1. The elementary gas-phase reaction

$$A \rightarrow B + 2C$$

is carried out isothermally in a flow reactor with no pressure drop. The specific reaction rate at 50℃ is 10^{-4} min^{-1} and the activation energy is 85 kJ/mol. Pure ***A*** enters the reactor at 10atm and 127℃ and a molar flow rate of 2.5 mol/min. Calculate the reactor volume and space time to achieve 90% conversion in:

(a) a CSTR **(5 pts)**

(b) a PFR **(5 pts)**

(c) If this reaction is to be carried out at 10atm and 127℃ in a batch mode with 90% conversion, what reactor size and cost would be required to process (2.5mol/min × 60min/h × 24h/day) 3600mol of ***A*** per day? **(5 pts)**

(d) Assume that the reaction is reversible with K_C = 0.025mol^2/dm^6 and calculate the equilibrium conversion and then redo (a) and (b)to achieve a conversion that is 90% of the equilibrium conversion. **(10 pts)**

2. **(25 pts)** 交通警語 "喝酒後不開車"，主要是因喝酒之後血液中的酒精來不及分解，造成酒精濃度增高，進而影響神經控制能力，容易導致交通事故。因此爲了避免危險事故，世界各國對於駕駛員血液中酒精濃度有一定嚴格的標準，符合標準才允許開車上路，例如美國標準爲 1g of ethanol per liter of body fluid，瑞典爲 0.5 g/L，台灣爲 0.25 g/L。

各位化工人未來難免有應酬多少要喝酒，可否利用 kinetics 與以下生理 model 來評估自己酒後何時可再開車。從生理學知道，酒精首先被腸胃吸收至血液中，此反應爲一級反應，其反應常數爲 10 h^{-1}；之後，酒精被血中酵素分解，此反應爲零級反應，其反應速率爲 0.192 g/h・L of body fluid。若某化學工程師於應酬時連續喝了兩杯高粱酒（假設每杯高粱約含 40 g 酒精），請問此人 (a) 在美國；(b) 在瑞典；(c) 在台灣 必須要休息多久才能上路？請畫出時間對血液中酒精濃度(C_B)作圖。

(Hint: Volume of body fluid = 40 L; 將此設爲連續反應 $A \xrightarrow{\text{吸收}} B \xrightarrow{\text{分解}} C$

且 t=0，血液中酒精濃度 C_B=0)

3. (a) The Clausius-Clapeyron equation, $ln\ P^{o} = c - (\Delta h/RT)$, is usually used to correlate the solid-vapor and liquid-vapor equilibrium cases (P^{o} and Δh are denoted as the vapor pressure and the latent heat). For example, the vapor pressure of solid and liquid hydrogen cyanides expressed in mmHg are given by

Solid (from 243 to 258 K): $\log P^{o} = 9.33902 - (1864.8/T)$

Liquid (from 265 to 300 K): $\log P^{o} = 7.74460 - (1453.06/T)$

Please calculate (1) the heat of sublimation; (2) the heat of vaporization; (3) the heat of fusion; (4) the triple point; and (5) the normal boiling point. (R = 1.9872 cal/g-mole = 8.3143 Joules/g-mole K = 82.06 atm-cm^3/g-mole K) (20 分)

(b) Please show the Clausius-Clapeyron equation: $ln\ P^{o} = c - (\Delta h/RT)$ and describe the assumptions. (Hint: Start from the differentials of chemical potentials for each phase in terms of T and P)(15 分)

4. Based on the Gibbs-Duhem equation and the definition of excess Gibbs free energy, G^{E}, please show $x_1 \frac{d\ln(y_1 P)}{dx_1} + x_2 \frac{d\ln(y_2 P)}{dx_1} = 0$ under a constant temperature and pressure, if the vapor phase of this binary system is an ideal gas. (15 分)