(损害式)

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### 國立中山大學八十七學年度碩博士班招生考試試題

共4頁第/頁

# 种目: 線全化学 他學

Total 50 pts.

- 1. (Thermodynamics)
- (a) A certain battery runs a toy truck and becomes partially discharged. In the process, it performs a total of 117.0 joules of work (w) on its immediate surroundings. It also gives off 3.0 joules of heat (q), which the surroundings absorb. No other work or heat is exchanged with the surroundings. Compute q, w, and  $\Delta U$  (internal energy) for the battery, making sure each quantity has the proper sign. (6 pts.)
- (b) The same battery is now recharged exactly to its original state. requires 210.0 joules of electrical work from an generator. Determine a for the battery in this process. (5 pts.)
- (c) Explain why q has the sign that it does. (5 pts.)
- 2. (Chemical Kinetics)
- (d) Liquid A decomposes by first-order kinetics and 5% of A is converted in 5 minutes. How much longer would it take to reach 75% conversion? (8 pts.)
- (e) Repeat the previous problem for second-order kinetics. (8 pts.)

#### 3. (Quantum Chemistry)

An extremely crude picture of an electron in an atom is to treat the electron as a particle in a one-dimensional box which has a length on the order of the size of the atom.

- (f) For an electron in a box of length 1.0 Å, calculate the separation between the two lowest energy levels. (6 pts.)
- (g) Calculate the wavelength of a photon corresponding to a transition between these two levels. (6 pts.)
- (h) What portion of the electromagnetic spectrum does this wavelength correspond to? (6 pts.)

 $(m_e = 9.1 \times 10^{-31} \text{ kg}, h = 6.6262 \times 10^{-34} \text{ joule} \cdot \text{s}, c = 3 \times 10^8 \text{ m/s})$ 

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# 型立中山大學 1 學年度碩博士班招生考試試題 科目: 然后(七子 化學系 共工) 分析(七子部分 (送老雨部分) 共4頁第2頁

- 1. The fact that atoms and molecules absorb light is the basis for many different spectroscopic techniques in chemical analysis. List ten <u>different</u> ways through which absorption can be detected. In each case indicate what signal is measured and how the signal is related to atomic or molecular concentration. (25%).
- 2. For each of the followings, indicate an appropriate method of quantitative analysis. Provide sufficient information so that the plan of the analytical approach and the most vital experimental conditions are apparent. Include in your description a consideration of suspected interferences and give a reasonable method for eliminating or circumventing the interferences.

#### Answer any three

- (a) ppb concentrations of chloride and sulfate in steam condensate
- (b) Selenium in human hair
- (c) cadmium traces in milk powder
- (d) Glucose, fructose and sucrose in a syrup
- (e) Determination of dissolved oxygen as a function of depth in a lake
- (f) Determination of percent nitrogen in an NH4NO3 fertilizer (5-10% N)
- (g) Determination of Cr(VI) at the ppm level in the presence of Cr(III) in industrial waste water. (25%)

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(株ま大) 國立中山大學 1 學年度碩博士班招生考試試題 科目: 《宋 2 /七子 化學系 共4頁第3頁

# 無机化了却分(選者雨部分)

- . 1. (10%) Use Molecular Orbital approach to explain the following:
  - (a) An electron can be easily removed from NO to give NO+.
  - (b)  $C_2^{-2}$  dianion is more stable than diatomic  $C_2$  molecule.
- 2. (20%) Please draw the three dimensional structure of the following:
  - (a)  $[Co(CO)_4]^{-1}$
  - (b)  $[Os_2Cl_8]^{-2}$
  - (c)  $Al_2(CH_3)_6$
  - (d) N(SiH<sub>3</sub>)<sub>3</sub>
  - (e) [ReH<sub>9</sub>]-2
- 3. (10%) If one  $[CuL_6]^{+2}$  solution is blue and another is green, which would be expected to have the higher value of octahedral crystal splitting energy ( $\Delta_0$ )? Explain your answer with energy diagrams of d orbitals in octahedral field.
- 4. (10%) Describe as much as you can about what information can be obtained when following physical techniques are applied on organometallic complexes:

(Please choose only two of the three techniques to answer)

- (a) Nuclear Magnetic Resonance (NMR)
- (b) X-Ray diffraction
- (c) Electron Paramagnetic Resonance (EPR)

#### THE PERIODIC TABLE

Principal	Subshells being completed																		
quantum number		15		(n-1)d										np					
n	1 2												Nonmetals						
1	H He Light metals		Transition metals													•		VIII A (18)	
"American" → "1-18" →	I A	II A						<b>^</b>					111 A (13)	IV A (14)	V A (15)	VI A (16)	VII A (17)	2 He	
2	(§) 3 Li	(2) 4 Be				•					• >		5 B	6 C	7 N	8 0	9 F	10 Ne	
3	11 Na	12 Mg	(3)	IV B (4)	V B (5)	VI B	VII B	(8)	VIII B (9)	(10)	T B (11)	11 B (12)	13 Al	14 Si	15 P	16 S	17 Cl	18 Ar	
4	19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	-32 Ge	33 As	34 Se	35 Br	36 Kr	
5	37 Rb	38 Sr	39 Y	40 Zr	4L Nb	42 Mo	43 Te	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 ln	50 Sn	51 Sb	52 Te	53 I	54 Xe	
6	55 Cs	56 Ba	57 La	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Is	78 Pt	79 Au	80 Hg	81 Ti	82 Pb	83 Bi	84 Po	85 At	86 Rn	
7	87 Fr	88 Ra	89 Ac	104 Rf (Unq)	105 Ha (Unp)	106 Unh	107 Uns	108 Uno	109 Une	Posttransition metals									
1	L	٠	1								(n-	2)f							
e e			Lanthanide series		58 Ce	59 <b>P</b> r	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Үь	71 Lu	
			Actin		90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	I00 Fm	101 Md	102 No	103 Lr	

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#### 國立中山大學八十七學目: 然之令化了 (拼書式) 年度碩博士班招生考試試題

共4頁第4頁

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## (選考面部分)

Write the structure of the major product of the following reactions (be sure to specify stereochemistry) (30 pts.).

(d) 
$$\frac{1) O_3}{2) (CH_3)_2 S}$$

(g) 
$$CH_3CH_2CH_2C = CCH_3$$
 1)  $NaNH_2$ ,  $\Delta$  (h)

2. Write step-by-step mechanism for the following reactions (10 pts.).

3. Explain the results of the following reactions (10 pts.).

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