國立中正大學
112學年度碩士班招生考試
試 題

[第1節]

科目名稱	一般化學
系所組別	化學暨生物化學系

選擇題，共 25 題，每題 4 分，共 100 分，答錯不倒扣。

[1] You dissolve 67.2 g of sodium bicarbonate in 500.0 mL of an aqueous solution (**solution I**). You take 60.0 mL of **solution I** and add water until the total volume is 120.0 mL to make **solution II**. You take 30.0 mL of **solution II** and add 90.0 mL of water to it to make **solution III**. You mix 10.0 mL of **solution II** and 40.0 mL of **solution III** to provide **solution IV**. What is the concentration of sodium bicarbonate in **solution IV**?

(A) 0.800 M (B) 0.035 M (C) 0.180 M (D) 0.015 M (E) 0.320 M

[2] Oxidation of 3-methyl-1-pentanol could yield:
I. 2-methyl-1-pentanone; **II.** 3-methylpentanal; **III.** 1-methylpentanal;
IV. 3-methylpentanoic acid; **V.** 1-methylpentanoic acid.

(A) **II** only (B) **III** only (C) **III** and **V** (D) **I** only (E) **II** and **IV**

[3] Hydrogen gas react with oxygen gas to produce water vapor which is a reversible reaction; what is the relationship between K and K_p at temperature T?

(A) $K_p = K(RT)^2$ (B) $K = K_p(RT)^2$ (C) $K = K_p$ (D) $K_p = K(RT)$ (E) $K = K_p(RT)$

[4] Which of the following names is correct?
I. 3,5-dibromopentane
II. 1-bromo-2,4-methyl-3-propylcyclohexane
III. *trans*-1,3-dimethylpropane
IV. 1,1-dimethyl-2,2-diethylbutane
V. 2-bromo-1-chloro-4,4-dimethyloctane

(A) **I** (B) **II** (C) **III** (D) **IV** (E) **IV**

[5] How many grams of silver carbonate are required to react completely with 14.6 g of sodium chloride to form silver chloride and sodium carbonate?

(A) 32.25 g (B) 20.88 g (C) 30.25 g (D) 17.22 g (E) 34.44 g

[6] The reaction $3NO \rightarrow N_2O + NO_2$ is found to obey the rate law Rate = $k[NO]^2$. If the first half-life of the reaction is found to be 3.5 s, what is the length of the fourth half-life?

(A) 53 s (B) 6.6 s (C) 21 s (D) 14 s (E) 65 s.

[7] Which of the following statements is true concerning ideal gases?

I. A gas exerts pressure as a result of the collisions of the gas molecules with the walls of the container.

II. At STP condition, 1.0 L of $Ar_{(g)}$ contains about twice the number of atoms as 1.0 L of $Ne_{(g)}$ because the molar mass of Ar is about twice that of Ne.

III. The temperature of the gas sample is directly related to the average velocity of the gas particles.

IV. The gas particles in a sample exert attraction on one another.

V.　The motion of the gas particles is entirely random; however, they repel each other.

(A) I (B) II (C) III (D) IV (E) V

[8] Which has the greater number of unpaired electrons?

I. Square planar $[Ni(CN)_4]^{2-}$

II. $[Co(NH_3)_6]^{3+}$

III. Octahedral $[Fe(CN)_6]^{4-}$

IV. $[Fe(H_2O)_6]^{3+}$

(A) IV (B) III (C) II (D) I (E) None of them has any unpaired electrons.

[9] Which of the following terms did Dalton discuss in his atomic theory?

I. isotopes **II.** ions **III.** protons **IV.** electrons

(A) none of these (B) **I** (C) **II** (D) **III** (E) **IV**

[10] Which of the experiments listed below did not provide the information stated about the nature of the atom?

I. The cathode-ray tube proved that electrons have a negative charge.

II. The Rutherford's experiment determined the charge on the nucleus.

III. The Rutherford's experiment proved that the Thomson "plum pudding" model of the atom was not essentially correct.

IV. Millikan's oil-drop experiment showed that the charge on any particle was a simple multiple of the charge on the electron.

V. In Rutherford's experiment, a thin metal foil was bombarded with β-particle to study the absorption of the radioactivity.

(A) **V** (B) **IV** (C) **III** (D) **II** (E) **I**

[11] Ionic hydrides are formed when hydrogen combines with elements from:

I. Group 1A   **II.** Group 2A   **III.** Group 3A   **IV.** Group 5A   **V.** Group 6A

(A) **I** and **II** and **III** (B) **I** and **II** (C) **II** and **V** (D) **I** and **III** (E) **II** and **III** and **IV**

[12] In which state of the following compounds does nitrogen have the most positive oxidation state?

(A) KNO_2 (B) $NaNO_3$ (C) LiN_3 (D) $NaNH_2$ (E) NH_4Cl

[13] Which of the following is the correct description of a protein?

I. A chain of amino acids connected by ester bonds.

II. An alternating chain of amino acids and nucleic acids.

III. Two antiparallel chains of nucleic acids connected by hydrogen bonding.

IV. A chain of amino acids formed by condensation polymerization.

V. A chain of nucleotides connected by phosphodiester bonds

(A) **V** (B) **IV** (C) **III** (D) **II** (E) **I**

[14] Which of the following is optically active (that is, **chiral**)?

I. 3-chloropentane

II. 5-bromopentanal

III. 2-chloropentane

IV. 6-fluoro-2,2-dimethylhexane

V. dimethylamine

(A) **I** (B) **III** (C) **V** (D) **II** (E) **IV**

[15] If a tree dies and the trunk remains undisturbed for 13,750 years, what percentage of the original ^{14}C is still present? (The half-life of ^{14}C is 5730 years.)
(A) 2.20% (B) 19.0% (C) 45.0% (D) 5.2% (E) 3.31%

[16] An electron in a one-dimensional box requires energy with wavelength 8080 nm to excite it from the n = 2 energy level to the n = 3 energy level.
Calculate the length of the box.
(A) 1.50 nm (B) 3.00 nm (C) 3.50 nm (D) 2.50 nm (E) 1.00 nm

[17] Which of the following statement is true?

(A) For any process, ΔS_{surr} and ΔS_{sys} have opposite signs.

(B) As long as the disorder of the surroundings is increasing, a process will be spontaneous.

(C) The value of ΔG° tells us nothing about the rate of a reaction, only its eventual equilibrium position.

(D) ΔH° is zero for a chemical reaction at constant temperature.

(E) If $\Delta S_{surr} = \Delta S_{sys}$, the process is at equilibrium.

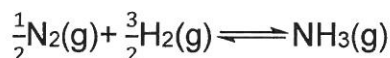**[18]** The following equilibrium concentrations were observed for the Haber process at 127 °C:

$[NH_3] = 3.1 \times 10^{-2}$ mol/L; $[N_2] = 8.5 \times 10^{-1}$ mol/L; $[H_2] = 3.1 \times 10^{-3}$ mol/L

I. Calculate the value of equilibrium constant K at 127 °C for Haber process.

II. Calculate the value of K at 127 °C for the reaction:

$$2NH_3(g) \rightleftharpoons N_2(g) + 3H_2(g)$$

III. Calculate the value of K at 127 °C for the reaction given by the equation:

$$\frac{1}{2}N_2(g) + \frac{3}{2}H_2(g) \rightleftharpoons NH_3(g)$$

(A) **I.** 3.8×10^4 L^2/mol^2 ; **II.** 3.8×10^4 L^2/mol^2 ; **III.** 3.8×10^4 L^2/mol^2

(B) **I.** 3.8×10^4 L^2/mol^2 ; **II.** 2.6×10^{-5} L^2/mol^2 ; **III.** 3.8×10^4 L^2/mol^2

(C) **I.** 3.8×10^4 L^2/mol^2 ; **II.** 2.6×10^{-5} mol^2/L^2 ; **III.** 1.9×10^2 L/mol

(D) **I.** 3.8×10^4 L^2/mol^2 ; **II.** 2.6×10^5 L^2/mol^2 ; **III.** 1.9×10^2 mol/L

(E) **I.** 2.6×10^{-5} mol^2/L^2 ; **II.** 2.6×10^{-5} mol^2/L^2 ; **III.** 2.6×10^{-5} mol^2/L^2

[19] A chemist needs to prepare a solution buffered at pH 4.30 using one of the following acids (and its sodium salt):

Chloroacetic acid ($K_a = 1.35 \times 10^{-3}$)

Propanoic acid ($K_a = 1.3 \times 10^{-5}$)

Benzoic acid ($K_a = 6.4 \times 10^{-5}$)

Hypochlorous acid ($K_a = 3.5 \times 10^{-8}$)

Hydrocyanic acid ($K_a = 6.2 \times 10^{-10}$)

Calculate the ratio of [HA]/[A-] required for each system to yield a pH of 4.30. Which system will work best?

(A) Chloroacetic acid/Sodium chloroacetate

(B) Propanoic acid/Sodium propanoate

(C) Benzoic acid/Sodium benzoate

(D) Hypochlorous acid/Sodium hypochlorite

(E) Hydrocyanic acid/Sodium cyanide.

[20] A solution contains the ions Ag^+, Pb^{2+}, Ni^{2+} and Fe^{3+}. Dilute solutions of NaCl, NaOH, Na_2SO_4, Na_2CO_3 are available to separate the positive ions from each other. In order to effect separation, the solutions should be added in which order?

(A) Na_2CO_3, NaOH, Na_2SO_4, NaCl (B) NaCl, Na_2SO_4, Na_2CO_3, NaOH (C) Na_2SO_4, NaCl, Na_2CO_3, NaOH (D) NaOH, Na_2SO_4, NaCl, Na_2CO_3 (E) NaCl, Na_2CO_3, Na_2SO_4, NaOH

[21] In which group are the elements listed in correct order of increasing first ionization energy?
(A) Al > Si > P (B) Na > P > Cl (C) K > Ca > Ge (D) Cs < Rb < Na (E) Cs > Na > K

[22] The reduction potentials for Au^{3+} and Ni^{2+} are as follows:

$Au^{3+} + 3e^- \rightarrow Au \quad E° = +1.50$ V

$Ni^{2+} + 2e^- \rightarrow Ni \quad E° = -0.23$ V

Calculate $\Delta G°$ (at 25°C) for the reaction: $2Au^{3+} + 3Ni \rightarrow 3Ni^{2+} + 2Au$

(A) $+1.00 \times 10^3$ kJ (B) -2140 kJ (C) -5.00×10^2 kJ (D) -1.00×10^2 kJ
(E) $+5.00 \times 10^3$ kJ.

[23] Which of the following statement is correct?
(A) Pi bonds are always stronger than sigma bond because pi bonds are formed in addition to sigma bonds by sideways overlapping of atomic orbitals. (B) Pi bonds have electron density on the internuclear axis. (C) Free rotation always does not occur about a single bond. (D) Sigma bonds result from the head-to-head overlap of atomic orbitals. (E) A triple bond is composed of two sigma bonds and one pi bond.

[24] You are holding two balloons in the department of chemistry and biochemistry, NCU. One contains helium, and one contains hydrogen. The volume ratio of hydrogen to helium is 2 to1. Which of the following statement is not correct?

(A) The pressures of the gas in the two balloons are the same.

(B) The temperature of the gas in the two balloons are the same.

(C) The densities of the gas in the two balloons are the same.

(D) The mass ratio of hydrogen to helium in the balloons is 1 to 1.

(E) The numbers of moles of the gas in the two balloons are different.

[25] The molecular-orbital electron configuration below: $(\sigma_{1s})^2(\sigma_{1s}*)^2(\sigma_{2s})^2(\sigma_{2s}*)^2(\pi_{2p})^4(\sigma_{2p})^2$; applies to which of the following molecules?

(A) NO (B) $FeCl_3$ (C) O_2 (D) CO (E) N_2.