1. Explain the main difference between thermodynamics and reaction kinetics when they are applied to the subject of chemical reactions. (5%)

2. Please give 1) vapor-liquid equilibrium conditions, 2) reaction equilibrium conditions. (10%, 2.5% for each condition you give)

3. A set of experimental vapor pressures and the Clausius-Clapeyron equation are given below. The C-C equation relates vapor pressure, volume change, and the enthalpy of vaporization of liquids. Based on the given equation and data prove that the enthalpy of vaporization of this mixture is independent of temperature if this liquid has vapor volume very much larger than its liquid volume. (10%)

$$\log p = \frac{-\Delta H_{vap}}{2.303RT}$$

Temperature/K	Vapor pressure /kPa
298.15	3.12
303.15	4.18
313.15	7.30
323.15	12.19

4. Explanation: (10%)
   (a) equilibrium and requirements for a reversible process
   (b) the phase rule for a reacting system
   (c) Why the residual properties $H^R = S^R = 0$, and $V^R \neq 0$ when $P \to 0$?
   (d) How can one calculate the fugacity and fugacity coefficient ?
   (e) How can one obtain the activity and activity coefficient ?

5. Show that $\oint \frac{dQ}{T} < 0$ for a closed system. (8%)

6. A small, well insulated cylinder and piston assembly (Fig. 1) contains an ideal gas at 10 atm and 70 °F. A mechanical lock prevents the piston from moving. The length of the cylinder containing the gas is 1 ft and the piston cross-sectional area 0.2 ft^2. The piston, which weights 500 lb, is tightly fitted and when allowed to move, there are indications that considerable friction is present.
   When the mechanical lock is released, the piston moves in the cylinder until it impacts and is engaged by another mechanical stop; at this point, the gas volume has just doubled.
   As an engineer, can you estimate the temperature and pressure of the gas such an expansion? clearly state any assumptions. (7%)

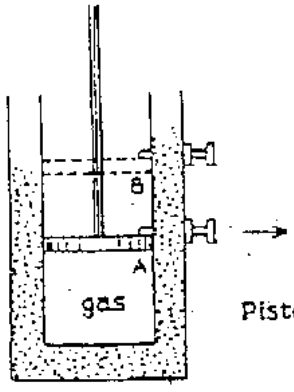

Fig. 1

Piston moves from A to B

7. Show that n plug flow reactors connected in series with a total volume V gives the same conversion as a single reactor of volume V. (10%)
How to distribute the feed for two reactors of volume 60 and 30 liters connected in parallel, in such manner that fluid streams which meet have the same composition ? (5%)

8. Describe how to use a mixed flow reactor to obtain kinetic data for the rate equation of a single reaction. (10%)

9. The elementary gaseous reaction A → B has a unimolecular reaction rate constant of 0.0015 min^{-1} at 80 ^{o}F. The reaction is to be carried out in parallel tubes 10 ft long and 1 in. inside diameter under a pressure of 132 psig at 260 ^{o}F. A production rate of 1000 lb/h of B is required. Assuming an activation energy of 25,000 cal/g mole, how many tubes are needed if the conversion of B is to be 90%? Assuming perfect gas laws. A and B each have molecular weights of 58. (15%)

10. An irreversible reaction A → B was carried out in a batch reactor and the following concentration-time data were obtained

time (min)	0	5	8	10	12	15	17.5	20
C_A (μmol/ml)	4.0	2.25	1.45	1.0	0.65	0.25	0.06	0.008

Determine the reaction order and specific reaction rate. (10%)