AP CHEMISTRY

TOPIC 8: KINETICS, PART E, Day 103:

- Reaction Mechanisms
- Rate-Determining Step
- Arrhenius Equation
- Catalysts

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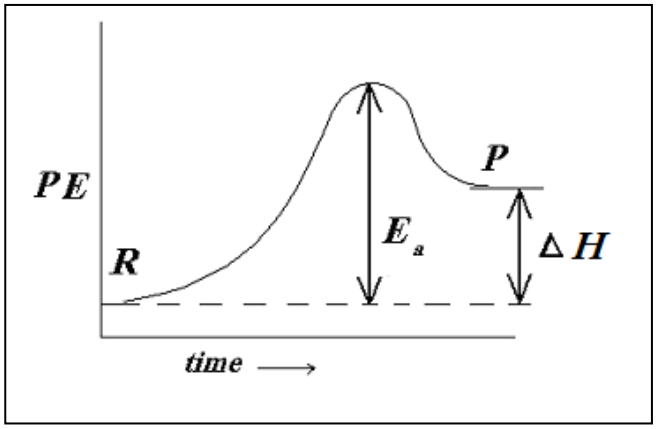
1. A possible mechanism for the decomposition of hydrogen peroxide is

$$H_2O_2 \rightarrow 2\,\cancel{OH}$$
$$H_2O_2 + \cancel{OH} \rightarrow H_2O + \cancel{HO_2}$$
$$\cancel{HO_2} + \cancel{OH} \rightarrow H_2O + O_2$$

What is the overall balanced equation for this reaction?

$$2\,H_2O_2 \rightarrow 2\,H_2O + O_2$$

2. For the following reaction profile, indicate
   a) the positions of the reactants and products
   b) the activation energy
   c) ΔH for the reaction



4. The mechanism for the reaction of nitrogen dioxide with nitrogen dioxide to form nitric oxide and carbon dioxide is thought to be

$$NO_2 + NO_2 \rightarrow NO_3 + NO \quad \text{(slow)}$$
$$NO_3 + CO \rightarrow NO_2 + CO_2 \quad \text{(fast)}$$

write the rate law expected for this mechanism. What is the overall balanced equation for the reaction?

$$\text{Rate} = k\,[\,NO_2\,]^{\,2}$$

Recall, the rate law is defined as all of the reactants (excluding the intermediates) up to and including the slow step.

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

A question to "jog" the memory and bring back some "fun" concepts…

5.

$$H_{2\,(g)} + I_{2\,(g)} \rightarrow 2\,HI_{\,(g)}$$

For the exothermic reaction represented above, carried out at 298 K, the rate law is

$$\text{Rate} = k\,[\,H_2\,]\,[\,I_2\,]$$

Predict the effect of each of the following changes on the initial rate of the reaction **AND EXPLAIN** your prediction.

a) Addition of hydrogen gas at constant volume and temperature.

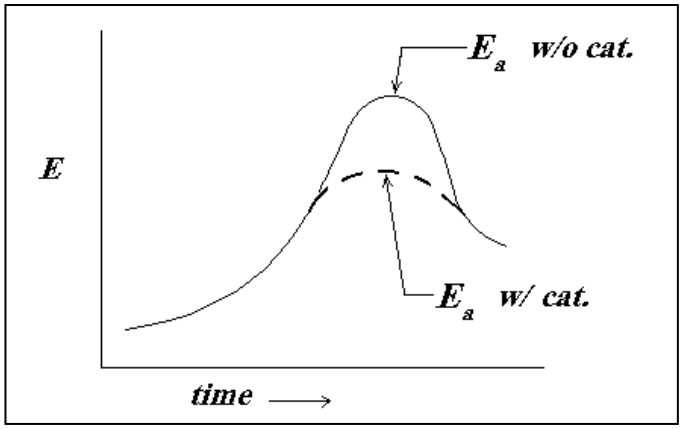
Initial Rate of the Reaction INCREASES. The concentration for H_2, since H_2 is a FIRST-ORDER reactant – therefore the rate will increase proportionately to the increase in concentration.

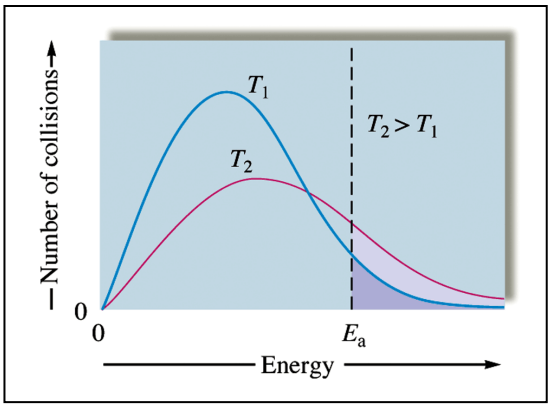
b) Increase in volume of the reaction vessel at constant temperature.

Initial Rate of the Reaction will be REDUCED. Increase in volume (with a constant temperature) is equal to a reduction in concentration of the initial reactants. If the INITIAL concentration is reduced – the collision between molecules is made "more difficult" because the concentrations are reduced.

c) Addition of a catalyst. In your explanation, include a diagram of potential energy versus reaction coordinate (time) for this reaction. Show a comparison between the catalyzed and non-catalyzed reaction.

The Addition of a catalyst to the Reaction will INCREACE the rate of Reaction. A catalyst helps lower the energy needed for the reactants to collide properly to form the activated complex. A catalyst helps lower the activation energy by "organizing" the reactants by assisting in the positioning of the molecules. Also, a catalyst is not consumed in the reaction. (see diagram below on left)





d) Increase in temperature. In your explanation, include a diagram, showing the number of molecules as a function of energy. Use a "before" and "after" presentation of information to show how the temperature change affects the distribution of molecules.

Initial Rate of the Reaction will INCREASE if the temperature is increased. A higher temperature equates to more reactant molecules possessing the minimum energy required to form the activated complex. (see diagram above on right)