Answer Key

SI Session 3
Jan. 21, 2014

1. Write the formula for the Arrhenius equation. What happens as T increases?

$K = Ae^{-Ea/RT}$ k increases and thus rate increases

2. A reaction is 10 times faster at 40 C (T_1) than at 25 C (T_2). Find the Ea of the reaction? Note R is 8.314 J/mol K.

$$\ln\left(\frac{K_1}{K_2}\right) = \frac{Ea}{R}\left(\frac{1}{T_2} - \frac{1}{T_1}\right)$$

$$\ln\left(\frac{10}{1}\right) = \frac{Ea}{8.314}\left(\frac{1}{(25+273)} - \frac{1}{(40+273)}\right)$$

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3. The rate constant at 25 C (T_1) is 2E-2. Ea is 10 kj/mol. What is the rate constant at 35 C (T_2)?

↳ 10,000 J/mol

$$\ln\left(\frac{2\times10^{-2}}{K_2}\right) = \frac{10,000}{8.314}\left(\frac{1}{(35+273)} - \frac{1}{(25+273)}\right)$$

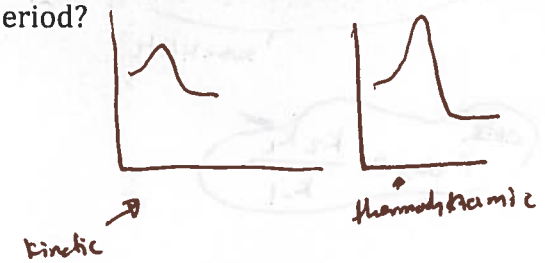
4. Why do catalyst increase the rate of reaction?

they decrease Ea needed

b. True or False: Transition state is higher energy than the reactant and product

True

5. Explain the difference between the kinetic product and the thermodynamic product. Which is most likely to be prevalent at low temperature in a short time period?



kinetic product has a lower activation energy so it forms fast especially at low temp.

thermodynamic product has a higher activation energy, but is more stable. Thus, it is favored at high temp when there is sufficient energy in the system.

6. *cis*-butenedioic acid → *trans*-butenedioic acid. Predict the rate law.

Rate = k [cis-butenedioic acid]

7. Write the overall reaction equation using the elementary steps below. List the intermediates. Predict the rate law.

$NO_2 + NO_2 \rightarrow NO + NO_3$ (slow)

$NO_3 + CO \rightarrow NO_2 + CO_2$ (fast)

intermediates: NO_3

overall: $NO_2 + CO \rightarrow NO + CO_2$

Rate law: $rate = k[NO_2]^2$

8. Write the overall reaction equation using the elementary steps below. List the intermediates. Predict the rate law.

$2NO \leftrightarrow N_2O_2$ (fast step)

$N_2O_2 + O_2 \rightarrow 2NO_2$ (slow step)

intermediate: N_2O_2

overall: $2NO + O_2 \rightarrow 2NO_2$

3 Reactions

$2NO \rightarrow N_2O_2$ $k_1[NO]^2$

$N_2O_2 \rightarrow 2NO$ $k_{-1}[N_2O_2]$

must be equal

$k_1[NO]^2 = k_{-1}[N_2O_2]$

$\frac{k_1[NO]^2}{k_{-1}} = [N_2O_2]$

$N_2O_2 + O_2 \rightarrow 2NO_2$ $k_2[N_2O_2][O_2]$

substitute

$Rate = k_2\left[\frac{k_1}{k_{-1}}[NO]^2\right][O_2]$

$Rate = k_{obs}[NO]^2[O_2]$

answer

note

$k_{obs} = \frac{k_2 k_1}{k_{-1}}$