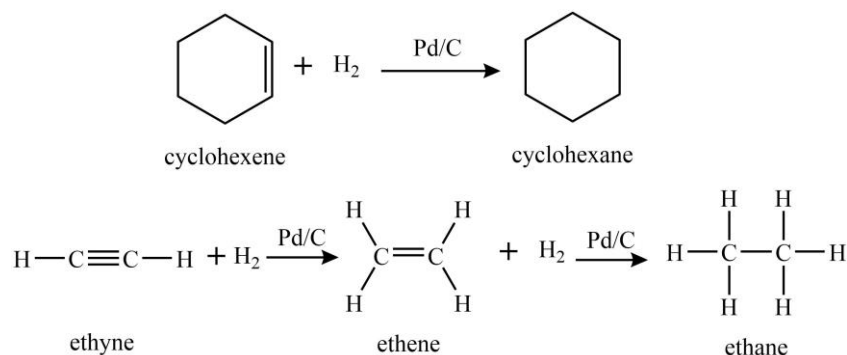


### ❖ Hydrogenation of Double and Triple Bonds

The double and triple bonds in organic compounds can easily be reduced by heterogeneous catalysis. One of the most common examples of such type of addition to multiple bonds is the process of hydrogenation of alkene or alkyne. These reactions involve the attachment of two hydrogen atoms across the double or triple bond. Since a  $\sigma$ -bond is stronger than the  $\pi$  one, the hydrogenation of a multiple bond is thermodynamically favored (exothermic reaction). The molecule's stability can also be quantified in terms of its heat released during its hydrogenation.

#### Illustrative Reaction:



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**Mechanism Involved:** It is also worth noting that the hydrogenation of multiple bonds does not proceed without the addition of a catalyst because the final product is thermodynamically favorable but the reactants are kinetically stable. To illustrate this, the reaction coordinate diagram for the hydrogenation of alkenes and alkynes is given below.

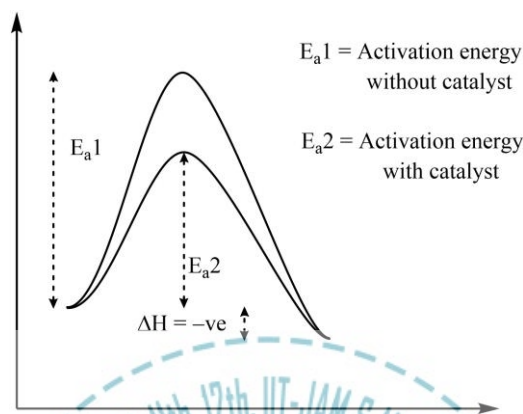
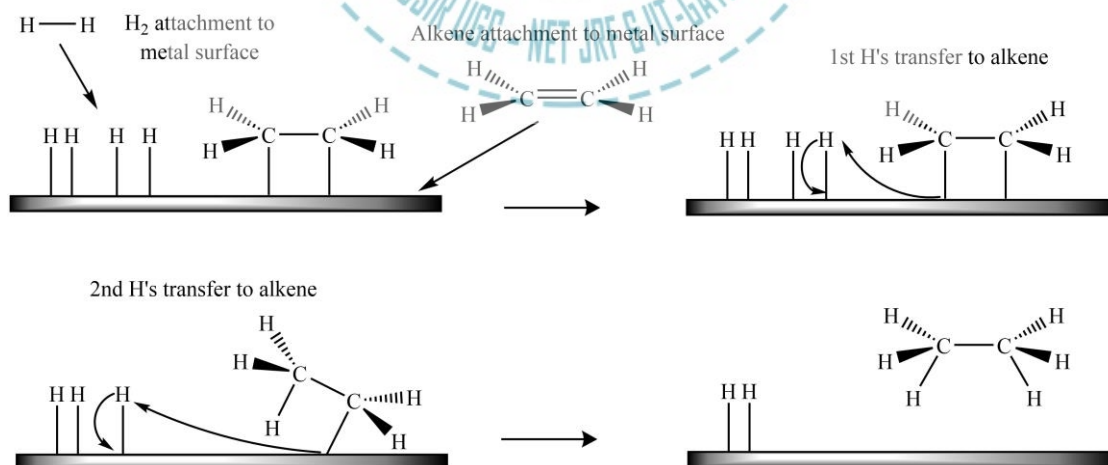


Figure 1: The reaction coordinate diagram for the catalytic hydrogenation of alkenes or alkynes.

The H–H bond in dihydrogen breaks in the presence of a metal catalyst and each hydrogen atom gets attached to the surface heterogeneous metal catalyst via a metal-hydrogen bond. The participating alkene also gets absorbed on the catalyst's surface. At this stage, an H atom is moved to the participating alkene, via a new C–H bond, followed by the movement of the second hydrogen atom via another C–H bond. Furthermore, since the hydrogens and alkene are on a flat surface of the metal catalyst, the two hydrogens being attached must do so via syn addition (i.e., at the same face of the double bond).



The most commonly used catalysts for alkene- or alkyne hydrogenation are platinum in the form of  $PtO_2$ , insoluble metals like palladium in the form of Pd-C, and Ni in the form of Ra-Ni.

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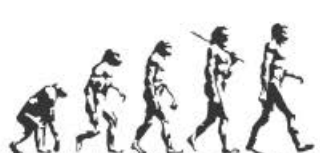
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