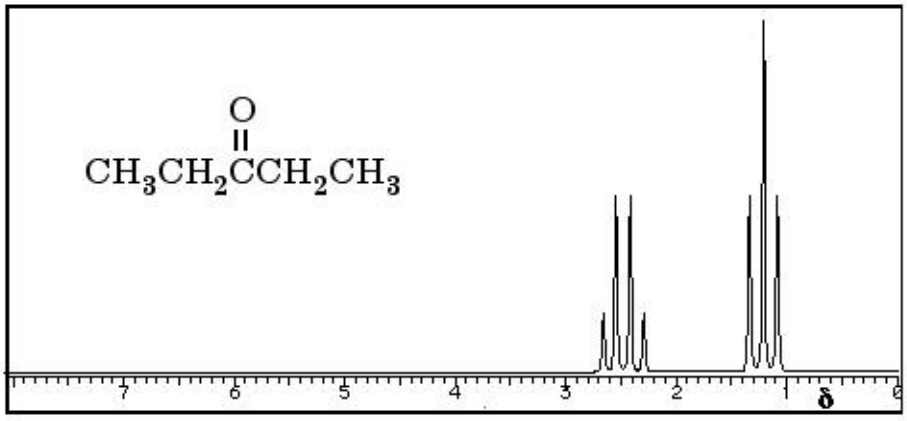
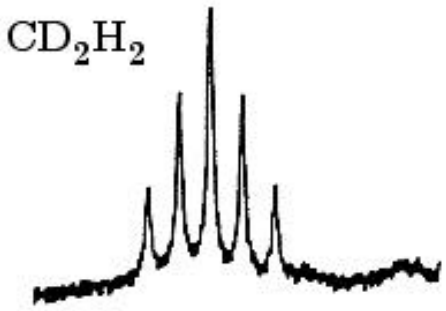
Chapter 14. Exercises

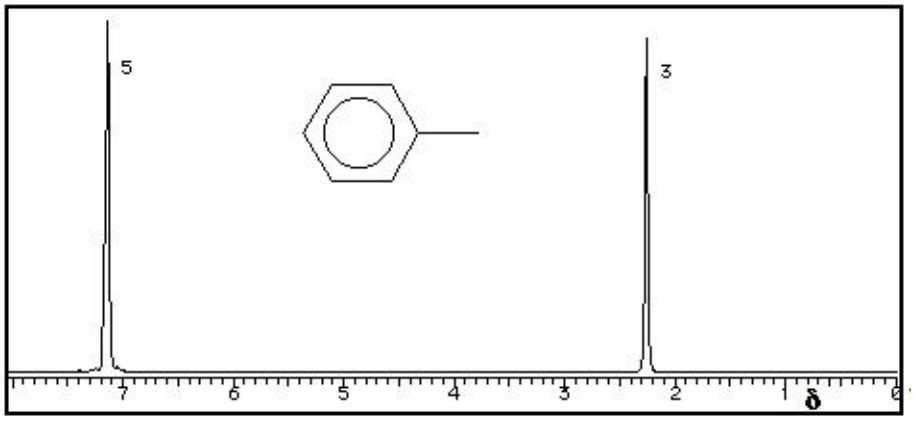
1. Analyze the proton NMR spectrum of diethylketone, shown below.



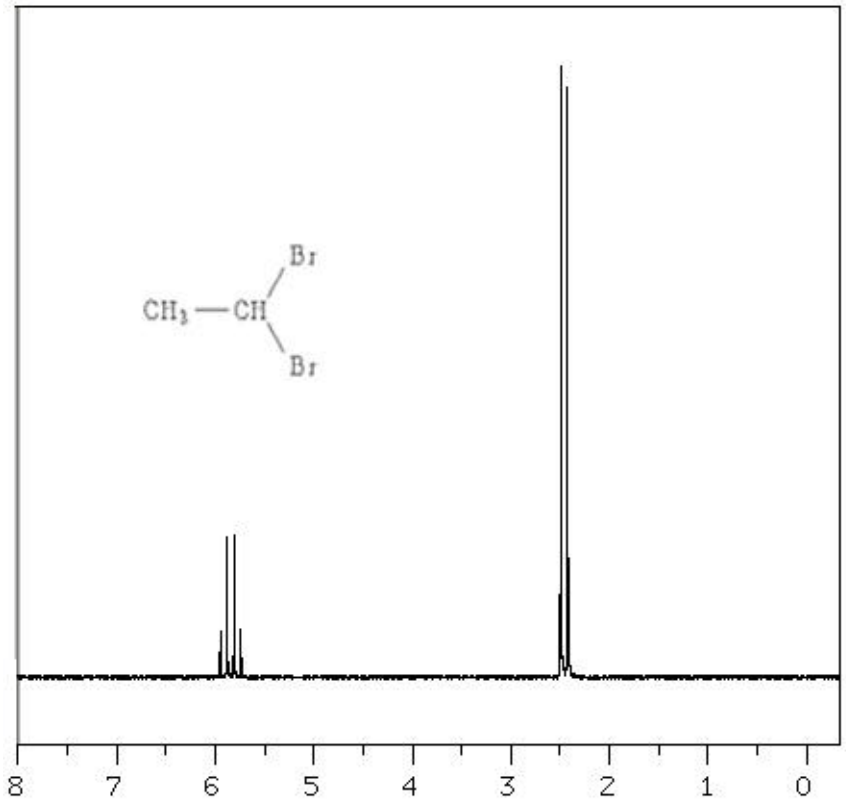
2. The NMR spectrum of methane CH_4 shows just a single peak. Explain why. Now explain the proton NMR spectrum of the isotopically-substituted dideuteromethane, shown below.



3. The proton magnetic resonance spectrum of toluene (methylbenzene) shows two peaks with relative intensities 5 : 3. Explain this spectrum.



4. Analyze the proton magnetic resonance spectrum of 1,1-dibromomethane. The bromine nuclei do not cause any detectable splittings.



Chapter 14. Solutions

1. Each CH_2 group is split by the neighboring CH_3 group into a 1:3:3:1 quartet. Correspondingly, each CH_3 group is split by the neighboring CH_2 into a 1:2:1 triplet. Protons in different ethyl groups are too far apart to interact.

2. The protons in methane are equivalent and do not exhibit spin-spin splittings. In CD_2H_2 each deuteron has a spin of 1, which by itself would cause splitting into a 1:1:1 triplet. Two deuterons will give a splitting pattern of 1:2:3:2:1, which is what we see for the proton resonances.

3. The 3 protons in the methyl group are equivalent with a chemical shift $\delta \approx 2$. The 5 protons on the phenyl group are not strictly equivalent but, evidently, their chemical shifts are nearly equal. Note that the ring protons are significantly deshielded, as shown in Fig. 5.

4. The methyl protons are split into a doublet by the lone proton on the other carbon atom. The latter proton is itself split into a 1:3:3:1 quartet.