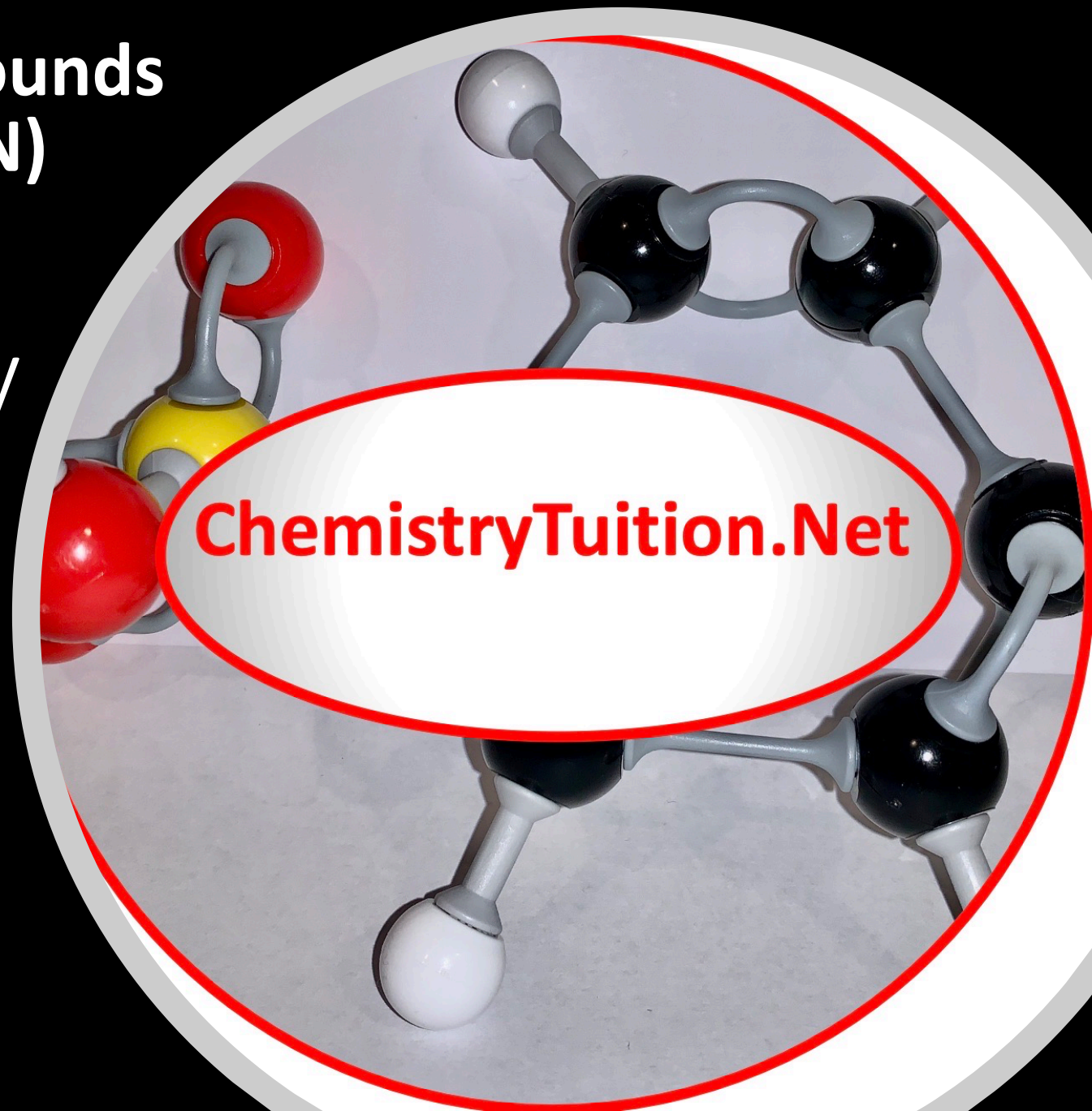


Reaction of Carbonyl Compounds with Hydrogen Cyanide (HCN)

Online 1-1 Chemistry
Tuition

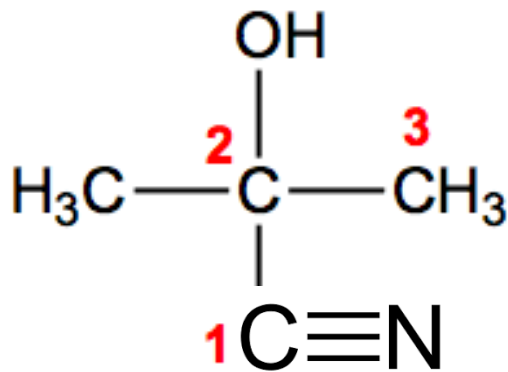
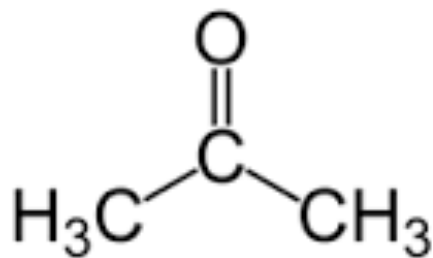
Dr Simon Orchard

These slides may be downloaded at
<https://www.chemistrytuition.net/>



Reaction of Aldehydes and Ketones with HCN

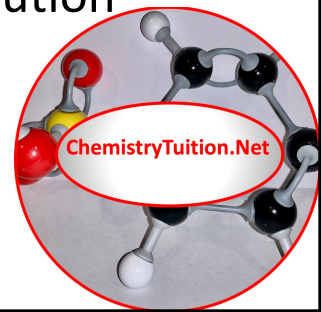
Hydrogen cyanide adds across the carbon-oxygen double bond in aldehydes and ketones to produce compounds known as hydroxynitriles.



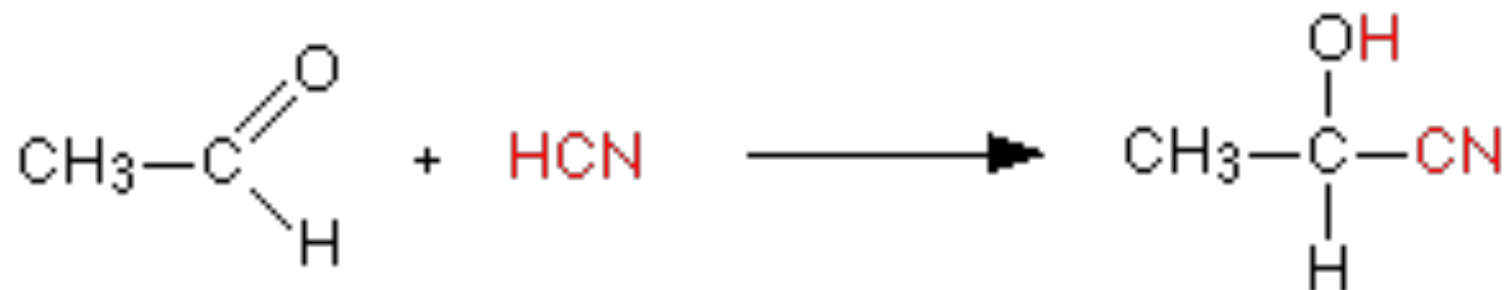
Naming: the longest carbon chain must include the –CN group. The carbon with the nitrogen attached is always counted as number 1.

The reaction isn't normally done using hydrogen cyanide itself, because this is an extremely poisonous gas.

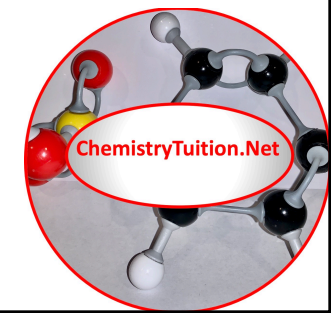
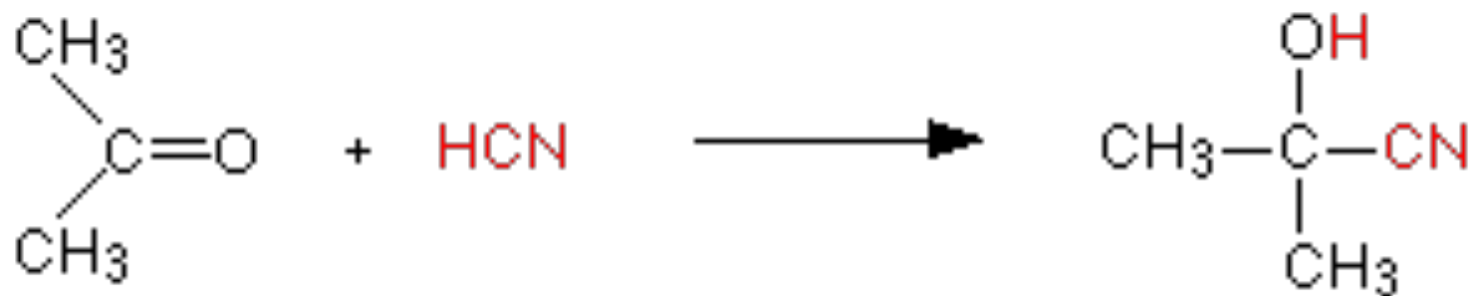
Instead, the aldehyde or ketone is mixed with a solution of sodium or potassium cyanide in water to which a little sulphuric acid has been added.



For example, with ethanal (an aldehyde) 2-hydroxypropanenitrile is formed:

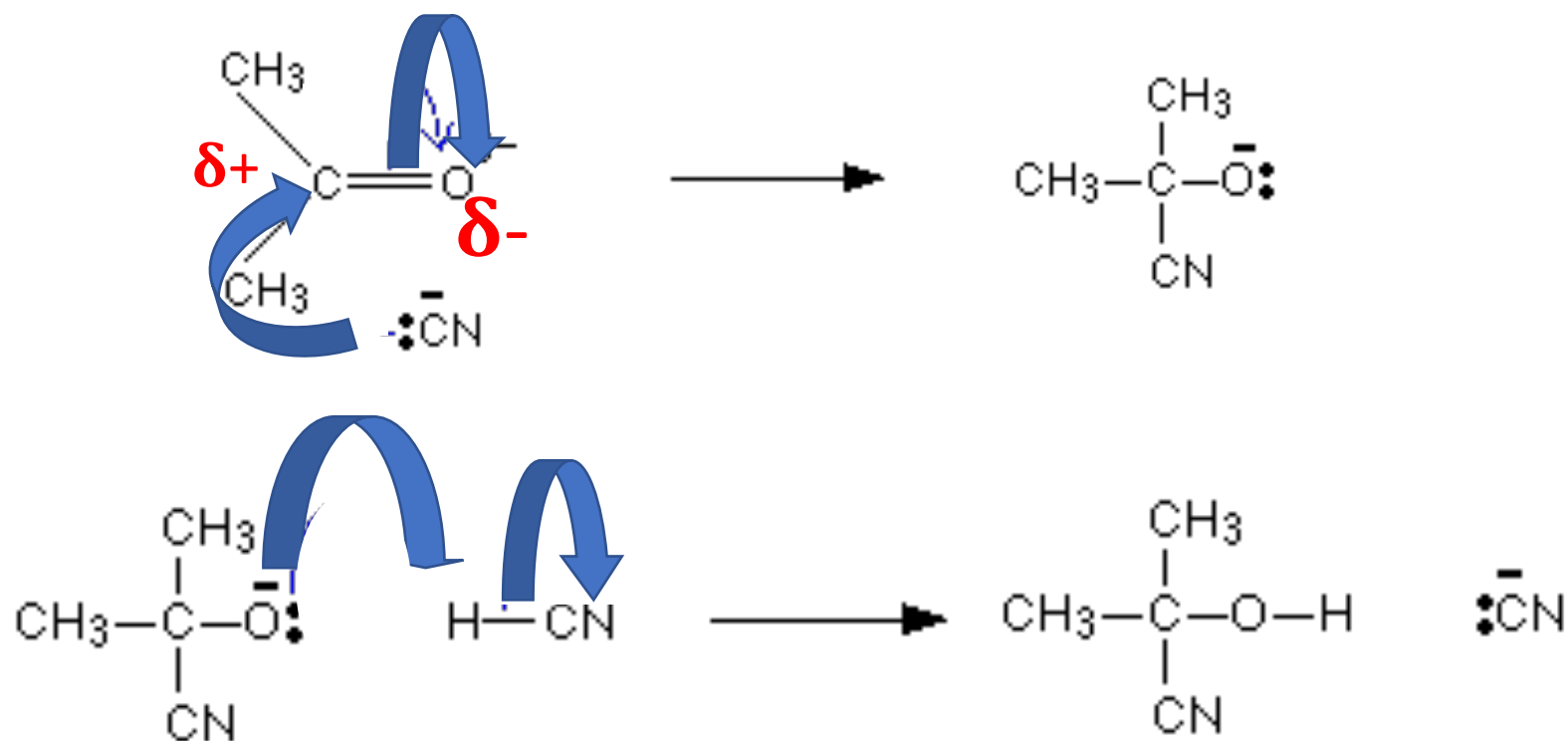


With propanone (a ketone) 2-hydroxy-2-methylpropanenitrile is formed:

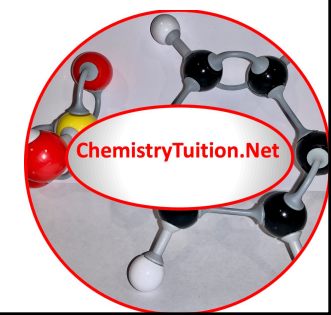


The mechanism for the addition of HCN to propanone – Nucleophilic Addition

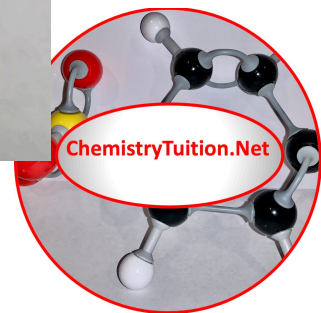
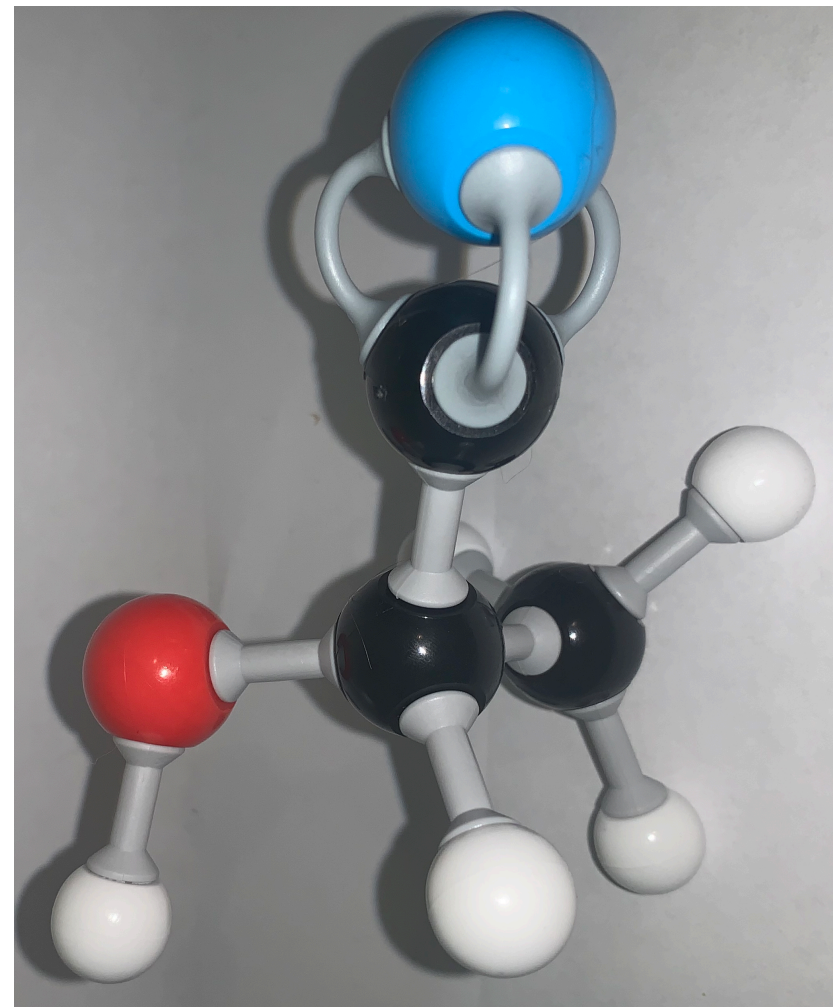
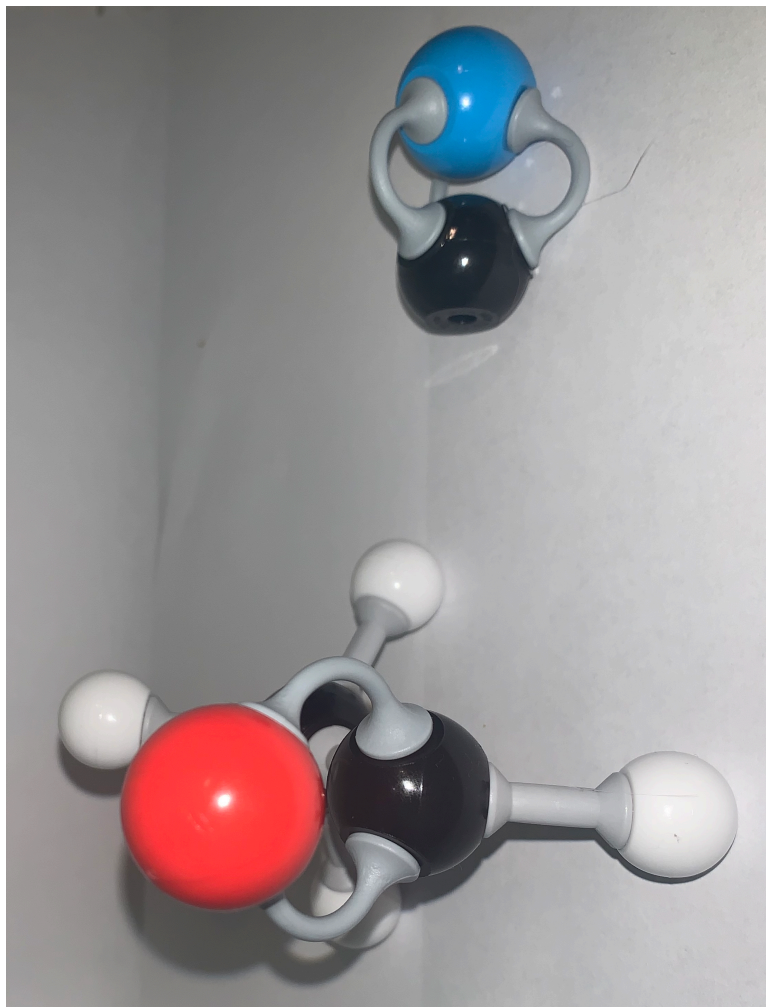
In the first stage, there is a nucleophilic attack by the cyanide ion on the slightly positive carbon atom.



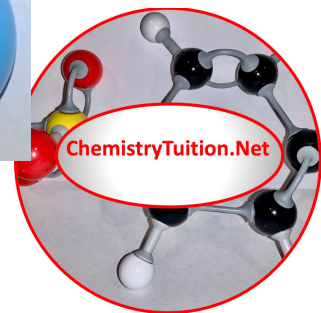
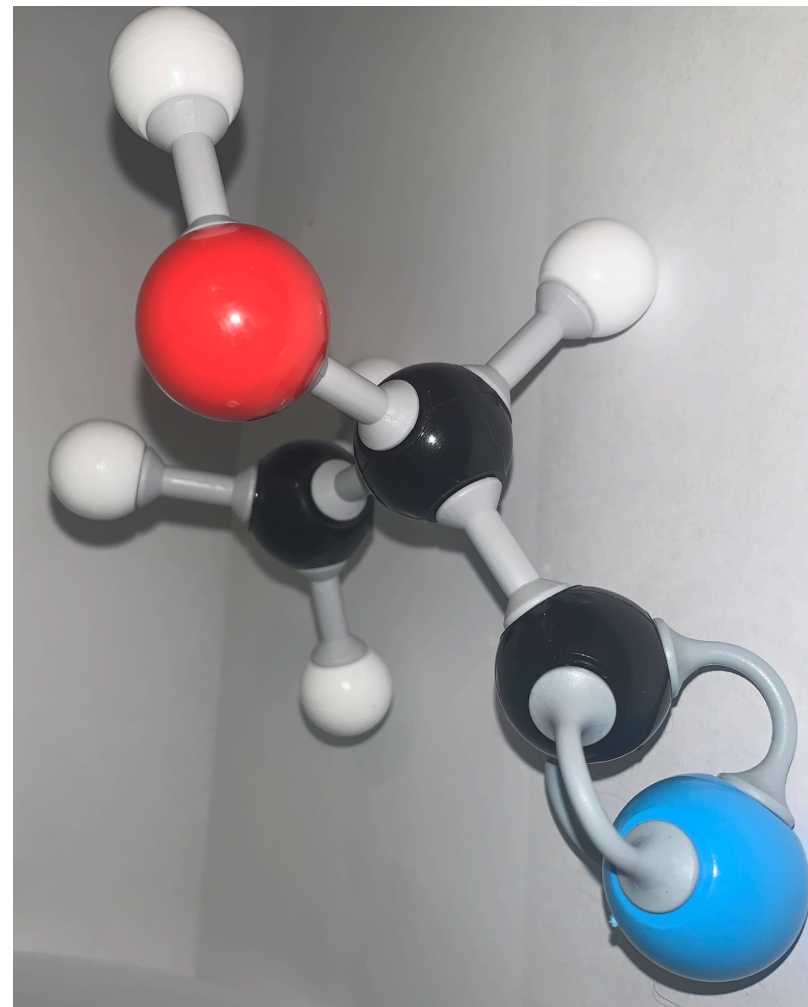
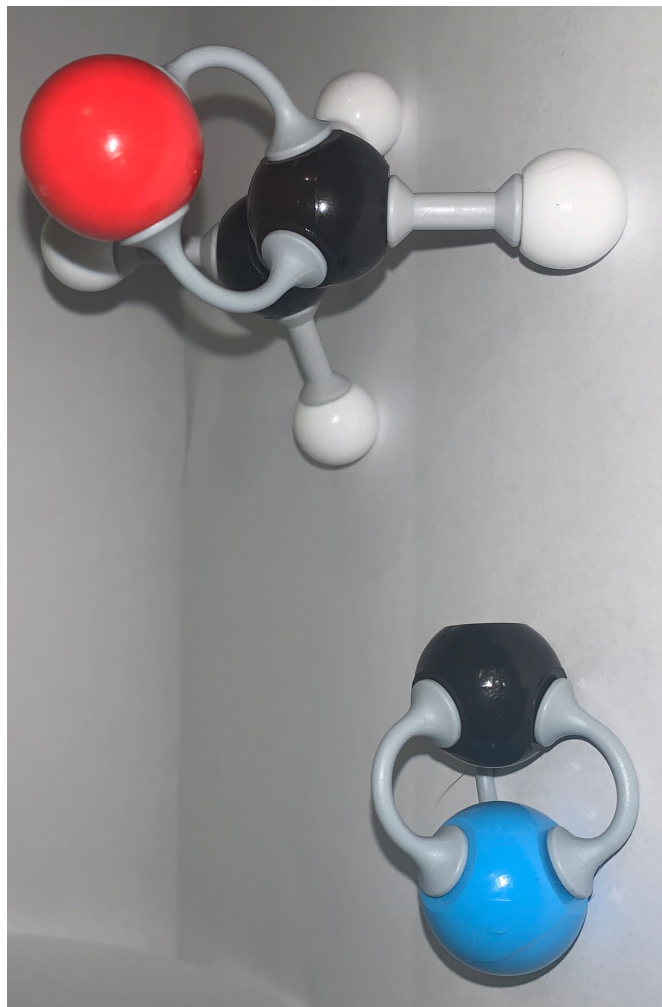
The negative ion formed then picks up a hydrogen ion from somewhere - for example, from a hydrogen cyanide molecule. The hydrogen ion could also come from the water present in the slightly acidic solution.

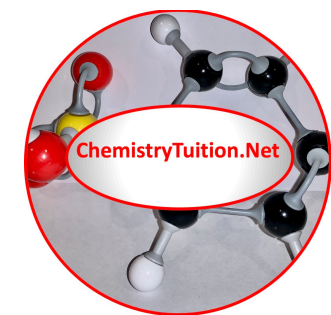
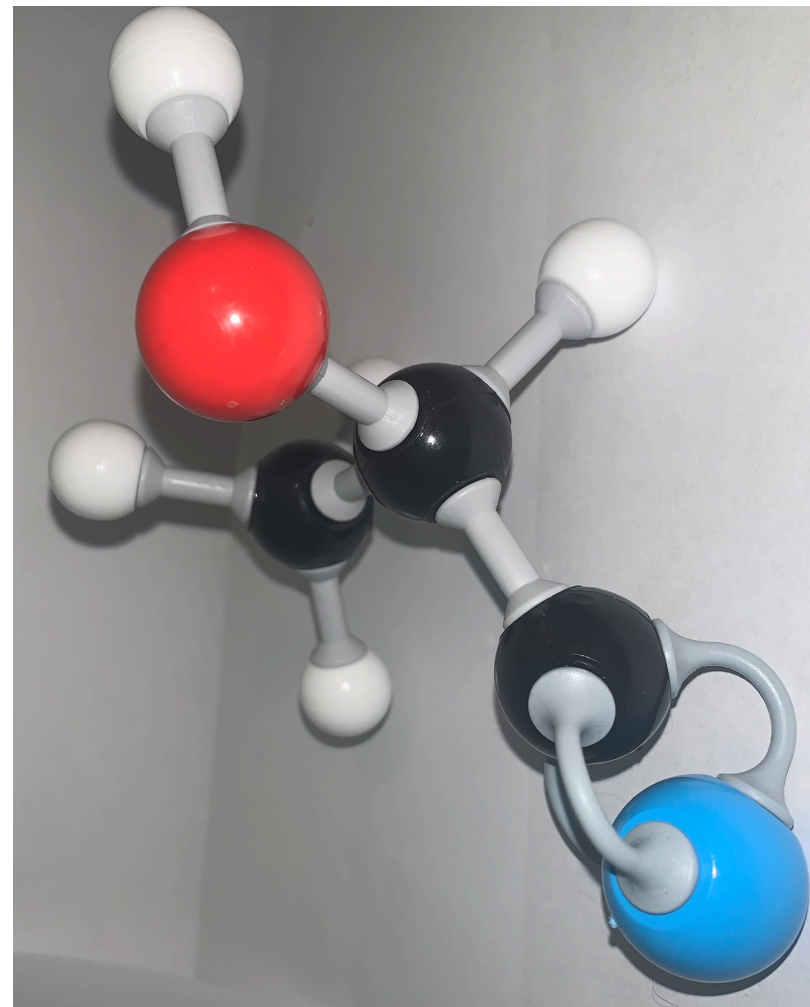
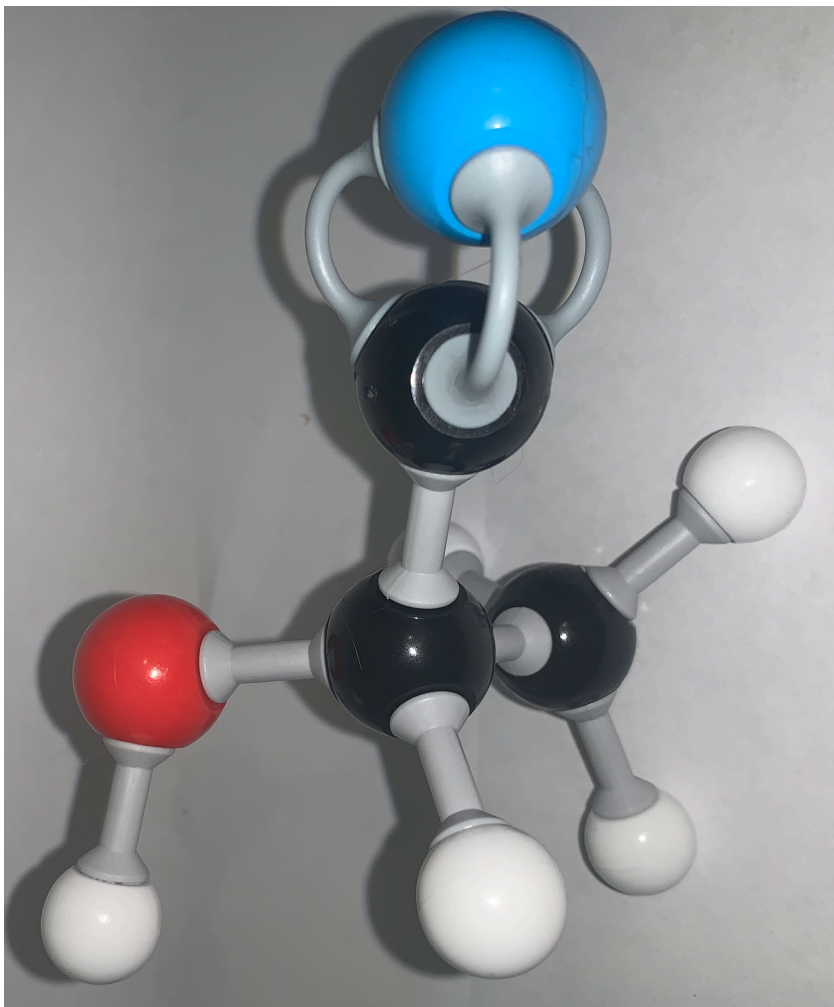


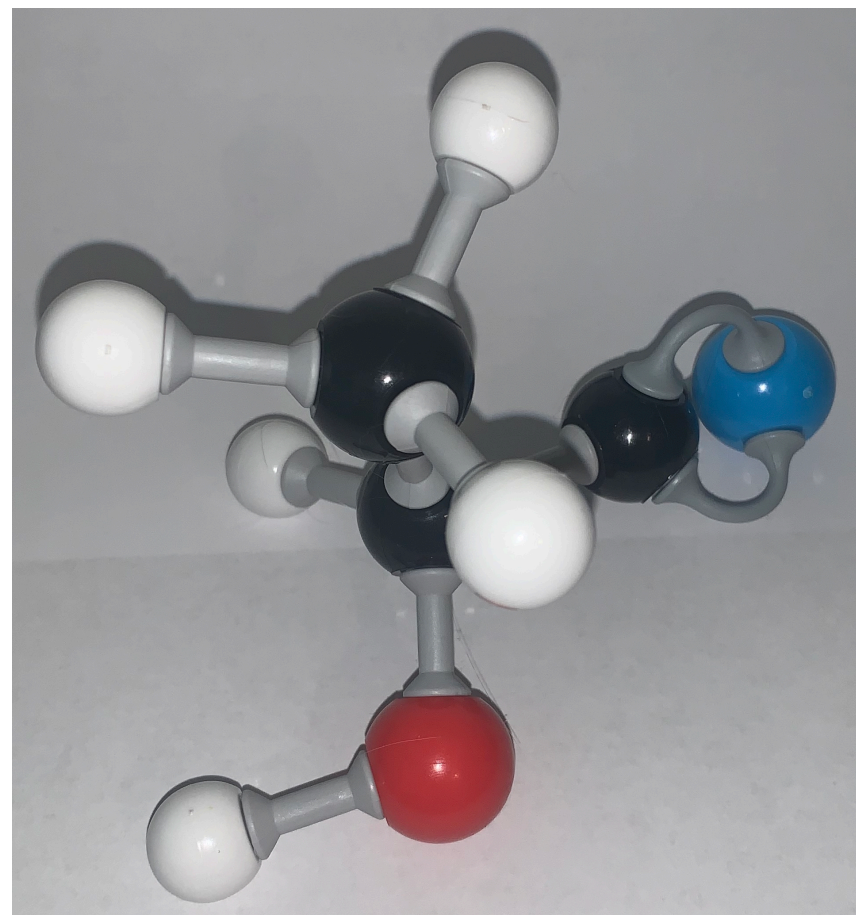
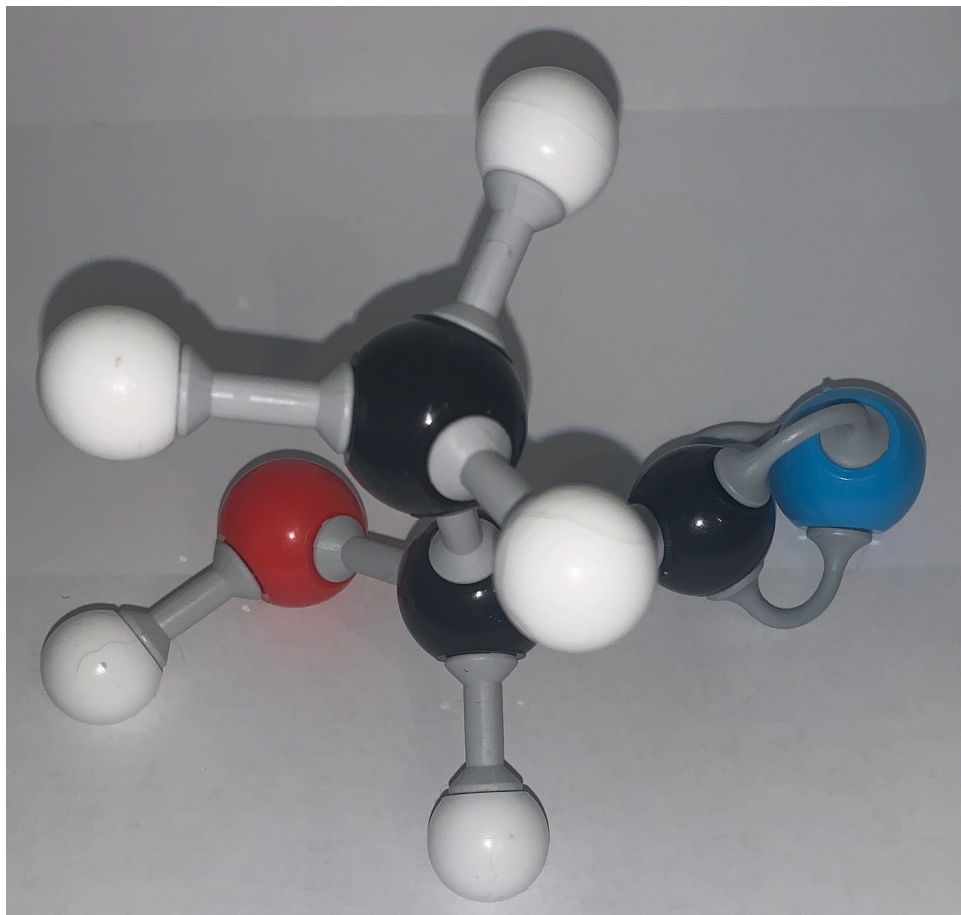
Attack from the CN^- ion from above



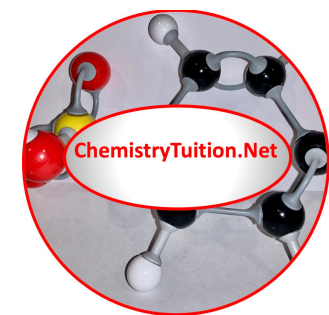
Attack from the CN^- ion from below

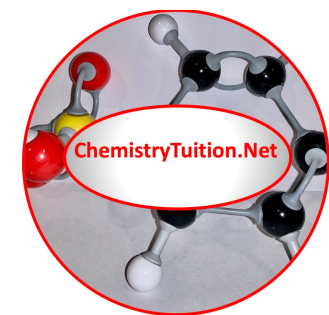
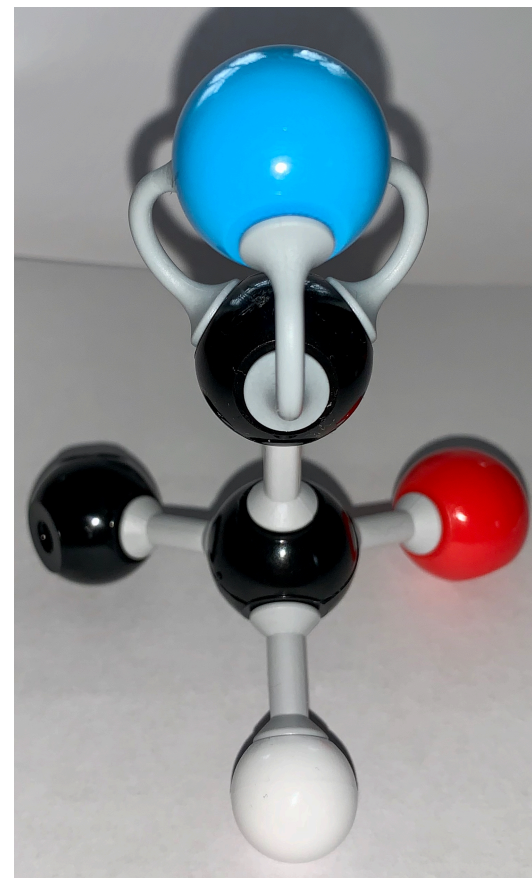
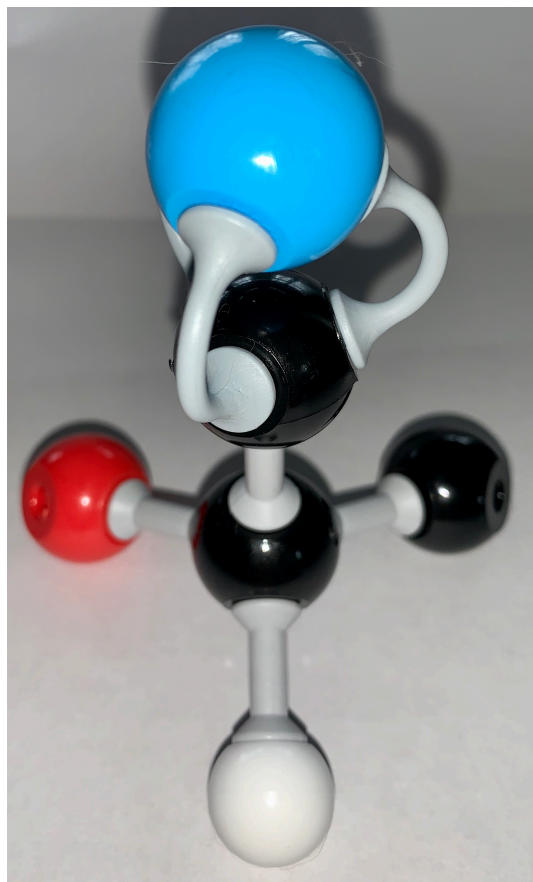






Optical Isomers – a form of stereoisomerism
Non-superimposable mirror images.
Four different groups attached to a carbon atom



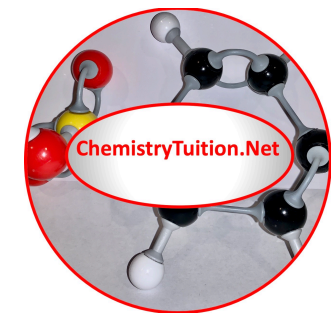


When aldehydes react with CN^- , a *racemic mixture* - (50/50 mixture) of two optical isomers.

Ethanal is a planar molecule and attack by a cyanide ion will either be from above the plane of the molecule, or from below. There is an equal chance of either happening.

All aldehydes and **unsymmetrical** ketones will form a racemic mixture.

The product molecule must have **four different groups attached to the carbon**, which was originally part of the carbon-oxygen double bond.





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