

Catalysis

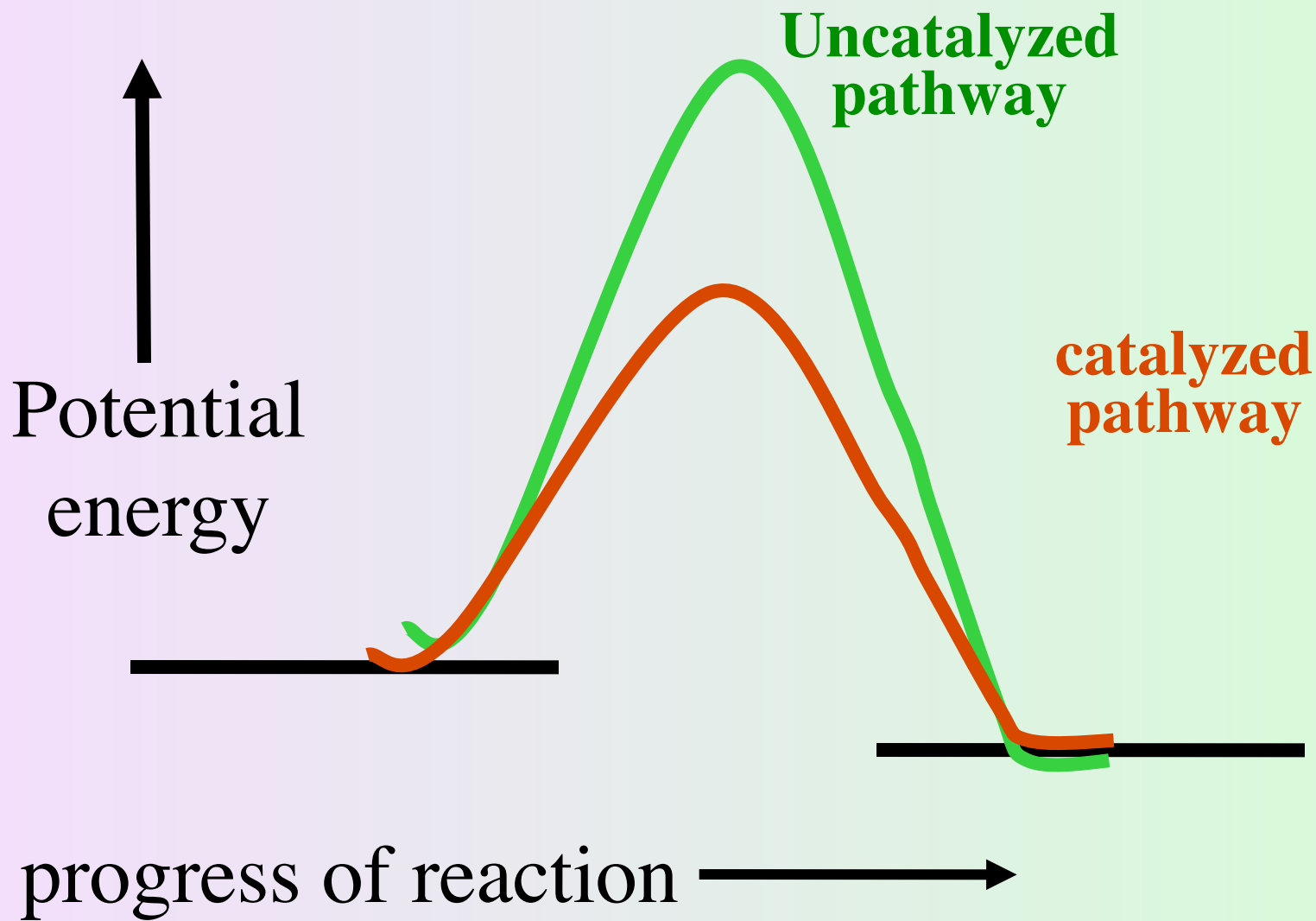
Catalyst

Increases reaction rate, but is not consumed in the reaction

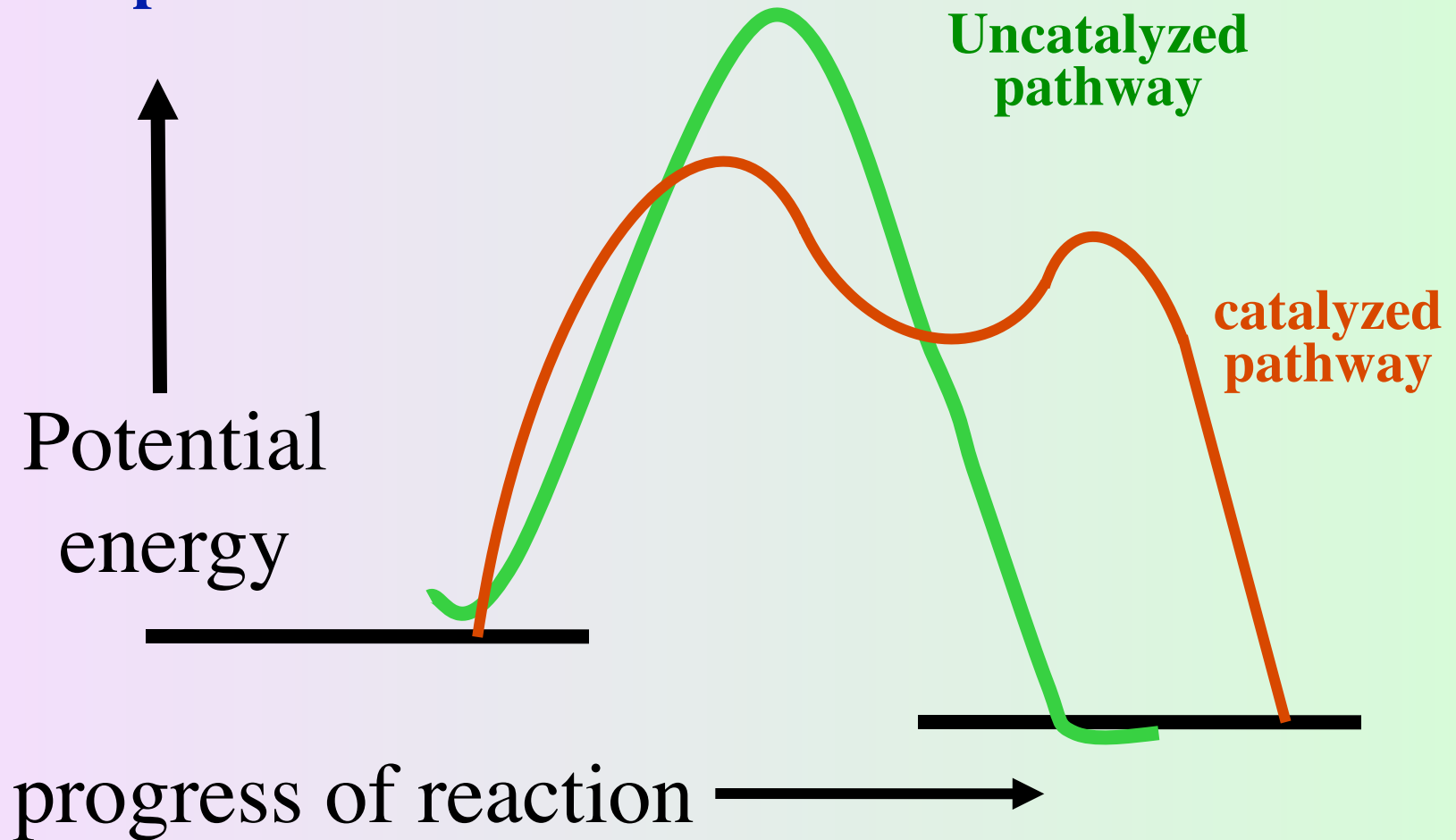
Increases the rate, by lowering activation energy

Causes a shift in mechanism

The diagram is instructive, but not strictly correct



Replace one-step process with high activation energy by a Two-step process with low activation energy for each step



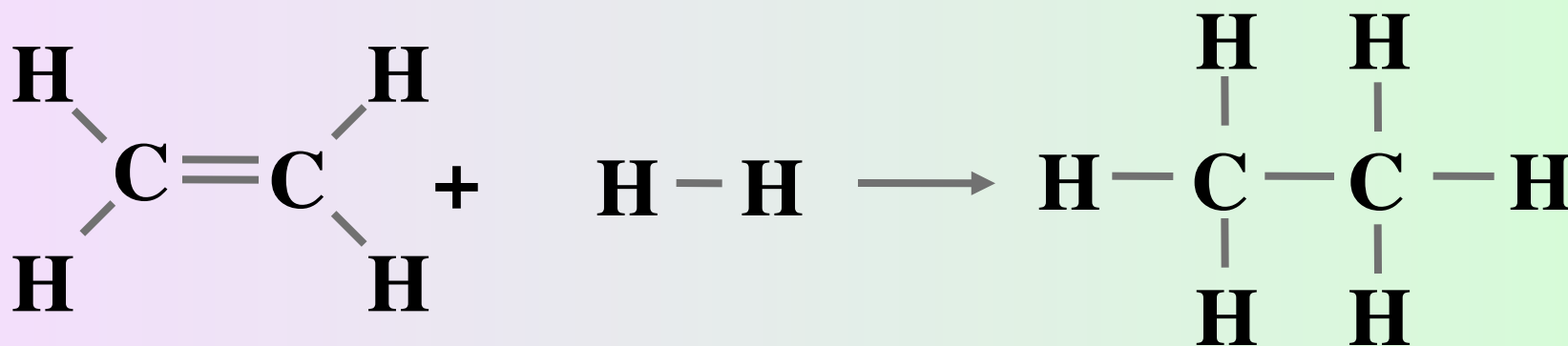
Heterogeneous Catalysis

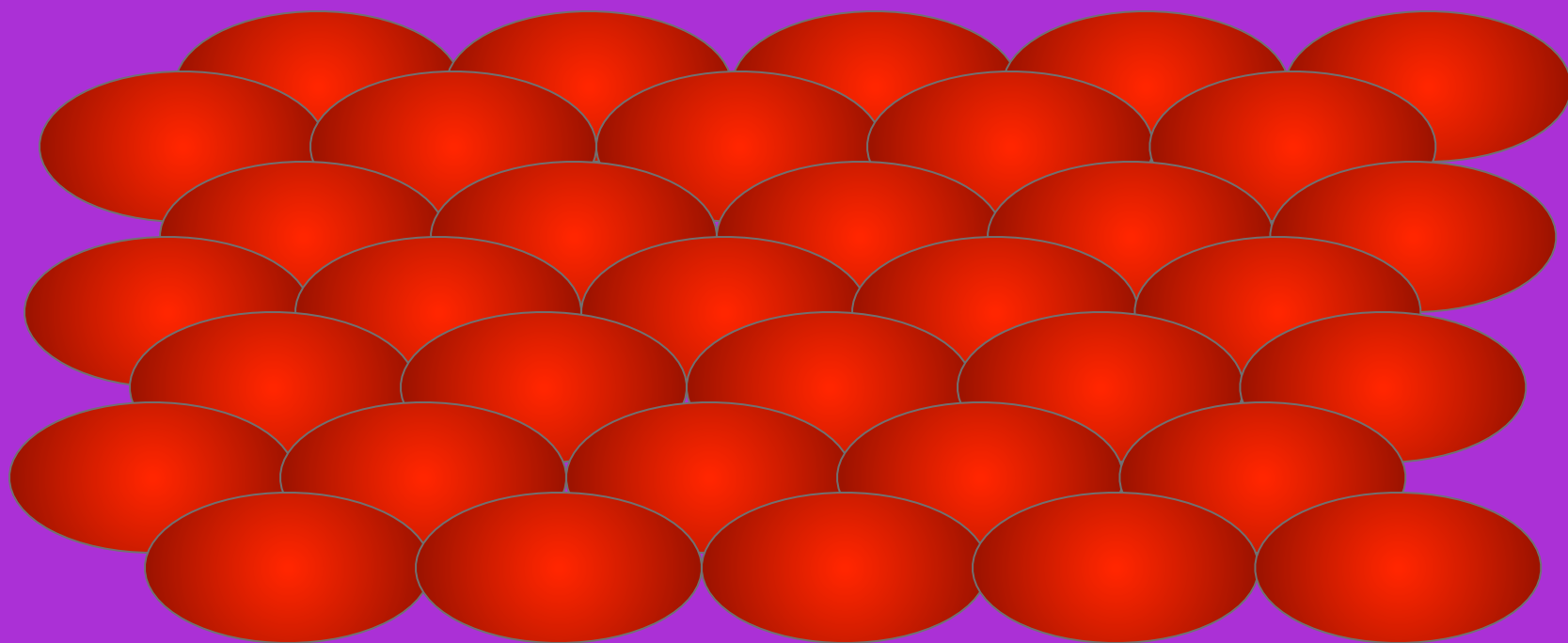
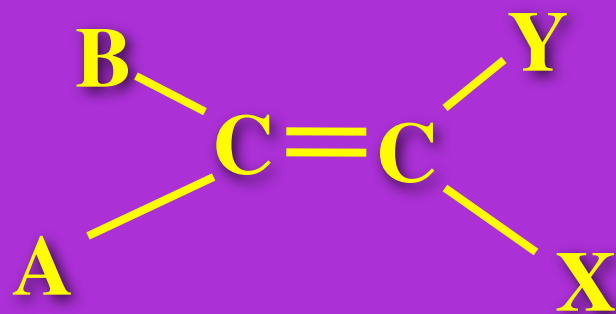
catalyst is present in a different phase than reactants

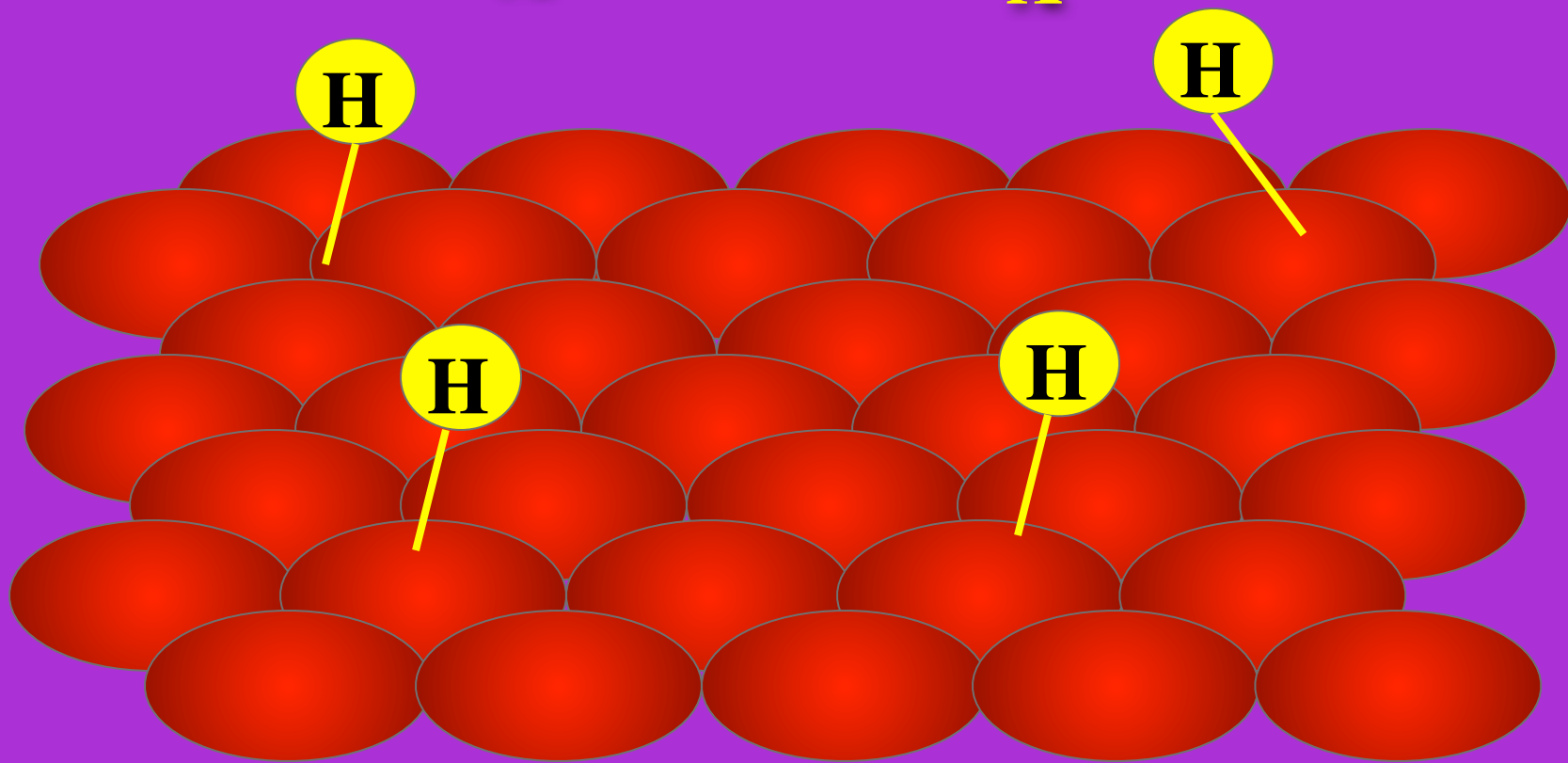
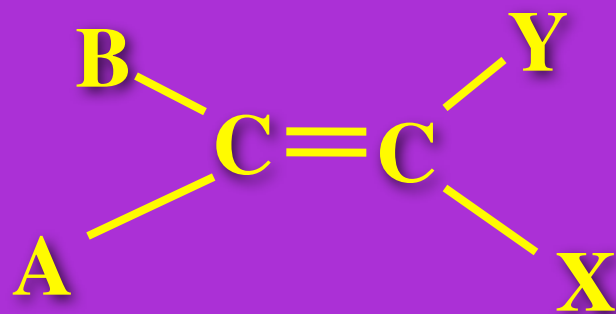
Hydrogenation of ethylene

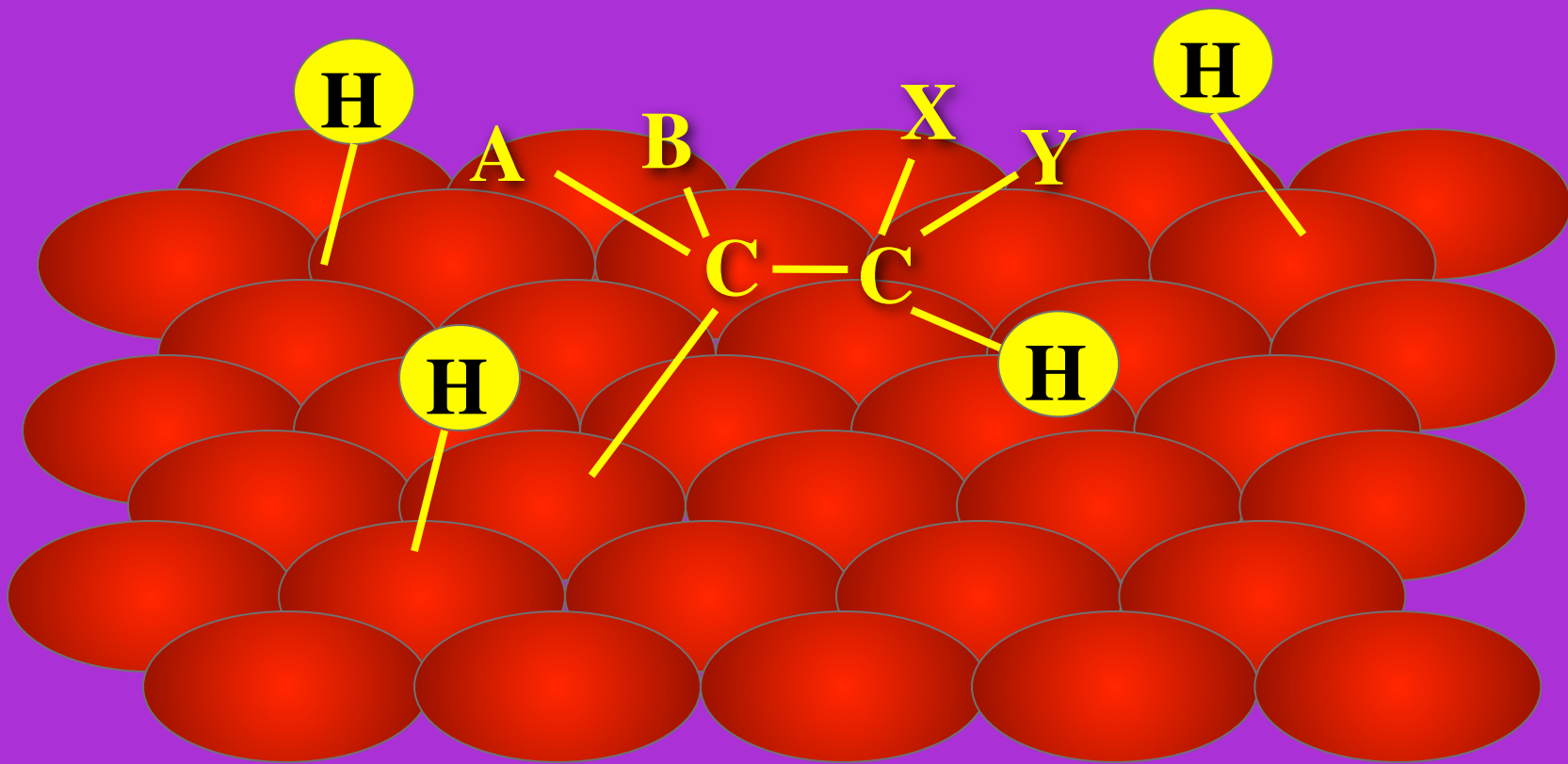
Exothermic $\Delta E^\circ = -136 \text{ kJ/mol}$

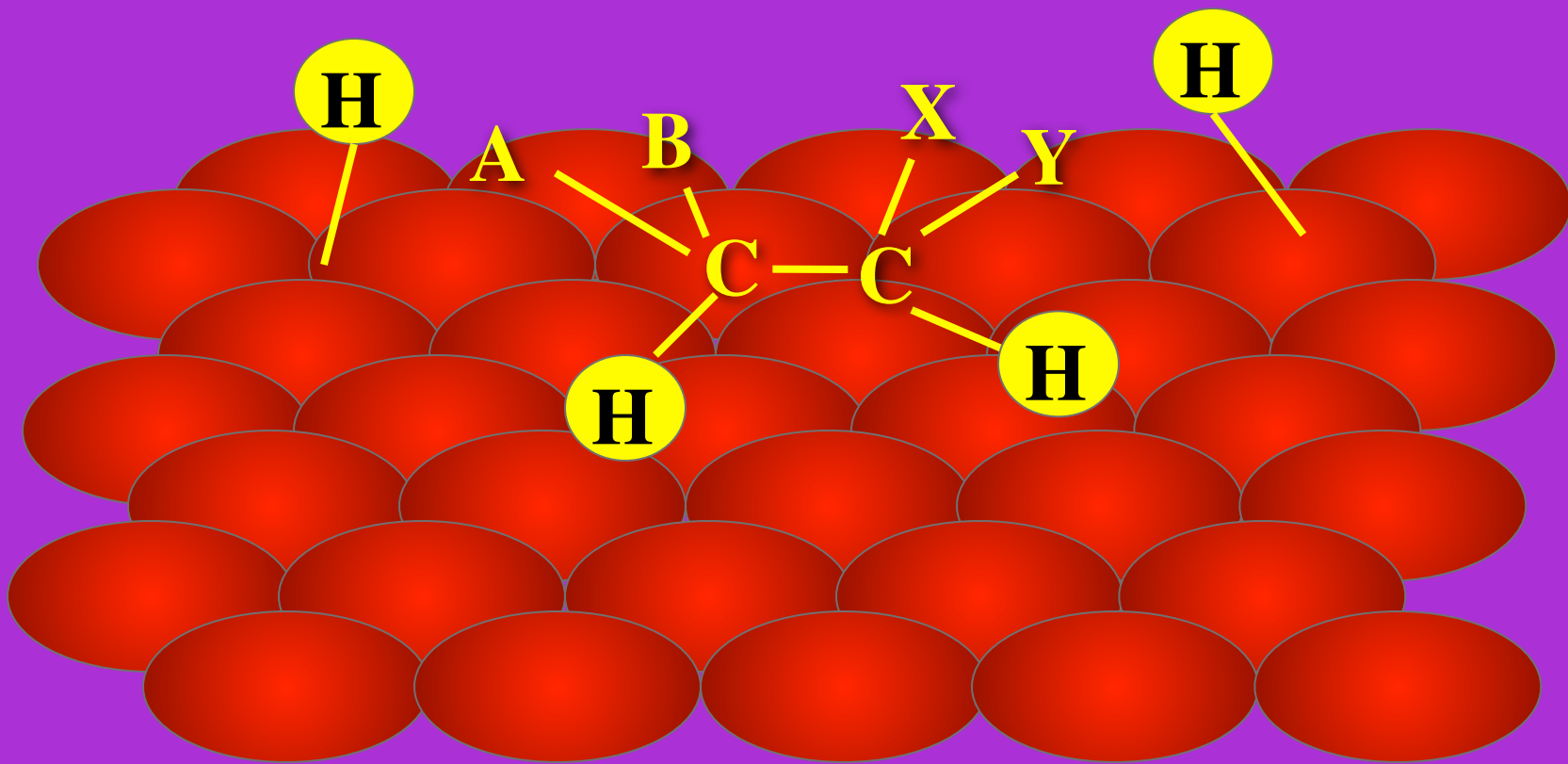
catalyzed by finely divided Pt, Pd, Rh, Ni

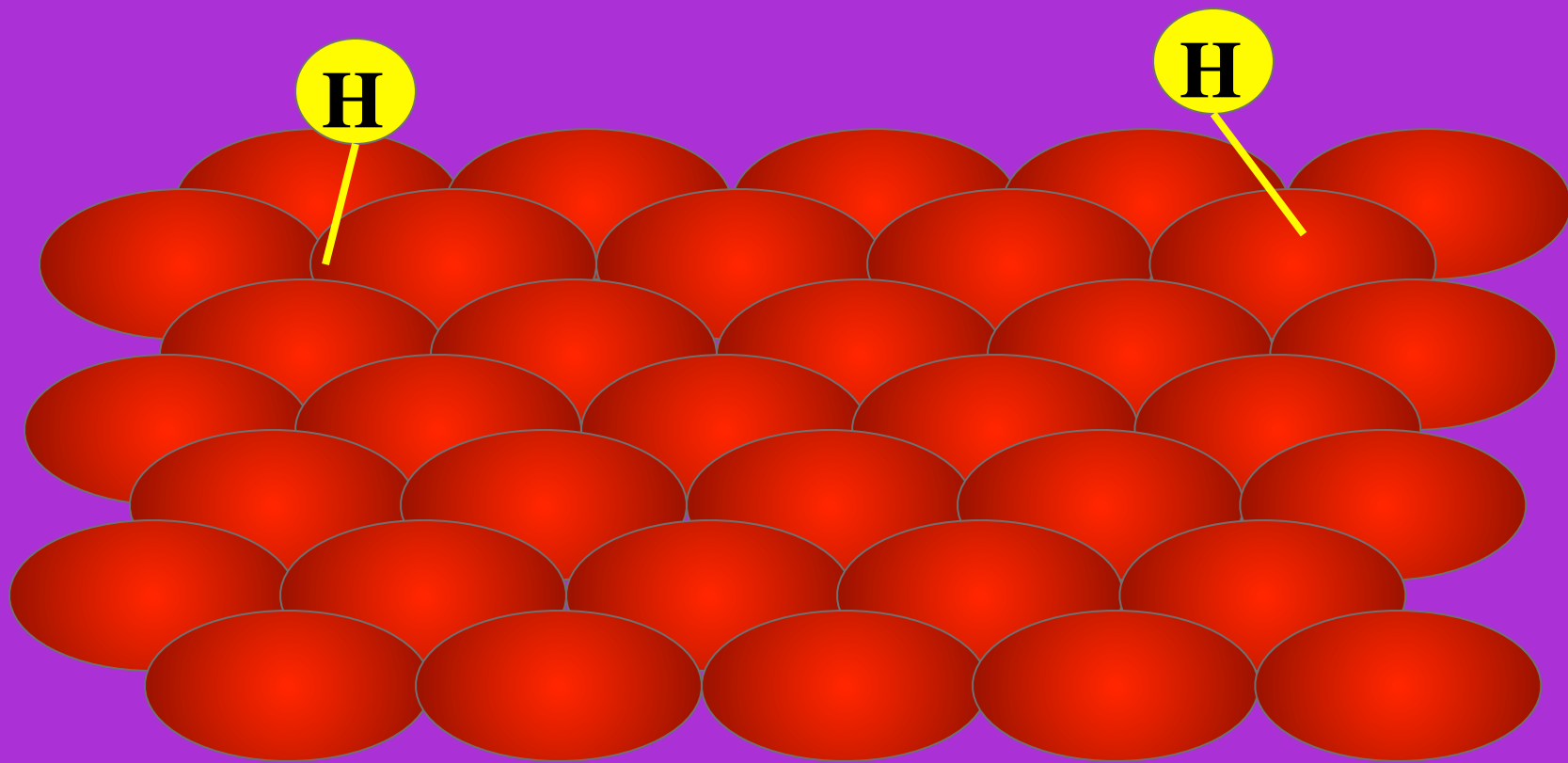
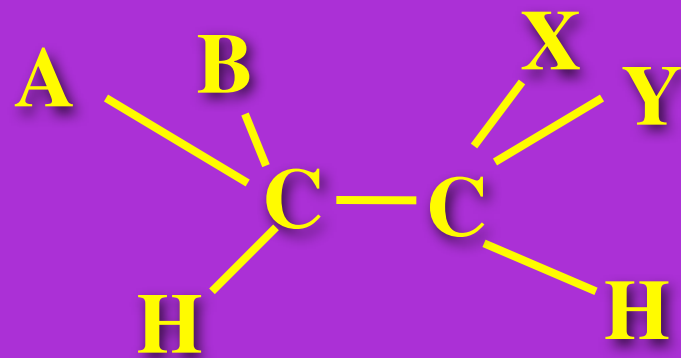








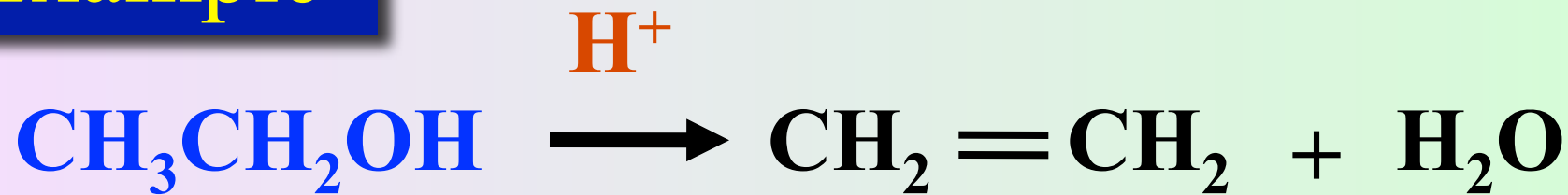




Homogeneous Catalysis

catalyst is present in the same phase as the reactants

Example



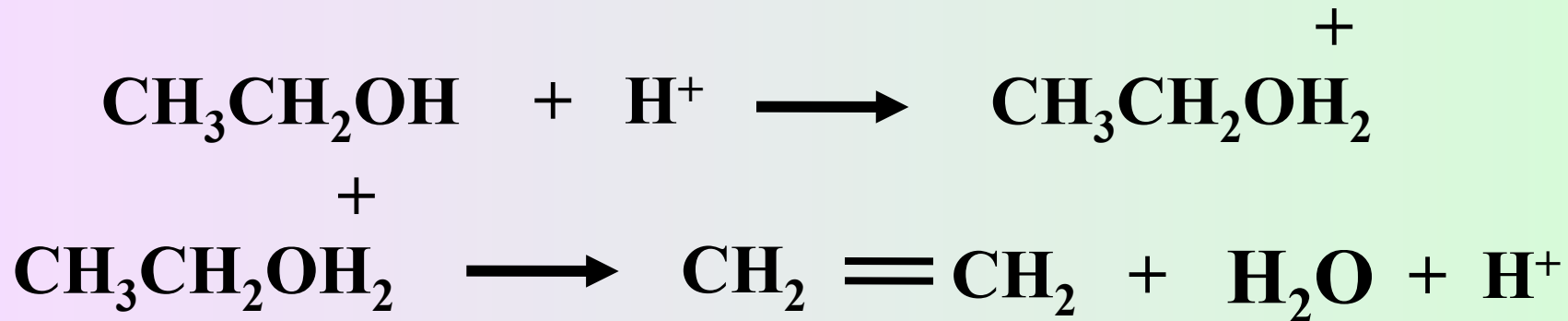
Rapid reaction in the presence of an acid catalyst;

Example

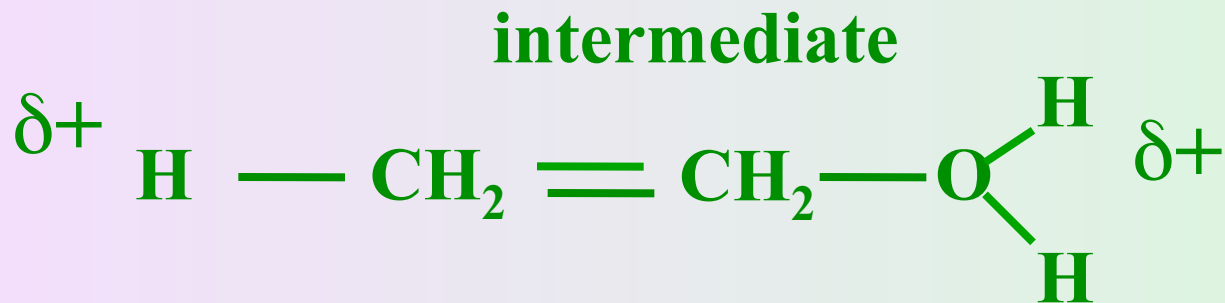
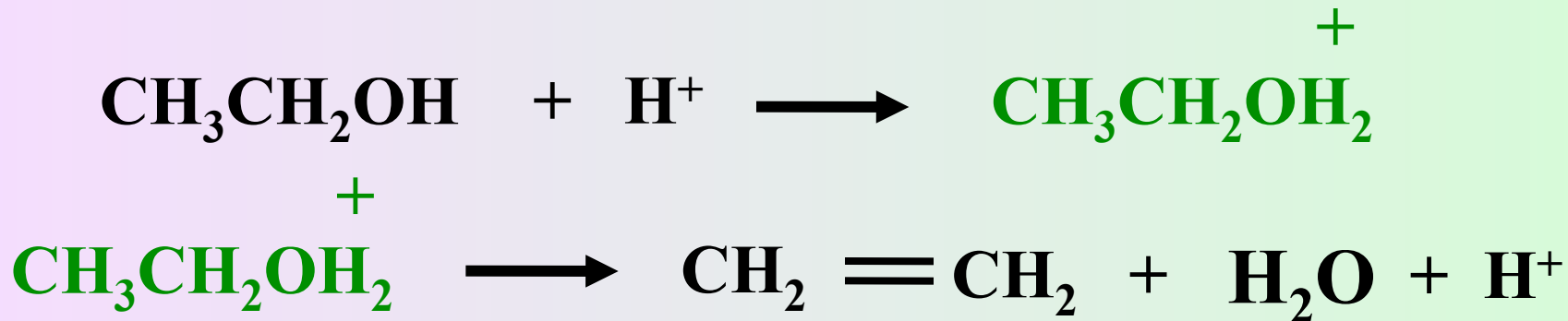


Rapid reaction in the presence of an acid catalyst; very slow in the absence of a catalyst

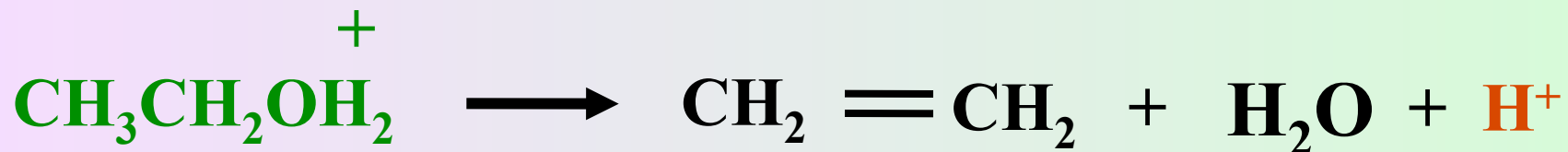
Role of the acid catalyst



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The acid catalyst enters the reaction and is retrieved at the end

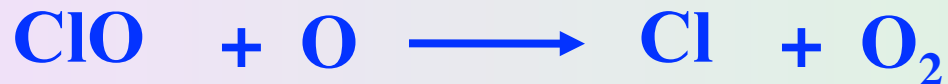
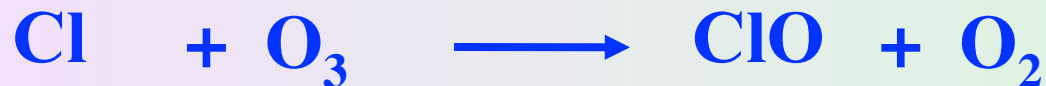
Example

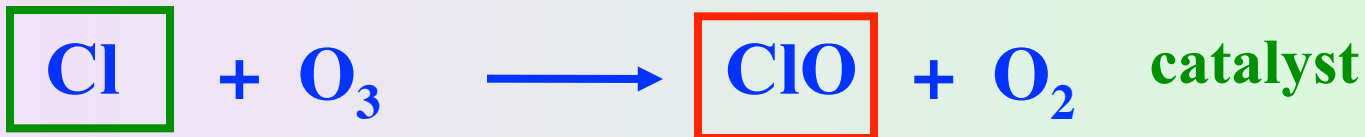
In recent years ozone has been depleted at an alarmingly fast rate by chloroflorocarbons (CFCs).

A CFC molecule such as CFCl_3 is first decomposed by UV radiation:



The chlorine radical then reacts with ozone as follows

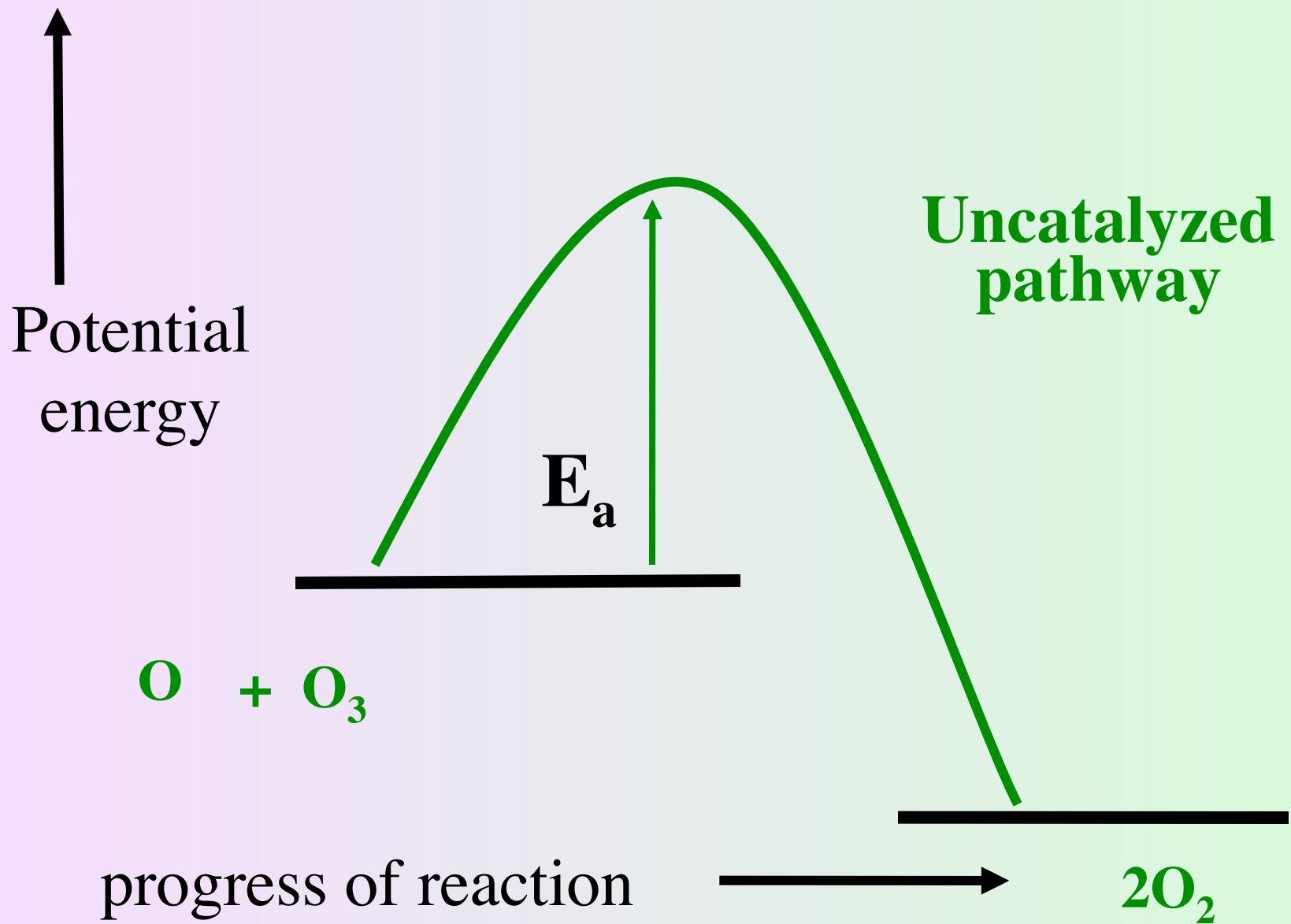


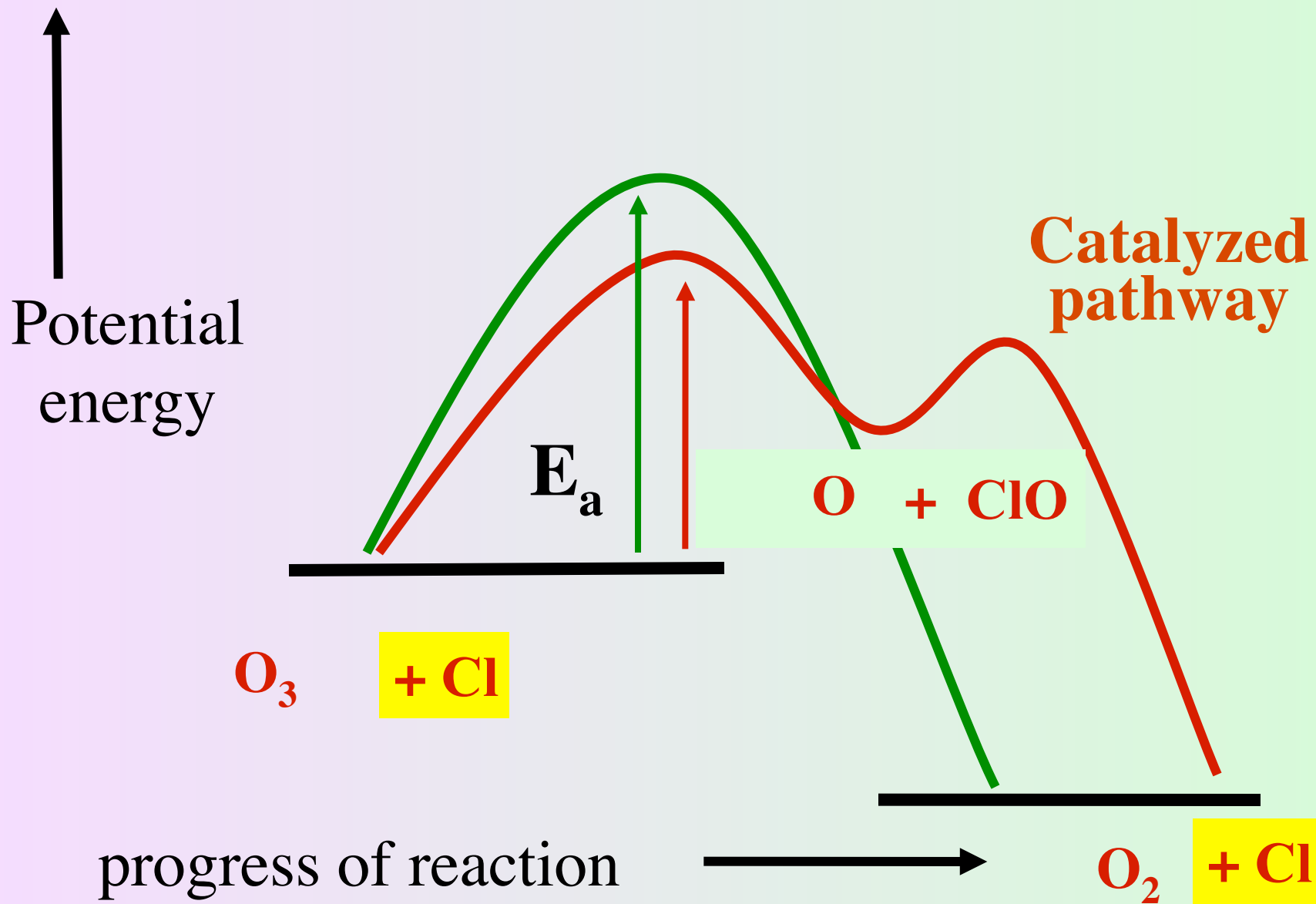


Write the overall reaction for the last two steps.

What are the roles of ClO and Cl ?

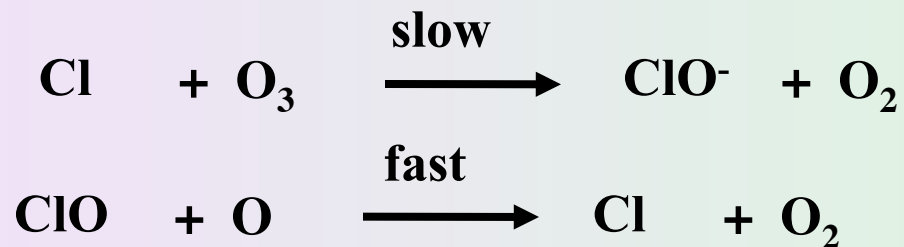
Draw the potential energy versus reaction progress diagrams for the uncatalyzed and catalyzed destruction of ozone.







A reasonable mechanism for the formation of oxygen from ozone is given by two elementary steps.

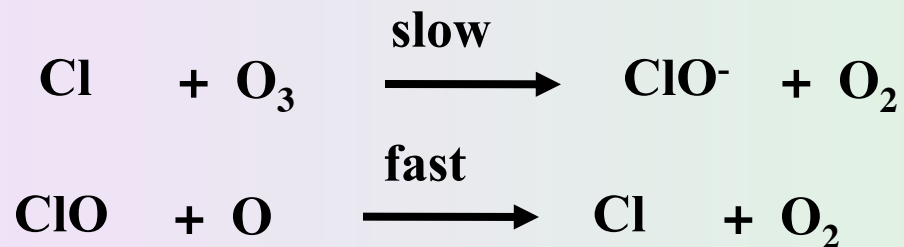


Which of the following statements concerning this proposed mechanism is true.

- A. ClO- is a catalyst
- B. ClO- is an intermediate
- C. The mechanism can't be correct because it involves a species (OCl-) that does not appear in the balanced equation
- D. The rate -determining step is unimolecular



A reasonable mechanism for the formation of oxygen from ozone is given by two elementary steps



What must the observed rate law be in order for the mechanism shown in problem to be correct.

- A. $\text{Rate} = k [\text{O}_3] [\text{O}]$
- B. $\text{Rate} = k [\text{O}_3] [\text{ClO}]$
- C. $\text{Rate} = k [\text{O}_3] [\text{O}]$
- D. $\text{Rate} = k [\text{O}_3] [\text{O}]$