$$\int_0^x \frac{1+ax}{1-x}dx = (1+a)\ln\frac{1}{1-x} - ax$$

$$\int_0^x \frac{1+ax}{(1-x)^2}dx = \frac{(1-a)x}{1-x} - a\ln\frac{1}{1-x}$$

$$\int_0^x \frac{(1+ax)^2}{(1-x)^2}dx = 2a(1+a)\ln(1-x) + a^2x + \frac{(1+a)^2x}{1-x}$$

$$Q - W_s - F_{A0}\int_{T_0}^{T} C_{p,mix}dT - \left[\Delta H^{\circ}_{RX}(T_R) + \int_{T_R}^{T}\Delta C_p dT\right]F_{A0}X = 0$$

1. (10%) A reversible reaction $A_{(g)} \leftrightarrows B_{(g)} + C_{(g)}$ is carried out in a tubular reactor. The product B may diffuse through the reactor wall and is collected outside of the reactor.
   (1) Please **explain** the advantages of this type of reactor.
   (2) Please sketch curves to show the flow rates along the reactor for all components. Make the **explanation**.

2. (24%) A gas-phase reaction between A and B to produce C is carried out in a tubular reactor.

   $$A + B \rightarrow C$$

   The feed, containing 40 mol% A, 40 mol% B, and 20% inert species, enters the reactor at a total rate of 1.5 mol/min, with a flow rate of 2.5 liter/min. The reaction is first-order with respect to both A and B, with k_A = 0.25 liter/mol/min.
   (a) Determine the reactor volume required to produce a product that contains 60 mol% C. Assume temperature and pressure are unchanged.
   (b) How do you decide the reactor size if the reaction is carried out adiabatically?
   (c) How do you decide the reactor size if the pressure drops along the reactor linearly?

3. (12%) The gas phase dehydrogenation of ethane to ethylene

   $$C_2H_6 \rightarrow C_2H_4 + H_2$$

   proceeds through the elementary reaction steps

(背面仍有題目,請繼續作答)

$$C_2H_6 + H \rightarrow C_2H_5 + H_2$$
$$C_2H_6 \leftrightarrows C_2H_5 + H$$
$$C_2H_5 \rightarrow C_2H_4 + H$$

(a) Identify the initiation, propagation, and termination steps.
(b) Find a reasonable expression for $r(C_{C2H6})$.
(c) The bond energy of ethane is 104 kcal/mole, and the propagation steps have very low activation energies. What is the approximate activation energy of this reaction?

4. (10%) Show that r(X,T) for A → B, $r = k_f C_A - k_b C_B$ has a maximum $\partial r/\partial T = 0$ if the reaction is exothermic but not if endothermic.

5. (12%) For the parallel decompositions of A, where R is desired,

$$\left.\begin{array}{ll} A \rightarrow R & r_R = 1 \\ A \rightarrow S & r_S = 2C_A \\ A \rightarrow T & r_T = C_A^2 \end{array}\right\} \quad \text{.....with } C_{A0}=1$$

What is the maximum C_R we may expect in isothermal operations
(a) in a mixed reactor,
(b) in a plug flow reactor.

6. (8%) 請簡要說明觸媒孔徑分佈(pore size distribution)與下面性質之關係：(1)觸媒表面積，(2)單位觸媒重量之活性。

7. (8%) A_2 與 B 皆能被某觸媒吸附，但吸附後彼此不反應，且知 A_2 是以解離形式被吸附($A_2 + 2S \leftrightarrows 2A{\cdot}S$)，請導出 A 之等溫吸附式(adsorption isotherm)。

8. (8%) 以一個蜂巢狀之觸媒當反應器進行 A + B → Products 之反應，若其活性甚高，因此其外表面之薄膜擴散為控制步驟，(1)請導出 A 在此觸媒內之質量平衡式，(2)若軸向擴散效應可忽略，請導出軸向 C_A 之表示式。

9. (8%) (a)氣液固三相反應器與氣固二相反應器互相比較，前者有何優點？(上述固相是觸媒)
(b)在何種情況(溫度、觸媒粒徑、流速等)下，求得外顯(apparent)反應活化能會低於真實值？何故？