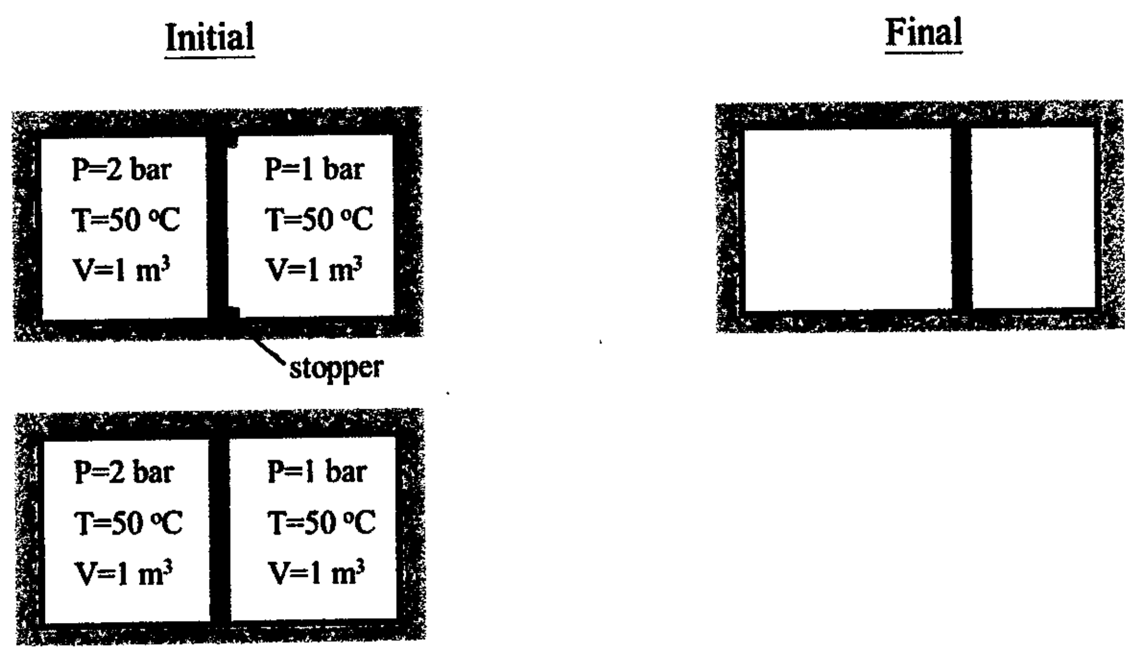
第一部分簡答題，每題 3 分。部份給分，答錯不倒扣分。

1. What are the criteria for two phases reaching thermodynamic equilibrium?
2. Please explain what is a thermodynamically reversible process.
3. Please explain what is Lewis-Randall Rule.
4. Please define the ideal solution (or ideal mixture).
5. What is the third law of thermodynamics?
6. What is elementary reaction?
7. What is the criterion for a reactor being differential?
8. What is the Eley-Rideal mechanism?
9. What is the Pseudo-Steady-State Hypothesis?
10. What is the Damkohler number?

第二部分計算題(11-15)，題分註明於問題後方括弧內。

11. An insulated system with two compartments with ideal gas, and a piston is placed in between the two compartments. Initially, the pressure of the left compartment is greater than the right one, but the piston does not move due to the stoppers. At some point, the stoppers are removed, so the piston is moving towards right. The entire system is isolated but the piston itself allows for heat transfer. You can assume the constant volume heat capacity of this ideal gas 2.5 *R*, where *R* is gas constant. You can also ignore the mass and volume of the piston.



(a) What is the temperatures of the left compartment at the final state? (5 points)

(b) What is the final pressure of the left compartment? (5 points)

(c) What is the entropy generation between the initial and final state? (10 points)

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12. Consider a binary mixture in an isolated system at equilibrium. The temperature is fixed at 300 K, the equilibrium compositions at different pressures are shown below.

P (bar)	1.70	1.72	1.75
X1	0.59	0.6	0.61
Y1	0.80	0.88	0.92

At 300K, the saturated pressure of species 1 is 2 bar, and that of species 2 is 1 bar. Please calculate the molar Gibbs energy change on mixing, $\Delta_{mix}\underline{G}$, of this mixture in liquid phase at the equilibrium state at 300 K and 1.72 bar. [15 points]

13. A gas-phase reaction ($A \rightarrow B + C$) is found to be irreversible and follows an elementary law. The reaction is performed in a plug-flow reactor isothermally at 1000 K and isobarically at 10 atm. The rate constant and activation energy are determined to be 0.1 s^{-1} at 800 K and 40 kJ mol^{-1}, respectively. The molar flowrate of A at inlet is 60 mol min^{-1}. Calculate the volume of reactor required to achieve a conversion of 90% for species A. [10 points].

14. A liquid-phase reaction is found to be irreversible and elementary following the sequence: $A \overset{k_1}{\rightarrow} B \overset{k_2}{\rightarrow} C$. The reaction is catalyzed by a solid catalyst in a packed-bed reactor isothermally. The concentration of species A at inlet is 0.005 mol L^{-1}. The volumetric flow rate is 2 L min^{-1}. The rate constants k_1 and k_2 are 0.1 and 0.001 L min^{-1} g-catalyst^{-1}, respectively. What is the mass of catalyst to maximize the concentration of species B? [15 points].

15. For an enzyme-catalyzed reaction, the mechanism can be expressed as follows:

(1) $E + S \leftrightarrow E \cdot S$　　k_1, k_{-1}: forward and backward rate constants

(2) $S + E \cdot S \leftrightarrow S \cdot E \cdot S$　　k_2, k_{-2}: forward and backward rate constants

(3) $E \cdot S \rightarrow P + E$　　k_3: forward rate constant

and $[E]$, $[S]$, $[E \cdot S]$, $[S \cdot E \cdot S]$, and $[P]$ represent the concentrations of enzyme, substrate, enzyme-substrate complex, substrate-enzyme-substrate complex, and product, respectively. The total concentration of enzyme is $[E_t]$. Derive the rate law for generation of product. [10 points].

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