

Most Reactions Have Multi-Steps

In complicated reactions, the overall reaction will take place in a series of single steps, often called elementary steps. An **elementary step** is a single, simple step in a multi-step process. An elementary step almost always involves only two particles. The series of elementary steps outline the process of the reaction. Most reactions do not take place in one step but rather as a combination of two or more elementary steps. This series of steps is referred to as a multi-step reaction.

The rate of reaction is dependent on the reactants in the slowest step of the multi-step process.

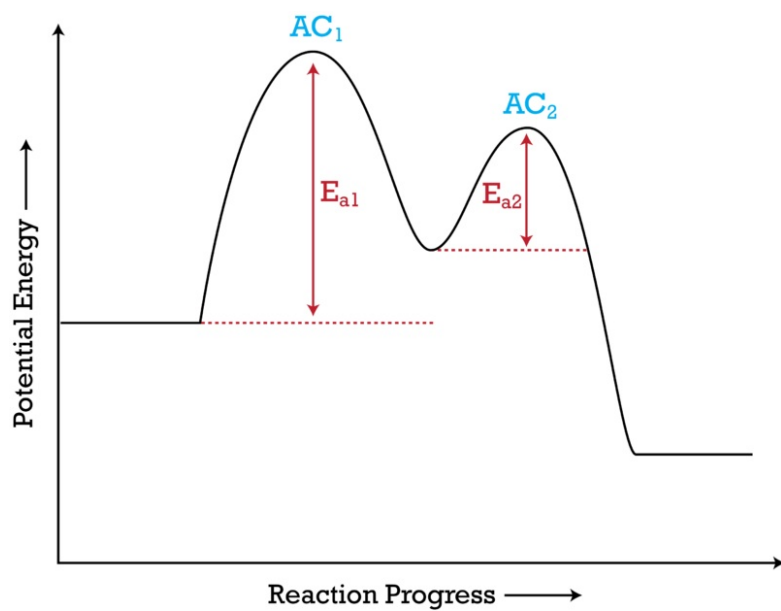
Each Step Has Its Own Activated Complex

When there is a single step reaction, we can draw potential energy diagrams like the ones we have seen earlier in this chapter. For a multi-step process where two or more elementary steps combine to form the net reaction, the potential energy diagram looks quite different. Look at the reaction below. This mechanism is involved in the depletion of the ozone layer.

The overall reaction is $\text{O}_{3(g)} + \text{O}_{(g)} \rightarrow 2 \text{O}_{2(g)}$

If we were to draw the potential energy diagram for this two-step process, it would look like the figure below.

Notice that for each reaction in the multi-step process, there is an activation energy barrier. Therefore, E_a is the activation energy associated with reaction 1, and E_b is the activation energy associated with reaction 2. The slow step has an activation energy barrier that is higher than that of the faster reaction.



Each reaction also has its own activated complex. Remember that at the top of the activation energy barrier is the activated complex, the transition state between reactants and products that has the most potential energy. AC_1 is the complex created in the first reaction, while AC_2 is the activated complex created in the second reaction. Thus, for this two-step process, there are two activated complexes.