

系所組別：地科、化工、材料、環工系

考試科目：普通化學

考試日期：0713，節次：1

※ 考生請注意：本試題 可 不可 使用計算機

說明：答案一律寫在試卷上；請依序作答，並標明題號。

( $h=6.626 \times 10^{-34}$  Js,  $R=8.314$  J/mole = 0.082 atm L/mole, K,

$K_a(\text{HC}_2\text{H}_3\text{O}_2)=1.8 \times 10^{-5}$ ,  $K_{a1}(\text{H}_2\text{CO}_3)=4.3 \times 10^{-7}$ ,  $K_{a2}(\text{H}_2\text{CO}_3)=4.8 \times 10^{-11}$ )

一、選擇題：(單選；每題3分，不倒扣，共75分)

1. Consider the bond order and magnetic property of CN molecule, which of the following is correct?

- (A) bond order 1.5, paramagnetic (B) bond order 2, diamagnetic  
 (C) bond order 2.5, paramagnetic (D) bond order 3, diamagnetic  
 (E) bond order 2, paramagnetic

2. How many nodes are there for the 2p and 3s orbitals of the hydrogen atom, respectively?

- (A) 0, 1 (B) 0, 2 (C) 2, 3 (D) 1, 3 (E) 1, 2

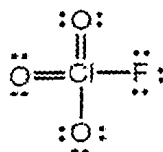
3. According to the valence bond theory, which hybridization orbital of Xe atom in  $\text{XeF}_2$  is used to bond with F atom?

- (A) sp (B)  $sp^2$  (C)  $sp^3$  (D)  $dsp^3$  (E)  $sp^3d^2$

4. Given that  $\text{A}^{2-}$ ,  $\text{B}^-$ ,  $\text{C}$ ,  $\text{D}^+$ , and  $\text{E}^{2+}$  are all isoelectronic, which of the following is correct for the radius?

- (A)  $\text{A}^{2-} > \text{B}^- > \text{C} > \text{D}^+ > \text{E}^{2+}$  (B)  $\text{E}^{2+} > \text{D}^+ > \text{C} > \text{B}^- > \text{A}^{2-}$  (C)  $\text{A}^{2-} > \text{B}^- > \text{E} > \text{D}^+ > \text{C}$   
 (D)  $\text{C} > \text{D}^+ > \text{E}^{2+} > \text{A}^{2-} > \text{B}^-$  (E) none of above

5. What's the formal charge of Cl atom in the Lewis structure of  $\text{ClO}_3\text{F}$ ?



- (A) 7 (B) 6 (C) 1 (D) 2 (E) 5

6. According to the VSEPR theory, what's the molecular shape of  $\text{NOCl}$ ?

- (A) linear (B) trigonal planar (C) bent (D) tetrahedral (E) trigonal pyramidal

7. Which of the following is correct for the molecular orbital configuration of  $\text{O}_2^-$ ?

- (A)  $(\sigma_{2s})^2(\sigma_{2s}^*)^2(\sigma_{2p})^2(\pi_{2p})^4(\sigma_{2p}^*)^2(\pi_{2p}^*)^1$  (B)  $(\sigma_{2s})^2(\sigma_{2s}^*)^2(\pi_{2p})^4(\sigma_{2p})^2(\sigma_{2p}^*)^2(\pi_{2p}^*)^1$   
 (C)  $(\sigma_{2s})^2(\sigma_{2s}^*)^2(\sigma_{2p})^2(\pi_{2p})^2(\sigma_{2p}^*)^2(\pi_{2p}^*)^3$  (D)  $(\sigma_{2s})^2(\sigma_{2s}^*)^2(\sigma_{2p})^2(\pi_{2p})^4(\pi_{2p}^*)^3$   
 (E) none of above

(背面仍有題目,請繼續作答)

系所組別：地科、化工、材料、環工系

考試科目：普通化學

考試日期：0713，節次：1

※ 考生請注意：本試題  可  不可 使用計算機

8. Which of the ions can only exist in high spin state in forming octahedral complex?  
 (A)  $\text{Cr}^{2+}$  (B)  $\text{Mn}^{4+}$  (C)  $\text{Fe}^{3+}$  (D)  $\text{Co}^{3+}$  (E)  $\text{Ni}^{2+}$
9. Which of the following octahedral complexes has the largest crystal field splitting energy?  
 (A)  $[\text{Cr}(\text{H}_2\text{O})_6]^{3+}$  (B)  $[\text{Cr}(\text{SCN})_6]^{3-}$  (C)  $[\text{Cr}(\text{NH}_3)_6]^{3+}$  (D)  $[\text{Cr}(\text{CN})_6]^{3-}$   
 (E)  $[\text{Cr}(\text{en})_3]^{3+}$  (en = ethylenediamine)
10. Order the following from the strongest to the weakest base:  
 (1)  $\text{NH}_3$ , (2)  $\text{C}_2\text{H}_5\text{NH}_2$ , (3)  $\text{CH}_3\text{NH}_2$ , (4)  $\text{C}_6\text{H}_5\text{NH}_2$   
 (A) 1, 3, 2, 4 (B) 4, 2, 3, 1 (C) 2, 3, 1, 4 (D) 2, 3, 4, 1 (E) 4, 1, 3, 2
11. For the reaction  $2\text{H}_2(\text{g}) + \text{O}_2(\text{g}) \rightleftharpoons 2\text{H}_2\text{O}(\text{g})$ , what is the relationship between  $K$  and  $K_p$  at temperature  $T$ ?  
 (A)  $K=K_p$  (B)  $K=K_p(\text{RT})^2$  (C)  $K_p=K(\text{RT})^2$  (D)  $K=K_p(\text{RT})$   
 (E)  $K_p=K(\text{RT})$
12. Consider an elementary reaction  $\text{A} \xrightleftharpoons[k_{-1}]{k_1} \text{B}$ . If  $k_1=3k_{-1}$ , and  $[\text{B}]_0=0$ , what is  $[\text{A}]/[\text{A}]_0$  at equilibrium?  
 (A) 3/4 (B) 2/5 (C) 1/3 (D) 2/3 (E) 1/4
13. A solution contains 0.05 M  $\text{HC}_2\text{H}_3\text{O}_2$  and 0.05 M  $\text{NaC}_2\text{H}_3\text{O}_2$ . What's the pH value when 0.01 mol of gaseous  $\text{HCl}$  is added to 1.0 L of above solution?  
 (A) 4.80 (B) 4.74 (C) 4.66 (D) 4.56 (E) 4.38
14. The enthalpy change for the following reaction  

$$1 \text{ mole } \text{CH}_4(\text{g}) + 2 \text{ mole } \text{O}_2(\text{g}) \rightarrow 1 \text{ mole } \text{CO}_2(\text{g}) + 2 \text{ mole } \text{H}_2\text{O}(\text{g})$$
 at 1 atm and 25 °C is -890 kJ. What is the change of internal energy for the reaction? (A) -895 kJ (B) -880 kJ (C) 4.97 kJ (D) -885 kJ (E) -890 kJ.
15. Calculate the  $\Delta S_{\text{sys}}$  for the reversible, isothermal compression of 2.0 mole of ideal gas molecules from 1.0 atm and 4.0 L to 20.0 atm and 0.20 L at 298 K.  
 (A) -26.4 J/K (B) -63.5 J/K (C) -54.3 J/K (D) -49.8 J/K (E) -36.8 J/K.
16. Calculate the standard free energy of formation of  $\text{HI}(\text{g})$  at 25 °C from the following data:  $\Delta H_f^\circ(\text{HI}(\text{g}))=26.48 \text{ kJ/mol}$ ,  $S_m^\circ(\text{HI}(\text{g}))=206.6 \text{ J/K,mol}$ ,  $S_m^\circ(\text{H}_2(\text{g}))=130.7 \text{ J/K,mol}$ ,  $S_m^\circ(\text{I}_2(\text{s}))=116.1 \text{ J/K,mol}$ .  
 (A) 2.53 kJ/mol (B) 1.69 kJ/mol (C) 1.85 kJ/mol (D) 1.24 kJ/mol  
 (E) 0.96 kJ/mol.

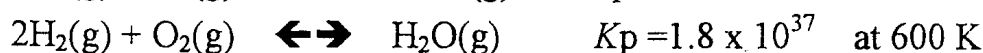
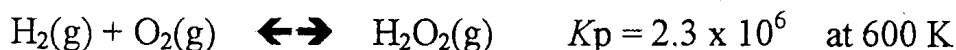
系所組別：地科、化工、材料、環工系

考試科目：普通化學

考試日期：0713，節次：1

※ 考生請注意：本試題  可  不可 使用計算機17. The dissociation of hydrogen  $\text{H}_2(\text{g}) \rightleftharpoons 2\text{H}(\text{g})$ 

- (A) is spontaneous at any temperature. (B) is spontaneous at high temperature.  
 (C) is spontaneous at low temperature. (D) is <sup>non</sup>spontaneous at any temperature.  
 (E) never takes place.

18. Calculate  $\Delta G^\circ$  for  $\text{H}_2\text{O}(\text{g}) + (1/2)\text{O}_2(\text{g}) \rightleftharpoons \text{H}_2\text{O}_2(\text{g})$  at 600 K, using the data:

- (A) 140 kJ (B) -220 kJ (C) -290 kJ (D) -350 kJ (E) 290 kJ

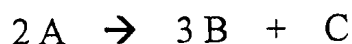
19. Calculate  $\Delta G$  at 25 °C for the reaction  $\text{CO}(\text{g}) + 2\text{H}_2(\text{g}) \rightarrow \text{CH}_3\text{OH}(\text{l})$ 

- , in which  $p_{\text{CO}} = 4.0 \text{ atm}$ ,  $p_{\text{H}_2} = 2.0 \text{ atm}$ ,  $\Delta G_f^\circ(\text{CO}) = -137 \text{ kJ/mol}$ ,  $\Delta G_f^\circ(\text{CH}_3\text{OH}) = -166 \text{ kJ/mol}$ . (A) -35.9 kJ (B) -22.1 kJ (C) -32.5 kJ (D) -26.1 kJ  
 (E) -38.2 kJ

20. How would  $\Delta G$  change during the reaction in Problem 19?

- (A) decreases monotonically (單調) to zero (B) increases monotonically to zero  
 (C) decreases first and then increases (D) decreases first and then increases  
 (E) none of above

21. What's the rate constant for the first-order reaction

if  $[\text{A}]_0 = 0.040 \text{ mol/L}$ ,  $[\text{B}]_0 = 0$ , and  $[\text{B}] = 0.030 \text{ mol/L}$  after 8.8 minutes?

- (A)  $6.2 \times 10^{-2} \text{ s}^{-1}$  (B)  $3.5 \times 10^{-3} \text{ s}^{-1}$  (C)  $1.3 \times 10^{-3} \text{ s}^{-1}$  (D)  $8.4 \times 10^{-2} \text{ s}^{-1}$  (E)  $5.6 \times 10^{-2} \text{ s}^{-1}$

22. What's the half-life in Problem(21)?

- (A) 724 s (B) 658 s (C) 126 s (D) 245 s (E) 528 s

23. Calculate the number of stages needed to change a mixture of  $^{13}\text{CO}_2$  and  $^{12}\text{CO}_2$  that is originally 0.10 % (by moles)  $^{13}\text{CO}_2$  to a mixture that is 0.010%  $^{13}\text{CO}_2$  by a gaseous diffusion process. (The mass of  $^{13}\text{C}$  is 13.003355 amu.)

- (A) 205 (B) 120 (C) 365 (D) 620 (E) 435

24. Which of the following names is a correct one?

- (A) 3,4-dichloropentane (B) 1-chloro-2,4-methyl-3-ethylcyclohexane  
 (C) 1,1-dimethyl-2,2-diethylbutane (D) *cis*-1,3-dimethylpropane  
 (E) 2-bromo-1-chloro-4,4-diethyloctane

25. How many isomers are there with the formula  $\text{C}_2\text{H}_2\text{Br}_2$ ? Include both structural and geometric isomers.

- (A) 2 (B) 3 (C) 4 (D) 5 (E) 6

(背面仍有題目,請繼續作答)

系所組別：地科、化工、材料、環工系

考試科目：普通化學

考試日期：0713，節次：1

※ 考生請注意：本試題  可  不可 使用計算機

二、非選擇題：(共 25 分，計算題務必列出計算過程，只寫答案不計分)

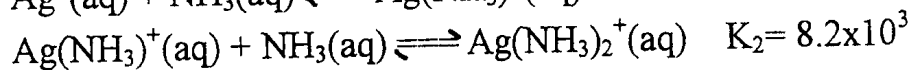
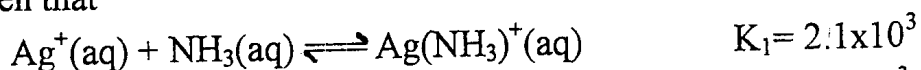
1. For the titration of 25.0 mL of 0.10 M  $\text{Na}_2\text{CO}_3$  with 0.10 M HCl.

(a) Calculate the pH after 50.0 mL HCl has been added.

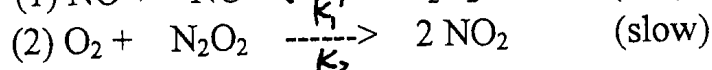
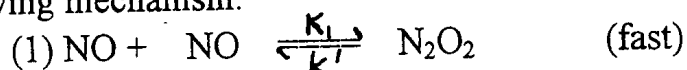
(b) Plot the titration curve.

(8%)

2. Given that

, calculate the equilibrium concentration of  $\text{Ag}^+$  for a solution by mixing 30.0 mL of 3.0 M  $\text{NH}_3$  and 400.0 mL of  $1 \times 10^{-3}$  M  $\text{AgNO}_3$ .

(6%)

3. The reaction  $2 \text{NO}(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2 \text{NO}_2(\text{g})$  is believed to take place by the following mechanism:(a) Derive the concentration of  $\text{N}_2\text{O}_2$  at steady-state.(b) Derive the equation for  $d[\text{NO}_2]/dt$  under the condition  $k_1' \gg k_2[\text{O}_2]$ . (11%)