NMR-1

Your primary goals for this lab are:

1) To determine the gyromagnetic ratio γ of the proton using the measured resonance frequency f at a single value of the magnetic field B_0, via $\gamma = f / B_0$.

2) To make a more precise measurement of the gyromagnetic ratio of the proton by measuring the resonance frequencies over a range of magnetic fields, and then using the slope of the resonance frequency versus magnetic field plot to determine γ. To understand why this provides a more precise determination. You should also check the effect of including the point at the origin, i.e., the point ($f=0$, $B_0=0$), on your result.

3) To determine the g-factor of the proton from your measured value of γ, and especially to understand the physical meaning of the g-factor. Why is the g-factor of the electron so close to 2? Why is the g-factor of the proton so far from 2?

4) To make a precise measurement of the ratio of the g-factor of the proton to the g-factor of the fluorine-19 nucleus. Please note that Parts 1, 2 and 3 above, are limited by the accuracy of the Hall effect gaussmeter---which is only good to several percent. However, since this part (Part 4) measures the ratio of the resonance frequencies (which are accurate to parts in ten million), this measurement of the ratio is much more precise than Parts 1-3.

5) To understand Edward Purcell's quantum mechanical description of NMR---including both absorption and emission

6) To understand Felix Bloch's classical description (i.e., using Newton's equations and Maxwell's equations)---including both absorption and emission.

7) To understand the relationship between Bloch's picture and Purcell's picture.

Day One: Learn how to take data, and take a preliminary set of data for the resonant frequency of protons, f(protons), versus the applied magnetic field.

Day Two: Take final data sets for f(protons) and f(fluorine) versus the applied magnetic field, and for f(protons) versus f(fluorine).

Day Three: Analyze your data. What value do you obtain for the g-factor of protons? How does this compare to the literature value? What value do you obtain for the g-factor of fluorine-19? How does this compare to the literature value? What value do you obtain for the ratio [f(proton) / f(fluorine)] ? How does this value compare with the literature value?