1. Enantiomerically pure 2-bromooctane 1 undergoes a substitution reaction, yielding octanols 2 and 3.

(a) On the above drawings of 1, 2, and 3, clearly indicate the R or S configuration for each stereogenic carbon in the starting material and products.

(b) Under the above figures for 2 and 3 indicate which product corresponds to substitution with inversion of configuration and which product corresponds to substitution with retention of configuration.

(c) What is the relationship between 2 and 3?

(d) What nucleophilic substitution mechanism dominates in this reaction?

(e) Which do you expect to be the predominant product?
2. The following proton transfer reaction occurs in a single step.

\[
\begin{array}{c}
\text{H}_3\text{O}^- + \text{HBr} \quad \rightleftharpoons \quad \text{H}_3\text{O}^+ + \text{Br}^- \\
pK_a = -9 & \quad pK_a = 17
\end{array}
\]

(a) On the equation above, use the arrow formalism to trace the conversion of starting materials to products (left-to-right reaction).

(b) Does the equilibrium favor starting materials (left side) or products (right side)?

(c) Construct a free energy versus reaction coordinate diagram for the one-step left-to-right reaction. On the diagram, indicate (1) the relative energies of starting materials and products, (2) the location of the transition state, and (3) the activation energy for the left-to-right reaction.

(d) Along the reaction coordinate, do you expect the transition state to be closer to starting materials (methoxide and hydrogen bromide) or products (methanol and bromide ion)?

(e) Draw a good picture of the transition state for this proton transfer reaction. Clearly indicate partially formed and broken bonds as well as partial charges.
3. Provide a suitable alkyl halide and any other reagents necessary to prepare each of the following molecules.

(a) 

(b) 

(c) 

(d)
4. Give the major organic product or products for each of the following reactions.

(a) 

(b) 

(c) 

(d) 

C₄H₈S₂
5. Draw the organic product for each of the following reactions.

(a) What is the stereochemical relationship between the two products?

(b) What is the stereochemical relationship between the two starting alkyl chlorides?