

# Chemistry 12

[Science](#), [Chemistry](#)



Chemistry 12 Unit 1 - Reaction Kinetics Chemistry 12 Worksheet 1-3 -

Reaction Mechanisms 1. It is known that compounds called

chlorofluorocarbons (C. F. C. s) (eg.  $\text{CFCl}_3$ ) will break up in the presence of ultraviolet radiation, such as found in the upper atmosphere, forming single chlorine atoms:  $\text{CFCl}_3 \xrightarrow{\text{UV}}$   $\text{CFCl}_2 + \text{Cl}$  The Cl atoms then react with Ozone ( $\text{O}_3$ ) as outlined in the following mechanism. Step 1:  $\text{Cl} + \text{O}_3 \rightarrow \text{ClO} + \text{O}_2$  Step 2:  $\text{ClO} + \text{O} \rightarrow \text{Cl} + \text{O}_2$  (single "O" atoms occur naturally in the atmosphere.) a)

Write the equation for the overall reaction. (Using steps 1 and 2)

\_\_\_\_\_ b) What is the catalyst in this reaction? c) Identify an intermediate in this reaction

\_\_\_\_\_ d) Explain how a small amount of chlorofluorocarbons can destroy a large amount of ozone. \_\_\_\_\_

\_\_\_\_\_ e) What breaks the bond in the  $\text{CFCl}_3$  and releases the free Cl atom?

\_\_\_\_\_ 2. Given the following mechanism, answer the questions below: Step 1:  $\text{O}_3 + \text{NO} \rightarrow \text{NO}_2 + \text{O}_2$  (slow) Step 2:  $\text{NO}_2 + \text{O} \rightarrow \text{NO} + \text{O}_2$  (fast) a) Give the equation for the overall reaction.

\_\_\_\_\_ b) What could the catalyst be in this mechanism? c) What is an intermediate in this mechanism? \_\_\_\_\_

Worksheet 1-3 - Reaction Mechanisms Page 1 Chemistry 12 Unit 1 - Reaction Kinetics d) Given that the uncatalyzed overall reaction is a slow exothermic reaction, draw a potential energy graph which shows the possible shape of

the curve for the uncatalyzed reaction. On the same graph, show a possible curve for the catalyzed reaction. Progress of Reaction 3. Consider the following mechanism: Step 1:  $\text{H}_2\text{O}_2 + \text{I}^- \rightarrow \text{H}_2\text{O} + \text{IO}^-$  (slow) Step 2:  $\text{H}_2\text{O}_2 + \text{IO}^- \rightarrow \text{H}_2\text{O} + \text{O}_2 + \text{I}^-$  (fast) a) Give the equation for the overall reaction.

\_\_\_\_\_ b) What acts as a catalyst in this mechanism? \_\_\_\_\_

\_\_\_\_\_ c) What acts as an intermediate in this mechanism? 4. What is meant by the rate determining step in a reaction mechanism? \_\_\_\_\_

\_\_\_\_\_ 5. What is meant by a reaction mechanism? \_\_\_\_\_

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\_\_\_\_\_ 7. Given

the following Potential Energy Diagram for a 3 step reaction, answer the questions below it: a) Which arrow indicates the activation energy for the first step of the reverse reaction? \_\_\_\_\_ b) Which arrow indicates the activation energy for the first step of the forward reaction? \_\_\_\_\_ c) Which arrow indicates the activation energy for the second step of the forward reaction? \_\_\_\_\_ d) Which arrow indicates the enthalpy change ( $\Delta H$ ) or "enthalpy change" for the overall forward reaction? \_\_\_\_\_ e) Which arrow indicates the enthalpy change ( $\Delta H$ ) or "enthalpy change" for the overall reverse reaction? Worksheet 1-3 - Reaction Mechanisms \_\_\_\_\_ Page 3

Chemistry 12 Unit 1 - Reaction Kinetics f) Which arrow indicates the activation energy for the overall forward reaction? \_\_\_\_\_ g) Which step would be the rate determining step in the forward reaction? \_\_\_\_\_ h) In a dashed line or another colour sketch a possible curve that would represent the route for the uncatalyzed overall reaction. Label this on the graph. 8.

Given the reaction:  $4\text{HBr} + \text{O}_2 \rightarrow 2\text{H}_2\text{O} + 2\text{Br}_2$  a) Would you expect this reaction to take place in a single step? Why or why not? \_\_\_\_\_

\_\_\_\_\_ b) This reaction is thought to take place by means of the following mechanism: Step 1:  $\text{HBr} + \text{O}_2 \rightarrow \text{HOBr}$  (slow) (fast) (fast) Step 2:  $\text{HBr} + \text{HOBr} \rightarrow 2\text{HOBr}$  Step 3:  $2\text{HBr} + 2\text{HOBr} \rightarrow 2\text{H}_2\text{O} + 2\text{Br}_2$  c) Identify the two intermediates

\_\_\_\_\_ d) A catalyst is discovered which increases the rate of Step 3. How will this affect the rate of the overall reaction? Explain your answer.

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\_\_\_\_\_ e) A catalyst is discovered which increases the rate of Step 1. How will this affect the rate of the overall reaction? Explain your answer.

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\_\_\_\_\_ f) Which step has the greatest activation energy? \_\_\_\_\_

Worksheet 1-3 - Reaction Mechanisms Page 4 Chemistry 12 Unit 1 - Reaction Kinetics g) How many "bumps" will the potential energy diagram for the

reaction mechanism have?

\_\_\_\_\_ h) Which step is called the rate determining step in this mechanism? \_\_\_\_\_ i)

In order to have successful collisions, the colliding particles must have both the proper amount of energy and the proper

\_\_\_\_\_ j) On the set of axes below, draw the shape of the curve you might expect for the reaction in this question.

The overall reaction is exothermic! Make sure you get the " bumps" the

correct relative sizes. 9. The equation for an overall reaction is:  $I^- + OCl^- \rightarrow IO^- + Cl^-$

a) The following is a proposed mechanism for this reaction. One of the species has been left out. Determine what that species is and write it in

the box. Make sure the charge is correct if it has one! Step 1:  $OCl^- + H_2O \rightarrow HOCl + OH^-$  ( fast )

Step 2:  $I^- + HOCl \rightarrow IOH + OH^-$  ( slow )

Step 3:  $IOH + OH^- \rightarrow IOH + Cl^- + H_2O$  ( fast )

b) Which species in the mechanism above acts as a catalyst? \_\_\_\_\_ c) Which three species in the mechanism above are intermediates? \_\_\_\_\_

d) Step \_\_\_\_\_ is the rate determining step.

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12 Unit 1 - Reaction Kinetics e) On the set of axes below, draw the shape of the curve you might expect for the reaction in this question. The overall reaction is endothermic! Make sure you get the " bumps" the correct relative

sizes. 10. Given the following steps for a mechanism: Step 1:  $Br_2 \rightarrow 2Br$  (fast)

Step 2:  $Br + OCl_2 \rightarrow BrOCl + Cl$  (slow)

Step 3:  $Br + Cl \rightarrow BrCl$  (fast)

a) Write the equation for the overall reaction. \_\_\_\_\_ b) A

substance is added that decreases the activation energy for step 1. Will this

speed up, slow down, or have no effect on the rate of the overall reaction?

\_\_\_\_\_ Give a reason for your answer.

\_\_\_\_\_ c) Is there a catalyst in this mechanism? \_\_\_\_\_. If so, what is it? d) Is there an intermediate in this mechanism? \_\_\_\_\_. If so, what is it? e) Which step is the rate determining step? \_\_\_\_\_

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The following potential energy diagram refers to a very slow one-step reaction of ozone (O<sub>3</sub>) and oxygen atoms in the upper atmosphere. On the axis below, draw a potential energy diagram which could represent the catalyzed mechanism for the reaction: Step 1: O<sub>3</sub> + NO → NO<sub>2</sub> + O<sub>2</sub> (slow)

Step 2: NO<sub>2</sub> + O → NO + O<sub>2</sub> (fast) Worksheet 1-3 - Reaction Mechanisms

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Explain your answer. \_\_\_\_\_

\_\_\_\_\_ 13. The

following overall reaction is fast at room temperature: H<sup>+</sup> + I<sup>-</sup> + H<sub>2</sub>O<sub>2</sub> → H<sub>2</sub>O + HOI

A student proposes the following two-step mechanism for the

above reaction: Step 1 : Step 2 : H<sup>+</sup> + H<sup>+</sup> + H<sub>2</sub>O<sub>2</sub> → H<sub>4</sub>O<sub>2</sub><sup>2+</sup> + I<sup>-</sup> → H<sub>2</sub>O

H<sub>4</sub>O<sub>2</sub><sup>2+</sup> + HOI + H<sup>+</sup> \_\_\_\_\_ Would you agree or disagree with

this proposed mechanism? Explain your answer

\_\_\_\_\_

\_\_\_\_\_ 14.

Consider the following reaction:  $\text{CO} + \text{NO}_2 \rightarrow \text{CO}_2 + \text{NO}$  a) The first step in each of two proposed reaction mechanisms for the above reaction is listed below. If each proposed reaction mechanism consists of only two steps, determine the second step for each mechanism. Proposed Mechanism One:

Step 1:  $2\text{NO}_2 \rightarrow \text{NO}_3 + \text{NO}$  (slow) Step 2:

\_\_\_\_\_ (fast) Proposed Mechanism Two:

Step 1:  $2\text{NO}_2 \rightarrow \text{N}_2\text{O}_4$  (fast) Step 2:

\_\_\_\_\_ (slow) b) Experimental data show

that the rate of the reaction is not affected by a change in the  $[\text{CO}]$ . Which of these two mechanisms would be consistent with these data? \_\_\_\_\_ Explain your answer. \_\_\_\_\_

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