

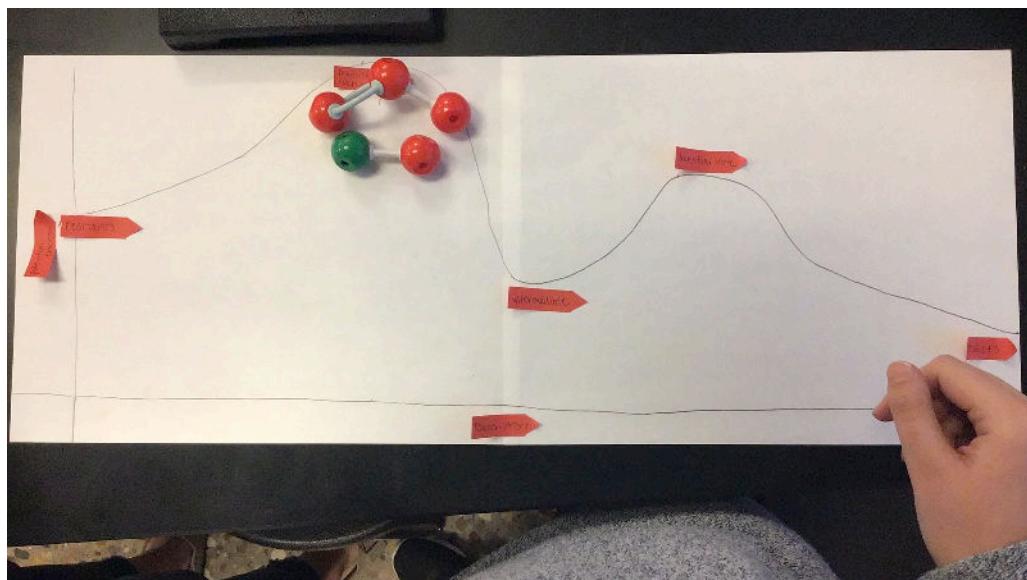
# Reaction Mechanisms Using Stop-Motion Video

## Teacher's Guide

| Atom Centers |          |             | Bonds |               |
|--------------|----------|-------------|-------|---------------|
| Qty          | Element  | Color/Holes | Qty   | Type          |
| 6            | Oxygen   | Red/4       | 4     | single        |
| 1            | Chlorine | Green/4     | 6     | double/triple |

On two blank sheets of paper taped end to end, the students should use a pencil to draw a labeled (on sticky notes) energy diagram similar to the one shown in the sample video. Check student diagrams for accuracy before they make their videos.

### Example Stop Motion Video:



### Answers to Questions:

1. An intermediate is a temporary product in a reaction mechanism. It is recognized by the fact that it is the product of one step and the reactant of another step.
2. A catalyst is a substance that can increase the rate of a chemical reaction and is the same at the end as it was at the start of the reaction. In a reaction mechanism a catalyst is a reactant of one step and the product of another step.
3. The uncatalyzed energy diagram would have a higher activation energy,
4. Another name for a transition state is an activated complex.
5.  $\text{Rate} = k[\text{Cl}][\text{O}_3]$

# Visualizing A Reaction Mechanism Using Stop-Motion Video

## Student Procedure

**Objective:** To model the mechanism of a chemical reaction ( $2\text{O}_3 \rightarrow 3\text{O}_2$ ) with a catalyst (Cl) and an intermediate (ClO) and to model the concept of an activated complex.

**Materials:** Model kit, Stop Motion Studio app (free), ring stand, test tube clamp or ring clamp, sticky notes, marker, two sheets of blank paper.

1. Assemble two models of ozone,  $\text{O}_3$ .
2. Using clear tape, tape two blank sheets of paper together, end to end (longways). Using a pencil, draw a potential energy diagram with the following attributes: two steps, exothermic, step 1 is the slower step. Label seven small sticky notes with the following: Potential Energy, Reaction Progress, Reactants, Products, Transition State: Activated Complex (step 1), Transition State (step 2), Intermediate. Place the sticky notes on the diagram in the proper locations. Have the instructor verify the diagram before making the video.
3. Make a stop motion video of the reaction process where ozone decomposes into oxygen with a chlorine atom catalyst utilizing this proposed mechanism:
  - a. Step 1:  $\text{Cl} + \text{O}_3 \rightarrow \text{ClO} + \text{O}_2$  slow
  - b. Step 2:  $\text{ClO} + \text{O}_3 \rightarrow \text{Cl} + 2\text{O}_2$  fast
4.  $\text{ClO}_3$  is the transition state for step 1 and  $\text{ClO}_4$  is the transition state for step 2. Place the models on the potential energy diagram in the proper locations.
5. The video should show the steps in the reaction. Adjust the speed of the movie so that the reaction process is clearly legible. Share the video with your instructor.

## Questions:

1. What is an intermediate? How do you recognize an intermediate in a reaction mechanism?
2. What is a catalyst? How do you recognize a catalyst in a reaction mechanism?
3. Describe the uncatalyzed energy diagram for this reaction.
4. What is another name for the transition state with the highest energy?
5. If step 1 is the slower step, what is the rate law for the reaction?