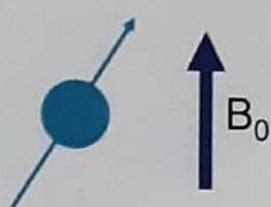
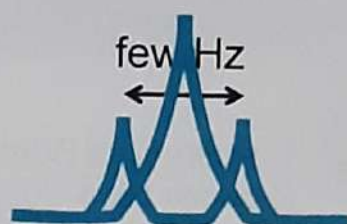
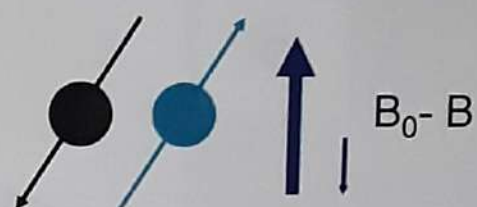
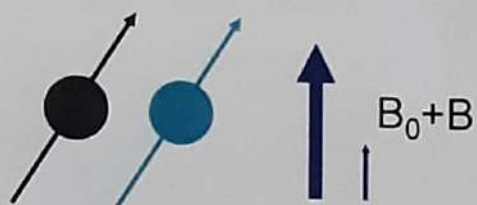


Spin Coupling


- If each nucleus is a magnet, they should see each other



one spin

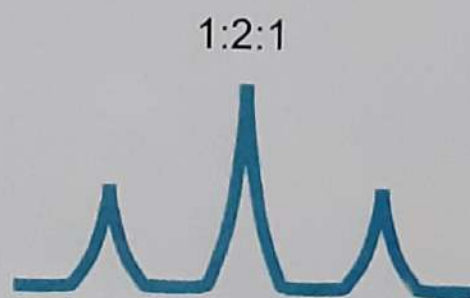
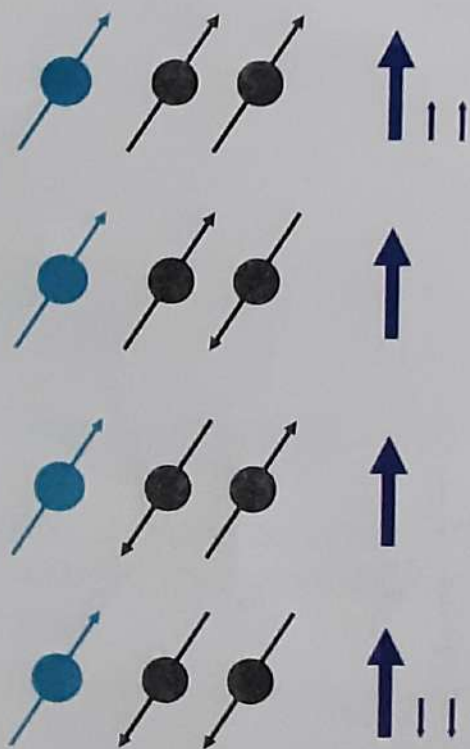


two spins
see each other

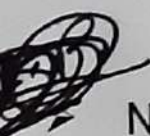
 Nucleus being observed

More Splitting

- Intensities and patterns are predictable



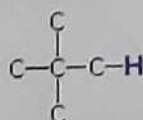
Spin-Spin Coupling for $I = \frac{1}{2}$ Nuclei



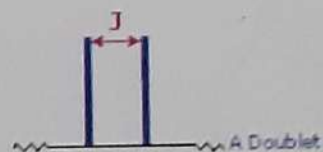
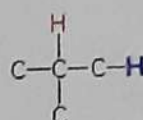
- Nuclei having the same chemical shift do not exhibit spin-splitting.
- Nuclei having different chemical shifts and separated by ≤ 3 bonds (e.g. vicinal and geminal nuclei) will usually be spin-coupled and will show mutual spin-splitting of the resonance signals (same J 's).
- Longer-range coupling may be observed in molecules having rigid configurations of atoms.
- The magnitude of the observed spin-splitting depends on many factors and is given by the coupling constant J (Hz). J is the same for both partners in a spin-splitting interaction and is independent of the external magnetic field strength.
- The splitting pattern of a given nucleus (or equivalent nuclei) can be predicted by the **$n+1$ rule**.

Splitting Patterns for Equal Coupling

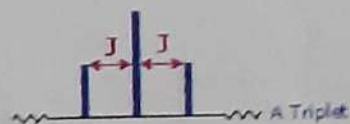
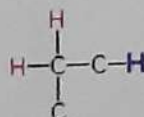
No Coupled
Hydrogens



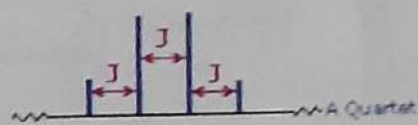
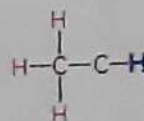
One Coupled
Hydrogen



Two Coupled
Hydrogens

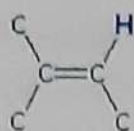


Three Coupled
Hydrogens

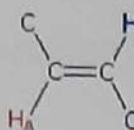


Splitting Patterns for Unequal Coupling

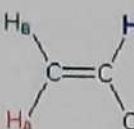
No Coupled
Hydrogens



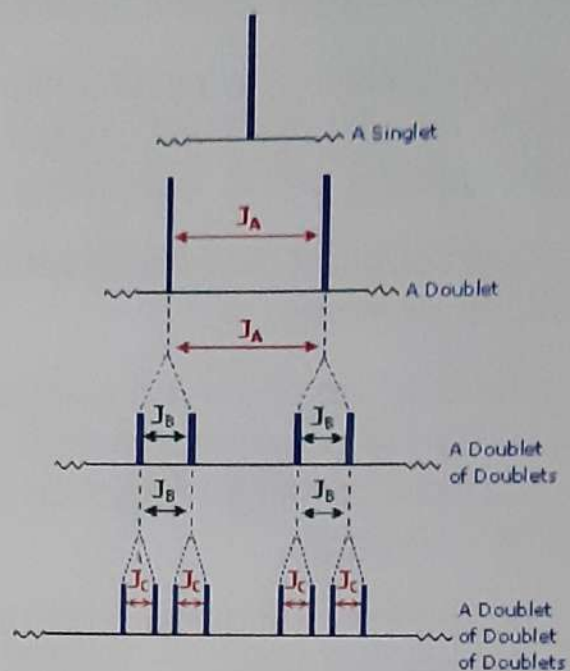
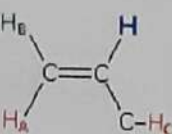
One Coupled
Hydrogen



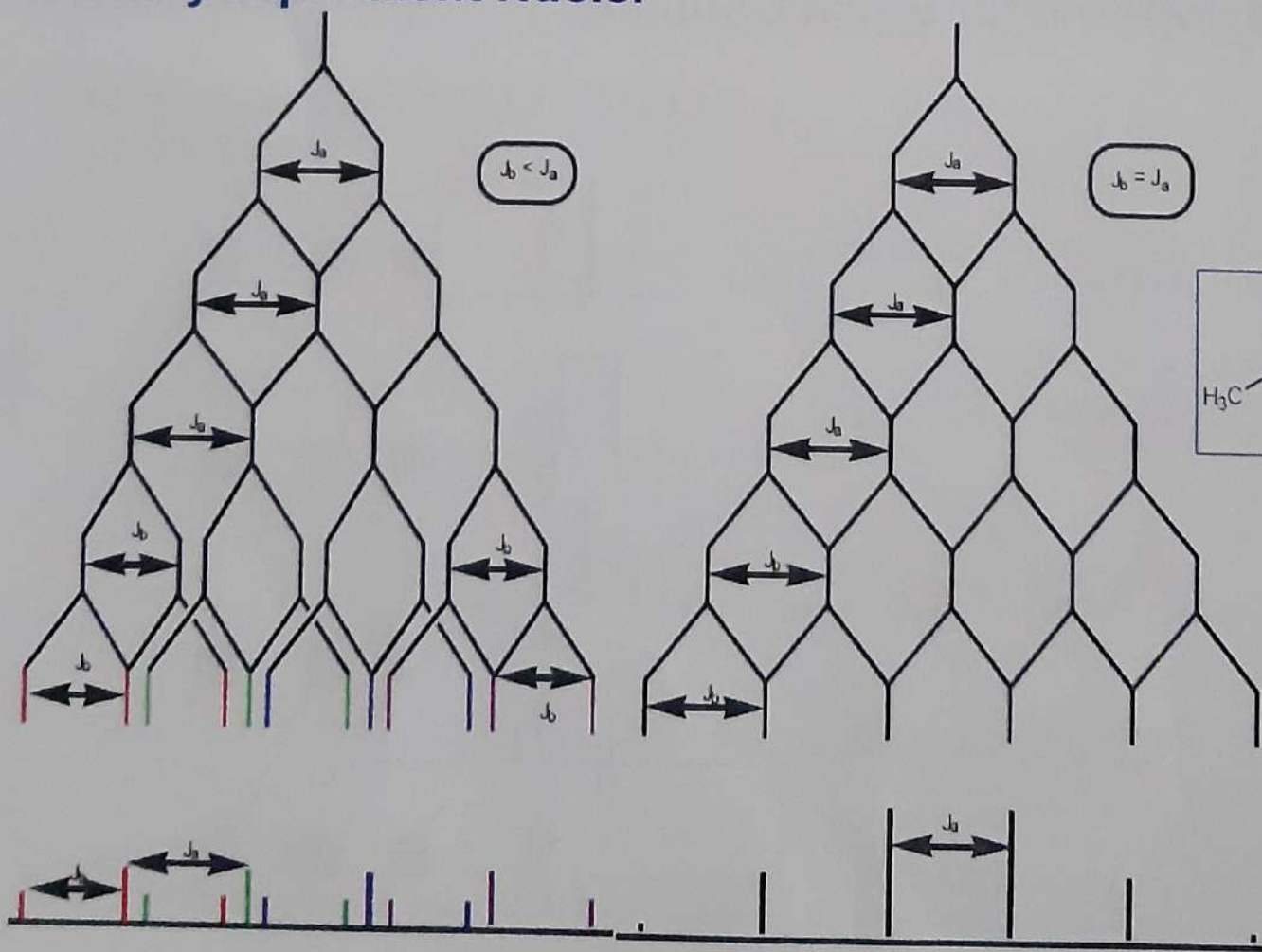
Two Coupled
Hydrogens



Three Coupled
Hydrogens

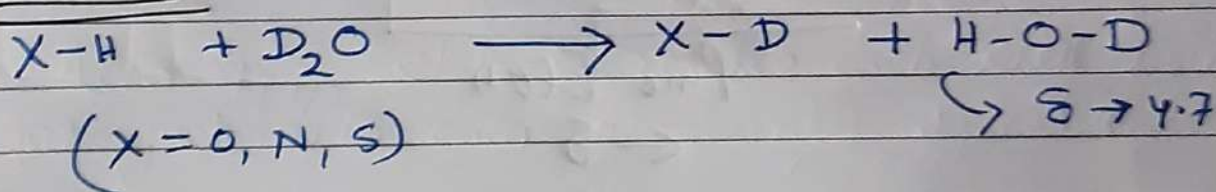


Identify Equivalent Nuclei

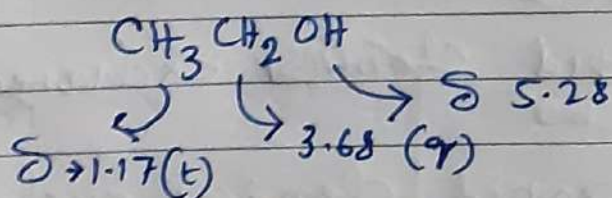


(*) Proton attach to the different atoms :-

Alcohol



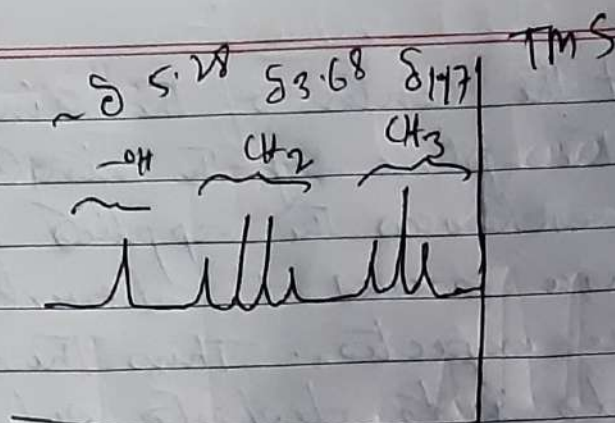
(a) Alcohols :- $\sim \delta \rightarrow 4.0 - 5.5$ (with moderately concⁿ solution)



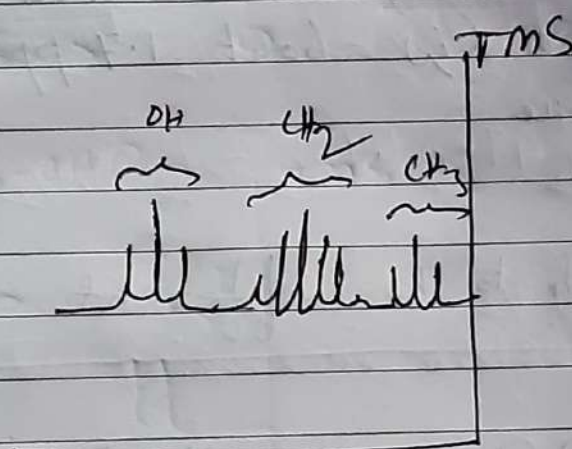
t \rightarrow triplet
q \rightarrow quartet

s \rightarrow sharp
m \rightarrow medium
b \rightarrow broad

shifts upfield on dilution due to intramolecular H-bond.



Ordinary EtOH
 $\leftarrow \delta$



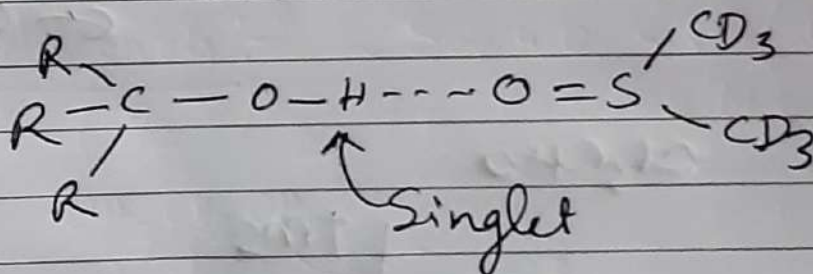
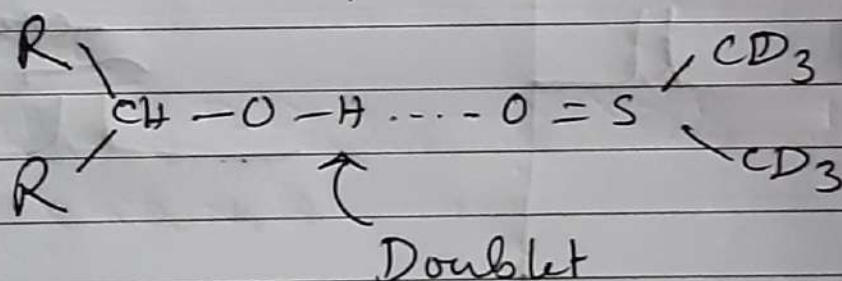
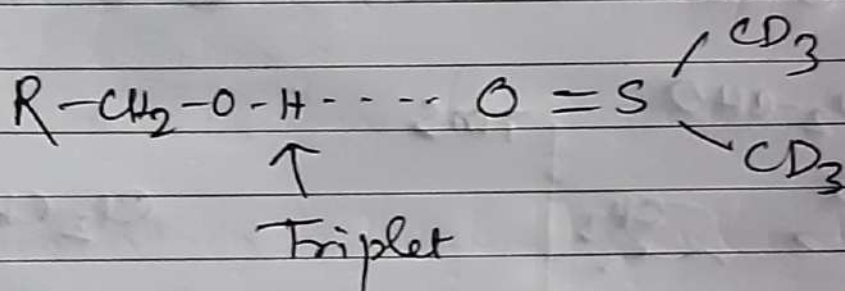
Pure EtOH
 $\leftarrow \delta$

The appearance of the hydroxyl proton as a broad singlet in an ordinary EtOH containing traces of acidic and basic impurities is due to the rapid chemical exchange.

Due to the rapid chemical exchange a particular hydroxyl proton, within the NMR time scale, is not attached to a particular ethanol molecule, but it is attached to a number of ethanol molecules so that a hydroxyl proton experiences an average of the spin orientation

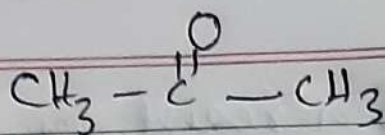
of the methylene proton. As a result the signals for the hydroxyl protons is not split by the methylene protons & vice-versa.

But the spectra of the alcohols are run in solvent like d_6 -DMSO which is capable of strong H bonding with the $-OH$ protons, the chemical exchanges is retarded or decreased and expected multiplets results.



If 'n' is the no. of nonequivalent adjacent protons, then no. of peak is $\rightarrow (n+1)$.

Follow (n+1) rule



6 equivalent protons

