PHAR 518, 06/03/2012 YOUR NAME:

Quiz: MRI Physics

1. Higher Magnetic Fields are 'better' if you perform NMR/MRI experiments. Why is that? Name two reasons. Bonus point for counter-examples.

   Higher fields lead to more signal due to: higher larmor frequency, higher magnetization due to higher excess of spins in the spin parallel vs spin anti-parallel state.

   Counter-examples. Costs go up, contrast due to differences in relaxation times is diminished, engineering challenges to achieve homogeneous fields are much higher

2. What quantities does the Larmor Equation $\omega_0 = \gamma B_0$ describe? Name and define them.

   ω_0 Larmor frequency: the frequency with which spins precess
   γ gyro-magnetic (magneto-gyric?) ratio. constant of proportionality for protons – it's different (and almost always smaller) for other nuclei!
   B_0 (Strong) magnetic field along which the magnetization aligns in equilibrium

3. Define spin-lattice relaxation. (Feel free to show a graph and typical time scales in liquids.)

   Time course whereby the spin system returns to thermal equilibrium. Timescales is usually hundreds of ms up to some s. Spins transition from one-spin state to another and in the process emit photons 'to the lattice'.

4. Define spin-spin relaxation.

   Time course during which spin coherence after an initial RF pulse dissipates. It occurs due to spin-spin interactions (e.g. Dipole-dipole). Time course is always faster than T1, typically ms to tens of ms in liquids.

5. Bonus: Which decay does a spin echo rephase: T1, T2, T2*, all three, neither, some of one or not the other? Why?
   Some of the temporally constant effects leading to T2* decay can be reversed with spin echos, e.g. Field inhomogeneities leading to spins experiencing differing Larmor frequencies.

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