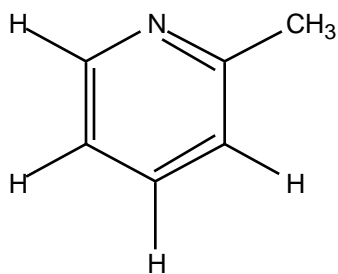


Name: \_\_\_\_\_

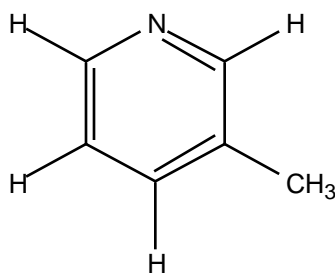
Dr. Jay H. Baltisberger

Please answer all 3 questions, showing all calculations - 25 points each, 75 total.

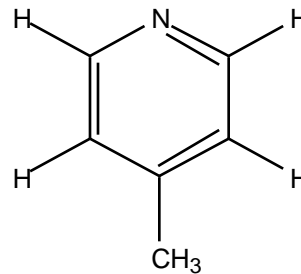
- Describe in your own words either A or B.
  - how two dimensional imaging works using MRI
  - what spectral density is and how this relates to NMR  $T_1$  measurements.
- The  $^1\text{H}$  NMR spectra of 2-methyl pyridine, 3-methyl pyridine and 4-methyl pyridine are shown below along with structures for each. Determine which spectrum goes with which molecule and assign the spectra. The spectra are included on the back side of this test.



2-methyl pyridine



3-methyl pyridine



4-methyl pyridine

- For a system of noninteracting molecules, let the molecular energy levels (not states) be  $\epsilon_1, \epsilon_2, \epsilon_3, \dots$ . If  $\epsilon_2 > \epsilon_1$ , is it possible for a system in equilibrium to have more molecules in the level  $\epsilon_2$  than  $\epsilon_1$ ? Explain.

