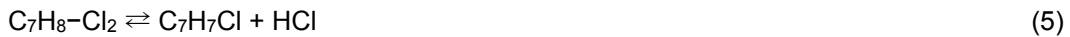# CE 329, Fall 2015

Assignment 9

Problem Purpose

This problem will help you determine whether you have mastered the learning objectives for this unit.

Problem Statement

Suppose that the monochlorination of toluene, reaction (1) proceeds according to the mechanism given in equations (2) through (5).

$$Cl_2 + C_7H_8 \rightarrow C_7H_7Cl + HCl \tag{1}$$

$$AlCl_3 + Cl_2 \rightleftarrows AlCl_5 \tag{2}$$

$$AlCl_5 + C_7H_8 \rightarrow C_7H_8\text{--}AlCl_5 \tag{3}$$

$$C_7H_8\text{--}AlCl_5 \rightleftarrows C_7H_8\text{--}Cl_2 + AlCl_3 \tag{4}$$

$$C_7H_8\text{--}Cl_2 \rightleftarrows C_7H_7Cl + HCl \tag{5}$$

In this mechanism, $AlCl_3$ acts as a homogeneous catalyst for the process. Derive a rate expression for the process assuming that reaction (3) is rate determining. Let $[AlCl_3]^0$ represent the initial amount of catalyst added to the system, expressed as a concentration. The final rate expression should not contain concentrations or partial pressures of reactive intermediates.