6.2: Answers to Questions in the Basic Theory section

In addition to the conceptual questions, the Basic Theory section also contains a series of simple quantitative questions, the answers of which are provided below.

Question 1

How many spin states would you predict for ^{2}H?

Solution

Deuterium has a spin of 1. Therefore there should be 3 possible spin states: +1, 0 and -1.

Question 2

Given the same magnetic field and temperature, how would the difference in population for ^{1}H and ^{31}P compare?

Solution

For this problem we will use the following equation:

$$\frac{N_{upper}}{N_{lower}} = e^{\frac{-\Delta E}{kT}} \tag{6.2.1}$$

The difference in population for ^{1}H and ^{31}P will be related to the differences in their ΔE values. Since $\Delta E=\gamma h B_o/2\pi$, for a fixed magnetic field the only differences between ^{1}H and ^{31}P is in their magnetogyric ratios.

$$\frac{\Delta E(^{1}H)}{\Delta E(^{31}P)} = \frac{26.752}{10.84} = 2.468 \tag{6.2.2}$$

The ratio of the N_{upper}/N_{lower} for ^{1}H is $e^{2.468}$ or =11.80 times larger than the ratio of N_{upper}/N_{lower} for ^{31}P.

Question 3

Calculate the wavelength of electromagnetic radiation corresponding to a frequency of 500 MHz.

Solution

The wavelength of electromagnetic radiation corresponding to a frequency of 500 MHz is 0.6 m.

Question 4

What range of frequencies would be excited by a 10 μs rf pulse?

Solution

A 10 μs rf pulse would excite a range of frequencies covering 100,000 Hz.

Question 5

What are the resonance line widths of nuclei that have apparent T_2 relaxation times (i.e.T_2* values) of 1 and 2 sec.

Solution

$$w_{\frac{1}{2}} = \frac{1}{\pi T_2^*} \tag{6.2.3}$$

Therefore, the two resonances have line widths of 0.32 and 0.16 Hz.