

九十一學年度 原子科學 系(所) 乙 組碩士班研究生招生考試

科目 普通化學 科號 3301 共 4 頁第 1 頁 \*請在試卷【答案卷】內作答

(一) 單選題，每題三分，無倒扣 (75%)

- 1 If a process is both endothermic and spontaneous then  
(a)  $\Delta S > 0$  (b)  $\Delta S < 0$  (c)  $\Delta H < 0$  (d)  $\Delta G > 0$  (e)  $\Delta E = 0$
  
- 2 For the gas-phase decomposition  $\text{PCl}_5 \rightleftharpoons \text{PCl}_3(\text{g}) + \text{Cl}_2(\text{g})$   
(a)  $\Delta H < 0$  and  $\Delta S < 0$  (b)  $\Delta H > 0$  and  $\Delta S > 0$  (c)  $\Delta H > 0$  and  $\Delta S < 0$   
(d)  $\Delta H < 0$  and  $\Delta S > 0$  (e)  $\Delta H = 0$  and  $\Delta S > 0$
  
- 3 The reaction  $\text{A}(\text{g}) + 2\text{B}(\text{g}) \rightarrow \text{C}(\text{g}) + \text{D}(\text{g})$  is an elementary process. In an experiment, the initial partial pressures of A and B are  $P_A = 0.60$  atm and  $P_B = 0.80$  atm. When  $P_C = 0.20$  atm, the rate of the reaction, relative to the initial rate, is  
(a)  $\frac{1}{4}$  (b)  $\frac{1}{8}$  (c)  $\frac{1}{16}$  (d)  $\frac{1}{2}$  (e)  $\frac{1}{3}$
  
- 4 For a hypothetical reaction  $\text{A} + 2\text{B} \rightarrow 3\text{C} + \text{D}$ ,  $d[\text{C}]/dt$  is equal to  
(a)  $-d[\text{A}]/dt$  (b)  $-d[\text{B}]/dt$  (c)  $+3d[\text{A}]/dt$  (d)  $-\frac{1}{2}d[\text{B}]/dt$  (e)  $+d[\text{A}]/dt$
  
- 5 For a reaction for which the activation energies of the forward and reverse directions are equal in value,  
(a) the stoichiometry is the mechanism (b)  $\Delta H = 0$  (c)  $\Delta S = 0$   
(d) the order is 0 (e) there is no catalyst
  
- 6 Potassium hexacyanoferrate(II) is the compound  
(a)  $\text{K}_4[\text{Fe}(\text{CN})_6]$  (b)  $\text{KFe}(\text{SCN})_4$  (c)  $\text{K}_3[\text{Fe}(\text{CN})_6]$  (d)  $\text{K}_3[\text{Fe}(\text{SCN})_6]$   
(e)  $\text{K}_4[\text{Fe}(\text{NCO})_6]$
  
- 7 Which of the following complexes exhibits optical isomerism?  
(a) *trans*-dithiocyanatotetraamminechromium(III) ion  
(b) *cis*-dicarbonatodiammincobaltate(III) ion  
(c) *trans*-dicarbonatodiammincobaltate(III) ion  
(d) *cis*-diglycinatoplatinum(II)  
(e) *trans*-diglycinatoplatinum(II)
  
- 8 Of the following complexes, the one with the largest value of the crystal field splitting,  $\Delta_0$ , is  
(a)  $\text{Fe}(\text{H}_2\text{O})_6^{2+}$  (b)  $\text{Ru}(\text{H}_2\text{O})_6^{2+}$  (c)  $\text{Fe}(\text{NH}_3)_6^{3+}$  (d)  $[\text{Ru}(\text{CN})_6]^{3-}$   
(e)  $[\text{Fe}(\text{CN})_6]^{3-}$

九十一學年度 原子科學系 系(所) 乙 組碩士班研究生招生考試

科目 普通化學 科號 3301 共 4 頁第 2 頁 \*請在試卷【答案卷】內作答

- 9 The amount of energy required to remove the electron from a  $\text{Li}^{2+}$  ion in its ground state is how many times greater than the amount of energy needed to remove the electron from an H atom in its ground state?  
 (a) 2 (b) 3 (c) 4 (d) 6 (e) 9
- 10 The most intense line in the Brackett series of the spectrum of atomic hydrogen is the transition  
 (a)  $n_H = \infty \rightarrow n_L = 1$  (b)  $n_H = 8 \rightarrow n_L = 4$  (c)  $n_H = \infty \rightarrow n_L = 4$   
 (d)  $n_H = 4 \rightarrow n_L = 3$  (e)  $n_H = 5 \rightarrow n_L = 4$
- 11 The ground state electronic configuration of  $\text{Fe}^{3+}$  is  
 (a)  $(\text{Ar})^{18}3d^34s^2$  (b)  $(\text{Ar})^{18}3d^64s^2$  (c)  $(\text{Ar})^{18}3d^5$  (d)  $(\text{Ar})^{18}3d^44s$   
 (e)  $(\text{Ar})^{18}3d^6$
- 12 When arranged in order of increasing atomic number, the elements exhibit periodicity for all of the following properties EXCEPT  
 (a) atomic radii (b) atomic weights (c) ionization energy  
 (d) boiling point (e) electronegativity
- 13 Which one of the five oxides of chlorine is paramagnetic?  
 (a)  $\text{Cl}_2\text{O}$  (b)  $\text{ClO}_2$  (c)  $\text{Cl}_2\text{O}_4$  (d)  $\text{Cl}_2\text{O}_6$  (e)  $\text{Cl}_2\text{O}_7$
- 14 Each of the following molecules has a nonzero dipole moment EXCEPT  
 (a)  $\text{C}_6\text{H}_6$  (b)  $\text{CO}$  (c)  $\text{SO}_2$  (d)  $\text{NH}_3$  (e)  $\text{LiH}$
- 15 In the best Lewis structure for  $\text{ICl}_3$ , the formal charge on I is  
 (a) 0 (b) +1 (c) -1 (d) +2 (e) -2
- 16 In which of the following compounds does every atom have eight electrons in its valence shell?  
 (a)  $\text{IF}_5$  (b)  $\text{C}_2\text{H}_4$  (c)  $\text{SF}_4$  (d)  $\text{NO}_2$  (e)  $\text{KH}$
- 17 Which of the following diatomic species do you expect to have the longest bond length?  
 (a)  $\text{NO}^+$  (b)  $\text{O}_2^-$  (c)  $\text{CO}$  (d)  $\text{O}_2^+$  (e)  $\text{N}_2^+$



九十一學年度 原子科學系(所) 乙 組碩士班研究生招生考試

科目 普通化學 科號 3301 共 4 頁第 3 頁 \*請在試卷【答案卷】內作答

- 18 If the system  $\text{CaCO}_3(\text{s}) \rightleftharpoons \text{CaO}(\text{s}) + \text{CO}_2(\text{g})$  is at equilibrium at constant temperature, and the number of moles of CaO in the vessel is doubled,
- The reaction quotient,  $Q$ , is doubled.
  - The reaction quotient,  $Q$ , is halved.
  - The number of moles of  $\text{CO}_2$  present at equilibrium is halved.
  - The number of moles of  $\text{CaCO}_3$  in the vessel increases.
  - The partial pressure of  $\text{CO}_2$  in the vessel remains unchanged.
- 19 All of the following are acid-base conjugate pairs EXCEPT
- $\text{HONO}, \text{NO}_2^-$
  - $\text{H}_3\text{O}^+, \text{OH}^-$
  - $\text{CH}_3\text{NH}_3^+, \text{CH}_3\text{NH}_2$
  - $\text{HS}^-, \text{S}^{2-}$
  - $\text{C}_6\text{H}_5\text{COOH}, \text{C}_6\text{H}_5\text{COO}^-$
- 20 When  $\text{K}_2\text{O}$  is added to water, the solution is basic because it contains a significant concentration of
- $\text{K}^+$
  - $\text{K}_2\text{O}$
  - $\text{O}^{2-}$
  - $\text{O}_2^{2-}$
  - $\text{OH}^-$
- 21 A solution has  $[\text{OH}^-] = 4.8 \times 10^{-3}$ . Its pH is
- 11.7
  - 8.4
  - 4.8
  - 3.7
  - 2.3
- 22 A buffer that is a mixture of acetic acid and potassium acetate has a  $\text{pH} = 5.24$ . The  $[\text{OAc}^-]/[\text{HOAc}]$  ratio in this buffer is
- 1:1
  - 3:1
  - 5:1
  - 1:3
  - 1:5
- 23 A weak base, B, has basicity constant  $K_b = 2 \times 10^{-3}$ . The pH of any solution in which  $[\text{B}] = [\text{BH}^+]$  is
- 4.7
  - 7.0
  - 9.3
  - 9.7
  - 10.3
- 24 The molar solubility,  $s$ , of  $\text{Mn}(\text{OH})_2$  in water in terms of its  $K_{sp}$  is
- $s = (K_{sp})^{1/2}$
  - $s = (K_{sp})^{1/3}$
  - $s = (K_{sp}/4)^{1/3}$
  - $s = (K_{sp}/6)^{1/3}$
  - $s = (K_{sp}/27)^{1/4}$
- 25 The relationship between the  $K_{sp}$  of AgBr and the molar solubility,  $z$ , of AgBr in 0.20 F KBr is that  $K_{sp}$  equals
- $z^2$
  - $z/0.20$
  - $z^{1/2}$
  - $4z^3$
  - $0.20 z$

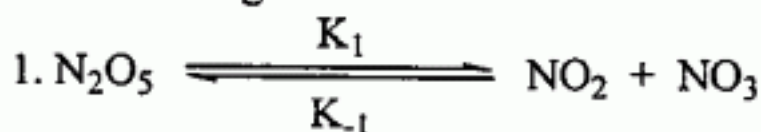
九十一學年度 原子科學 系(所) 乙 組碩士班研究生招生考試

科目 普通化學 科號 3301 共 4 頁第 4 頁 \*請在試卷【答案卷】內作答

(二) The mechanism of the reaction



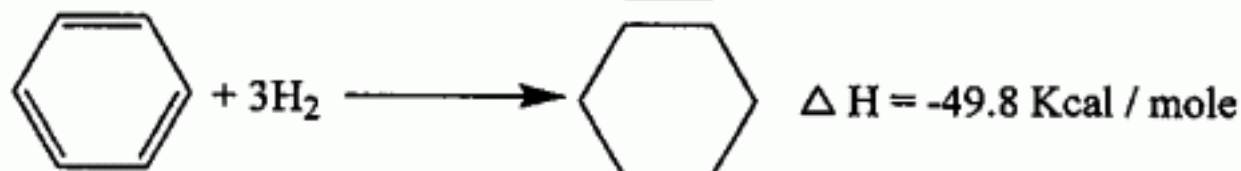
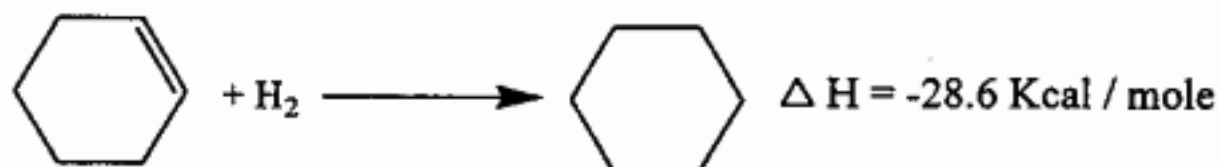
are following :



$$\text{Show that rate} = \frac{d[\text{O}_2]}{dt} = \frac{\text{K}_1 [\text{N}_2\text{O}_5]}{\text{K}_{-1} + 2\text{K}_2}$$

(10%)

(三) The hydrogenation of the following reactions are



From the above values of  $\Delta H$ , estimate the resonance energy (of  $6\pi$  electrons) for benzene. (10%)

(四) Prove that for an ideal gas

$$C_p = C_v + R$$

Where  $C_p$  and  $C_v$  are the heat capacity at constant pressure and volume, respectively.

$R$  is gas constant.

(5%)