

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 112 學年度碩士班考試入學試題

系所班組別：分析與環境科學研究所

科目代碼：2903

考試科目：物理化學

—作答注意事項—

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。

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共 2 頁，第 1 頁

*請在【答案卷】作答

1. The graph below shows the dependence of the compression factor (Z) on the pressure at $T = 400$ K for the ideal gas and three different gases: H_2 , O_2 , and C_2H_4 . Assign each trace (A, B, C, and D) and explain your answer. Indicate on the graph the regions where the attractive interactions and the repulsive interactions dominate, respectively. (20%)

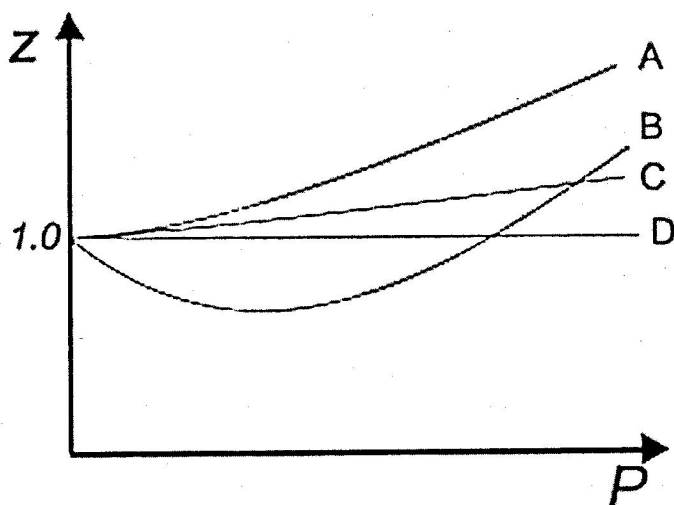


Table 1. van der Waals coefficients

	$a/\text{atm L}^2 \text{mol}^{-2}$	$b/\text{L mol}^{-1}$
H_2	0.242	0.0265
O_2	1.364	0.0319
C_2H_4	4.552	0.0582

Ref: a van der Waals equation: $[P + a/(V_m^2)](V_m - b) = RT$

2. A camper stranded in snowy weather loses heat by wind convection. The camper is packing emergency rations consisting of 58% sucrose, 31% fat, and 11% protein by weight. Assuming the fat content of the rations can be treated with palmitic acid data and the enthalpies for combustion of sucrose, palmitic acid, and a typical protein are 16.51 kJ/g, 39.2 kJ/g, and 22.0 kJ/g, respectively. Based on these data, how much emergency rations must the camper consume in order to compensate for a reduction in body temperature of 3.5 K? Assume the heat capacity of the body equals that of water. Assume the camper weighs 67 kg. State any additional assumptions. (20%)

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共 2 頁，第 2 頁

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3. Calculate ΔS , ΔS_{surr} , and ΔS_{univ} for heating α mol of liquid water from T_{in} to T_{final} K ($T_{\text{final}} < 373\text{K}$). The system and the surroundings are connected only by a thin rod and the process is carried out at a constant pressure of 1 atm. The heat capacity of water at constant pressure is C_p J/mol K. Assume that the surroundings (consider the thin rod only) remain at T_{hot} as the system warms up. Show that this process is spontaneous. (20%)
4. The reaction $A \rightleftharpoons B$, where A and B are ideal gases, is studied at 298K and 1 atm. The standard chemical potential of A at this temperature is 40 kJ/mol and that for B is 37 kJ/mol. The reaction is started with 1 mol of A only, so the amounts of A and B at a later time are given in terms of extent of reaction ξ by $n_A = 1 - \xi$ and $n_B = \xi$, respectively. (a) Derive the function of Gibbs energy of the reaction. (b) Plot G versus ξ . (c) Plot $dG/d\xi$ versus ξ . (d) Plot $d^2G/d\xi^2$ versus ξ . (20%)
5. You are caught without an umbrella in the rain and wish to get to your dorm, 1 km away, in the driest possible condition. Should you walk or run? To answer this question, calculate the ratio of the rain drop collisions with your body under the two conditions. Assume that the cross section is independent of direction (i.e., that you are spherical), that you run at 8 m/s, you walk at 3 m/s, and that the rain is falling vertically with a constant velocity of 15 m/s. (20%)