the same mass of oxygen (and with an excess of CH_4 and H_2). In which case will you make more water (3%), and why? (3%)

2. What is the correct order of boiling points for $NaNO_3$, CH_3OH, C_2H_6, and Ne (3%), and why? (3%)

3. Diagram and label a vapor pressure diagram for an ideal solution of two volatile liquids. (3%) Indicate the deviation predicted by an endothermic heat of solution. (3%)

4. Balance each of the following equations.

1) $MnO_4^- + Br^- \rightarrow MnO_2 + BrO_3^-$ (base) (3%)

2) $C_3H_5(NO_3)_3 \rightarrow N_2 + CO_2 + H_2O + O_2$ (3%)

3) $Cr_2O_7^{2-} + I^- \rightarrow Cr^{3+} + IO_3^-$ (acid) (3%)

5. The ionization energies, in kcalories, for Mg and Ca are

	Mg	Ca
first	176	141
second	346	247
third	1847	

1) Indicate the reasons for the relatively high third ionization energy for magnesium. (3%)

2) Indicate the reasons for the difference between the first ionization energies for Mg and Ca. (3%)

6. Define solubility product constant (3%), and explain how the solubility of an ionic solid at a constant temperature for a given ionic solid can vary. (3%)

7. Refer to the SeF_4 molecule:

1) What is the hybridization of the central atom? (2%)

2) How many lone pairs of electrons are around the central atom? (2%)

3) What is the shape of the molecule around the central atom? (2%)

4) Is the molecule polar or nonpolar? (1%)

8. True or False? (2%) The pH of a strong acid solution is always lower than the pH of a weak acid solution. If this is true, explain why and include an example with calculations. If it is false, explain why and include a counterexample with calculations. (4%)

9. The mechanism below has been proposed for the reaction $2A_2 + B_2 \rightarrow 2C$

step 1 (very slow) $A_2 + B_2 \rightarrow R + C$

step 2 (slow) $A_2 + R \rightarrow C$

1) What is the molecularity of step 2? (3%)

2) Which step(s) is(are) rate-determining? (3%)

10. Consider the following reaction:

$$2Al(s) + 3Cl_2(g) \rightarrow 2AlCl_3(s), \quad \Delta H = -1390.81 \text{ kJ}$$

1) Is the reaction exothermic or endothermic? (3%)

2) How many grams of Al are required to produce 139.081 kJ of energy? Atomic weight: Al, 26.98; Cl, 35.45. (3%)