

**Chemistry 416, Fall Semester 1993, Dr. Glaser**

**Quiz III: "NMR Spectroscopy", Monday, November 22, 1993, 20 minutes, not announced**

Your Name: \_\_\_\_\_

**Question 1. Terminology. (9 points)**

Nuclei with an intrinsic \_\_\_\_\_  $\mathbf{P}$  show an associated magnetic moment  $\mu$  proportional to  $\mathbf{P}$ ,  $\mu = \gamma \mathbf{P}$ , where  $\gamma$  is the \_\_\_\_\_ constant. In the presence of an external magnetic field  $\mathbf{B}$ , different energy levels result depending as to how the z-component of  $\mathbf{P}$  is aligned with the external field. For spin 1/2 nuclei, there are two levels and the level splitting in a magnetic field is called the \_\_\_\_\_ effect.

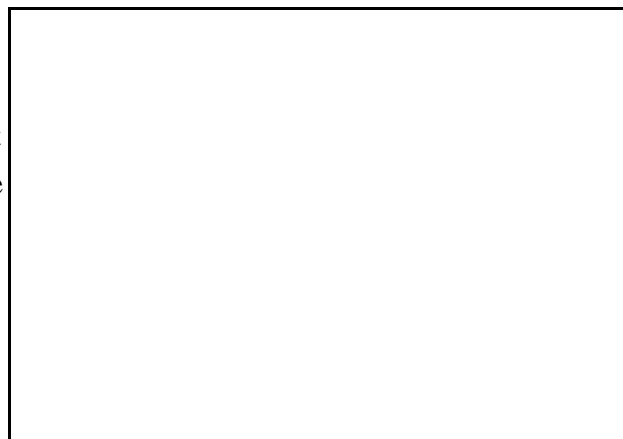
In a magnetic field, a macroscopic magnetization occurs that is parallel to the external field. A  $90^\circ_x$  pulse rotates the magnetization into a plane that is perpendicular to the  $\mathbf{B}$  field. The relaxation of the magnetization has two components with different relaxation times:  $T_1$  is the spin-lattice or \_\_\_\_\_ relaxation time and  $T_2$  is the \_\_\_\_\_ or transverse relaxation time.

The chemical shift depends on the shielding which is the sum of the following six terms. For the first four terms, state what each accounts for:

dia: _____	para: _____
N: _____	R: _____
e: <u>electric field effects</u>	i: <u>intermol. interactions (solv &amp; H-bond.)</u>

**Question 2. Anisotropy. (4 points)**

[18]-Annulene shows two  $^1\text{H-NMR}$  signals at  $\delta = +8.9$  and  $-1.8$  ppm. Draw the molecule and assign the signals. Briefly explain your assignment.

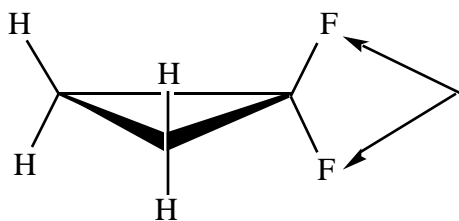


**OVER**

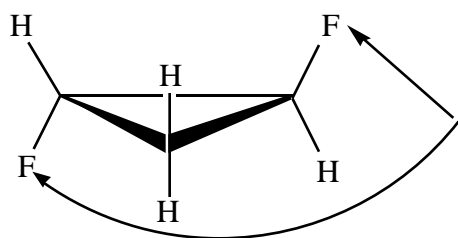
Points for Question 1:	/9		
Points for Question 2:	/4		
Points for Question 3:	/12	Total Points:	/25

**Question 3. Symmetry.** (12 points)

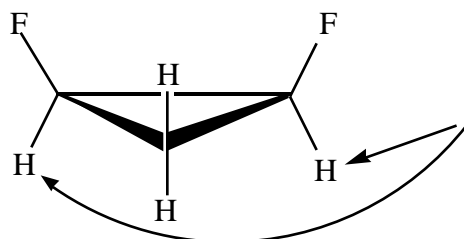
For each of the following compounds, give the number of NMR signals (do not worry about multiplicity!) For the indicated atoms, state whether they are *homotopic*, *enantiotopic* or *diastereotopic*.



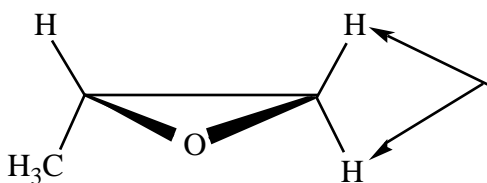
F-atoms are  
# of F-NMR signals:  
# of H NMR signals:



F atoms are  
# of F NMR signals:  
# of H NMR signals:



H atoms are  
# of F NMR signals:  
# of H NMR signals:



H-atoms are  
# of C-NMR signals:  
# of H NMR signals: