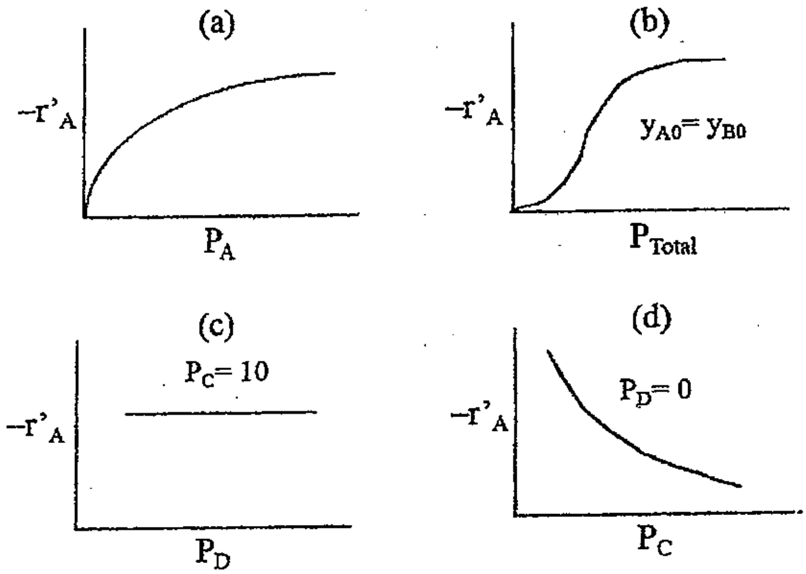
※ 考生請注意：本試題可使用計算機。　請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

1. Calculate the ratio of the volumes of a CSTR and a PFR (V_{ST} / V_{PF}) required to achieve a fractional conversion of 0.99 for the reactant A with an identical feed rate for each reactor, if the liquid-phase reaction $A \rightarrow$ Products is
   (a) first-order with respect to A (please find the value of V_{ST} / V_{PF}) **(6%)**
   (b) second-order with respect to A (please find the value of V_{ST} / V_{PF}) **(9%)**

2. **(10%)** Two identical plug flow reactors are used to carry out two gas-phase reactors separately:
   (a) $A \rightarrow 2B$
   (b) $A \rightarrow B$
   These two reactions have the same rate constant, and the feed conditions are the same in these two reactors. Without deriving any design equation, how do you judge which reactor will achieve the higher conversion.

3. For a reactor system composed of *n* ideal and isothermal CSTRs with the same space time of τ_i connected in series (*n* is a positive integer),
   (a) Please derive the expression for the conversion (x_A) of a first-order and liquid phase reaction, $A \rightarrow B$, carried out in this reactor system. Pure A is fed, and the rate constant is *k*. **(10%)**
   (b) Use the Lavenspiel plot to illustrate that an ideal PFR could be described using this reactor system with *n* approaches to infinity. **(5%)**

4. The following figures were reported for the reaction $A + B \rightarrow C + D$
   Please find the rate law **(9%)** and mechanism **(6%)** for the reaction.



5. **(10%)** A reversible exothermic reaction needs to be carried out in continuous-stirred tank reactors. The heat of reaction should be managed.
   (a) Explain the importance of temperature controlling.
   (b) Raise three practical methods to do the job, and explain how it works.

6. The following liquid-phase reactions were carried out in a 100-dm^3 PRF at 300K. The entering volumetric flow rate was 10 dm^3/min, with equal molar feed of A and B of $C_{A0} = C_{B0} = 2$ mol/dm^3.

   $A + 2B \rightarrow 2C + 3D$　　$r_{1D} = k_{1D} C_A C_B^2$　　$k_{1D} = 0.25\ (\text{dm}^3/\text{mol})^2/\text{min}$

   $2D + 3A \rightarrow C + 2E$　　$r_{2E} = k_{2E} C_A C_D$　　$k_{2E} = 0.1\ (\text{dm}^3/\text{mol})^2/\text{min}$

   $B + 2C \rightarrow 3D + 4F$　　$r_{3F} = k_{3F} C_B C_C^2$　　$k_{3F} = 5.0\ (\text{dm}^3/\text{mol})^2/\text{min}$

   (a) Please list out all the equations you need to input into a computer software in order to obtain the species concentrations and the instantaneous selectivity $S_{C/DEF}$ (i.e., C is the desired product and D~F are undesired products) as a function of reactor volume. **(10%)**
   (b) Please qualitatively describe how to enhance the selectivity and which type of reactor would be suitable. **(5%)**

7. An ideal gas mixture is charged to a tubular reactor at the rate of 10 kmoles/hr. The reactor is operated isothermally at 500K and the pressure is 6 atm. The reactor is 10 cm in inner diameter. The second-order irreversible reaction

   $$A + B \rightarrow D$$

   that is taking place in the reactor has a specific reaction rate of 6 m^3/mole/hr at 500K. The feed composition is: 40% A, 40% B, and 20% inert.
   (a) Derive the design equation for this reactor. **(10%)**
   (b) What reactor length is necessary for 80% conversion? **(10%)**