Victoria Junior College

JC2 H2 Chemistry

Hydroxy Compounds – Appendix

1. Alkoxide Ions and Ethers

We have learnt in this topic that alcohols undergo a redox reaction with reactive metals, such as Na, to form alkoxides and hydrogen gas.

for example,

$$2CH_3CH_2OH + 2Na \rightarrow 2CH_3CH_2O^-Na^+ + H_2$$

ethanol — sodium ethoxide

This reaction can also be carried out with very strong bases, such as sodium amide ($NaNH_2$) and sodium hydride (NaH):

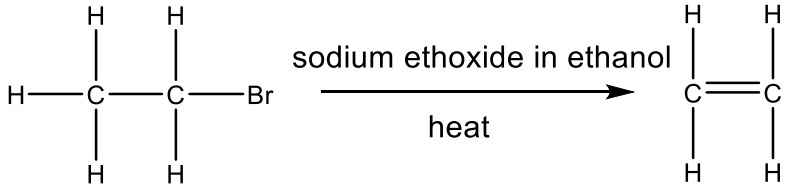
$$CH_3CH_2OH + NaNH_2 \rightarrow CH_3CH_2O^-Na^+ + NH_3$$

$$CH_3CH_2OH + NaH \rightarrow CH_3CH_2O^-Na^+ + H_2$$

The alkoxide ions formed in this way can be used as **bases** or **nucleophiles**:

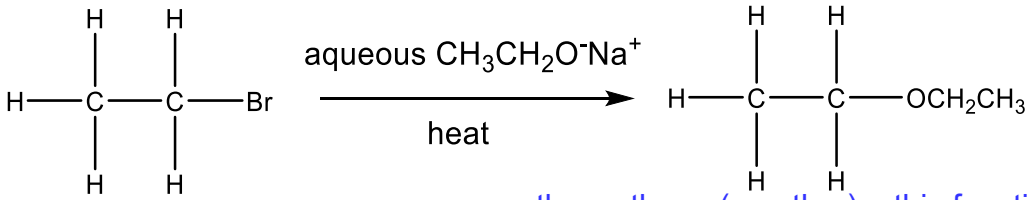
a) As bases:

Recall that alcohols are weaker acids than water. (Refer to Hydroxy Compounds Notes for more elaboration on this) – therefore, this makes alkoxide ions **stronger bases** than hydroxide ion. For example, elimination reactions of halogenoalkanes can also be carried out using alkoxide ions:



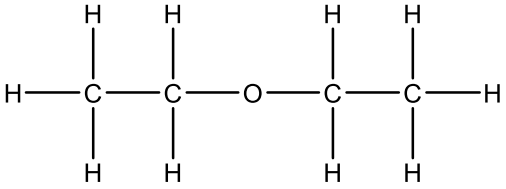
b) As nucleophiles:

Alkoxide ions can act as nucleophiles, for example, in their reactions with halogenoalkanes, to form **ethers**:

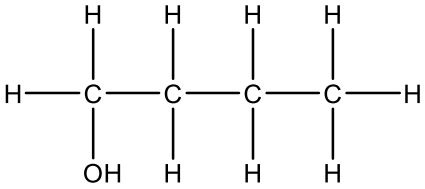


ethoxyethane (an ether) – this functional group is not required for H2 syllabus.

The ethers formed are generally unreactive. They are commonly used as solvents in the laboratory. They are also functional group isomers of alcohols:



ethoxyethane



butan-1-ol

2. **Comparing Lithium Aluminium Hydride ($LiAlH_4$) and Sodium Borohydride ($NaBH_4$) as Reducing Agents**

Both $LiAlH_4$ and $NaBH_4$ are reducing agents as they contain **polar metal-hydrogen bonds,** where the H atoms bear a negative charge, thus **behaving like a nucleophilic hydride ion, H^-.**

(This is because H is **more electronegative** than both B and Al; thus when covalently bonded to B or Al, the H atom acquires a partial negative charge.)

However, as Al is **more electropositive** than B (recall from *Periodic Table* that electronegativity decreases down the same group), the **Al - H bond is more polar than the B – H bond**. This makes $LiAlH_4$ **a stronger reducing agent** than $NaBH_4$:

Functional Groups Reduced By $LiAlH_4$	**Functional Groups Reduced by $NaBH_4$**
aldehydes to 1° alcohols	aldehydes to 1° alcohols
ketones to 2° alcohols	ketones to 2° alcohols
carboxylic acids to 1° alcohols	
nitriles to amines	
amides to amines	

However, $LiAlH_4$ is also much harder (and more dangerous) to handle than $NaBH_4$. For example, $LiAlH_4$ is incompatible with water, alcohols, halogen derivatives and esters (all of which are common solvents). It reacts vigorously with water to liberate hydrogen gas:

$$LiAlH_4 + 4H_2O \longrightarrow LiOH + Al(OH)_3 + 4H_2$$

On the other hand, reductions using $NaBH_4$ are usually milder and can take place in alcoholic solvents.