

編號: 21 系所: 化學系、生科系

科目: 普通化學

本試題是否可以使用計算機: 可使用, 不可使用 (請命題老師勾選)

說明: 答案一律寫在試卷上; 請依序作答, 並標明題號。

一、選擇題: (單選; 1-25 每題 3 分, 不倒扣, 共 75 分)

電子質量為 9.1×10^{-31} kg, Planck's constant = 6.626×10^{-34} J s, $R = 0.08206$ L atm / K mol

- Four identical 1.0-L flasks contain the gases He, Cl₂, CH₄, and NH₃, each at 0°C and 1 atm pressure. For which gas do the molecules have the smallest average kinetic energy?
(A) He (B) Cl₂ (C) CH₄ (D) NH₃ (E) all gases the same
 - The value of K_p for the reaction $\text{H}_2(\text{g}) + \text{O}_2(\text{g}) \rightarrow \text{H}_2\text{O}_2(\text{g})$ is 2.3×10^6 at 600K. Determine value for K for this reaction at 600K.
(A) 4.7×10^4 (B) 2.3×10^6 (C) 1.13×10^8 (D) 4.35×10^7 (E) 4.35×10^8
 - Identify the strongest base.
(A) CH₃O⁻ (B) CH₃OH (C) CN⁻ (D) H₂O (E) NO₃⁻
 - Calculate the pH of a solution that contains 3.25 M HCN ($K_a = 6.2 \times 10^{-10}$), 1.00 M NaOH and 1.50 M NaCN.
(A) 8.28 (B) 8.86 (C) 9.18 (D) 9.25 (E) 9.78
 - Consider the following standard heats of formation: $\text{P}_4\text{O}_{10}(\text{s}) = -3110$ kJ/mol, $\text{H}_2\text{O}(\text{l}) = -286$ kJ/mol, $\text{H}_3\text{PO}_4(\text{s}) = -1279$ kJ/mol. Calculate the change in enthalpy (kJ) for the following process:
$$\text{P}_4\text{O}_{10}(\text{s}) + 6\text{H}_2\text{O}(\text{l}) \rightarrow 4\text{H}_3\text{PO}_4(\text{s})$$

(A) -290 (B) -390 (C) -490 (D) 390 (E) 290
 - You take 325 g of a solid (melting point = 58.0°C, heat of fusion = 345 J/g) and let it melt in 755 g of water. The water temperature decreases from its initial temperature to 30.0°C. Calculate the initial temperature of the water.
(A) 32.0°C (B) 57.8°C (C) 87.0°C (D) 93.5°C (E) 100.0°C
- 7-8 Substance X has a heat of vaporization of 55.4 kJ/mol at its normal boiling point (423°C). For the process $\text{X}(\text{l}) \rightarrow \text{X}(\text{g})$ at 1 atm and 423°C:
- Calculate the value of ΔS_{surr} (J/K mol).
(A) 0 (B) 79.6 (C) 103 (D) -79.6 (E) -103
 - Calculate the value of ΔG (J/K mol).
(A) 0 (B) 79.6 (C) 103 (D) -79.6 (E) -103
 - One mole of an ideal gas at 25°C is expanded isothermally from 5.0 L to 10.0 L under such conditions that no work is produced in the surroundings. Which statement is correct?
(A) $\Delta S_{\text{gas}} = 0$ (B) $\Delta S_{\text{gas}} = R \ln 2 / 298$ (C) $\Delta S_{\text{univ}} = 0$ (D) $\Delta S_{\text{surr}} = 0$ (E) $\Delta S_{\text{gas}} = \Delta S_{\text{surr}}$
 - The standard potential for the reaction $\text{Zn} + 2\text{Ag}^+ \rightarrow \text{Zn}^{2+} + 2\text{Ag}$ is 1.56 V. Given that the standard reduction potential for $\text{Ag}^+ + \text{e}^- \rightarrow \text{Ag}$ is 0.80V, determine the standard reduction potential for $\text{Zn}^{2+} + 2\text{e}^- \rightarrow \text{Zn}$.
(A) -0.76 (B) 1.52 (C) 0.76 (D) 0.38 (E) -0.38
 - The reduction potentials for Au³⁺ and Ni²⁺ are as follows:
$$\text{Au}^{3+} + 3\text{e}^- \rightarrow \text{Au} \quad E^\circ = +1.50 \text{ V}; \quad \text{Ni}^{2+} + 2\text{e}^- \rightarrow \text{Ni} \quad E^\circ = -0.23 \text{ V}$$
Calculate ΔG° (kJ, at 25°C) for the reaction: $2\text{Au}^{3+} + 3\text{Ni} \rightarrow 3\text{Ni}^{2+} + 2\text{Au}$
(A) -5.00×10^2 (B) 5.00×10^2 (C) -2.14×10^3 (D) 1.00×10^3 (E) -1.00×10^3

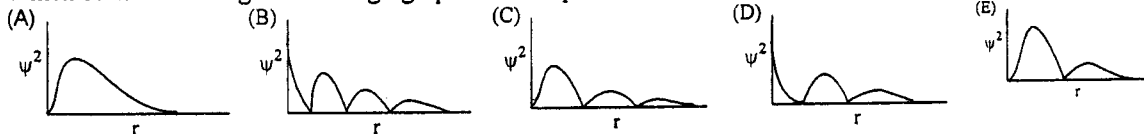
(背面仍有題目, 請繼續作答)

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12. Which of the followings is the rough graph for the square of the radial wave function for 3d orbital in hydrogen?



13. Estimate the bond energy (kJ/mol) of the
- N_2
- molecule.

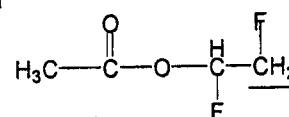
 ΔH_f° for $NH_3 = -46.0$ kJ/mol, N-H bond energy = 391 kJ/mol, H-H bond energy = 432 kJ/mol

- (A) 1140 (B) 479 (C) 958 (D) 877 (E) 560

14. What type of structure does the
- $XeOF_2$
- molecule have?

- (A) T-shaped (B) pyramidal (C) tetrahedral (D) see-saw (E) trigonal planar

15. Which is the correct multiplet of H-NMR spectrum for the underlined group in



- (A) singlet (B) doublet (C) triplet (D) quartet (E) quintet

16. Which of the following species has the highest ionization energy?

- (A) O (B)
- O_2^+
- (C)
- O_2
- (D)
- O_2^-
- (E)
- O_2^{2-}

17. What is the hybridization of each N atom in
- N_2H_4
- ?

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

18. Consider the second order reaction
- $aA \rightarrow$
- Products (which has a first half-life of 25 sec).

If the concentration of A after 10.0 sec is 0.45 M, determine the initial concentration of A.

- (A) 0.50 M (B) 0.53 M (C) 0.55 M (D) 0.60 M (E) 0.63 M

19. For the reaction
- $A + B \rightarrow$
- products, the following data were obtained:

Initial rate(mol/L · s)	0.30	0.059	0.060	0.090	0.090
$[A]_0$ (mol/L)	0.10	0.20	0.20	0.30	0.30
$[B]_0$ (mol/L)	0.20	0.20	0.30	0.30	0.50

What is the experimental rate law?

- (A)
- $k[A]$
- (B)
- $k[B]$
- (C)
- $k[A][B]$
- (D)
- $k[A]^2[B]$
- (E)
- $k[A][B]^2$

20. Which of the following compounds has the highest boiling point?

- (A)
- CH_4
- (B) CO (C)
- O_2
- (D)
- N_2
- (E) He

21. The solubility of the salt
- $MxAy$
- is
- 1.0×10^{-2}
- mol/L at
- $25^\circ C$
- .

The osmotic pressure exhibited by a solution saturated with $MxAy$ at $25^\circ C$ is 1.22 atm.

Determine the values of x and y by assuming ideal behavior.

- (A)
- $x = 1, y = 2$
- (B)
- $x = 1, y = 3$
- (C)
- $x = 2, y = 2$
- (D)
- $x = 2, y = 3$
- (E)
- $x = 2, y = 4$

22. Which of the following metals has the highest melting point?

- (A) Na (B) Mg (C) Al (D) Ca (E) K

23. Which of the following is the oxidation state of nitrogen in nitric acid?

- (A) 1 (B) 2 (C) 3 (D) 4 (E) 5

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24. How many different possible tetramethylbenzenes exist?
(A) 2 (B) 3 (C) 4 (D) 5 (E) 6
25. When heat is added to proteins, the hydrogen bonding in the secondary structure breaks apart. What are the algebraic signs of ΔH and ΔS for the denaturation process?
(A) Both ΔH and ΔS are positive (B) Both ΔH and ΔS are negative.
(C) ΔH is negative and ΔS is positive. (D) ΔH is positive and ΔS is negative.
(E) ΔH is positive and ΔS is 0

二、非選擇題（共 25 分，每題 5 分，計算題務必列出計算過程，只寫答案不計分。）

1. If an electron is confined to a one dimensional box 3×10^{-10} m in length, calculate the frequency (Hz) of light required to promote the electron from the $n = 1$ state to the $n = 5$ state.
2. Nickel has a face-centered cubic unit cell. The density of nickel is 6.84 g/cm^3 . (Ni: 58.69 g/mol , $N = 6.022 \times 10^{23}$)
(A) How many Ni atoms are in each unit cell?
(B) Calculate cube edge length of Ni unit cell in cm.
(C) Calculate a value for the atomic radius of nickel in cm.
3. A chemist is given a white solid that is suspected of being pure cocaine. (atomic mass: C:12, H:1)
When 1.22 g of the solid is dissolved in 15.60 g of benzene the freezing point is lowered by 1.32°C .
Calculate the molar mass of the solid. The molal freezing point constant (K_f) for benzene is 5.12°C/m .
4. The color of RS-Hb and $\text{O}_2\text{-Hb}$ (Hb = hemoglobin) are green and red, respectively.
(A) What is the active metal in hemoglobin?
(B) Which absorbs higher frequency of electromagnetic radiation?
(C) Which complex has stronger ligand field? Explain your answer.
5. ${}_{92}\text{U}^{238}$ decays to the stable ${}_{82}\text{Pb}^{206}$ and the half-life of 4.5×10^9 yr.
Analysis showed the ratio of ${}_{82}\text{Pb}^{206}$ atoms to ${}_{92}\text{U}^{238}$ atoms to be 0.115 in a rock. Calculate the age of the rock.