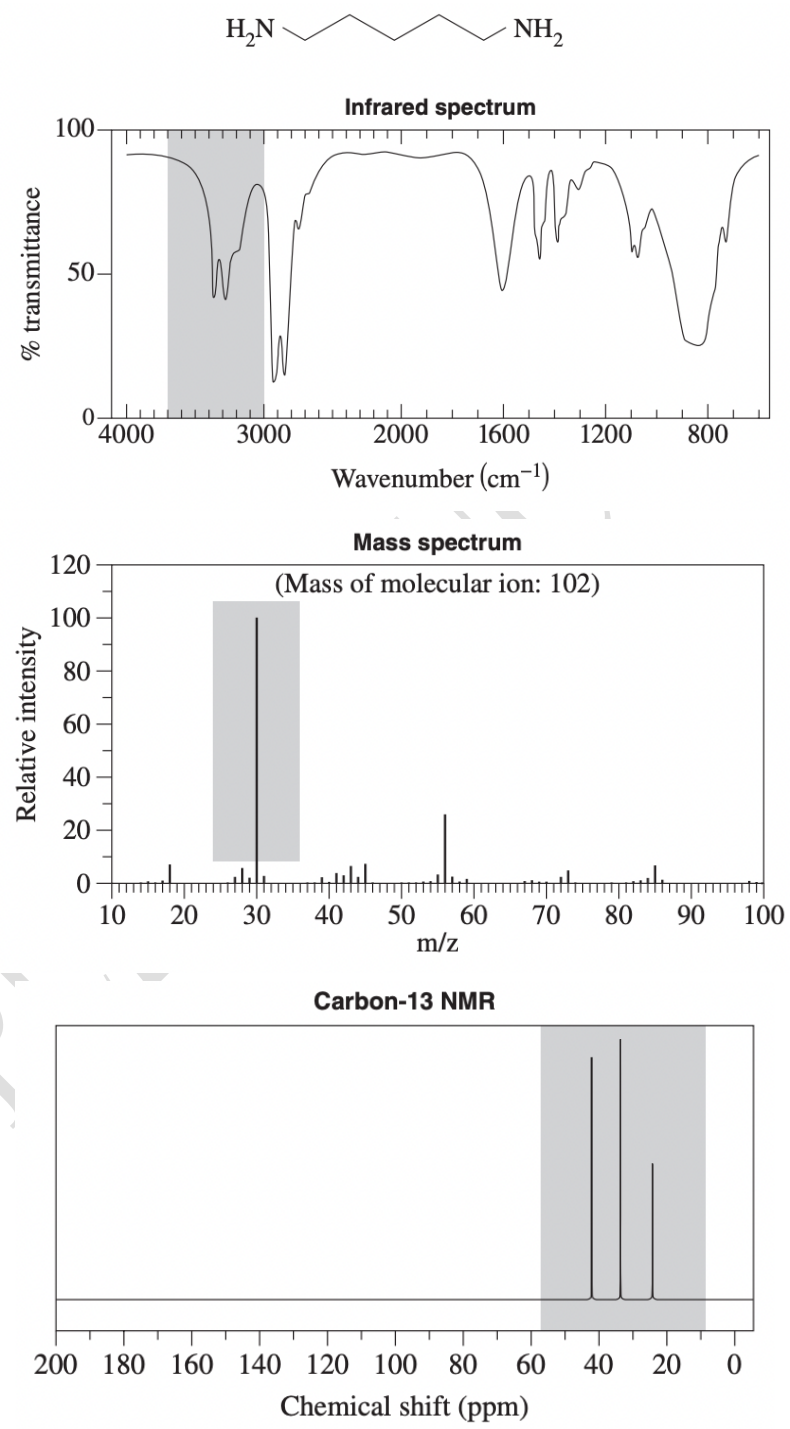
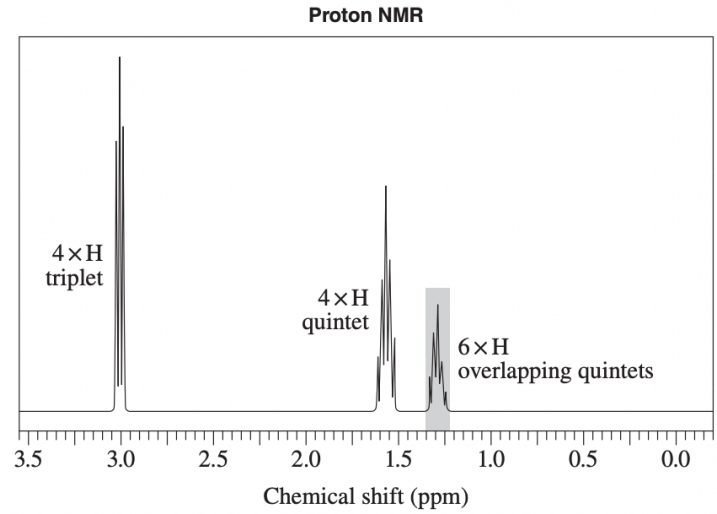
[2021 HSC] A chemist obtained spectral data of pentane-1,5-diamine ($C_5H_{14}N_2$). Relate the highlighted features of the spectra to the structure of pentane-1,5-diamine. (7 marks)





IR Spectrum: The medium absorption band at 3300 – 3500 cm^{-1} indicates the presence of an amine group (N-H), which is also located on the terminal carbons of the provided compound.

Mass Spectrum: The peak at m/z = 30 indicates that there is a $CH_2NH_2^+$ fragment ion that was formed via the fragmentation of the unstable molecular ion.

^{13}C NMR Spectrum: The three signals on the spectrum indicate three unique C environments in the provided molecule. The signal at 42 ppm represents the deshielded C-N environments, the signal at 34 ppm represents the CH_2 atoms next to the central carbon atom and the signal at 25 ppm represents the central C environment of CH_2.

^{1}H NMR Spectrum: The signal at 1.3 ppm is composed of 2 quintet signals. One signal represents the central CH_2 environment which has four proton neighbours. The other signal represents the CH_2 environments adjacent to the central carbon atom. The overlap of a 2H and 4H signal results in the integration being 6H. The low shift indicates that these two environments are well shielded as they aren't close to the electronegative NH_2 groups.