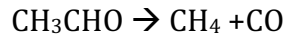ABE 202 Homework 2. 2017

1. Mass Balance for a Mixture with Chemical Reaction

    At high temperatures acetaldehyde (CH_3CHO) dissociates into methane and carbon monoxide by the following reaction

    $$CH_3CHO \rightarrow CH_4 + CO$$

    At 520°C the rate at which acetaldehyde dissociates is

    $$\frac{dC_{CH_3CHO}}{dt} = -0.48C_{CH_3CHO}^2 \frac{m^3}{kmol\ s}$$

    where C is the concentration in kmol/m³. The reaction occurs in a constnt-volume, 1-L vessel, and the initial concentration of acetaldehyde is 10 kmol/m³

    a. If 5 mols of the acetaldehyde reacts, how much methane and carbon monoxide is produced?
    b. Develop expressions for the amounts of acetaldehyde, methane, and carbon monoxide present at any time, and determine how long it would take for 5 mol of acetaldehyde to have reacted.

2. At high temperatures phosphine (PH_3) dissociates into phosphorus and hydrogen by the following reaction:

    $$4PH_3 \rightarrow P_4 + 6H_2$$

    At 800°C the rate at which phosphine dissociates is

    $$\frac{dC_{PH_3}}{dt} = -3.715 \times 10^{-6}\ C_{PH_3}$$

    for t in seconds. The reaction occurs in a constant-volume, 2-L vessel, and the initial concentration of phosphine is 5kmol/m³

    a. If 3mol of the phosphine reacts, how much phosphorus and hydrogen is produced?
    b. Develop expressions for the number of moles of phosphine, phosphorus, and hydrogen present at any time, and determine how long it would take for 3 mol of phosphine to have reacted.

3. The following reaction occurs in air:

    $$2NO + O_2 \rightarrow 2NO_2$$
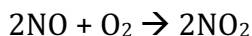
    at 20°C the rate of this reaction is

$$\frac{dC_{NO}}{dt} = -1.4 \times 10^{-4}\ C_{NO}^2 C_{O_2}$$

for t in seconds and concentrations in kmol/m³. The reaction occurs in a constant-volume, 2-L vessel, and the initial concentration of NO is 1kmol/m³ and that of O_2 is 3kmol/m³

a. If 0.5 mol of NO reacts, how much NO_2 is produced?
b. Determine how long it would take for 0.5 mol of NO to have reacted.