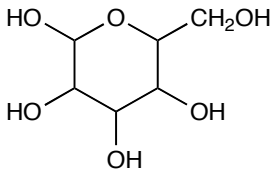
# STEREOCHEMISTRY EXERCISES

The first digit of each question number corresponds to the section of the website in which the topic is covered. Familarity with stereochemistry from earlier courses is assumed.

1.1 Draw two different chair conformations of *trans*-1,4-dimethylcyclohexane, and label all positions as axial or equatorial.

1.2 β-Glucose contains a six-membered ring in which all of the substituents are equatorial. Draw β-glucose in its more stable chair conformation.

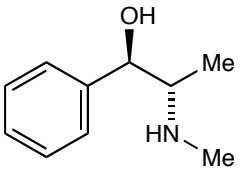
*GLUCOSE*



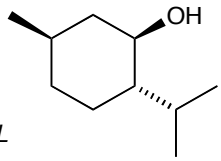

1.3 Of the first four cycloalkanes, only cyclohexane can be described as strain-free. Explain the origins of the strain in the other three.

2.1 Assign the chiral centres in (–)-ephedrine and (–)-menthol as (*R*) or (*S*).

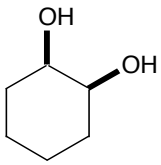
*(–)-EPHEDRINE*

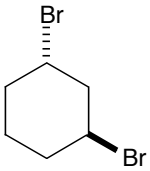


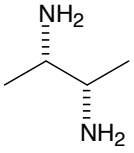

*(–)-MENTHOL*

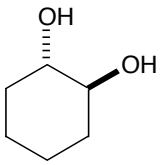


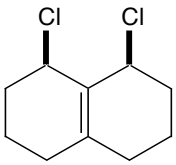

2.2 Identify which of the following structures are optically active and those that are *meso* compounds.

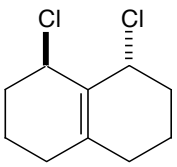


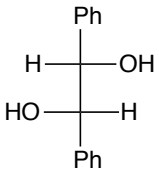



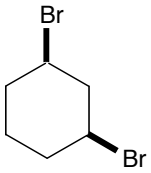



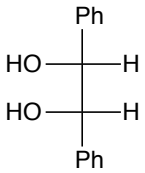



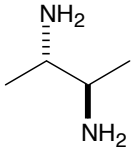



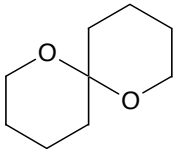



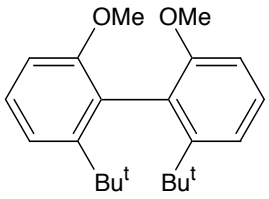



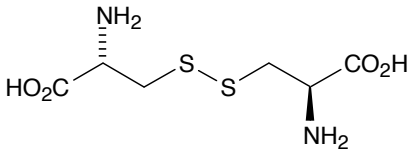

2.3 Draw a 3-D representation of each of the following molecules:

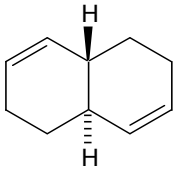
a) (2*S*)-2-chlorobutan-1-ol
b) (2*S*,3*S*)-pentan-2,3-diol
c) (1*R*, 3*S*)-3-methylcyclohexan-1-ol
d) (2*S*)-but-3-en-2-ol

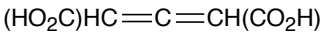
3.1 Use models (or drawings) to determine which of the following compounds are stable chiral molecules at room temperature. For those that are chiral, draw three-dimensional (perspective) diagrams of the enantiomeric forms.

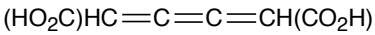


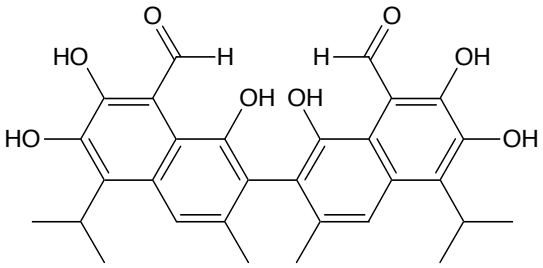



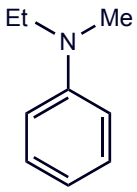

3.2 Gossypol is a natural product isolated from cotton seed. Explain why it is chiral and draw the three-dimensional structure of the (*S*)-isomer.




*GOSSYPOL*

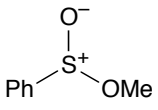
3.3 Draw the structures of the following species:

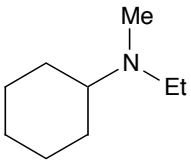
(a) The (*R*)-invertomer of **a**,
(b) (*S*)-1,3-dimethoxyallene,
(c) (*S*)-3,3'-diphenyl-[1,1'-binaphthalene]-2,2'-diol,
(d) the (*Z*)-oxime of (*R*)-2-methylcyclohexanone.

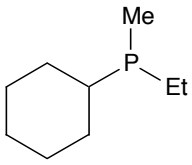


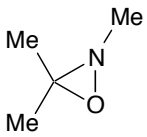

**(a)**

4.1 For each of the following compounds, draw three-dimensional (perspective) diagrams of the enantiomeric pair. Indicate any pairs that would be configurationally stable (*i.e.* separable) at room temperature.



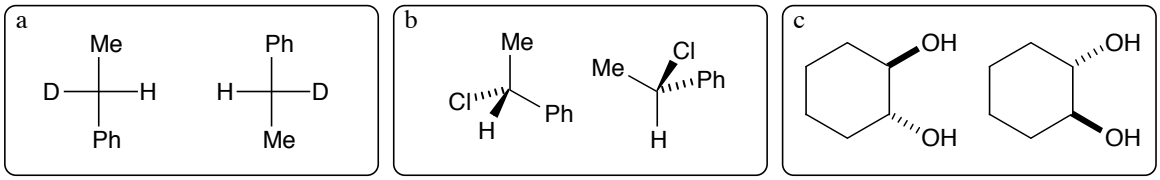



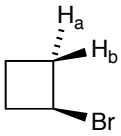

4.2 Optically pure (*R*)-1-phenylethanol (5 g) was dissolved in methanol (100 ml). The observed optical rotation of this sample in a cell of 10 cm length was +2.25°. What is the $[\alpha]_D$ of (*R*)-1-phenylethanol?

5.1 For each of the following pairs of structures, identify their stereochemical relationship.

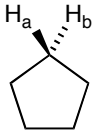



5.2 You are an unidentified nucleophile approaching the *Si*-face of benzaldehyde. Sketch your view as you begin to bond with the carbonyl C-atom.

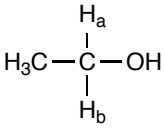
5.3 State whether the $H_a$ and $H_b$ hydrogens in each of the following molecules are homotopic, enantiotopic or diastereotopic.



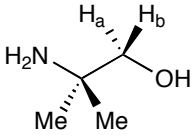

(**a**)



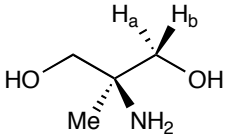

(**b**)



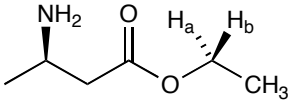

(**c**)




(**d**)

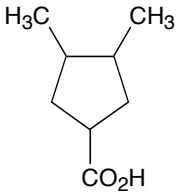



(**e**)

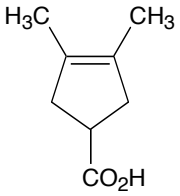



(**f**)

6.1 Draw all of the stereoisomers of compounds **a** and **b**, and indicate any that are chiral. Suggest how they might each be separated from each other.



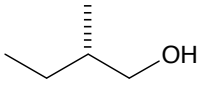

(**a**)



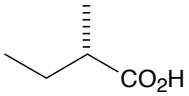

(**b**)

6.2 You have been given a large quantity of (+)-1-phenylethylamine. Draw a flow diagram to show how you would use it to make a quantity of pure (–)-tartaric acid by resolution of (±)-tartaric acid (*hint:* see section 6.1.1).

7.1 Which method would you use to measure the enantiomeric purity of *almost racemic* samples of **a** and **b**? In each case, outline the procedure and the principles.



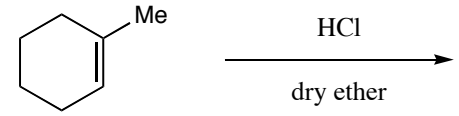

(**a**)

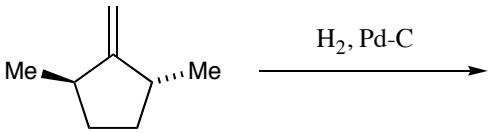


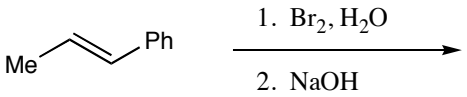

(**b**)

7.2 A sample of optically enriched (*R*)-1-phenylethan-1-ol (see question 4.2) made by enzymatic reduction of acetophenone had an $[\alpha]_D$ of +30. What is the enantiomeric excess of this sample?

8.1 For each of the following reactions, draw all of the possible products and predict whether any selectivity would be observed.




8.2 Predict the major product expected for the following reactions. Explain your reasoning with the aid of mechanistic diagrams.