1. (10 pts) What effect would you expect the following changes to have on the rate of reaction on sodium iodide with 1-chlorobutane in diethyl ether?
   a. The concentration of the halide is doubled rate doubled
   b. The concentration of the iodide is halved rate halved

2. (8 pts) How might you prepare the following molecule using a nucleophilic substitution reaction?

3. (8 pts) Given the following sequence of reactions indicate if the products are optically active by using a check for optical activity and an x for inactivity.
4. (15 pts) Draw the saw-horse projection leading to E2 product. Put the number 1 carbon "in front" and number 2 carbon "in back". Draw the expected product as well.

5. (15 pts) Given the following reaction draw the mechanism that leads to the observed products. Indicate if this Sn1, Sn2, E1 or E2.
6. (16 pts) Draw the product(s) and indicate major and minor if you expect to observe a significant amount of the minor. Also indicate if Sn1, Sn2, E1 or E2.

7. (20 pts) Below are three sets of 1H and 13C spectra labeled 1, 2 and 3. Given the following possible structures draw the correct structure beside the spectra. Assign only ONE set of 1H and 13C spectra using the provided labels.
Set 3

\[ \text{b, a, e} \text{ hard to assign but order is b, a, e} \]
8. (20 pts) Provide a structure for the following unknown yielding a molecular formula of CH$_3$OH.

![Chemical Structure Image]

**F.G.**

- R-O-R
- R-O-H (IR)
- Chain (No symmetry from $^{13}$C)

*Parent not observed*
0.93 ppm 3H triplet, 1.17 3H doublet, 1.46 2H pentet, 2.37 1H s, 3.709 1H sextet

4 carbons → no symmetry

10.01 ppm, 22.83, 32.07, 69.28

only 1 that fits 'H NMR
MS also fits.