

國立高雄大學 114 學年度研究所碩士班招生考試試題

科目：普通化學
考試時間：100 分鐘

系所：應用化學系
本科原始成績：100 分

是否使用計算機：是

— 作答注意事項 —

考試時間：100分鐘

作答方式：總分：100分

作答方式：

- 選擇題用原子筆在「答案卷」上作答。
- 答案卷每人一張，不得要求增補。
- 第 1 題至第 23 題為單選題，每題四分。
- 第 24 題為計算題，請列出計算步驟共八分。

參考資料

一、元素週期表

hydrogen 1 H 1.0079																	helium 2 He 4.0026				
lithium 3 Li 6.941	beryllium 4 Be 9.0122															boron 5 B 10.811	carbon 6 C 12.011	nitrogen 7 N 14.007	oxygen 8 O 15.999	fluorine 9 F 18.998	neon 10 Ne 20.180
sodium 11 Na 22.990	magnesium 12 Mg 24.305															aluminum 13 Al 26.982	silicon 14 Si 28.086	phosphorus 15 P 30.974	sulfur 16 S 32.065	chlorine 17 Cl 35.453	argon 18 Ar 39.948
potassium 19 K 39.098	calcium 20 Ca 40.078	scandium 21 Sc 44.956	titanium 22 Ti 47.867	vanadium 23 V 50.942	chromium 24 Cr 51.996	manganese 25 Mn 54.938	iron 26 Fe 55.845	cobalt 27 Co 58.933	nickel 28 Ni 58.693	copper 29 Cu 63.546	zinc 30 Zn 65.39	gallium 31 Ga 69.723	germanium 32 Ge 72.61	arsenic 33 As 74.922	selenium 34 Se 78.96	bromine 35 Br 79.904	krypton 36 Kr 83.80				
rubidium 37 Rb 85.468	strontium 38 Sr 87.62	yttrium 39 Y 88.906	zirconium 40 Zr 91.224	niobium 41 Nb 92.906	molybdenum 42 Mo 95.94	technetium 43 Tc [98]	ruthenium 44 Ru 101.07	rhodium 45 Rh 102.91	palladium 46 Pd 106.42	silver 47 Ag 107.87	cadmium 48 Cd 112.41	indium 49 In 114.82	tin 50 Sn 118.71	antimony 51 Sb 121.76	tellurium 52 Te 127.60	iodine 53 I 126.90	xenon 54 Xe 131.29				
cesium 55 Cs 132.91	barium 56 Ba 137.33	57-70 ★	lutetium 71 Lu 174.97	hafnium 72 Hf 178.49	tantalum 73 Ta 180.95	tungsten 74 W 183.84	rhenium 75 Re 186.21	osmium 76 Os 190.23	iridium 77 Ir 192.22	platinum 78 Pt 195.08	gold 79 Au 196.97	mercury 80 Hg 200.59	thallium 81 Tl 204.38	lead 82 Pb 207.2	bismuth 83 Bi 208.98	polonium 84 Po [209]	astatine 85 At [210]	radon 86 Rn [222]			
francium 87 Fr [223]	radium 88 Ra [226]	89-102 ★ ★	lawrencium 103 Lr [262]	rutherfordium 104 Rf [261]	dubnium 105 Db [262]	seaborgium 106 Sg [266]	bohrium 107 Bh [264]	hassium 108 Hs [269]	meitnerium 109 Mt [268]	unnilium 110 Uun [271]	ununium 111 Uuu [272]	unbibium 112 Uub [277]	ununquadium 114 Uuq [289]								

理想氣體常數和亞佛加厥常數

$$R = 8.314 \text{ J/mol} \cdot \text{K} = 0.0821 \text{ L} \cdot \text{atm/K} \cdot \text{mol}; \text{ Avogadro's number} = 6.022 \times 10^{23}$$

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For Questions 1~23, each question has only one correct answer.

- How many significant figures are there in the number 0.0006728?
 - 7
 - 3
 - 8
 - 4
 - 0
- Which of the following is incorrectly named?
 - $\text{Pb}(\text{NO}_3)_2$, lead(II) nitrate
 - NH_4ClO_4 , ammonium perchlorate
 - PO_4^{3-} , phosphate ion
 - $\text{Mg}(\text{OH})_2$, magnesium hydroxide
 - NO_3^- , nitrite ion
- Phosphorus has the molecular formula P_4 , and sulfur has the molecular formula S_8 . How many grams of phosphorus contain the same number of molecules as 7.76 g of sulfur?
 - 3.75 g
 - 0.267 g
 - 7.49 g
 - 7.76 g
 - none of these
- When $\text{NH}_3(\text{aq})$ is added to $\text{Cu}^{2+}(\text{aq})$, a precipitate initially forms. Its formula is:
 - $\text{Cu}(\text{NH})_3$
 - $\text{Cu}(\text{NO}_3)_2$
 - $\text{Cu}(\text{OH})_2$
 - $\text{Cu}(\text{NH}_3)_2^{2+}$
 - CuO
- A student weighs out 0.556 g of KHP (molar mass = 204.22 g/mol) and titrates to the equivalence point with 36.78 mL of a stock NaOH solution. What is the concentration of the stock NaOH solution? KHP is an acid with one acidic proton.
 - 0.00272 M
 - 0.100 M
 - 0.0151 M
 - 0.0740 M
 - none of these

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6. A vessel with a volume of 18.9 L contains 2.80 g of nitrogen gas, 0.807 g of hydrogen gas, and 79.9 g of argon gas. At 25°C, what is the pressure in the vessel?
- A. 107.0 atm
 - B. 0.271 atm
 - C. 3.88 atm
 - D. 3.23 atm
 - E. 61.1 atm
7. Which conditions of P, T, and n, respectively, are most ideal?
- A. high P, high T, high n
 - B. low P, low T, low n
 - C. high P, low T, high n
 - D. low P, high T, high n
 - E. low P, high T, low n
8. Calculate the work associated with the compression of a gas from 121.0 L to 80.0 L at a constant pressure of 23.4 atm.
- A. -959 L atm
 - B. 959 L atm
 - C. 1.75 L atm
 - D. -1.75 L atm
 - E. 101 L atm
9. Which of these is an isoelectronic series?
- A. Na^+ , K^+ , Rb^+ , Cs^+
 - B. K^+ , Ca^{2+} , Ar, S^{2-}
 - C. Na^+ , Mg^{2+} , S^{2-} , Cl^-
 - D. Li, Be, B, C
 - E. none of these (A-D)
10. Given the following bond energies:
- C-C 347 kJ/mol
 - C=C 614 kJ/mol
 - C-O 358 kJ/mol
 - C=O 799 kJ/mol
 - C-H 413 kJ/mol
 - O-H 463 kJ/mol
 - O-O 146 kJ/mol
- estimate ΔH for the reaction $\text{H}_2\text{O}_2 + \text{CH}_3\text{OH} \rightarrow \text{H}_2\text{CO} + 2\text{H}_2\text{O}$.

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- A. -345 kJ
- B. -199 kJ
- C. -105 kJ
- D. +199 kJ
- E. +345 kJ

11. The hybridization of the central atom in ClF_2^+ is:

- A. sp
- B. sp^2
- C. sp^3
- D. dsp^3
- E. d^2sp^3

12. How many electrons are involved in pi bonding in benzene, C_6H_6 ?

- A. 12
- B. 30
- C. 3
- D. 6
- E. 18

13. Which substance involves no bonding forces except London dispersion forces?

- A. NaCl(l)
- B. HF(l)
- C. $\text{N}_2\text{(s)}$
- D. $\text{H}_2\text{O(l)}$
- E. K(s)

14. The unit cell in a certain lattice consists of a cube formed by an anion at each corner, an anion in the center, and a cation at the center of each face. The unit cell contains a net:

- A. 5 anions and 6 cations
- B. 5 anions and 3 cations
- C. 2 anions and 3 cations
- D. 3 anions and 4 cations
- E. 2 anions and 2 cations

15. Benzene and toluene form an ideal solution. At 298 K, what is the mole fraction of benzene in the liquid that is in equilibrium with a vapor that has equal partial pressures of benzene and toluene? At 298 K, the vapor pressures of pure benzene and pure toluene are 95 and 28 torr, respectively.

- A. 0.50
- B. 0.77

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- C. 0.23
- D. 0.30
- E. none of these

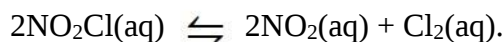
16. Calculate the molarity of a solution containing KCl and water whose osmotic pressure at 33.3°C is 125 torr. Assume complete dissociation of the salt.

- A. 0.00654 M
- B. 4.97 M
- C. 0.0301 M
- D. 0.00327 M
- E. 0.0602 M

17 For the reaction $2A + 4B \rightarrow 2C + 2D$, at a particular instant in time, the rate of the reaction is 0.0352 M/s. What is the rate of change of B?

- A. 0.0088 M/s
- B. -0.0088 M/s
- C. -0.141 M/s
- D. -0.0352 M/s
- E. 0.141 M/s

18. Apply the law of mass action to determine the equilibrium expression for



- A. $K = 2[\text{NO}_2][\text{Cl}_2]/2[\text{NO}_2\text{Cl}]$
- B. $K = 2[\text{NO}_2\text{Cl}]/2[\text{NO}_2][\text{Cl}_2]$
- C. $K = [\text{NO}_2\text{Cl}]^2/[\text{NO}_2]^2[\text{Cl}_2]$
- D. $K = [\text{NO}_2]^2[\text{Cl}_2]/[\text{NO}_2\text{Cl}]^2$
- E. $K = [\text{NO}_2\text{Cl}]^2/[\text{NO}_2]^2[\text{Cl}_2]$

19. Which of the following is not true for a solution at 25°C that has a hydroxide concentration of $2.5 \times 10^{-6} \text{ M}$?

- A. $K_w = 1 \times 10^{-14}$
- B. The solution is acidic.
- C. The solution is basic.
- D. The $[\text{H}^+]$ is $4.0 \times 10^{-9} \text{ M}$.
- E. The K_w is independent of what the solution contains.

20. You have a 250 mL sample of 1.090 M acetic acid ($K_a = 1.8 \times 10^{-5}$). Assuming no volume change, how much NaOH must be added to make the best buffer?

- A. 5.45 g
- B. 10.9 g

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- C. 15.5 g
- D. 20.5 g
- E. none of these

21. Calculate the concentration of chromate ion, CrO_4^{2-} , in a saturated solution of CaCrO_4 ($K_{\text{sp}} = 7.08 \times 10^{-4}$).

- A. $2.66 \times 10^{-2} \text{ M}$
- B. $1.42 \times 10^{-3} \text{ M}$
- C. $7.08 \times 10^{-4} \text{ M}$
- D. $5.01 \times 10^{-7} \text{ M}$
- E. $3.54 \times 10^{-4} \text{ M}$

22 The melting point of water is 0°C at 1 atm pressure because under these conditions:

- A. ΔS for the process $\text{H}_2\text{O}(\text{s}) \rightarrow \text{H}_2\text{O}(\text{l})$ is positive.
- B. ΔS and ΔS_{surr} for the process $\text{H}_2\text{O}(\text{s}) \rightarrow \text{H}_2\text{O}(\text{l})$ are both positive.
- C. ΔS and ΔS_{surr} for the process $\text{H}_2\text{O}(\text{s}) \rightarrow \text{H}_2\text{O}(\text{l})$ are equal in magnitude and opposite in sign.
- D. ΔG is positive for the process $\text{H}_2\text{O}(\text{s}) \rightarrow \text{H}_2\text{O}(\text{l})$.
- E. None of these is correct.

23 What is the cell reaction for the voltaic cell $\text{Al}(\text{s}) | \text{Al}^{3+}(\text{aq}) || \text{Br}^-(\text{aq}) | \text{Br}_2(\text{g}) | \text{Pt}$?

- A. $\text{Al}(\text{s}) + 2\text{Br}^-(\text{aq}) \rightarrow \text{Br}_2(\text{g}) + \text{Al}^{3+}(\text{aq})$
- B. $2\text{Al}^{3+}(\text{aq}) + 6\text{Br}^-(\text{aq}) \rightarrow 2\text{Al}(\text{s}) + 3\text{Br}_2(\text{g})$
- C. $\text{Al}(\text{s}) + 3\text{Br}_2(\text{g}) \rightarrow \text{Al}^{3+}(\text{s}) + 2\text{Br}^-(\text{aq})$
- D. $2\text{Al}(\text{s}) + 3\text{Br}_2(\text{g}) \rightarrow 2\text{Al}^{3+}(\text{aq}) + 6\text{Br}^-(\text{aq})$
- E. none of these

Calculation Question

24. The following data were obtained for the reaction $2\text{A} + \text{B} \rightarrow \text{C}$ where $\text{rate} = \Delta[\text{C}]/\Delta t$

		Initial Rate
$[\text{A}](\text{M})$	$[\text{B}](\text{M})$	(M/s)
0.100	0.0500	2.13×10^{-4}
0.200	0.0500	1.70×10^{-2}
0.400	0.100	1.36×10^{-1}

What is the value of the rate constant?