Problem 9.1

Setty and Prengle¹ studied reaction (1) and proposed the mechanism given in reactions (2) through (5). The reaction was catalyzed by AlCl₃, which was added to the system by dissolving a known amount of it in nitromethane and injecting the resulting solution. As reaction (2) indicates, some of the AlCl₃ complexes with the nitromethane, and this complex is the catalytically active entity. Derive an expression for the rate of consumption of hexene on the basis of this mechanism. In doing so, you may assume that nitromethane will always be present in sufficient quantity to permit easy measurement of its concentration.

$C_6H_{12} + C_6H_6 \rightleftharpoons phenylhexanes$	(1)
$AICI_3 + CH_3NO_2 \rightleftharpoons AICI_3:NO_2CH_3$	(2)
$C_6H_{12} + AlCl_3: NO_2CH_3 \rightleftarrows C_6H_{12}\text{-}AlCl_3: NO_2CH_3$	(3)
$C_6H_6 + C_6H_{12}\text{-}AlCl_3\text{:}NO_2CH_3 \rightleftharpoons 2\text{-}phenylhexane + AlCl_3\text{:}NO_2CH_3$	(4)
$C_6H_6 + C_6H_{12}\text{-}AlCl_3\text{:}NO_2CH_3 \rightleftharpoons 3\text{-}phenylhexane + AlCl_3\text{:}NO_2CH_3$	(5)

¹ H. S. N. Setty and H. W. Prengle, Jr., Ind. Eng. Chem. Fund. 3(4), 300, 1964.