Summary of tasks required for PNMR lab (adapted and altered from Univ. of Wash. PNMR lab manual):

1) Learn how to use the pulse programmer and understand its function: set up single-pulse sequences, double-pulse sequences and multi-pulse sequences, with various repetition times, delay times and A and B pulse widths.

   note – Unless required in the manual, DO NOT use a 10-ms repetition time for the remaining tasks below (2-6); the machine *will* overheat at such a rate.

2) Observe free induction decay (FID) by applying a $\pi/2$ pulse to a mineral oil sample; find resonance and study the effect of varying the A pulse width. Measure T_2* of the maximum FID signal at resonance for mineral oil.

3) See what happens to the FID signal by altering the pulse repetition time; the "variable" setting knob fine tunes the repetition time. Use this effect to attempt a qualitative measure of T_1 for mineral oil (see Sec. 2.2.1 in the U. of W. lab manual).

4) Set up a π-$\pi/2$ two-pulse sequence to make an accurate measurement of T_1 by measuring the amplitude of the FID signal of mineral oil as a function of the pulse sequence delay time. Measure T_1 using this method for at least two other (different) samples; there is a box containing other types of liquid samples near the lab station.

   note – Make sure to measure the type of signal shown in fig. 12 of the U. of W. lab manual! Please do not use the zero-crossing method for a rigorous measurement of T_1; it is okay to use this method to make a rough and quick measure of T_1 and note it in your notebook.

5) If the M-G switch is OFF, turn it ON. Using a $\pi/2$-π multi-pulse sequence, observe and measure the spin echoes of mineral oil and at least two other (different) samples. Use the envelope of the echo amplitude (*i.e.*, $V(t) \sim M_{x,y}(t) = M_0 \exp(-t/T_2)$) to obtain an accurate measurement of T_2 for the three samples you chose. Using your measurements of T_1, T_2 and T_2* for mineral oil, calculate the spread in Larmor frequencies ($\Delta\omega_0 = \gamma\Delta B$) and comment on what it means physically.

   note – Please see *Exercise 5: The Meiboom-Gill multi-pulse sequence* in the Univ. of Wash. Lab manual to understand the function of the "M-G" switch and how turning the switch ON yields a better T_2 measurement. In your lab report, you *must* discuss and quantify the benefits of the "M-G" multi-pulse sequence for the case of mineral oil. Note that this means you will have to turn the switch OFF in order to quantify the error.

6) Choose one of the following (for 128B students, please do both):

   a) Track and measure T_2 of paraffin as it makes the transition from a liquid to a solid (with M-G ON). Ask the TA how to melt the paraffin wax safely within the vial supplied.
   b) Measure T_1 (zero-crossing method is OK) of a dilution series of a paramagnetic buffer solution (water doped with $CuSO_4$ ions); ask the TA for the vials. Using the measured values, determine the viscosity of the medium in which the ions are dispersed (see eq. 54 of Bloembergen, "Relaxation Effects in Nuclear Magnetic Resonance Absorption," *Phys. Rev*. **73**, 679-712 (1948)).

In your lab *notebook*, you must report and discuss the measurements made in <u>all</u> tasks.
In your lab *report*, you must report and discuss the measurements made in tasks 4, 5 and 6.