

國立暨南國際大學九十二學年度碩士班研究生入學考試試題

第 3 節普通化學 適用：(應化所 446)

(本試題共 6 頁，第 1 頁)

考生注意：1. 依次序作答，只要標明題號，不必抄題。

2. 答案必須寫在答案卷上，否則不予計分，並限以藍黑色筆作答。

3. 試題隨卷繳回。(餘請詳閱試場規則)

1. (60%) Multiple-Choice Questions:

1. Oxalic acid dihydrate, $\text{H}_2\text{C}_2\text{O}_4 \cdot 2\text{H}_2\text{O}(s)$ is often used as a primary standard to standardize sodium hydroxide solutions. Which of these facts are reasons to choose this substance as a primary standard? I. It is diprotic. II. It is a stable compound that can be weighed directly in air. III. It is available in a pure form.

- (A) III only (B) I and II only (C) II and III only (D) I, II, and III

2. When FeCl_3 is ignited in an atmosphere of pure oxygen, this reaction takes place.



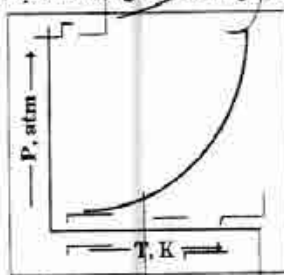
If 3.0 mol of FeCl_3 are ignited in the presence of 2.0 mol of O_2 gas, how much of which reagent is present in excess and therefore remains unreacted?

- (A) 0.33 mol FeCl_3 remain unreacted
(B) 0.67 mol FeCl_3 remain unreacted
(C) 0.25 mol O_2 remain unreacted
(D) 0.50 mol O_2 remain unreacted

3. A student finds that 31.26 mL of a 0.165 M solution of barium hydroxide, $\text{Ba}(\text{OH})_2$, solution is required to just neutralize 25.00 mL of a citric acid, $\text{H}_3\text{C}_6\text{H}_5\text{O}_7$, solution. What is the concentration of the $\text{H}_3\text{C}_6\text{H}_5\text{O}_7$ solution?

- (A) 0.413 M (B) 0.309 M (C) 0.206 M (D) 0.138 M

4. The vapor pressure of most substances increase with temperature as depicted by this curve. Which way of plotting these data is expected to give a straight line?



- (A) $1/P$ versus T (B) P versus $1/T$ (C) $\ln P$ versus T (D) $\ln P$ versus $1/T$

5. Sodium chloride, NaCl , usually crystallizes in a face-centered cubic lattice. How many Cl^- ions are in contact with any single Na^+ ion?

- (A) 4 (B) 6 (C) 8 (D) 12

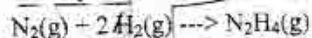
國立暨南國際大學九十二學年度碩士班研究生入學考試試題

第 3 節普通化學 適用：(應化所 446)

(本試題共 6 頁，第 2 頁)

考生注意：1. 依次序作答，只要標明題號，不必抄題。
2. 答案必須寫在答案卷上，否則不予計分，並限以藍黑色筆作答。
3. 試題隨卷繳回。(除請詳閱試場規則)

6. Use the bond energies in the table to determine ΔH for the formation of hydrazine, N_2H_4 , from nitrogen and hydrogen according to this equation:



Bond Energies	
N-N	159 kJ mol ⁻¹
N=N	418 kJ mol ⁻¹
N {triple bond} N	941 kJ mol ⁻¹
H-H	436 kJ mol ⁻¹
H-N	389 kJ mol ⁻¹

(A) $\Delta H = -711$ kJ (B) $\Delta H = -98$ kJ (C) $\Delta H = +98$ kJ (D) $\Delta H = +711$ kJ

7. For which of these processes is the value of ΔS negative?

- I. Sugar is dissolved in water. II. Steam condenses on a surface. III. $CaCO_3$ is decomposed into CaO and CO_2 .

(A) I only (B) II only (C) I and III only (D) II and III only

8. The rates of many chemical reactions double for a ten degree rise in temperature. Which of these factors does not contribute to this change in rate with increasing temperature?

- (A) the average kinetic energy of the reactant species.
(B) the number of collisions in a given time.
(C) the number of very energetic species.
(D) the activation energy.

9. When the acids; H_2Se , HBr , and HI , are arranged in order of increasing strength (weakest acid first), which is the correct order?

- (A) $H_2Se < HBr < HI$
(B) $HBr < HI < H_2Se$
(C) $HBr < H_2Se < HI$
(D) $HI < H_2Se < HBr$

10. The pK_a values for several acid-base indicators are given in the table. Which indicator should be used in the titration of a weak base with a strong acid?

Indicator, pK_a	
2,4-dinitrophenol	3.5
bromthymol blue	7.0
cresol red	8.0
alizarin yellow R	11.0

(A) 2,4-dinitrophenol (B) bromthymol blue (C) cresol red (D) alizarin yellow R

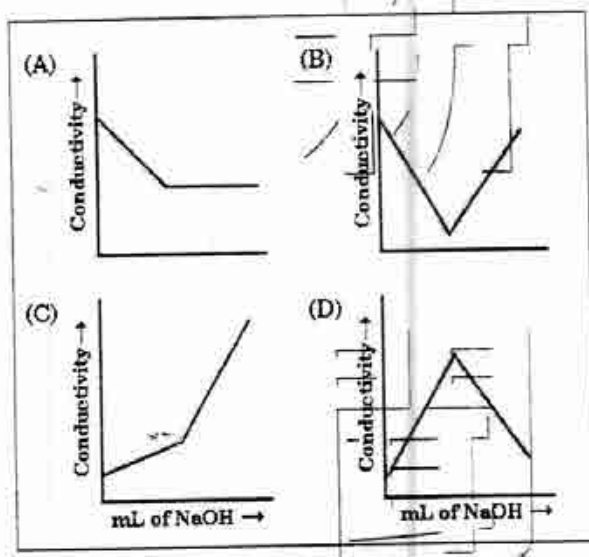
國立暨南國際大學九十二學年度碩士班研究生入學考試試題

第 3 節普通化學 適用：(應化所 446)

(本試題共 6 頁，第 3 頁)

考生注意：1. 依次序作答，只要標明題號，不必抄題。
2. 答案必須寫在答案卷上，否則不予計分，並限以藍黑色筆作答。
3. 試題隨卷繳回。(餘詳詳閱試場規則)

11. Which graph best represents the electrical conductivity behavior that occurs when an aqueous solution of acetic acid, $\text{HC}_2\text{H}_3\text{O}_2$, is titrated with an aqueous solution of sodium hydroxide, NaOH ?



12. What products are formed during the electrolysis of a concentrated aqueous solution of sodium chloride?

- I. $\text{Cl}_2(\text{g})$ II. $\text{NaOH}(\text{aq})$ III. $\text{H}_2(\text{g})$
 (A) I only (B) I and II only (C) I and III only (D) I, II, and III

13. Ions with the electronic structure $1s^2 2s^2 2p^6 3s^2 3p^6$ would not be present in which aqueous solution?

- (A) $\text{NaF}(\text{aq})$ (B) $\text{NaCl}(\text{aq})$ (C) $\text{KBr}(\text{aq})$ (D) $\text{CaI}_2(\text{aq})$

14. When ethanol is heated with sulfuric acid, the major product is

- (A) ethane (B) ethane (C) ethyne (D) ethyl sulfate

15. Many alcohols can be oxidized to aldehydes, and aldehydes can be oxidized to

- (A) carboxylic acids (B) esters (C) ethers (D) ketones

16. Which concentrations can be calculated if the mole fraction and density of an aqueous solution of HCl are known? 1. molality 2. molarity 3. percent by mass

- (A) 1 only (B) 3 only (C) 1 and 2 only (D) 1, 2, and 3

國立暨南國際大學九十二學年度碩士班研究生入學考試試題

第 3 節普通化學 適用：(應化所 446)

(本試題共 6 頁，第 4 頁)

考生注意：1. 依次序作答，只要標明題號，不必抄題。

2. 答案必須寫在答案卷上，否則不予計分。並限以藍黑色筆作答。

3. 試題隨卷繳回。(詳閱詳閱試場規則)

17. The second law of thermodynamics states that the

- (A) energy of the universe is increasing.
(B) energy of the universe is constant.
(C) entropy of the universe is increasing.
(D) entropy of the universe is constant.

18. Which substance is expected to have the greatest lattice enthalpy?

- (A) LiF (B) LiI (C) CsF (D) CsI

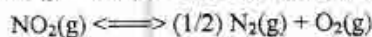
19. Which values can be obtained from the information represented by the vapor pressure curve of a liquid? I. normal boiling point II. normal freezing point III. enthalpy of vaporization

- (A) I only (B) I and II only (C) I and III only (D) I, II, and III

20. All are state functions except

- (A) pressure. (B) heat. (C) free energy. (D) enthalpy.

21. For the reaction $\text{N}_2(\text{g}) + \text{O}_2(\text{g}) \rightleftharpoons 2\text{NO}(\text{g})$, the equilibrium constant is K_1 . The equilibrium constant is K_2 for the reaction $2\text{NO}(\text{g}) + \text{O}_2(\text{g}) \rightleftharpoons 2\text{NO}_2(\text{g})$. What is K for this reaction?



- (A) $1/(K_1 K_2)$ (B) $1/(2K_1 K_2)$ (C) $1/(4K_1 K_2)$ (D) $[1/K_1 K_2]^{1/2}$

22. When these acids are arranged in order of increasing strength (weakest acid first), what is the correct order?

- (A) $\text{HOCl}(\text{aq}) < \text{H}_2\text{SeO}_4(\text{aq}) < \text{H}_3\text{PO}_4(\text{aq})$
(B) $\text{H}_3\text{PO}_4(\text{aq}) < \text{H}_2\text{SeO}_4(\text{aq}) < \text{HOCl}(\text{aq})$
(C) $\text{H}_2\text{SeO}_4(\text{aq}) < \text{HOCl}(\text{aq}) < \text{H}_3\text{PO}_4(\text{aq})$
(D) $\text{HOCl}(\text{aq}) < \text{H}_3\text{PO}_4(\text{aq}) < \text{H}_2\text{SeO}_4(\text{aq})$

23. Some compounds that are insoluble in water dissolve in acids. Which of these compounds is expected to be more soluble in 1.0 M HNO_3 than in an equal volume of distilled water?

I. AgCl II. BaCO_3 III. AlPO_4

- (A) II only (B) I and III only (C) II and III only (D) I, II and III

24. Which of these species is paramagnetic? I. Ti^{4+} II. Fe^{2+} III. Zn^0

- (A) II only (B) III only (C) I and II only (D) II and III only

25. In how many elements does the last electron have the quantum numbers of $n = 4$ and $l = 1$?

- (A) 4 (B) 6 (C) 8 (D) 10

國立暨南國際大學九十二學年度碩士班研究生入學考試試題

第 3 節普通化學 適用：(應化所 446)

(本試題共 6 頁，第 5 頁)

考生注意：1. 依次序作答，只要標明題號，不必抄題。

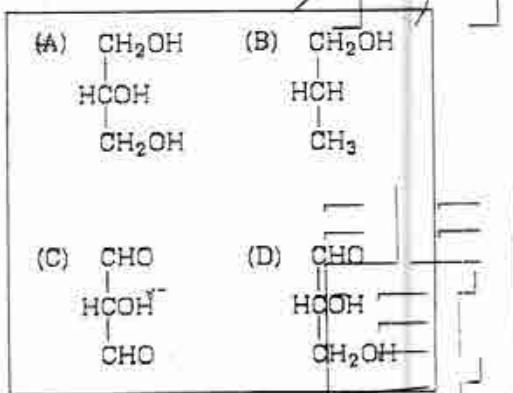
2. 答案必須寫在答案卷上，否則不予計分，並限以藍黑色筆作答。

3. 試題隨卷繳回。(餘請詳閱試場規則)

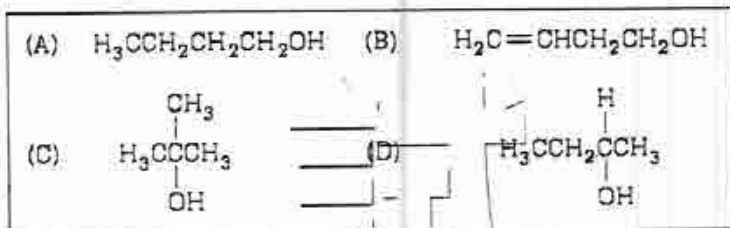
26. How many different compounds have the formula C_3H_8O ?

- (A) one (B) two (C) three (D) four

27. Many biologically-active compounds exist as two enantiomers (two non-superimposable optical isomers), one of which is active while the other is not. Which of these compounds could exist as optical isomers?



28. A four-carbon alcohol was oxidized with acidified potassium dichromate to form a ketone. Which structure represents the original alcohol?



29. Which statement is false with respect to proteins?

- (A) Primary structure refers to the sequence of nucleotides.
 (B) Secondary structure includes helixes or pleated sheets.
 (C) Tertiary structure includes disulfide bonds.
 (D) The overall shape of a protein is related to the tertiary structure.

30. How many of the following apply to fibrous proteins? I. Provide structural integrity and strength for many types of tissues. II. Transport and store oxygen and nutrients. III. Act as catalysts. IV. Are the main components of muscle, hair, and cartilage. V. Fight invasion of the body by foreign objects.

- (A) 1 (B) 2 (C) 3 (D) 4

國立暨南國際大學九十二學年度碩士班研究生入學考試試題

第 3 節普通化學 適用：(應化所 446)

(本試題共 6 頁，第 6 頁)

考生注意：1. 依次序作答，只要標明題號，不必抄題。
2. 答案必須寫在答案卷上，否則不予計分，並限以藍黑色筆作答。
3. 試題隨卷繳回。(餘詳詳閱試場規則)

- II. (12%) Using the MO model, write the unpaired electrons and bond orders for the following molecules: O_2 , O_2^+ and O_2^- .

Molecules	Unpaired electron	Bond order
O_2	2	2
O_2^+	1	2.5
O_2^-	3	1.5

- III. (8%) The initial concentration of A is $[A]_0$ for the reaction of $aA \rightarrow \text{Products}$. What is the differential rate law, integrated rate law and the half-life for the reaction if the reaction is the zero, first or second order in [A].

Order of the reactant A	Zero order	First order	Second order
Differential Rate Law	$R = -\frac{d[A]}{dt} = k$	$R = k[A]^1$	$R = k[A]^2$
Integrated Rate Law			$\frac{1}{[A]} - \frac{1}{[A]_0} = kt$
Half-Life of the reaction	$\frac{[A]_0}{2k}$		

- IV. (8%) For each of the following molecules or ions, describe the molecular structure and the hybridization of Xe atom: XeF_2 and XeF_4 .

Molecules	Molecular structure	The hybridization of Xe atom
XeF_2	Linear	sp^3
XeF_4	Square planar	sp^3d^2

- V. (6%) Compare the wavelength λ_e for an electron (mass = 9.11×10^{-31} kg) traveling at a speed of 1.0×10^7 m/s with the wavelength λ_b for a ball (mass = 0.911 kg) traveling at 100 m/s. What is the ratio of λ_e / λ_b ? ($h = 6.626 \times 10^{-34}$ kg m²/s)

- VI. (6%) Consider the system to be an ideal monoatomic gas for which the function X is characterized by: $dX = (3/2) R dT + P dV$, where R is the gas constant. (a) Is X a state function? (b) Now consider the function Y characterized by $dY = dX / T$. Is Y a state function?