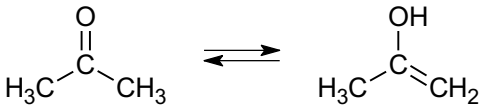
**Types of catalysts**

1. Acid Base – A reactant will either lose or gain $H^+$, forming a new intermediate, and as a result the reaction rate is changed.

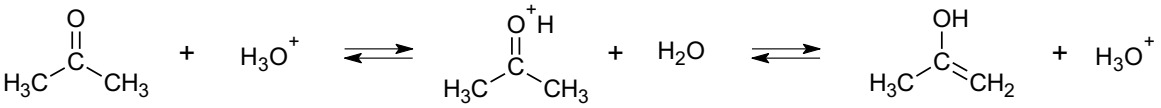
***Task***

***In organic chemistry, a specific class of compound called a ketone can be converted to another class of compound called an enol with a simple rearrangement. One such conversion is shown below.***

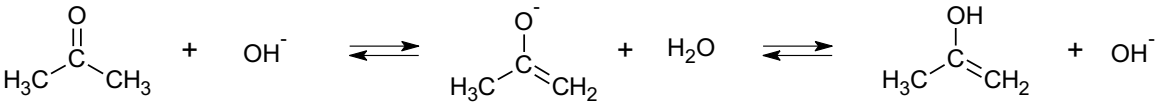



Ketone Enol

***It is found that the rate of this conversion can be changed by the introduction of another substance. The chemical equations showing two examples of the introduction of such substances are given below.***




Ketone Enol




Ketone Enol

***(a) It is found that $H_3O^+$ and $OH^-$ both increase the rate of the keto-enol conversion. Identify the role of $H_3O^+$ and $OH^-$ in the reactions above and explain your answer.***

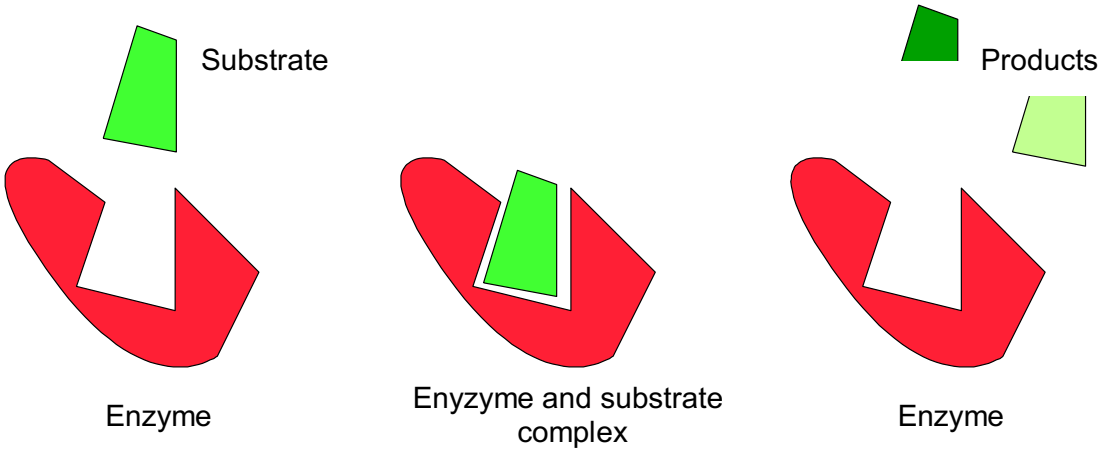
***(b) What feature of the equations shown above, support your answer to (a)?***

2. Surface – A surface catalyst is often a metal, working in a gaseous reactant environment. The gas molecules can be adsorbed on to the surface of the metal where a number of things (depending on the specific reaction) can occur. If for example, we consider the Haber process that manufactures ammonia

form $H_2$ and $N_2$, then the reactant molecules are adsorbed on to the surface of a metal catalyst and the covalent bonds within the $N_2$ and $H_2$ molecules are weakened. This produces highly reactive, singular, H and N atom intermediates, which then react quickly to form $NH_3$.

Another effect of adsorbing the gases onto a metal surface is that effectively their concentration is increased. Putting more gas molecules into a smaller area (only on the surface of the metal rather than spread throughout the whole container), concentrates them, and a higher concentration means more collisions and a faster reaction.

3. Enzyme – Enzymes are complex protein molecules that act as biological catalysts. They have many active sites on them, which interact with substrate (reactant) molecules, and lower the activation energy for the biological process. Originally thought of as a 'lock & key' model, where only specific substrates and enzymes would fit together and work, the *induced fit mechanism* suggests that both enzymes and substrates are more flexible in their structures to allow a single enzyme to interact with more than one substrate.




Other enzymes will react with the substrate to form a completely new intermediate with a lower energy for the transition state.

***Task Answers***

***(a) They are both catalysts since they both increase the rate of reaction, and at the end of the experiment they are regenerated, i.e., are unchanged***

***(b) In each case the $H_3O^+$ and the $OH^-$ are regenerated***