國立雲林科技大學 所別：化工所
八十八學年度研究所碩士班入學考試試題 科目：化工熱力學

1. Define the following terms.
   (a) Intensive property (4%)
   (b) The third law of thermodynamics (4%)
   (c) State function (4%)
   (d) Partial molar property (3%)
   (e) Ideal solution (3%)
   (f) Principle of corresponding state (4%)

2. The PVT behavior of a gas is described by the van der Waals equation:

$$P = \frac{RT}{V-b} - \frac{a}{V^2}$$

   Show that

$$a = \frac{27R^2T_C^2}{64P_C} \qquad b = \frac{RT_C}{8P_C}$$

   where P_C and T_C are the critical pressure and critical temperature, respectively. (16%)

3. One mole of an ideal gas, $C_p = (7/2)R$ and $C_V = (5/2)R$, is compressed adiabatically in a piston/cylinder device from 2 bar and 25 ℃ to 7 bar. The process is irreversible and requires 20% more work than a reversible, adiabatic compression from the same initial state to the same final pressure. What is the entropy change of the gas? (22%)

國立雲林科技大學
八十八學年度研究所碩士班入學考試試題

所別：化工所
科目：化工熱力學

4. A tank containing oxygen at 420 K and 50 bar is vented until the temperature in the tank falls to 320 K. Assuming there is no heat transfer between the gas and the tank, find the pressure in the tank at the end of the venting process and the fraction of the initial mass of gas remaining in the tank for the above case. You need only solve with qualitative description. If oxygen obeys the law of corresponding states. (25%)

5. An ideal gas at P_1 bar and T_1 K undergoes a Joule-Thomson expansion to atmospheric pressure. What will be the temperature of the gas after the expansion. (15%)

國立雲林科技大學　　所別：化工所
八十八學年度研究所碩士班入學考試試題　科目：化工動力學

1. 請基於反應物A於反應器中的總質量平衡，演導下列適用於 PFR 反應器(plug flow reactor)的設計方程式：$V = F_{A0}\int_{X_{in}}^{X_{out}} \frac{dX}{(-r_A)}$；

式中 V 為反應率(X)由入口反應率(X_{in})變化至出口反應率(X_{out})所需的反應器體積，F_{A0} 為反應物 A 的入口莫耳流率(entering molar flow rate)，$-r_A$ 為反應物 A 的消耗率(rate of disappearance)。(8 分)

(註：請敘述各項假設條件)

2. 以一批次定體積反應槽（a constant-volume batch reactor)進行如下的不可逆(irreversible)反應：A→products，另外假設速率方程式為：$-r_A = kC_A^{\alpha}$，

(a) 說明如何安排實驗，並繪簡圖說明如何以微分法(the differential method)分析實驗數據，並進一步求得α與 k。(10 分)

(b) 說明如何安排實驗，並繪簡圖說明如何以起始速率法 (the method of initial rates)分析實驗數據，並進一步求得α與 k。(10 分)

(c) 比較以上兩個方法的優缺點。(5 分)

3. 一等溫(isothermal)等壓(isobaric)的氣相流動系統的反應如下：$\frac{1}{2}N_2 + \frac{3}{2}H_2 \rightarrow NH_3$，另外已知 N_2 與 H_2 具有相等的入口莫耳流率，

(a) 請以 H_2 為計算基準，建立一完整的反應計量表(a complete stoichiometric table)。(5 分)

(b) 假設入口總壓為 16.4 atm、入口溫度為 1727℃，請計算當 H_2 反應率為 60%時 H_2 與 NH_3 的濃度。(12 分)

(註：R=0.082 atm.liter/g-mol.°K)

國立雲林科技大學
八十八學年度研究所碩士班入學考試試題

所別：化工所
科目：化工動力學

4. 一可逆反應 $A \leftrightarrow B$ 在一塞流管柱(Plug flow,截面積為 S)中進行,正反應速率常數為 k_1,逆反應速率常數為 k_{-1}.若線性流速為 u ,(a)管柱之最佳長度 (最高產率時之管長) 為何 ? (15 分) (b)此化學反應在此種管柱中最高之轉化率為何 ? (10 分)

5. 一反應系統: $2A \rightarrow R$; $A+B \rightarrow S$; $2B \rightarrow T$. 於混合流反應器中進行,上述反應均為基本反應步驟(Elementary reactions). 試問,若欲使產物 S 之產率為最大時,A 與 B 之濃度應維持何種比例 ? (25 分)

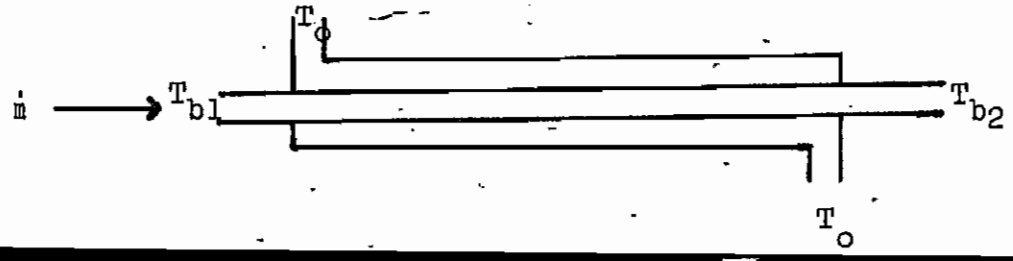
國立雲林科技大學
八十八學年度研究所碩士班入學考試試題

所別：化工所
科目：單元操作與輸送現象

1. Answer the following questions: (35%)
   (1) Write down the definition of the following number or theory and describe its physical meaning: (a) Schmidt number, (b) Fick's first law of diffusion. (10%).
   (2) Explain the term 'adsorption' and indicate its difference from 'absorption'. (5%)
   (3) For rectification in a distillation column, should the operating line lie above or below the equilibrium line? Why? (5%)
   (4) A distillation column used to be designed for the separation of a binary mixture, which was a cold feed. The McCabe-Thiele assumptions applied for this system. However, in practical case, the feed would be a mixture of 30% vapor and 70% liquid. Assuming that the column diameter and the reflux ratio remain at the design value, should the feed tray location be higher or lower than what was initially designed? (5%)
   (5) In an absorption process, a solute gas A is absorbed from a mixture by a substance B in the liquid phase. The chemical reaction is irreversible as $A + B \rightarrow AB$. What will be the effect of this chemical reaction on the absorption performance? (5%)
   (6) Assuming that the filter cake is incompressible, how does the filtrate volume vary with increasing filtering time in a constant pressure operation? Why? (5%)

2. Consider a sphere of fixed radius r_1 in an infinite gas medium. Component A at partial pressure p_{A1} at the surface is diffusing into the surrounding stagnant medium B, where $p_{A2} = 0$ at some large distance away. Find the total molar flux of A at the surface for steady-state diffusion. (15%)

3. A parallel flow heat exchanger is to be redesigned. Condensing steam on the outside of the inner tube maintains the tube wall temperature at T_o. Using the Sieder-Tate correlation shown below for determine h_1 (based on the initial temperature difference): $Nu = 0.026\,(Re)^{0.8}\,(Pr)^{0.3}$
   What will happen to the temperature difference $T_{b2} - T_{b1}$ if:
   (1) The inner tube diameter is doubled, while maintaining the original mass flow rate and tube length. (10%)
   (2) The inner tube length is halved, while maintaining the original mass flow rate and tube diameter. (10%)



國立雲林科技大學
八十八學年度研究所碩士班入學考試試題

所別：化工所
科目：單元操作與輸送現象

4. An incompressible Newtonian fluid is located in the space between plates that are separated by a distance B. The upper plate is moving in the +x-direction with a velocity V, thus contributing to the motion of the fluid. An additional contribution to the fluid motion is that due to a constant applied pressure gradient dp/dx. Assume that the flow is sufficiently slow that viscous heating is not important.
   (1) Find the velocity profile and the volume rate of flow. (15%)
   (2) Rework the problem with the fixed surface at y = B and the surface at y = 0 moving with velocity V, (15%)