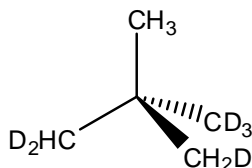
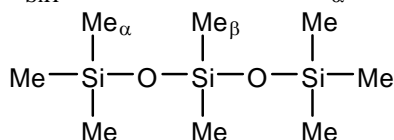


Problem Set #2

1. (8 points) (a) What is the point group of the following molecule? (b) Predict the ^1H and ^2H ($I = 1$) NMR spectra for this species.

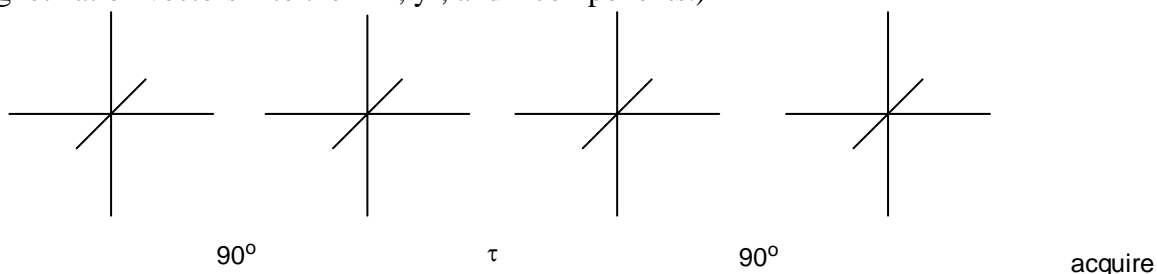


2. (8 points) (a) Predict the ^1H NMR spectra of the following molecule acquired using a 500 MHz NMR spectrometer and a 200 MHz NMR spectrometer. Include coupling to ^{29}Si ($I = 1/2$, 5% natural abundance), but not to ^{13}C . In your depiction of the NMR spectra use the following parameters: $J_{\text{SiH}} = 20$ Hz for both Me_α and Me_β and $\Delta\delta_{\alpha\beta} = 0.1$ ppm



3. (12 points) (a) Predict the ^{19}F NMR spectrum of BF_4^- . Remember that both ^{11}B ($I = 3/2$, 80% abundance) and ^{10}B ($I = 3$, 20% abundance) are NMR active. (b) Predict the ^{11}B NMR spectrum of BF_4^- and BF_3 . (c) Explain qualitatively how the line widths would differ between these two molecules.

4. (13 points) Consider the following pulse sequence: $90^\circ - \tau - 90^\circ - \text{acquire}$, where τ represents an arbitrary length of time. Draw the magnetization vectors and the resulting spectrum for this pulse sequence when (a) $\tau = 0$ (b) $\tau = 10$ times the T_1 value, and (c) $\tau = T_1/\sqrt{2}$. Remember to label your axes and direction of B_0 . (Hint: break your magnetization vectors into their x' , y' , and z components.)



- (d) (6 points) Consider the pulse sequence: $90^\circ - \tau - 90^\circ - \tau - 90^\circ - \text{acquire}$, where $\tau = T_1/\sqrt{2}$. Draw the magnetization vectors for this pulse sequence. Remember to label your axes and direction of B_0 .

5. (3 points) (a) Discuss three factors which affect T_1 relaxation. (b) (1 point) Under what conditions can T_1 relaxation be longer than T_2 relaxation. (c) (1 point) Under what conditions can T_2 relaxation be longer than T_1 relaxation.