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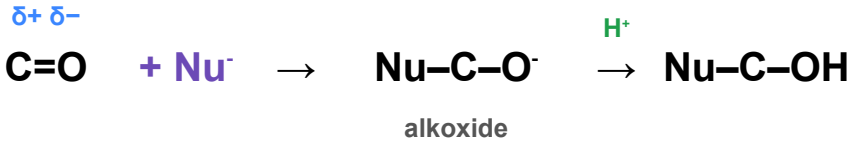
Nucleophilic Addition to the Carbonyl Group

1. Why C=O reacts

Oxygen is more electronegative than carbon, so it pulls the bonding electrons. Carbon becomes **δ+** (electrophilic) and oxygen **δ−**.

2. The mechanism

1. A **nucleophile** (electron-rich species) attacks the carbonyl carbon from above the plane.
2. The **π electrons** move onto oxygen.
3. Carbon changes from **sp² (flat)** to **sp³ (tetrahedral)**: an **alkoxide intermediate**.
4. The intermediate takes a **proton** to give the product.



3. Example

R–CHO + HCN → R–CH(OH)–CN, a **cyanohydrin**.

4. Aldehydes react faster than ketones

Reason	Aldehyde	Ketone
Steric	One alkyl group and a small H: easy to reach	Two alkyl groups: crowded
Electronic	One electron-releasing group: carbon more positive	Two groups: carbon less positive

Solved example

Q. Arrange in increasing reactivity towards HCN: ethanal, propanone, methanal.
A. Propanone < ethanal < methanal. Methanal has no alkyl group, ethanal has one and propanone has two.

Practice questions

1. (MCQ) A nucleophile attacks the (a) carbonyl oxygen (b) carbonyl carbon (c) alkyl group (d) hydrogen
2. (Very short) What is the hybridisation of the carbonyl carbon before attack?
3. (Very short) Name the intermediate formed.
4. (Short) Why is the carbonyl carbon electrophilic?
5. (Short) Give two reasons why aldehydes are more reactive than ketones.
6. (Short) What does HCN give with an aldehyde?

Answer key

1. (b).
2. sp^2.
3. Tetrahedral alkoxide intermediate.
4. Oxygen pulls electrons, leaving carbon δ+.
5. Less steric crowding; fewer electron-releasing alkyl groups, so carbon is more positive.
6. A cyanohydrin.

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