注意：考試開始鈴響前，不得翻閱試題，並不得書寫、畫記、作答。

國立清華大學 113 學年度碩士班考試入學試題

系所班組別：生醫工程與環境科學系
　　　　　　丙組(應用化學組)

科目代碼：2702

考試科目：物理化學

一作答注意事項一

1. 請核對答案卷（卡）上之准考證號、科目名稱是否正確。

2. 考試開始後，請於作答前先翻閱整份試題，是否有污損或試題印刷不清，得舉手請監試人員處理，但不得要求解釋題意。

3. 考生限在答案卷上標記「▗ 由此開始作答」區內作答，且不可書寫姓名、准考證號或與作答無關之其他文字或符號。

4. 答案卷用盡不得要求加頁。

5. 答案卷可用任何書寫工具作答，惟為方便閱卷辨識，請儘量使用藍色或黑色書寫；答案卡限用 2B 鉛筆畫記；如畫記不清（含未依範例畫記）致光學閱讀機無法辨識答案者，其後果一律由考生自行負責。

6. 其他應考規則、違規處理及扣分方式，請自行詳閱准考證明上「國立清華大學試場規則及違規處理辦法」，無法因本試題封面作答注意事項中未列明而稱未知悉。

1. Explain the following terms: (20%)

    (a) Ideal gas law

    (b) Mathematical statement of the second law of thermodynamics

    (c) Ideal solution

    (d) Boyle temperature

2. Considering a van der Waals gas $[P+a/(V_m^2)](V_m-b) = RT$,

    (a) derive the slope of compression factor ($Z = PV_m/(RT)$) as a function of P as $P \to 0$.

    (b) At what temperature does the slope of the Z versus P curve as $P \to 0$ have its maximum value?

    (c) What is the value of the maximum slope?

    (d) If the temperature is extremely high, what is the value of the slope? (20%)

3. One mole of an ideal gas expands isothermally and reversibly from 90 to 300 L at 300K. (a) Calculate q, w, ΔU, ΔH and ΔS for this system. (b) If the expansion is carried out irreversibly by allowing the gas to expand into an evacuated container, what are the values of q, w, ΔU, ΔH and ΔS for this process. (20%)

4. 50.0 L of dry air was slowly bubbled through a thermally insulated beaker containing 250 g of water initially at 25 °C. Calculate the final temperature. The vapor pressure of water is approximately constant at 3.17 kPa throughout, and its heat capacity is 75.5 J/(K mol). Assume that the air is not heated or cooled and that water vapor is a perfect gas. The molar enthalpy change of vaporization of water at 25 °C is equal to 44.02 kJ/mol. (20%)

5. Estimate the residual molar entropy of (a) CO_2, (b) ice by taking into account the distribution of hydrogen bonds and chemical bonds about the oxygen atom of one H_2O molecule, (c) HCF_3, (d) 1,2-difluorobenzene, and (e) 1.4-difluorobenzene on the assumption that the van der Waals radii of H and F are similar such that steric effects on molecular ordering in the crystal are minimal. Please list the descending order (sorted from highest to lowest). (20%)