科目：綜合化學(II)　　　　系所：應用化學系
考試時間：100 分鐘　　　　本科原始成績：100 分　　　是否使用計算機：是

1. (4 分)詳細說明 molarity、molality、weight percent、ppm 的定義。
2. (4 分)兩個數字進行加減乘除運算時，最後答案的有效數字位數(significant figures)要如何決定?
3. (4 分)簡略說明為何 25°C 時 10^{-5} M 鹽酸 pH 值為 5，但 10^{-8} M 鹽酸 pH 值不是 8 而小於 7。
4. (4 分)詳細說明 sensitivity 和 limit of detection (LOD)有何不同。
5. (4 分)詳細說明 systematic error 和 random error 有何不同。
6. (4 分) Fluorescence 和 phosphorescence 有何不同?
7. (4 分) UV/Vis 和 IR 光譜所觀察分析物的物性有何不同?
8. (4 分) Chromatography 中 normal-phase 和 reversed-phase 的操作有何不同?
9. (6 分) Chromatography 中 Eddy diffusion (multipath)和 longitudinal diffusion 有何不同?
10. (6 分)詳細說明定量分析中的標準添加法如何操作。
11. (6 分)以玻璃電極紀錄水溶液 pH 時，說明除了溫度、電極表面清潔度以外，所有可能會造成測量值偏離實際值的原因。

公式與常數: R = 8.314 J K^{-1} mole^{-1}, $P_iV_i^\gamma = P_fV_f^\gamma$, $\ln(P_f/P_i)$, $(C_{p,m}/C_{v,m})$, $-\dfrac{\Delta H}{R}\left(\dfrac{1}{T_f} - \dfrac{1}{T_i}\right)$

12. (5 分) The right-hand figure shows the ground and the first few excited states of He atom, and it also illustrates several, but not all, allowed (solid lines) and forbidden (dashed lines) transitions.
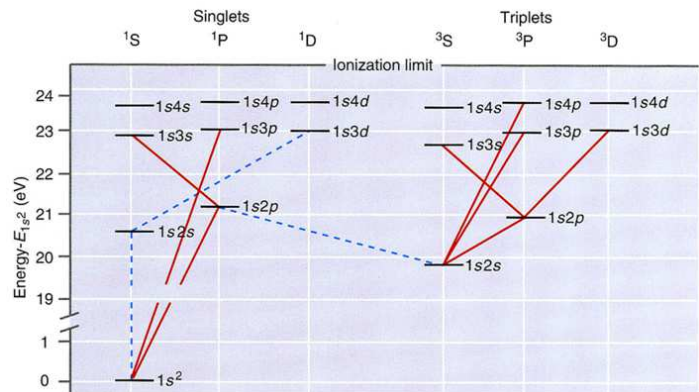
    What are the selection rules of the allowed electronic transitions?

13. (5 分)The normal boiling temperature of benzene is 353.24 K, and the vapor pressure of liquid benzene is 1.19×10^4 Pa at 20.0°C. Use the Clausius-Clapeyron equation to calculate (a) $\Delta H_{vaparization}$ (b) $\Delta S_{vaporization}$.

14. (10 分) Is $\Psi(x) = Ae^{ikx} + Be^{-ikx}$ an eigenfunction of the d/dx and d^2/dx operators? If so, what are the eigenvalues? A, B, and k are real numbers.

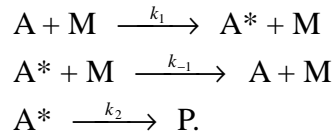15. (5 分) Calculate the root-mean square speed of O_2 at 300 K.

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16. (10 分) The Lindemann mechanisms for a unimolecular reactions, A → P, are proposed as the following:

$$A + M \xrightarrow{\ k_1\ } A* + M$$
$$A* + M \xrightarrow{\ k_{-1}\ } A + M$$
$$A* \xrightarrow{\ k_2\ } P.$$

(a) Derive the rate equation: $d[P]/dt = k_{uni}[A]$ by applying the steady state to A*

(b) What are the apparent k_{uni} in the limits of low and high M concentration, respectively?

(c) Plot k_{uni}^{-1} vs. $[M]^{-1}$, what information can be derived?

17. (15 分) One mole ideal gas for which $C_{v,m} = 5R/2$ undergoes the following processes from an initial state characterized by T = 300 K and P = 10^5 Pa:

(a) It is expanded reversibly and adiabatically until the volume tripled.

(b) It is reversibly heated at constant volume until T increases to 300 K.

(c) It is compressed reversibly and isothermally to P = 10^5 Pa.

Calculate q, w, ΔU, ΔH, and ΔS for each step in the cycle, and for the total cycles.