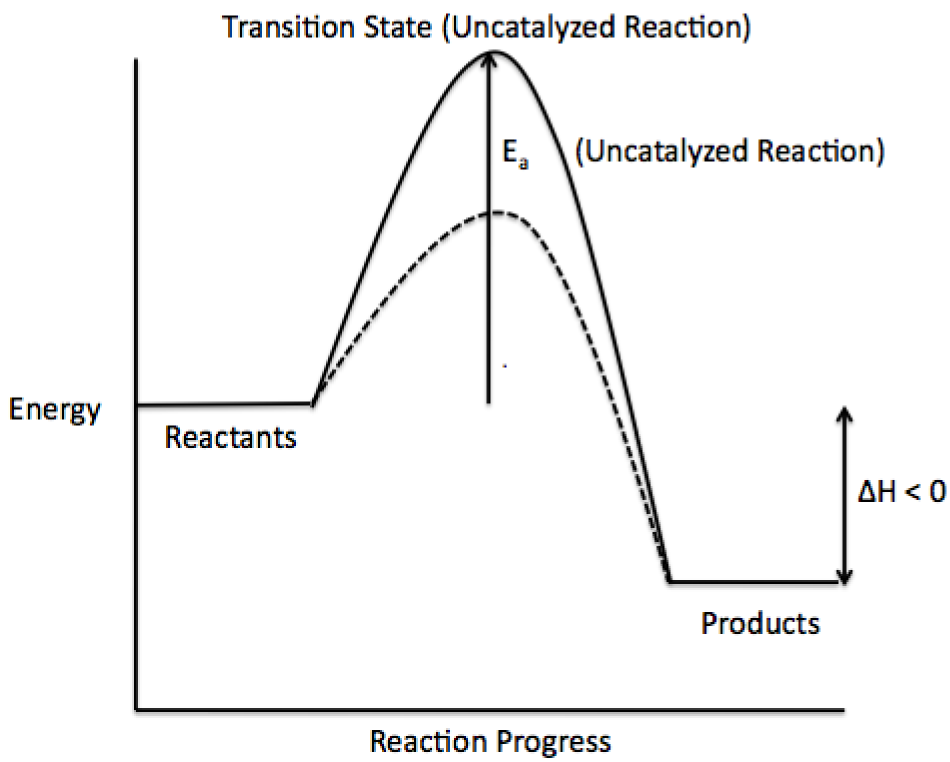
Non Sibi High School

Andover's Chem 300: Accelerated/Honors Chemistry

Chapter 19, Review Quiz 1 Answers

1

Sketch a completely-labeled reaction energy profile (reaction progress diagram) for an exothermic reaction. Indicate any effects a catalyst would have the sketch.



-------- = effect of catalyst (lowers transition state and E_a, no change in reactants/products and ΔH)

2

The following mechanism has been proposed for a reaction:

Step 1: $NO_2 + NO_2 \longrightarrow NO_3 + NO$

Step 2: $NO_3 + CO \longrightarrow NO_2 + CO_2$

Identify the intermediate and write the overall balanced equation for the reaction.

NO_3 is formed in the first step but then consumed in the second step, so NO_3 is the intermediate that cancels out of the overall balanced equation $NO_2 + CO \longrightarrow NO + CO_2$.

3

If the rate of formation of hydrogen gas in the reaction $4PH_3(g) \longrightarrow 6H_2(g) + P_4(g)$ is found to be 0.0066 $M{\cdot}s^{-1}$, what is the rate of disappearance of PH_3 gas?

$$0.0066\,\mathrm{mol}\cdot\mathrm{L}^{-1}\cdot\mathrm{s}^{-1}\left(\frac{4\,\mathrm{mol\,PH_3}}{6\,\mathrm{mol\,H_2}}\right) = 0.0044\,\mathrm{mol}\cdot\mathrm{L}^{-1}\cdot\mathrm{s}^{-1}$$

$$\text{rate of disappearance of } PH_3 = 0.0044\,\mathrm{M}\cdot\mathrm{s}^{-1}$$

4

For the reaction $\frac{1}{2}Cl_2(g) + NO(g) \longrightarrow NOCl(g)$, the following data were collected:

Experiment	$[Cl_2]$ (M)	[NO] (M)	Initial Rate ($M{\cdot}min^{-1}$)
1	0.12	0.12	0.0025
2	0.24	0.12	0.0050
3	0.48	0.48	0.16

Determine the overall order of the reaction, write the rate law, and calculate the value of k with units.

$$\mathrm{rate} = \mathrm{k}[\mathrm{Cl_2}]^{\mathrm{x}}[\mathrm{NO}]^{\mathrm{y}}$$

$$\mathrm{rate_1} = \mathrm{k}(0.12\,\mathrm{M})^{\mathrm{x}}(0.12\,\mathrm{M})^{\mathrm{y}} = 0.0025\,\mathrm{M}\cdot\mathrm{min}^{-1}$$

$$\mathrm{rate_2} = \mathrm{k}(0.24\,\mathrm{M})^{\mathrm{x}}(0.12\,\mathrm{M})^{\mathrm{y}} = 0.0050\,\mathrm{M}\cdot\mathrm{min}^{-1}$$

$$\mathrm{rate_3} = \mathrm{k}(0.48\,\mathrm{M})^{\mathrm{x}}(0.48\,\mathrm{M})^{\mathrm{y}} = 0.16\,\mathrm{M}\cdot\mathrm{min}^{-1}$$

$$\frac{\mathrm{rate_2}}{\mathrm{rate_1}} = \frac{\mathrm{k}(0.24\,\mathrm{M})^{\mathrm{x}}(0.12\,\mathrm{M})^{\mathrm{y}}}{\mathrm{k}(0.12\,\mathrm{M})^{\mathrm{x}}(0.12\,\mathrm{M})^{\mathrm{y}}} = \frac{0.0050\,\mathrm{M}\cdot\mathrm{min}^{-1}}{0.0025\,\mathrm{M}\cdot\mathrm{min}^{-1}}$$

$$2^{\mathrm{x}} = 2$$

$$\mathrm{x} = 1$$

$$\frac{\mathrm{rate}_3}{\mathrm{rate}_2} = \frac{\mathrm{k}(0.48\,\mathrm{M})^1(0.48\,\mathrm{M})^{\mathrm{y}}}{\mathrm{k}(0.24\,\mathrm{M})^1(0.12\,\mathrm{M})^{\mathrm{y}}} = \frac{0.16\,\mathrm{M}\cdot\mathrm{min}^{-1}}{0.0050\,\mathrm{M}\cdot\mathrm{min}^{-1}}$$

$$(2)(4)^{\mathrm{y}} = 32$$

$$\mathrm{y} = 2$$

$$\text{overall order} = 1 + 2 = 3$$

$$\mathrm{rate} = \mathrm{k}[\mathrm{Cl_2}]^1[\mathrm{NO}]^2$$

$$\mathrm{k} = \frac{0.0050\,\mathrm{M}\cdot\mathrm{min}^{-1}}{(0.24\,\mathrm{M})^1(0.12\,\mathrm{M})^2} = 1.4\,\mathrm{M}^{-2}\cdot\mathrm{min}^{-1}$$

5

Concentration versus time data were collected for the reaction $2N_2O_5(g) \longrightarrow O_2(g) + 4NO_2(g)$. Graphs of $[N_2O_5]_t$ v. t, $\ln[N_2O_5]_t$ v. t, and $1/[N_2O_5]_t$ v. t were plotted, and the data points on the graph of $\ln[N_2O_5]_t$ v. t were found to fit a straight line most closely. Is the reaction zero-order, first-order, or second-order?

Since the data points on the graph of $\ln[N_2O_5]_t$ v. t had the best straight line fit, the reaction is first-order.

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