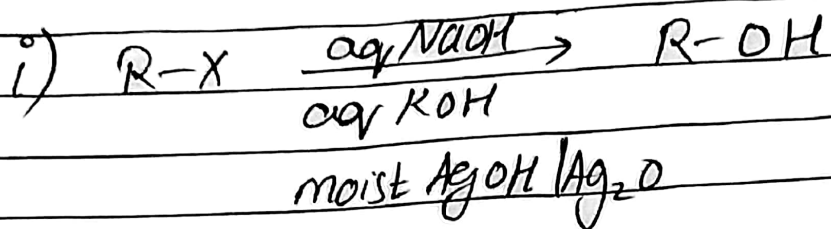


Nucleophilic Substitution Reactions of Alkyl Halide

① Substitution by $-OH$ group \rightarrow Formation of Alcohols

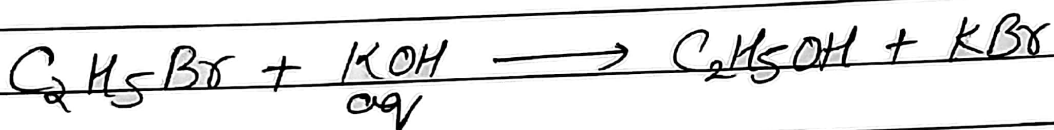


$3^\circ \rightarrow SN^1$ (always)

$2^\circ \rightarrow SN^1$ & SN^2 depends on conditions (like Nu^-)

$1^\circ \rightarrow SN^2$ (always)

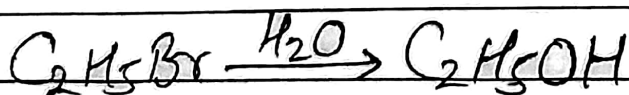
$\text{NaOH} / \text{KOH} / \text{AgOH} \xrightarrow[\text{aq}]{\text{moist}}$ \rightarrow Strong Bases \rightarrow Strong Nu^-
favours SN^2



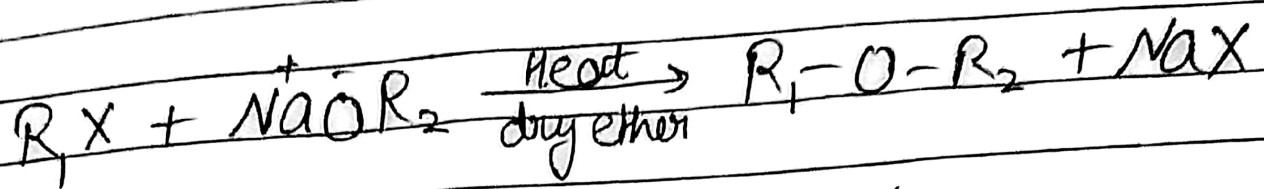
Note: In case of alcoholic $KOH / NaOH \rightarrow$ elimination product will be Major.



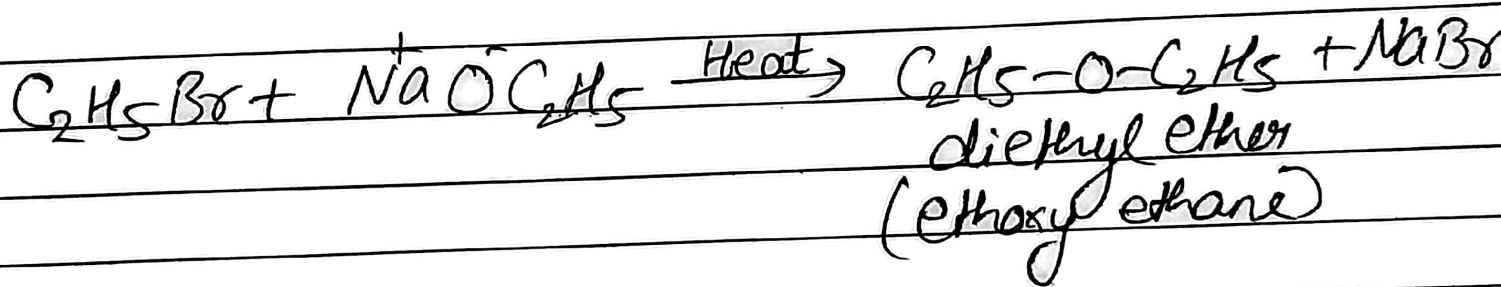
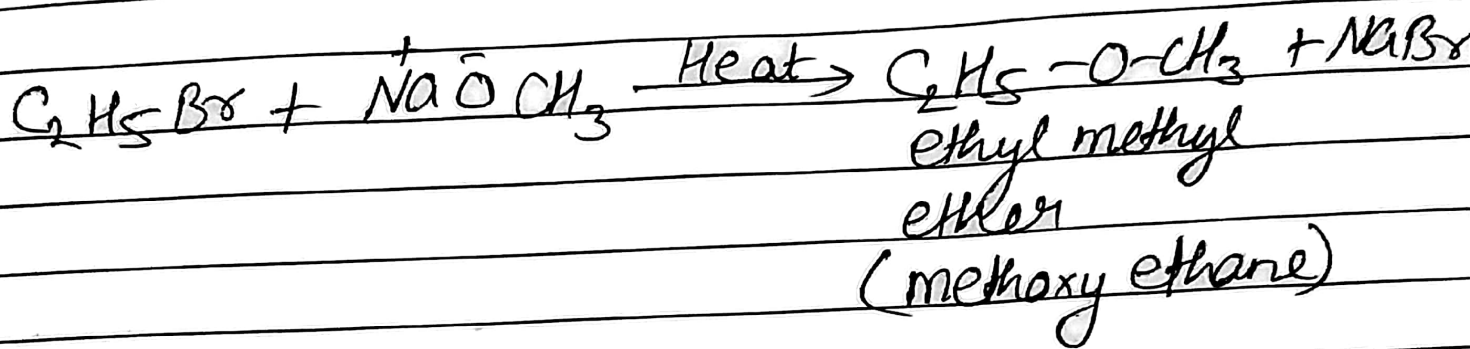
$H_2O \rightarrow$ weak Nu^-
 \downarrow
favours SN^1



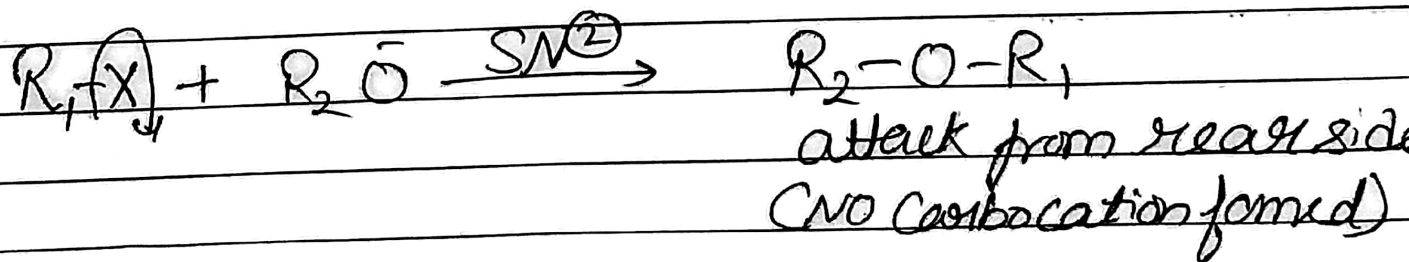
② Substitution by $-OR$ group \Rightarrow formation of ethers



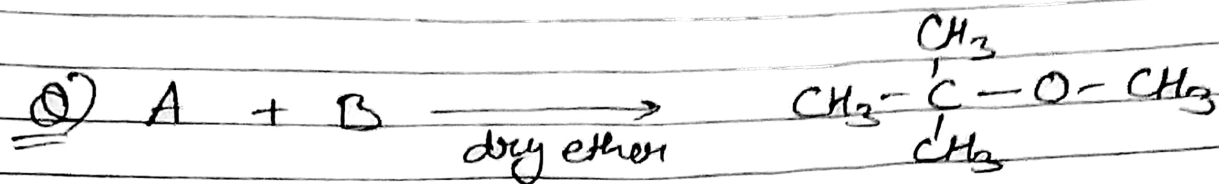
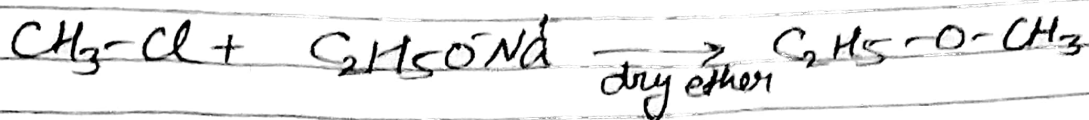
Williamson's Synthesis
of ethers.



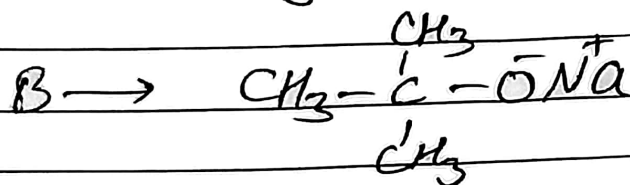
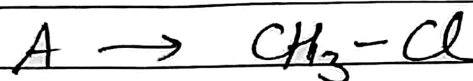
Mechanism: $SN^{(2)}$



Since $SN^{(2)}$ $R_1 \rightarrow$ should be 1°
($3^\circ \rightarrow$ goes $SN^{(1)}$)



Remember $\text{A} \rightarrow 1^\circ$ (for SN^2)



Alkyl Halide should be 1°

Types of alkyl halide that cannot be used in Williamson's synthesis

i) Vinyl Halide $\text{CH}_2=\text{CH-X}$

As C-X has partial π bond due to Resonance

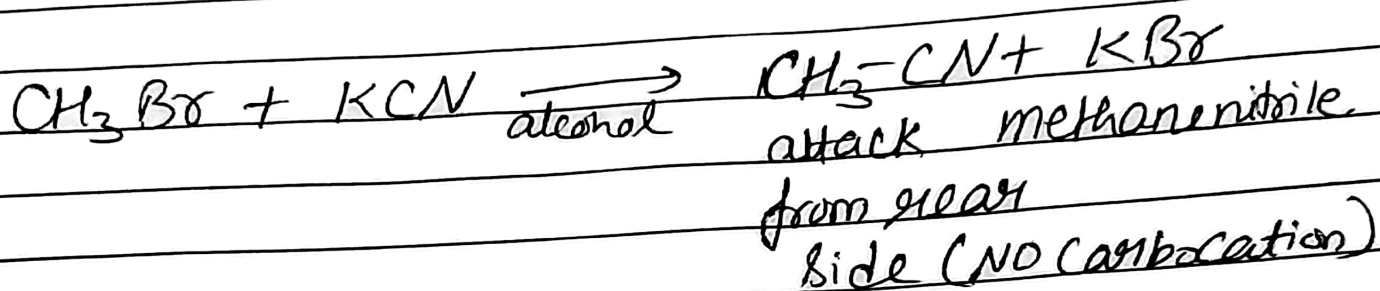
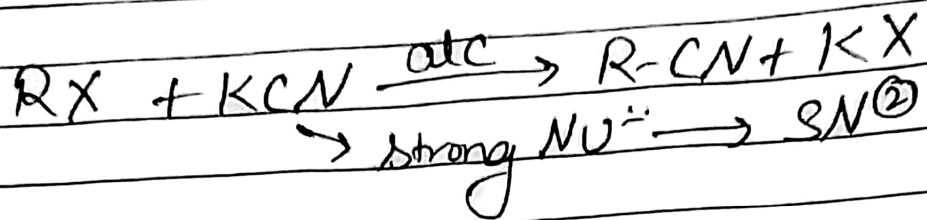
ii) Aryl Halide



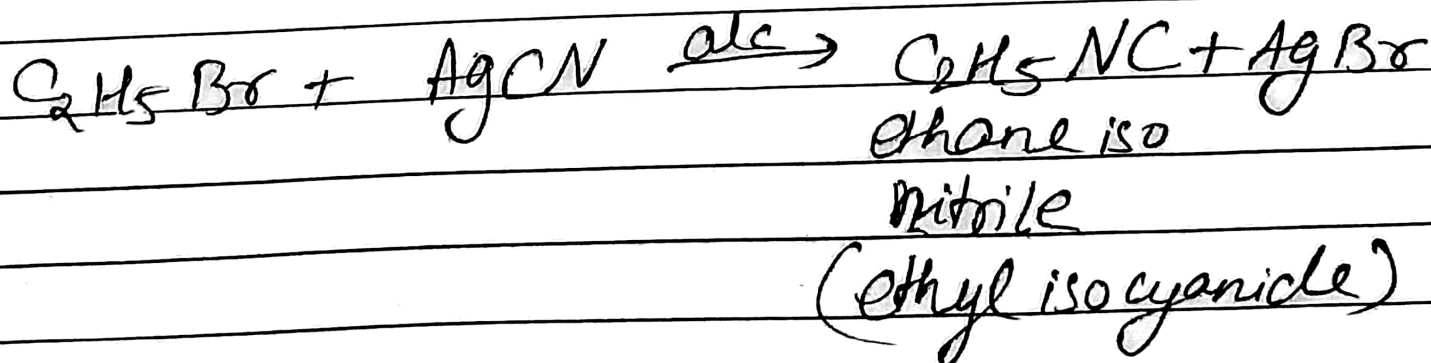
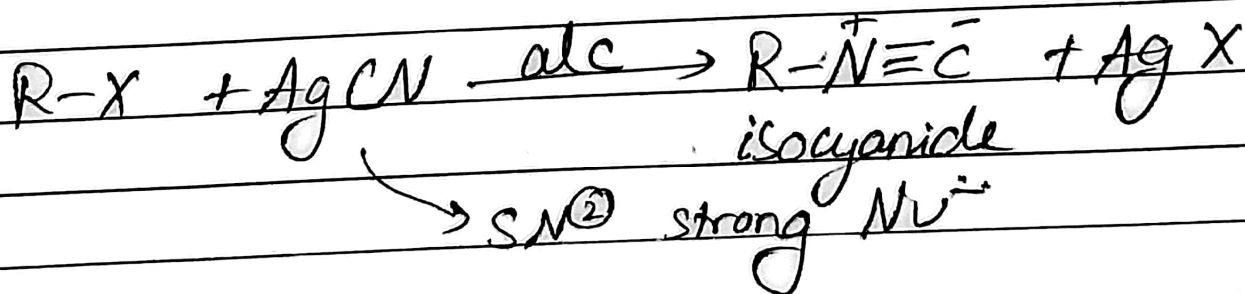
\rightarrow C-X again has partial π bond due to Resonance.

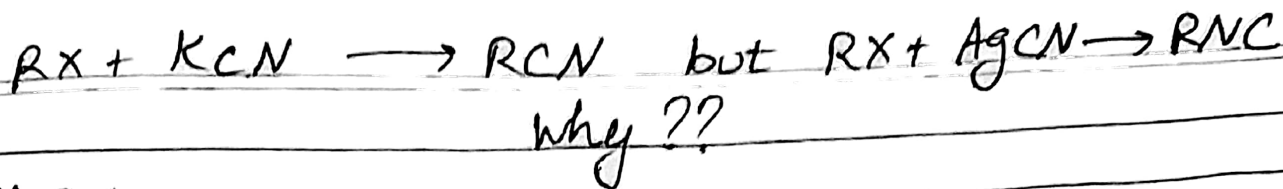
iii) 3° Alkyl halide \rightarrow Steric hindrance \rightarrow goes SN^1

③ Substitution by $-CN \rightarrow$ formation of Alkyl cyanide or alkanenitriles



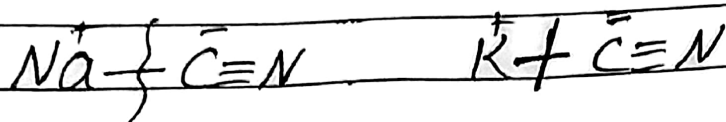
Substitution by $-NC \Rightarrow$ formation of Alkyl isocyanide or alkanisonitrile





Reason:

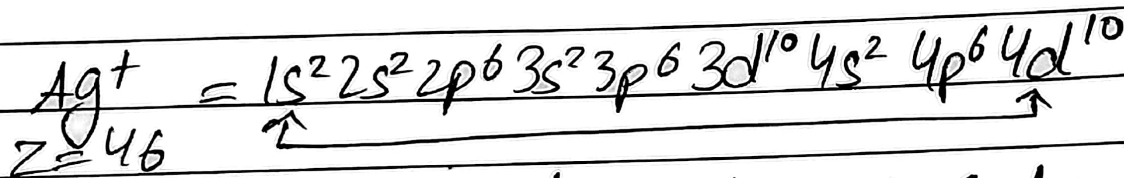
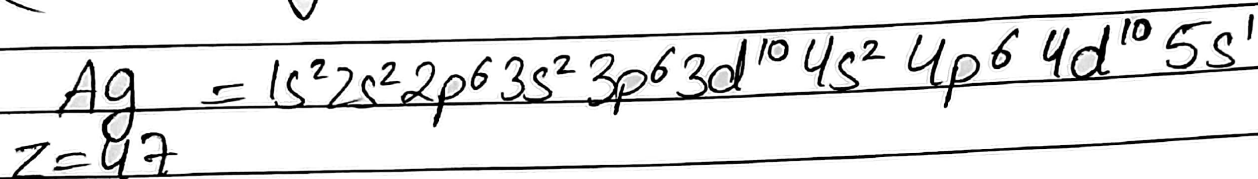
KCN NACN are predominately ionic



Attack occurs through \bar{C} atom of $C \equiv N$

AgCN is predominately covalent

(Reason: Ag^+ has pseudo noble gas configuration)



Pseudo noble gas Configuration

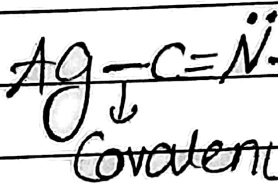
Fajan's Rule \rightarrow If cation is pseudo noble gas configuration

\Rightarrow Covalent character

Poor shielding effect of $4d^{10} e^-$

hence more effective pull of nucleus which increases polarising power of cation \Rightarrow

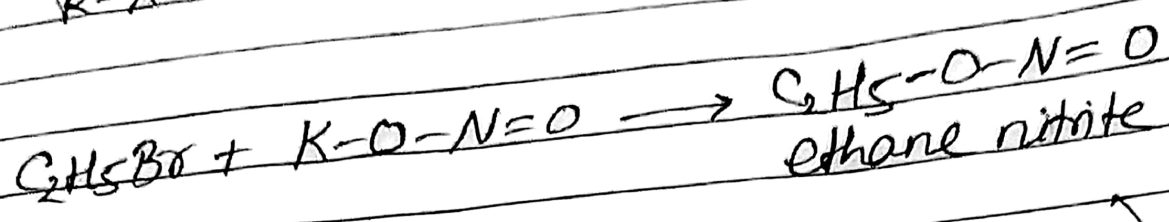
More polarisation \Rightarrow More covalent character



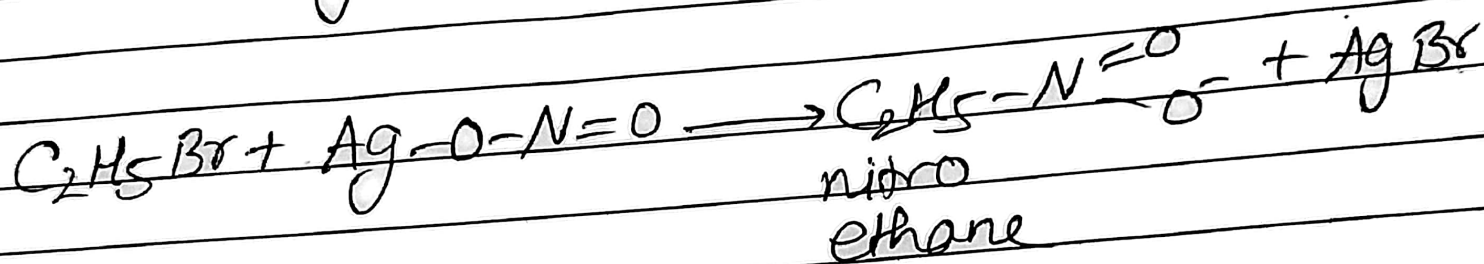
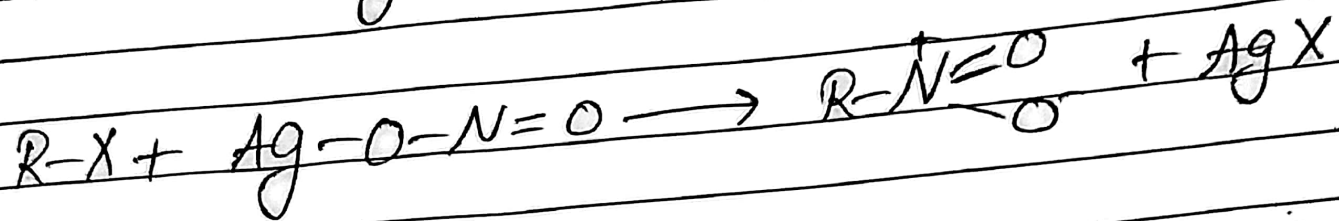
Attack occurs through N atom of $C \equiv N$



⑤ Substitution by nitrite ($-O-N=O$) group
 $R-X + K-O-N=O \longrightarrow R-O-N=O + KX$

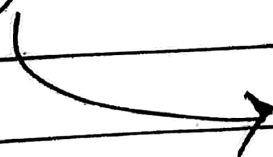
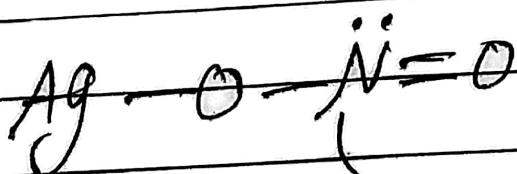
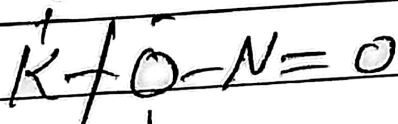


⑥ Substitution by nitro ($-NO_2$ group)



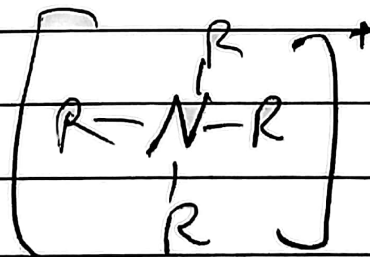
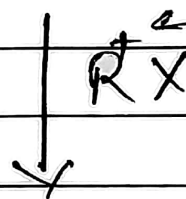
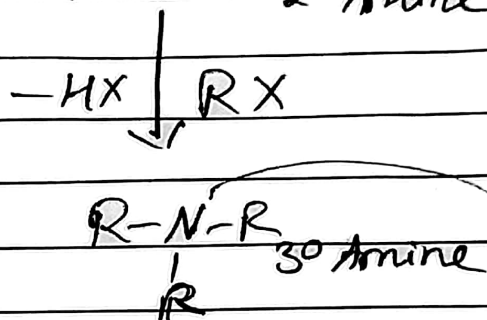
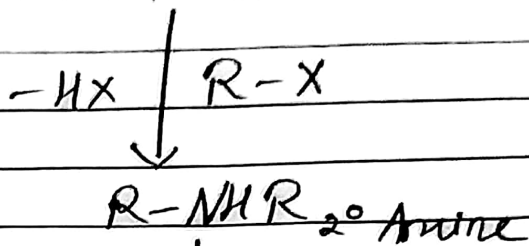
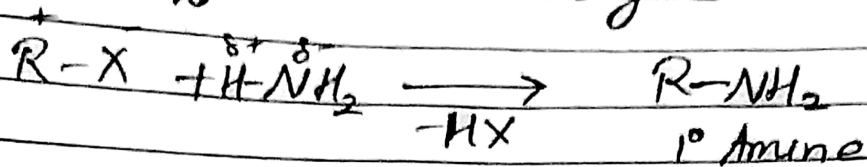
Reason: $K^+ \bar{O}^-$ ionic \Rightarrow attack occurs through \bar{O}

$Ag-O$ covalent \Rightarrow attack occurs through \bar{N}



⑦ Substitution by (NH_2) group \Rightarrow Formation of Amines

Hoffmann Ammonolysis



Quaternary Ammonium Halide (salt)