A Note on the Field Strength of the Magnet

The literature for the TeachSpin PS1-B PNMR instrument states that the strength of the field of the permanent magnet is stamped on a plate on the magnet case. That plate gives the model of the unit (Magnet) and its serial number (147). The last item on the plate is a frequency, which is 15.1 MHz. This may seem odd.

You may have seen NMR instruments advertised either by the radiofrequency at which they operate, or by the field of the magnet in tesla. As you will see in this lab, the two are related. The frequency at which a proton precesses in a magnetic field depends on the strength of that field, and is given by the equation $\omega = \gamma_p \mathbf{B}$, where ω is the angular precession frequency, γ_p is the proton gyromagnetic ratio (the ratio of its magnetic moment to its spin angular momentum, sometimes called the magnetogyric ratio), and **B** is the magnetic field.

The effective magnetic field around a proton in a molecule is influenced by the electrons and nuclei of the neighboring atoms. This causes a slight change in the precession frequency, and thus the frequency of the resonance relative to that of an isolated proton. This so-called "chemical shift," however, is typically quite small – on the order of parts per million to hundreds of parts per million. For the purposes of this experiment this is negligible, and we may take the accepted value of γ_p, which is $2.675 \times 10^8\ s^{-1}T^{-1}$ (from CODATA; rounded to four significant figures), and use the equation above to find the strength of the magnetic field.

We have $\mathbf{B} = \omega/\gamma_p$. $\omega = 2\pi\nu$, so $\mathbf{B} = 2\pi\nu/\gamma_p$, or $2\pi(1.51 \times 10^7\ s^{-1})/2.675 \times 10^8\ s^{-1}T^{-1}$, which equals 0.355 T or 3.55 kG.