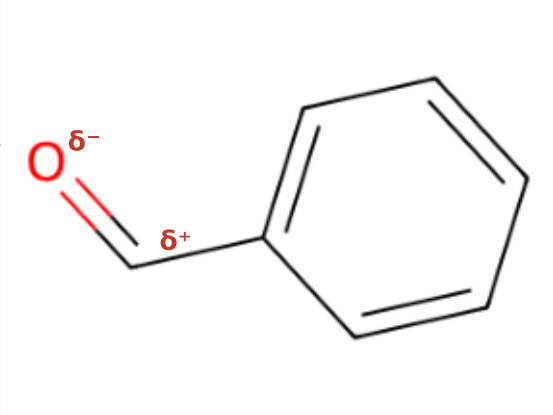


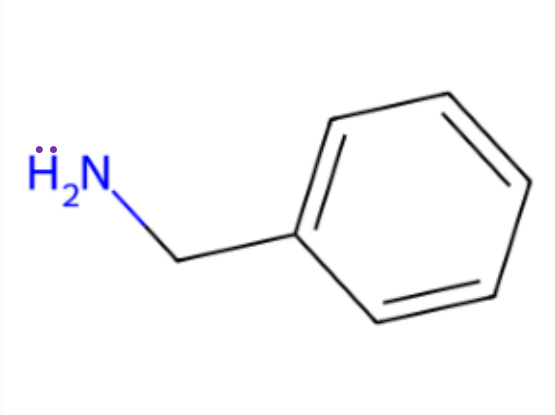
Benzaldehyde + Benzylamine → N-Benzylbenzylamine [Reagents: H⁺ (cat.), NaBH₃CN]

Step 0 — Starting Materials



Benzaldehyde
(aldehyde)

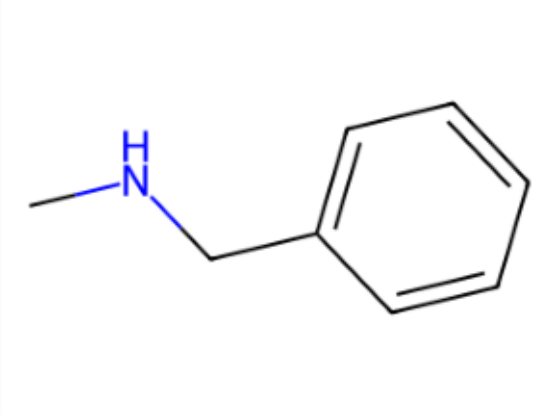
+



Benzylamine
(1° amine)



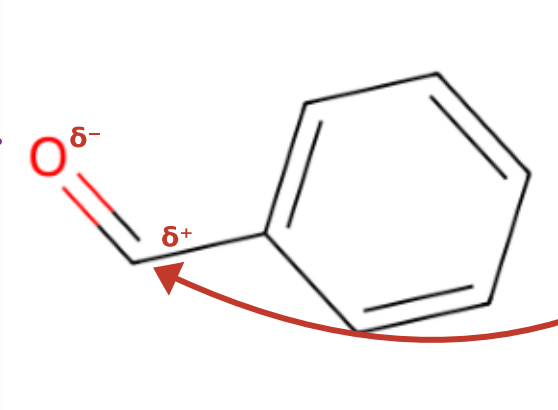
H⁺ (cat.)
NaBH₃CN



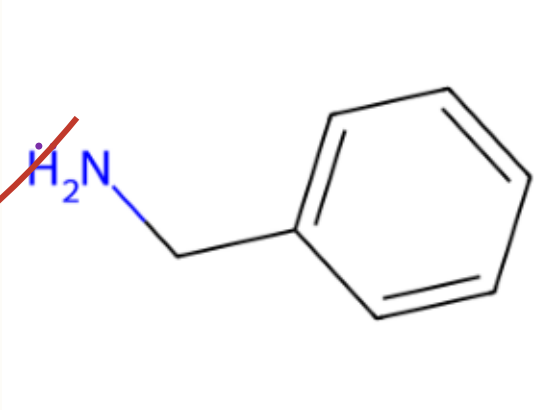
N-Benzylbenzylamine
(2° amine product)

Step 1 — Nucleophilic Addition (N lone pair attacks C=O)

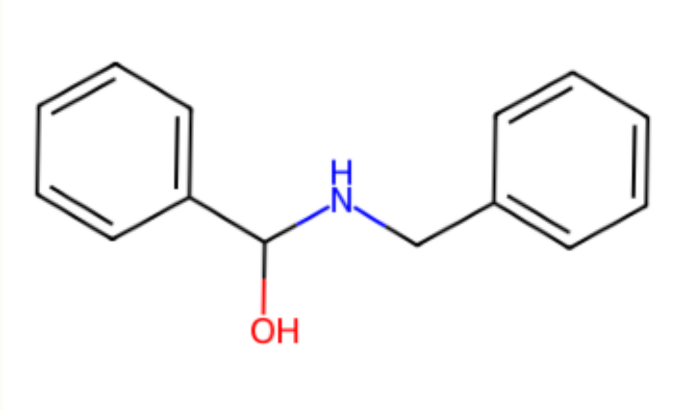
No reagent — spontaneous



Aldehyde
(electrophile, δ⁺ on C)



Amine
(nucleophile, N lone pair)

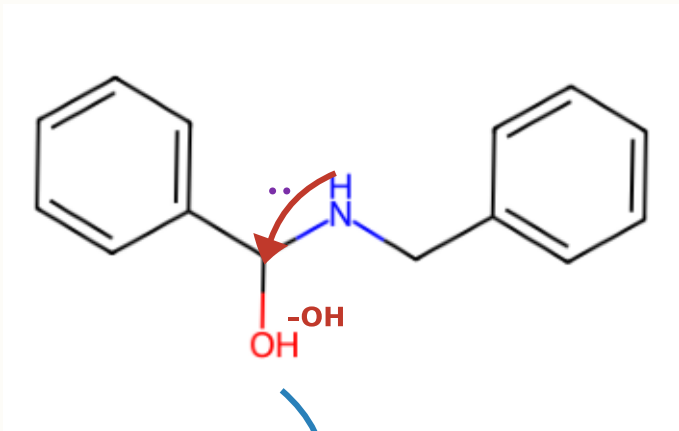


Carbinolamine
(tetrahedral intermediate)

N lone pair (nucleophile) → electrophilic carbonyl C → N-C bond forms, C becomes sp³ (tetrahedral)

Step 2 — Protonation of -OH then Dehydration (loss of H₂O)

H⁺ catalyst



Carbinolamine



H⁺, -H₂O



Iminium Ion
(C=N⁺, electrophilic carbon)

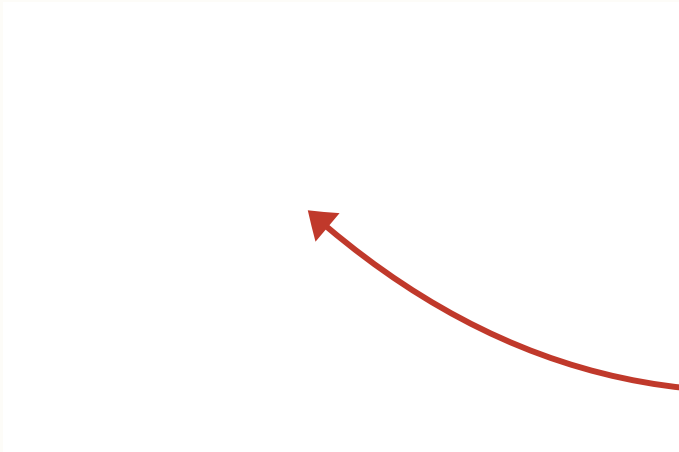
N lone pair pushes into C → C-O bond breaks → Water leaves → Iminium ion (C=N⁺) formed

H₂O

H₂O
(leaves)

Step 3 — Hydride Reduction of Iminium Ion (C=N⁺ → C-N)

NaBH₃CN (hydride source)



Iminium Ion
(electrophilic C=N⁺)

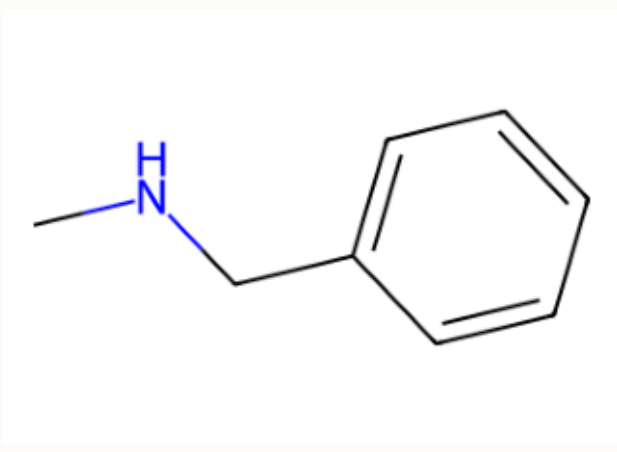
+

H:⁻

from NaBH₃CN



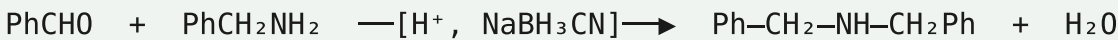
NaBH₃CN



N-Benzylbenzylamine
(secondary amine ✓ PRODUCT)

Hydride H:⁻ (nucleophile) → electrophilic C of C=N⁺ → C-H bond forms, N becomes neutral → secondary amine

Overall Reaction:



Legend & Mechanism Summary

— Red curved arrow

Electron pair movement (nucleophile → electrophile)

— Blue curved arrow

Bond breaking / leaving group departure

•• Purple dots

Lone pair electrons on heteroatom

δ⁺ / δ⁻

Partial charges from polarisation

N: → C=O

Step 1: N lone pair attacks carbonyl C

N: → C-OH

Step 2: N lone pair pushes out -OH (water)

H:⁻ → C=N⁺

Step 3: Hydride from NaBH₃CN reduces iminium