

臺灣綜合大學系統

107 學年度 學士班

轉學生聯合招生考試

試 題

類組：A11

科目名稱：普通化學 B

科目代碼：E0018

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本科試題共計 3 頁

說明：答案一律寫在答案卷上；請依序作答，並標明題號。

($R = 0.082 \text{ atm L/mol K} = 8.314 \text{ J/mol K}$, $K_a(\text{HCN}) = 6.2 \times 10^{-10}$, $\log 2 = 0.301$,
 $\ln 2 = 0.693$, $\ln 20 = 3.0$, $10^{3/5} = 4.0$, $7.2^{0.5} = 2.7$)

一、選擇題：(單選 24 題，每題 3 分，不倒扣，共 72 分)

- Consider a certain gas at Kelvin temperatures T_1 and T_2 , where $T_2 = 2T_1$. Calculate the ratio for the mean free path at T_1 relative to that at T_2 .
 (A)0.5 (B)2.0 (C)1.0 (D)1.4 (E)0.7
- HF is a stronger acid than $\text{HC}_2\text{H}_3\text{O}_2$. Order the following according to base strength.
 (A) $\text{C}_2\text{H}_3\text{O}_2^- > \text{F}^- > \text{Cl}^- > \text{H}_2\text{O}$ (B) $\text{C}_2\text{H}_3\text{O}_2^- > \text{F}^- > \text{H}_2\text{O} > \text{Cl}^-$ (C) $\text{Cl}^- > \text{F}^- > \text{C}_2\text{H}_3\text{O}_2^- > \text{H}_2\text{O}$
 (D) $\text{F}^- > \text{C}_2\text{H}_3\text{O}_2^- > \text{H}_2\text{O} > \text{Cl}^-$ (E)none of these
- What's the $[\text{H}^+]$ (in 10^{-7} M) in $1.0 \times 10^{-4} \text{ M HCN}$?
 (A)2.5 (B)2.7 (C)3.0 (D)4.2 (E)5.1
- Consider five identical flasks filled with 1.0 mole different gases at 0°C .
 Flask A: CO at 250 torr, Flask B: N_2 at 600 torr, Flask C: H_2 at 400 torr,
 Flask D: O_2 at 800 torr, Flask E: CH_4 at 600 torr,
 In which flask will the molecules have the highest density?
 (A)A (B)B (C)C (D)D (E)E
- A certain metal fluoride crystallizes in such a way that the fluoride ions occupy simple cubic lattice sites, while the metal atoms occupy the body centers of half the cubes. What is the formula for the metal fluoride?
 (A) MF_2 (B) M_2F (C) MF_3 (D) M_3F (E)none of these
- Which of the metal ions in the following complex has a d^5 electron configuration?
 (A) $[\text{Ti}(\text{H}_2\text{O})_6]^{2+}$ (B) $[\text{Ni}(\text{NH}_3)_6]^{3+}$ (C) $[\text{Cr}(\text{CN})_6]^{3-}$ (D) $[\text{Fe}(\text{CN})_6]^{3-}$ (E) $[\text{FeCl}_6]^{4-}$
- How many of the following molecules or ions (NF_3 , NO_3^- , BrF_3 , I_3^- , PCl_3 , ICl_3) have trigonal pyramid structures?
 (A)0 (B)1 (C)2 (D)3 (E)4
- How many of the molecules or ions in Problem 7 have a hybridization of dsp^3 on the central atom?
 (A)0 (B)1 (C)2 (D)3 (E)4
- Consider the titration of 100.0 mL of a 0.05 M solution of the hypothetical weak acid H_3X ($K_{a1} = 1.0 \times 10^{-3}$, $K_{a2} = 1.0 \times 10^{-7}$, $K_{a3} = 1.0 \times 10^{-12}$) with 0.100 M KOH.
 Calculate the pH of the solution after adding 25.0 mL KOH.
 (A)2.2 (B)2.8 (C)3.0 (D)3.9 (E)4.5
- Calculate the pH of the solution in Problem 9 after adding 50.0 mL (total) KOH.
 (A)4.5 (B)6.0 (C)5.5 (D)5.0 (E)6.5
- Calculate the bond energy of F_2^- (in kJ/mol) by using the following data:
 ionization energy of F_2^- (290 kJ/mol), ionization energy of F^- (327.8 kJ/mol), and
 bond energy of F_2 (154 kJ/mol).
 (A)77 (B)86 (C)98 (D)107 (E)116
- Arrange the following species in order of the shortest to the longest N-O bond:
 (1) H_2NOH , (2) N_2O , (3) NO^+ , (4) NO_2^- , (5) NO_3^- .
 (A)3, 2, 4, 5, 1 (B)4, 2, 3, 5, 1 (C)2, 3, 4, 1, 5 (D)1, 5, 4, 2, 3 (E)2, 3, 4, 5, 1

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本科試題共計 3 頁

13. A certain substance, X, has a triple-point temperature of 20°C at a pressure of 2.0 atm. Which one of the following statements cannot possibly be true?
 (A) X can exist as a liquid above 20°C.
 (B) X can exist as a solid above 20°C.
 (C) Liquid X can exist as a stable phase at 25°C, 1 atm.
 (D) Both liquid and solid X have the same vapor pressure at 20°C.
 (E) All of these statements could be true.
14. The temperature at some planet is so high that the electronic ground state of the hydrogen atom is at $n = 4$. What's the ionization energy of the hydrogen atom at that planet if that in the Earth is equal to E ?
 (A) $E/4$ (B) $4E$ (C) $E/16$ (D) $15E/16$ (E) $16E$
15. Arrange the elements C, N, and O in order of increasing ionization energy.
 (A) C, N, O (B) O, N, C (C) C, O, N (D) N, O, C (E) none of these
16. 1.0 mole monatomic ideal gas at 300 K and 10.0 atm is expanded adiabatically and reversibly to 1.0 atm. Calculate the final volume (in L).
 (A) 5.2 (B) 13.5 (C) 7.6 (D) 9.8 (E) 11.2
17. What's the work (in R) in Problem 16?
 (A) -210 (B) -270 (C) -360 (D) -320 (E) -440
18. A certain reaction has the following general form: $a A \rightarrow b B$.
 At a particular temperature and $[A]_0 = 2.50 \times 10^{-3} \text{ M}$, a plot of $1/[A]$ vs. time resulted in a straight line with a slope of $4.0 \times 10^{-2} \text{ L/mol}\cdot\text{s}$. What's the "third" half-life (in 10^4 s)?
 (A) 5.0 (B) 1.0 (C) 2.0 (D) 6.0 (E) 4.0
19. The reaction $2 \text{NO}(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2 \text{NO}_2(\text{g})$ is believed to take place by the following mechanism:
 (1) $\text{NO} + \text{NO} \rightleftharpoons \text{N}_2\text{O}_2$ (rate constant: k_1 and k_{-1} , fast)
 (2) $\text{O}_2 + \text{N}_2\text{O}_2 \rightarrow 2 \text{NO}_2$ (rate constant k_2 , slow)
 What's $d[\text{NO}_2]/dt$ under the condition $k_{-1} \gg k_2[\text{O}_2]$?
 (A) $k_{-1}k_2[\text{NO}]^2[\text{O}_2]/k_1$ (B) $k_{-1}k_2[\text{NO}][\text{O}_2]/k_1$ (C) $2k_1k_2[\text{NO}]^2[\text{O}_2]/k_{-1}$
 (D) $k_{-1}k_2[\text{NO}]^2/k_1$ (E) $k_1k_2[\text{NO}]^2[\text{O}_2]/k_{-1}$
20. Consider the reaction $3A + B + C \rightarrow D + E$, where the rate law is defined as

$$-d[A]/dt = (1.66 \times 10^2 \text{ L}^3/\text{mol}^3 \text{ s})[A]^2[B][C]$$
 An experiment is carried out where $[B]_0 = 2.0 \text{ M}$, $[C]_0 = 1.0 \text{ M}$ and $[A]_0 = 2.5 \times 10^{-4} \text{ M}$. What's the concentration (in 10^{-5} M) of A after 5.0 minutes?
 (A) 7.2 (B) 8.7 (C) 6.5 (D) 4.2 (E) 1.3
21. How many unpaired electrons are found in $[\text{CoCl}_6]^{3-}$ (weak field)?
 (A) 0 (B) 1 (C) 2 (D) 4 (E) 5
22. What is the correct systematic name for the molecule 2-ethyl-4-tertiary-butylpentane?
 (A) 2-*t*-butyl-5-methylhexane (B) 2-ethyl-4,5,5-trimethylhexane
 (C) 3,5,6,6-tetramethylheptane (D) 2,2,3,5-tetramethylheptane (E) none of these
23. Which of the following types of compounds lacks a sp^2 -hybridized carbon center?
 (A) aldehydes (B) ketones (C) alcohols (D) alkenes (E) toluene
24. How many isomers of an alcohol (formula $\text{C}_4\text{H}_{10}\text{O}$) can be oxidized to acid?
 (A) 1 (B) 2 (C) 3 (D) 4 (E) 5

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二、選擇題：(單選 7 題，每題 4 分，不倒扣，共 28 分)

- Given that $\text{Ag}^+(\text{aq}) + 2 \text{NH}_3(\text{aq}) \rightleftharpoons \text{Ag}(\text{NH}_3)_2^+(\text{aq})$ ($K_{\text{eq}}=1.6 \times 10^7$) calculate $[\text{Cl}^-]_{\text{eq}}$ (in M) when the solid AgCl ($K_{\text{sp}}=1.0 \times 10^{-10}$) is put in a 10.0 M NH_3 solution.
(A)0.42 (B)0.37 (C)0.47 (D)0.68 (E)0.56
- Given that pure liquid A has vapor pressure x , and pure liquid B has vapor pressure y , with $x > y$, calculate the mole fraction of A in the ideal A/B solution if the vapor above the solution is 20% A?
(A) $y/(4x + y)$ (B) $4y/(x + 4y)$ (C) $x/(x + 4y)$ (D) $4x/(4x + y)$ (E) $2y/(x + 2y)$
- Consider the galvanic cell based on the following half-reactions:
 $\text{Zn}^{+2} + 2 \text{e}^- \rightarrow \text{Zn}, E^\circ = -0.76 \text{ V}; \quad \text{Fe}^{+2} + 2 \text{e}^- \rightarrow \text{Fe}, E^\circ = -0.44 \text{ V}.$
What's E°_{cell} (in V) at 25 °C if $[\text{Zn}^{+2}] = 0.10 \text{ M}$ and $[\text{Fe}^{+2}] = 1.0 \times 10^{-5} \text{ M}$?
(A)0.32 (B)0.28 (C)0.26 (D)0.23 (E)0.20
- Consider the following equilibrium:
 $\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \rightleftharpoons 2\text{NH}_3(\text{g})$
with $K_{\text{eq}} = 2.0 \times 10^{-6}$. Assuming that 1.00 mol each of all reactants and products is placed initially in a 1.00-L container, what's the equilibrium concentration (in M) of N_2 ?
(A)0.5 (B)1.0 (C)1.5 (D)2.0 (E)2.5
- What's the equilibrium concentration (in 10^{-3} M) of NH_3 in Problem 4?
(A)5.2 (B)3.3 (C)8.7 (D)2.1 (E)6.8
- Calculate the ΔS_{sys} (in R) for 1.0 mole of monatomic (單原子) ideal gas changing from state A (1.0 atm, 300 K) to state B (2.0 atm, 600 K).
(A)1.7 (B)1.0 (C)2.5 (D)3.2 (E)2.1.
- Calculate ΔG (in kJ) at 300 K for the reaction $\text{CO}(\text{g}) + 2 \text{H}_2(\text{g}) \rightarrow \text{CH}_3\text{OH}(\text{l})$, in which $p_{\text{CO}} = 2.23 \text{ atm}$, $p_{\text{H}_2} = 3.0 \text{ atm}$, $\Delta G_f^\circ(\text{CO}) = -137 \text{ kJ/mol}$, and $\Delta G_f^\circ(\text{CH}_3\text{OH}) = -166 \text{ kJ/mol}$.
(A)-36.5 (B)-42.2 (C)-33.4 (D)-38.1 (E)-45.6