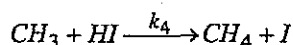
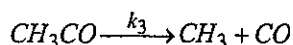
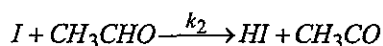
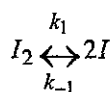
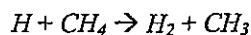


- (24%) Explain the (a) Bragg law, (b) Beer-Lambert (or Lambert-Beer) law, (c) Langmuir adsorption isotherm, (d) Zeta potential. (You may draw figures to explain.)
- (24%) True or false? Please explain. (a) If the partial pressure  $P_i$  increases in an ideal gas mixture held at constant  $T$ , then  $\mu_i$  increases in the mixture. (b) It is impossible for the entropy of a closed system to decrease substantially in an irreversible process. (c) For a one-component system, the maximum number of phases that can coexist in equilibrium is two. (d) For a one-component system, the most stable phase at a given  $T$  and  $P$  is the phase with the lowest  $H_m$ . (e)  $\Delta S_{\text{sys}} + \Delta S_{\text{surr}}$  is positive for every irreversible process. (f) The work done by a closed system can exceed the decrease in the system's internal energy. (g) For every process in an isolated system,  $\Delta T = 0$ . (h)  $\Delta T = 0$  for every adiabatic process in a closed system.
- (a) (14%) Estimate  $(\partial U / \partial V)_T$  for  $N_2$  gas at  $25^\circ\text{C}$  and 1 atm using the van der Waals equation. (For  $N_2$ ,  $a = 1.35 \times 10^6 \text{ cm}^6 \text{ atm/mol}^2$ ,  $b = 38.6 \text{ cm}^3/\text{mol}$ ) (b) (12%) The normal boiling of ethanol is  $78.3^\circ\text{C}$ , and at this temperature  $\Delta H_{\text{vap}} = 38.9 \text{ kJ/mol}$ . To what value must  $P$  be reduced if we want to boil ethanol at  $25^\circ\text{C}$  in a vacuum distillation?
- (16%) The following is a slightly simplified version of the mechanism to explain the iodine-catalyzed decomposition of acetaldehyde:



Apply the steady-state treatment (or pseudo-steady-state-hypothesis) to  $I$ ,  $CH_3CO$  and  $CH_3$ , and obtain a rate expression of  $CO$ .

- (10%) The activation energy for the reaction,



has been measured to be  $49.8 \text{ kJ/mol}$ . Some estimates of enthalpies of formation,  $\Delta H_f^\circ$ , are:  $H$ :  $218 \text{ kJ/mol}$ ,  $CH_4$ :  $-74.8 \text{ kJ/mol}$ ,  $CH_3$ :  $139.5 \text{ kJ/mol}$ . Estimate a value for the activation energy of the reverse reaction.