55) First step is rate determining step

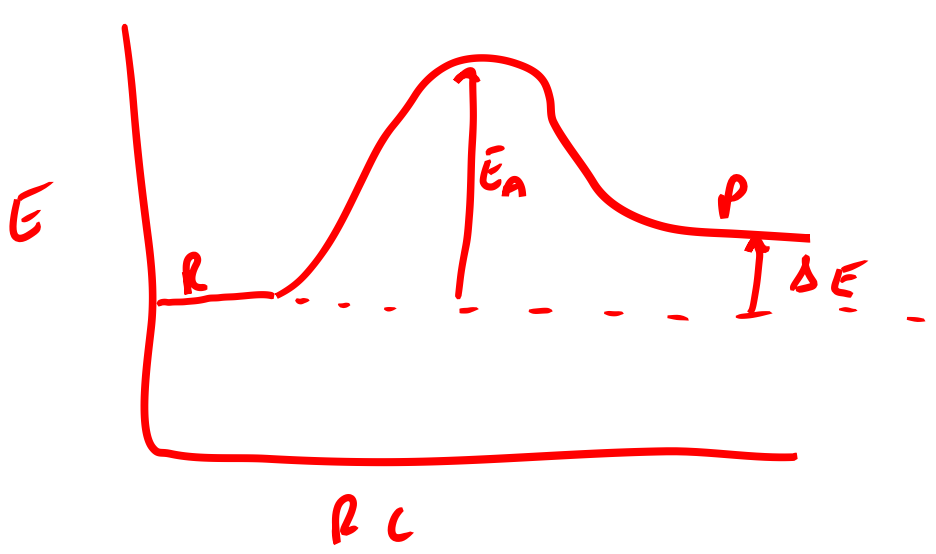
rate = $k[C_4H_9Br]$

$$C_4H_9Br \longrightarrow C_4H_9^+ + Br^-$$
$$C_4H_9^+ + H_2O \rightarrow C_4H_9OH_2^+$$
$$C_4H_9OH_2^+ + H_2O \rightarrow C_4H_9OH + H_3O^+$$

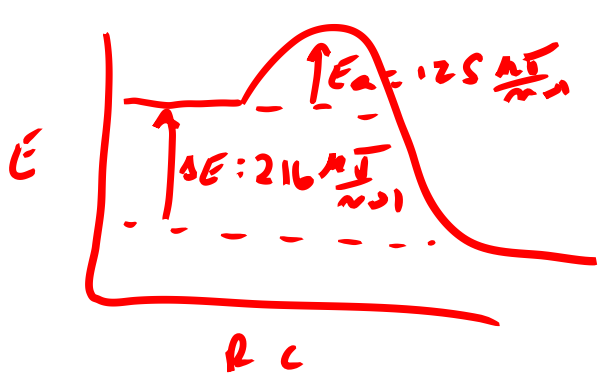
$$C_4H_9Br + 2H_2O \longrightarrow C_4H_9OH + Br^- + H_3O^+$$

intermediates: $C_4H_9^+$ and $C_4H_9OH_2^+$

57)



59)



$E_{a,\,reverse} = 125 + 216 = 341 \frac{kJ}{mol}$

63) $\ln \frac{k_2}{k_1} = \frac{E_a}{R}\left[\frac{1}{T_1} - \frac{1}{T_2}\right]$

$\ln \frac{x}{3.52\times10^{-7}} = \frac{1.86\times10^{5} \frac{J}{mol}}{8.31 \frac{J}{mol\cdot K}}\left[\frac{1}{555K} - \frac{1}{645K}\right] = 5.6$

$\frac{x}{3.52\times10^{-7}} = e^{5.6} = 270$

$x = 270\,(3.52\times10^{-7}) = 9.5\times10^{-5} \frac{L}{mol\cdot s}$

69) a) catalyst : NO

b) intermediate : NO_2

c) $\frac{k_{cat}}{k_{uncat}} = \frac{A e^{-E_a/RT}}{A e^{-E_a/RT}} = \frac{k_{cat}}{k_{uncat}} = e^{\frac{E_{a(uncat)} - E_{a(cat)}}{RT}}$

$\frac{k_{cat}}{k_{uncat}} = e^{\left(\frac{21000\ J\ mol^{-1}}{8.314\ J\ mol^{-1} K^{-1}}\right)(298\ K)} = e^{0.85} = 2.3$ times faster