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 109 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：2802

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. 作答中如有發現試題印刷不清，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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系所班組別：生醫工程與環境科學系碩士班 丙組(應用化學組)

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1. In Joule's experiment to determine $(\frac{\partial U}{\partial V})_T$, the heat capacities of the gas and the water bath surroundings were related by $C_{surroundings}/C_{system} \approx 1000$. If the precision with which the temperature of the surroundings could be measured is ±0.006°C, what is the minimum detectable change in the temperature of the gas? State your comment. (20%)

2. You have accidentally arrived at the end of the range of an ethanol-in-glass thermometer so that the entire volume of the glass capillary is filled. By how much will the pressure in the capillary increase if the temperature is increased by another 10.0°C? Will the thermometer survive your experiment? The isobaric thermal expansion coefficients (β) for glass and ethanol are 2.00×10^{-5} ($°C^{-1}$) and 11.20×10^{-4} ($°C^{-1}$), respectively. The isothermal compressibility (κ) for ethanol is 11.0×10^{-5} bar^{-1}. (20%)

3. A cloud mass moving across the ocean at an altitude of 2000 m encounters a coastal mountain range. As it rises to a height of 3500 m to pass over the mountains, it undergoes an adiabatic expansion. The pressure at 2000 m and 3500 m is 0.802 and 0.602 atm, respectively. If the initial temperature of the cloud mass is 288 K, what is the cloud temperature as it passes over the mountains? Assume that $C_{p,m}$ for air is 28.86 J/(Kmol) and that air obeys the ideal gas law. If you are on the mountain, should you expect rain or snow? (20%)

4. An autocatalytic reaction is one in which a product acts as a catalyst. Assume that the reaction A → B has the rate law -d[A]/dt = k[A][B].

(a) Please derive the integrated rate law. (the assumption might be the initial concentrations of A and B are both nonzero)

(b) Find [A] at t = 10.0 min if $[A]_0$ = 0.50 mole/L, $[B]_0$ = 0.010 mole/L, and k = 0.1 L/(mol min). (20%)

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5. The average human with a body weight of 70 kg has a blood volume of 5.0 L. The Henry's law constant for the solubility of N_2 in H_2O is 9.04×10^4 bar at 298 K. Assume that this is also the value of the Henry's law constant for blood and that the density of blood is 1.0 kg/L. (a) Calculate the number of moles of nitrogen absorbed in this amount of blood in air of composition 80% N_2 at sea level, where the pressure is 1 bar and at a pressure of 50 bar. (b) Assume that a diver accustomed to breathing compressed air at a pressure of 50 bar is suddenly brought to sea level. What volume of N_2 gas is released as bubbles in the diver's bloodstream? (c) What are the risks for the diver? (20%)