

- a) Calculate the equilibrium constant at 25 °C.
- b) Calculate the heat of reaction at 25 °C. Is the reaction exothermic or endothermic?
- c) Assuming that the heat of reaction does not change much with temperature, calculate the equilibrium constant at 550 °C.
- d) Is it an acceptable assumption that the heat of reaction does not change much with temperature? (Answers without justification do not count.)
- e) The reactor initially contains one mole of ethanol and nothing else. The reaction is run at 550 °C and 2 bar until equilibrium is reached. What is the mole fraction of species at equilibrium?
- f) It is desirable to react 98% of the initial amount of ethanol. If the temperature is to remain at 550 °C, at what pressure should you run the reaction?

**Problem 14.14:** (~~Fall 2001~~) The gas-phase dehydrogenation of propane is carried out according to the reaction



The reaction takes place in the presence of a catalyst in an isothermal reactor that is maintained at 5 bar.

- a) Calculate the equilibrium constant at 25 °C.
- b) Calculate the standard enthalpy of reaction at 25 °C. Is the reaction exothermic or endothermic?
- c) The reactor feed contains pure propane. If the desired conversion of propane is 95%, at what temperature should you run the reaction? Assume the reaction reaches equilibrium.
- d) Due to upstream process modifications, the reactor feed has now changed from pure propane into a mixture that contains 50% nitrogen (by mol). If the reactor pressure remains at 5 bar, how should you adjust the temperature to achieve 95% conversion?
- e) Just as you finished adjusting the temperature to handle the propane/nitrogen feed of the previous part, the compressor malfunctions and the reactor pressure drops to 1 bar. How should you adjust the temperature to achieve 95% conversion?
- f) Clearly state all the assumptions.

**Problem 14.15:** (~~Fall 1994~~) The standard Gibbs energy of formation of a substance based on one standard state ( $s_1$ ) may be related to any other standard state ( $s_2$ ) according to the following equation:

$$\Delta G^\circ(s_2) - \Delta G^\circ(s_1) = \mu(s_2) - \mu(s_1)$$