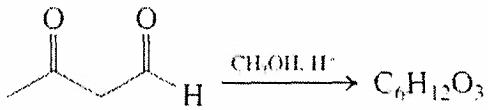
Mid-Sem Exam: CH4204 (Spring 2019)

Total marks: 40 **Time: 90 min**

Part A (15 marks)

1. In acidic methanol, 3-oxobutanal is transformed into a compound with molecular formula $C_6H_{12}O_3$. The NMR and IR spectral data are given below. Identify the compound and assign each of the NMR peaks to the appropriate protons in the molecule.

(4 marks)



3-Oxobutanal

^{1}H NMR: δ = 2.19 (s, 3 H), 2.75 (d, 2 H), 3.38 (s, 6 H), 4.89 (t, 1 H) ppm; **IR**: 1715 cm^{-1}

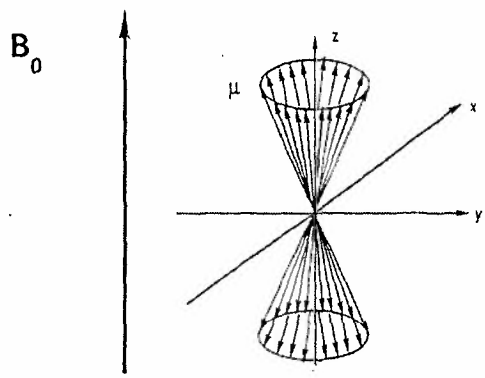
2. ^{1}H nuclei under 9.4 T magnetic field precess with 400 MHz frequency. Say we apply a radiofrequency pulse orthogonal to the magnetic field. The magnetic field associated with the R_f pulse is around 9.4 x 10^{-4} T. Calculate the time required for a 180° pulse.

(3 marks)

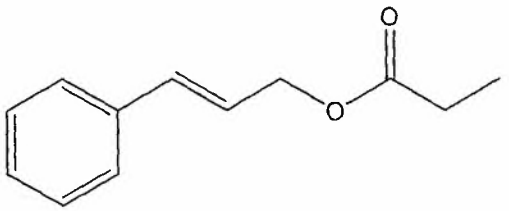
3. The distribution of spins for a group of nuclei (I = ½) in a precessional cone is shown below (B_0 is applied along the Z-axis). A 90° pulse is applied to these spins (along the X-axis).

A) How does the precessional cone look like immediately after the 90° pulse?

B) What is the net magnetization along Z and Y axes before and after the application of the pulse? Whether there would be any change in the spin distribution before and after the application of the pulse in the two spin states? Explain. (4 marks)



4. The structure and proton NMR data (excluding aromatic protons) of cinnamyl propionate are given below. Assign all the peaks to the appropriate protons. (4 marks)



δ in ppm: 6.65 (d), 6.29 (td), 4.74 (t), 2.38 (q), 1.17 (t)

Part B (25 marks)

5. Explain the diffraction of the light waves by the object with respect to Wavelength (λ), Phase (α or ϕ) and Amplitude (|F|). (3 marks)

6. Define and prove the Bragg's Law. (2 marks)

7. What is *symmetry operation and what is symmetry element?* (2 marks)

8. Mention all of the symmetry operations of PF_5 molecule. (2 marks)

9. Define Seven (7) Crystal Systems with respect to a, b, c and α, β, γ. (3 marks)

10. Draw 3 bar roto inversion axis with respect to stereographic projection. (2 marks)

11. Prove the following: *If there are two intersecting diad axes with an angle $2\pi/n$ between them, then there must be an n-fold axis perpendicular to both of the diad axes.* (3 marks)

12. Draw point group 32 (D_3). (1 mark)

13. Draw point group $4/mmm$. (1 mark)

14. Draw the plane group *P2gg and C2mm.* (3 marks)

15. Define and draw the relationship between 4_3 and 4_1. (3 marks)