本科考試可使用計算器，廠牌、功能不拘

＊請在試卷答案卷（卡）內作答

化工熱力學 (50%)

(3%)

1. Figure (一) shows the fugacities of component 1 and 2, $\hat{f}_1^l$ and $\hat{f}_2^l$, in a liquid phase. Please express $\hat{f}_1^l$ in terms of **composition, activity coefficient**, and **reference state** which is chosen as the pure fugacity of component 1 at system pressure and temperature.

(3%)

2. In Figure (一), the straight lines are also the fugacities, but for special mixtures. Please explain what conditions are imposed on this mixture?

(3%)

3. Figure (二) is the vapor-liquid equilibrium *y*-*x* diagrams of different mixtures at a specific pressure. Among these mixtures, which one is the easiest to be separated by distillation process.

(3%)

4. Also among the mixtures in Figure (二), explain why mixtures b and d are the most difficult or even impossible to be separated by a single distillation column. Please explain with thermodynamic consideration.

(6%)

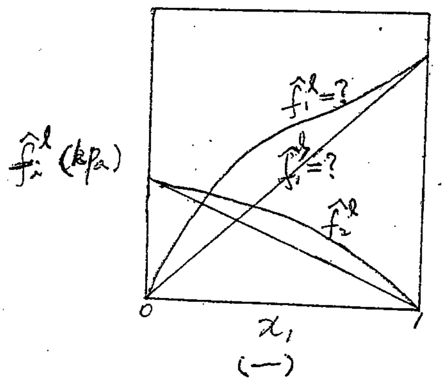
5. The general energy balance equation of an open system (also the first law of thermodynamics) is given as

$$\left[(H+\frac{u^2}{2g_c}+\frac{gZ}{g_c})\delta M\right]_{in}-\left[(H+\frac{u}{2g_c}+\frac{gZ}{g_c})\delta M\right]_{out}+\delta Q-\delta W=d\left[M(U+\frac{u^2}{2g_c}+\frac{gZ}{g_c})\right]_{sys}$$

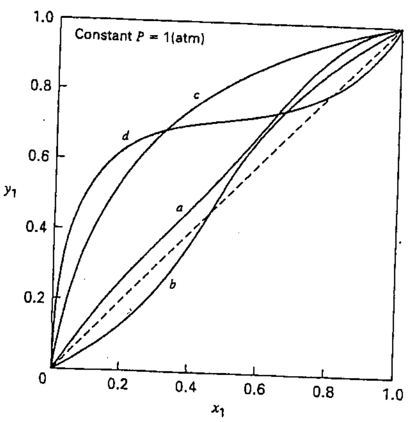
where all the thermodynamic properties are in quantity per mole.
Please **reduce** the above equation to its **simplest and correct** form for a steam flowing steadily through a horizontal, insulated nozzle when considering **System: the nozzle and its contents.**

(7%)

6. Same as Problem 1, but **System is one mole of steam flowing.**



(一)



(二)

注意：背面有試題

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(25%)
7.
A frictionless piston-and-cylinder system shown in Figure A is subjected to 1.013 bar of external pressure. The piston mass is 200 kg, it has an area of 0.1 m^2, and the initial volume of the entrapped gas (40 mol % CO_2 and 60 mol % O_2) is 0.15 m^3. The piston and cylinder do not conduct heat, but heat can be added to the gas by a heating coil. The blocks in Figure A are removed so the piston can move freely.

If heat is added so to raise the temperature from 35 to 400 °C, determine the amount of added heat, the amount of work done by the piston, and the change in internal energy of the gas. You may assume that nitrogen and oxygen gas behave ideally under these conditions. (25 points)

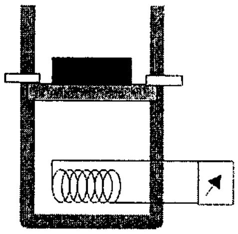

Figure A

化學反應工程 (50%)

(12%)
1. The mechanism of a reaction is shown below.
   a) What is the overall reaction?
   b) Which compounds are intermediates?
   c) Predict the rate law based on this mechanism.
   d) What is the overall order of the reaction?

   $HOOH + I^- \rightarrow HOI + OH^-$ (slow)
   $HOI + I^- \rightarrow I_2 + OH^-$ (fast)
   $2OH^- + 2H_3O^+ \rightarrow 4\,H_2O$ (fast)

參考用

(13%)
2. Calculate the equilibrium conversion and equilibrium concentration for each of the following reactions. (R = 0.082 L atm/ mol K)
   a) The liquid-phase reaction $A + B \rightleftharpoons C$ with $C_{A0} = C_{B0} = 2$ mol/L and $K_C = 10$ L/mol. (6%)
   b) The gas-phase reaction $A \rightleftharpoons 3C$ carried out in a flow reactor with no pressure drop. Pure A enters at a temperature of 400 K and 10 atm. At this temperature, $K_C = 0.25$ L/ mol^2. (7%)

注意：背面有試題

國立中央大學100學年度碩士班考試入學試題卷

所別：化學工程與材料工程學系碩士班甲組(一般生)　　共 3 頁　第 3 頁
科目：化工熱力學及化學反應工程

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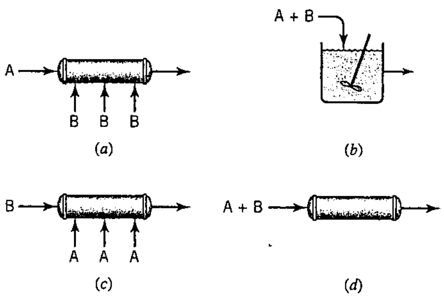
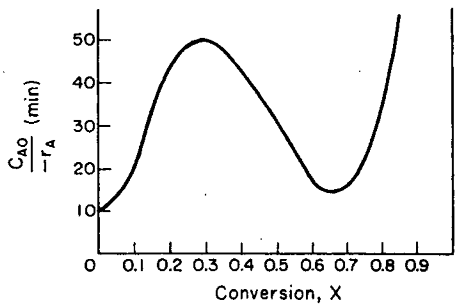
(12%)

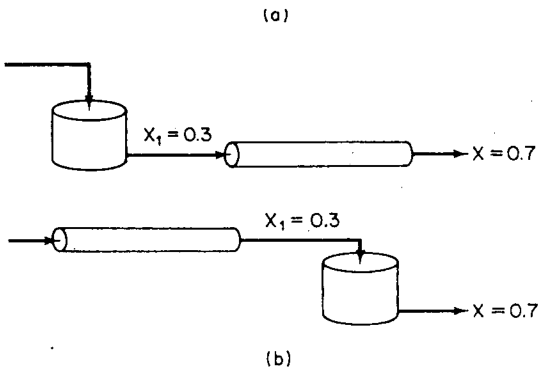
3. Given the two reactions A + B → S, $-r_1 = k_1C_AC_B$; S + B → C $-r_2 = k_2C_S^2C_B$, where S is the desired product and is to be maximized. Rate the following four schemes either "good" or "not so good", and reason it out.



(13%)

4. The following Figure shows $C_{A0}/-r_A$ versus conversion of X_A for a nonisothermal decomposition of reactant A.





(a) Consider the two systems proposed above in which a CSTR and a plug-flow reactor are connected in series. The intermediate conversion is 0.3 and the final conversion is 0.7. How should the reactors be arranged to obtain the minimum total volume? Explain. (8%)

(b) Is there a better mean (smallest volume) of achieving 70%conversion other than either of the systems proposed? (5%)