

國立彰化師範大學 100 學年度博士班招生考試試題

系所：科學教育研究所

科目：基礎化學(含無機、物化)

組別：丙

☆☆請在答案紙上作答☆☆

第 1 頁，共 3 頁

I. Answer the following questions [70%]

Note : (1) Must show detailed calculation processes in your answer.

(2) The calculation results might be ignored if calculator is prohibited.

1. Consider manganese, whose electron configuration is $[\text{Ar}]4s^23d^5$. When the Mn^{2+} ion is formed, we might expect the two electrons to be removed from the 3d orbitals to yield $[\text{Ar}]4s^23d^3$. Is it true? If it is wrong, what is the correct electron configuration and why? (5%)

2. In general, ionization energy increases from left to right across a given period. Aluminum, however, has lower ionization energy than magnesium. Explain. (5%)

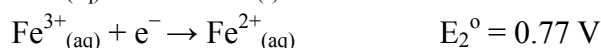
3. Alkali metals have a greater affinity for electrons than alkaline earth metals. Explain. (5%)

4. The wave function for the 1s orbital in the hydrogen atom is $\Psi_{1s} = \frac{1}{\sqrt{\pi}} e^{-r}$, where r is the value of the radius of the Bohr orbit radius a_0 , equal to 0.0529 nm. Derive that the distance of a_0 from nucleus has the maximum of Radial probability. (5%)

5. Write Lewis structures, the geometry of molecule and hybridization of central atom of the H_2O , SF_4 and XeF_4 . (18%)

6. A 74.6-g ice cube floats in the Arctic Sea. The temperature and pressure of the system and surroundings are at 1 atm and 0°C . Calculate ΔS_{sys} , ΔS_{surr} , and ΔS_{univ} for the melting of the ice cube. (12%)

7. Based on the following standard reduction potentials:



Calculate the standard reduction potential for the half reaction $\text{Fe}^{3+}_{(\text{aq})} + 3\text{e}^- \rightarrow \text{Fe}_{(\text{s})}$ (5%)

8. The half-life of Rn-222 is 3.8 days. Starting with the radioactivity level of 10 pC due to Rn-222, how long is it before the radioactivity level decreases to 4 pC, the up-limit value recommended by EPA? (pC means 3.70×10^{-2} disintegrations of radioactive nuclei per second.) (5%)

9. Calculate the molar solubility of AgCl (A) in water and (B) in a 1.0 M NH_3 solution. ($K_{\text{sp}} = 1.6 \times 10^{-10}$ for AgCl, $K_{\text{f}} = 1.5 \times 10^7$ for $\text{Ag}(\text{NH}_3)_2^+$) (10%)

國立彰化師範大學 100 學年度博士班招生考試試題

系所：科學教育研究所

科目：基礎化學(含無機、物化)

組別：丙

☆☆請在答案紙上作答☆☆

第 2 頁，共 3 頁

II. Multiple choice questions (choose only one answer) [30%]

- The ion $[\text{Co}(\text{NH}_3)_6]^{2+}$ is octahedral and high spin. This complex is
(A) diamagnetic. (D) paramagnetic, with 1 unpaired electron.
(B) paramagnetic, with 5 unpaired electrons. (E) paramagnetic, with 3 unpaired electrons.
(C) paramagnetic, with 4 unpaired electrons.
- The systematic name for the compound represented below is
$$\begin{array}{c} \text{CH}_2\text{-CH}_3 \\ | \\ \text{CH}_3\text{-CH}_2\text{-CH}_2\text{-CH-CH-CH}_3 \\ | \quad | \\ \text{CH}_2 \quad \text{CH}_2\text{-CH}_3 \end{array}$$

(A) 3-methyl-4-propylheptane (D) 4,5-diethylheptane
(B) 3-propyl-4-ethylhexane (E) 2-ethyl-4-propylhexan
(C) 3-ethyl-4-propylhexane
- The intermolecular force between bases on the opposite strands of DNA responsible for its double-helical structure is
(A) ionic force. (D) dispersion force.
(B) dipole-dipole force. (E) hydrogen bonding.
(C) covalent bonding.
- Which choice contains all three molecular units found in nucleotides?
(A) phosphate, sugar, amino acid (D) amino acid, nitrogen-containing base, sugar
(B) carboxylic acid, sugar, protein (E) sugar, amino acid, protein
(C) phosphate, nitrogen-containing base, sugar
- Which of the following statements about the binding of oxygen to deoxyhemoglobin is correct?
(A) The binding of oxygen to Fe^{2+} in the first heme pushes the iron ion out of the porphyrin ring, decreasing the affinity for the second oxygen.
(B) The binding of oxygen to Fe^{2+} in the first heme pulls the iron ion into the porphyrin ring, increasing the affinity for the second oxygen.
(C) The binding of oxygen to Fe^{2+} in the first heme pulls the iron ion into the porphyrin ring, decreasing the affinity for the second oxygen.
(D) The binding of oxygen to Fe^{2+} in the first heme pushes the iron ion out of the porphyrin ring, increasing the affinity for the second oxygen.
- Ammonia reacts with diatomic oxygen to form nitric oxide and water vapor:
$$4\text{NH}_3 + 5\text{O}_2 \rightarrow 4\text{NO} + 6\text{H}_2\text{O}$$

When 40.0 g NH_3 and 50.0 g O_2 are allowed to react, which is the limiting reagent?
(A) NH_3 (B) O_2 (C) NO (D) H_2O (E) No reagent is limiting.

國立彰化師範大學 100 學年度博士班招生考試試題

系所：科學教育研究所

科目：基礎化學(含無機、物化)

組別：丙

☆☆請在答案紙上作答☆☆

第 3 頁，共 3 頁

7. The first step in the Ostwald process for producing nitric acid is
 $4\text{NH}_3(\text{g}) + 5\text{O}_2(\text{g}) \rightarrow 4\text{NO}(\text{g}) + 6\text{H}_2\text{O}(\text{g})$
 If the reaction of 150.0 g of ammonia with 150.0 g of oxygen gas yields 87.0 g of nitric oxide (NO), what is the percent yield of this reaction?
 (A) 100% (B) 49% (C) 77% (D) 33% (E) 62%
8. Which of the following compounds is a *strong electrolyte*?
 (A) H_2O (B) CH_3OH (C) C_6H_6 (D) HF (E) NaCl
9. The oxidation number of N in NaNO_3 is
 (A) +6 (B) +5 (C) +3 (D) -3 (E) None of the above.
10. 35.0 mL of 0.255 M nitric acid is added to 45.0 mL of 0.328 M $\text{Mg}(\text{NO}_3)_2$. What is the concentration of nitrate ion in the final solution?
 (A) 0.481 M (B) 0.296 M (C) 0.854 M (D) 1.10 M

Useful Information: <http://www.qdm.ks.edu.tw/wakiki/chem/chm.htm>

化學元素週期表

原子序
↓
元素中文名稱
↓
說明：氫 H
↓
元素符號
↓
1.008
↓
原子量

氣體-藍色
惰性氣體-綠色
金屬固體-黃色
非金屬固體-紫色
液體-白色
人造元素-橘色

IA 1 1 氫 H 1.008	金屬																非金屬					VIIIA 2 2 氦 He 4.00													
2 3 3 鋰 Li 6.94	4 4 4 鈹 Be 9.01	過渡元素										5 5 5 硼 B 10.81	6 6 6 碳 C 12.01	7 7 7 氮 N 14.01	8 8 8 氧 O 16.00	9 9 9 氟 F 19.00	10 10 10 氖 Ne 20.2																		
3 11 11 鈉 Na 22.99	12 12 12 鎂 Mg 24.31	13 13 13 鋁 Al 26.98	14 14 14 矽 Si 28.1	15 15 15 磷 P 31.0	16 16 16 硫 S 32.1	17 17 17 氯 Cl 35.5	18 18 18 氬 Ar 39.9	19 19 19 鉀 K 39.1	20 20 20 鈣 Ca 40.08	21 21 21 鈦 Ti 47.88	22 22 22 釩 V 50.94	23 23 23 鉻 Cr 52.00	24 24 24 錳 Mn 54.94	25 25 25 鐵 Fe 55.85	26 26 26 鈷 Co 58.93	27 27 27 鎳 Ni 58.69	28 28 28 銅 Cu 63.55	29 29 29 鋅 Zn 65.38	30 30 30 鎳 Ga 69.72	31 31 31 鍺 Ge 72.64	32 32 32 砷 As 74.92	33 33 33 硒 Se 78.96	34 34 34 溴 Br 79.90	35 35 35 碘 I 126.9	36 36 36 氙 Kr 83.8										
4 37 37 鉀 Rb 85.5	38 38 38 鐳 Sr 87.62	39 39 39 鈾 Y 88.91	40 40 40 鋯 Zr 91.22	41 41 41 鈮 Nb 92.91	42 42 42 鉬 Mo 95.94	43 43 43 錳 Tc (99)	44 44 44 鈦 Ru 101.1	45 45 45 銻 Rh 102.9	46 46 46 鈀 Pd 106.4	47 47 47 銀 Ag 107.9	48 48 48 鎘 Cd 112.4	49 49 49 銦 In 114.8	50 50 50 錫 Sn 118.7	51 51 51 銻 Sb 121.8	52 52 52 碲 Te 127.6	53 53 53 碘 I 126.9	54 54 54 氙 Xe 131.3	55 55 55 銻 Cs 132.9	56 56 56 鋇 Ba 137.3	57-71 57-71 57-71 鐳系元素	72 72 72 釷 Th 232.0	73 73 73 釷 Pa 231.0	74 74 74 釷 U 238.0	75 75 75 釷 Np 237.0	76 76 76 釷 Pu 242.0	77 77 77 釷 Am 243.0	78 78 78 釷 Cm 247.0	79 79 79 釷 Bk 247.0	80 80 80 釷 Cf 251.0	81 81 81 釷 Es 252.0	82 82 82 釷 Fm 253.0	83 83 83 釷 Md 256.0	84 84 84 釷 No 259.0	85 85 85 釷 Lr 260.0	86 86 86 釷 Rn 222.0
鐳系元素		57 57 57 鐳 La 138.9	58 58 58 鐳 Ce 140.1	59 59 59 鐳 Pr 140.9	60 60 60 鐳 Nd 144.2	61 61 61 鐳 Pm (147)	62 62 62 鐳 Sm 150.4	63 63 63 鐳 Eu 152.0	64 64 64 鐳 Gd 157.3	65 65 65 鐳 Tb 158.9	66 66 66 鐳 Dy 162.5	67 67 67 鐳 Ho 164.9	68 68 68 鐳 Er 167.3	69 69 69 鐳 Tm 168.9	70 70 70 鐳 Yb 173.0	71 71 71 鐳 Lu 175.0																			
錒系元素		89 89 89 錒 Ac (227)	90 90 90 錒 Th 232.0	91 91 91 錒 Pa (231)	92 92 92 錒 U 238.0	93 93 93 錒 Np (237)	94 94 94 錒 Pu (242)	95 95 95 錒 Am (243)	96 96 96 錒 Cm (247)	97 97 97 錒 Bk (247)	98 98 98 錒 Cf (251)	99 99 99 錒 Es (252)	100 100 100 錒 Fm (253)	101 101 101 錒 Md (256)	102 102 102 錒 No (259)	103 103 103 錒 Lr (260)																			