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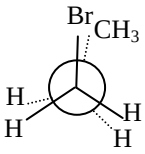
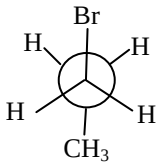
Exercises Topic 7: Introduction to Organic Chemistry

1. Consider 1-bromopropane. Select the C1-C2 bond and draw the Newman projections for the most and least stable conformers.

Solution:



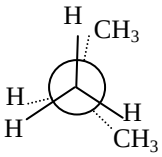
Less stable



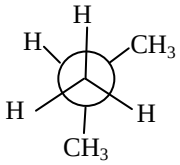
Most stable

2. Consider the C2-C1 bond of 2-methylpropane. Draw the Newman projections for the most and least stable conformers. Plot energy as a function of rotation angle. Assign relative values to the maxima and minima of your plot.

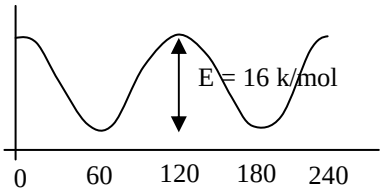
Solution:



Less stable

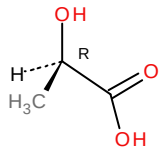


Most stable

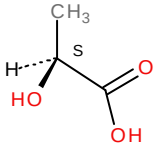


3. Consider lactic acid (2-hydroxypropanoic acid) and alanine (2-aminopropanoic acid). Find their structures and their chiral centers and draw structures for their R and S enantiomers. Plot also the Fisher projections.

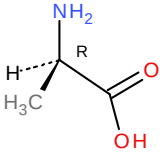
Solution:



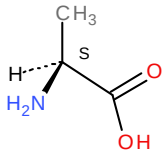
(2R)-2-hydroxypropanoic acid



(2S)-2-hydroxypropanoic acid

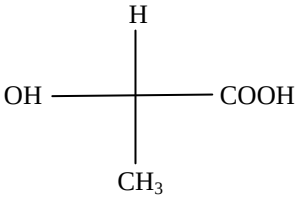


(2R)-2-aminopropanoic acid

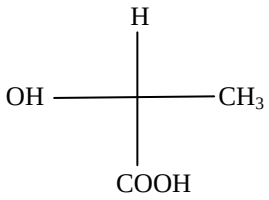


(2S)-2-aminopropanoic acid

Fisher projections:

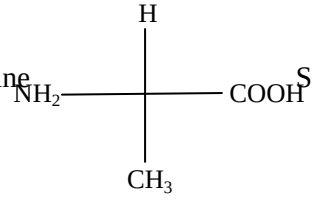


R lactic

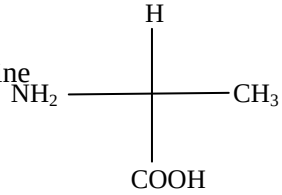


S lactic

R alanine

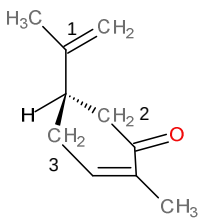


S alanine

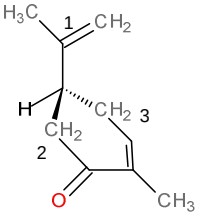


4. Carvone (5-isoprenyl-2-methyl-cyclohe-2-en-1-one) has two enantiomers. The R smells like spearmint (menta); S smells as caraway (alcaravea o comino). Study the molecule and propose structures for the R and S enantiomers.

Solution:

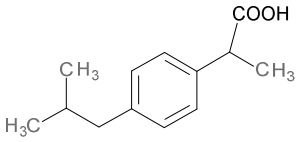


R enantiomer

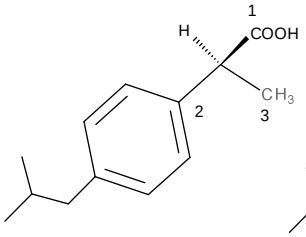


S enantiomer

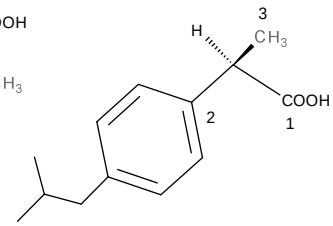
5. Synthetic drugs usually consist of a mixture of enantiomers (racemic mixtures) sometimes with adverse effects on health. The active form of Ibuprofen is the S enantiomer and the presence of R reduces the speed of its analgesic effect. Find the quiral centre in the shown structure of Ibuprofen and draw the R and S isomers.



Solution:



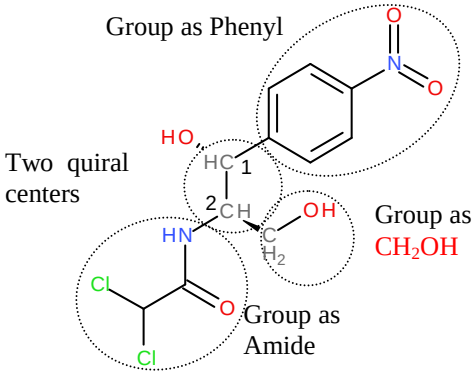
S enantiomer

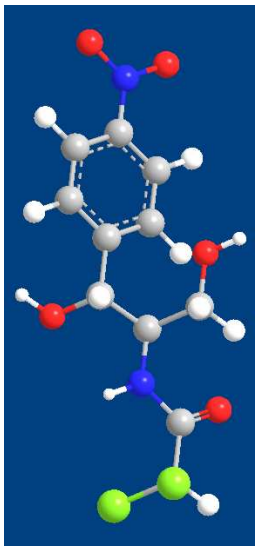


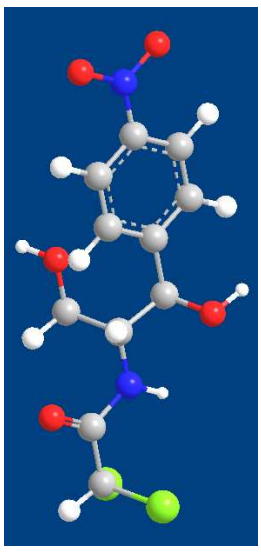
R enantiomer

6. Look for the structural formula of Chloramphenicol, a broad spectrum antibiotic, and draw the different diastereoisomers.

Solution:







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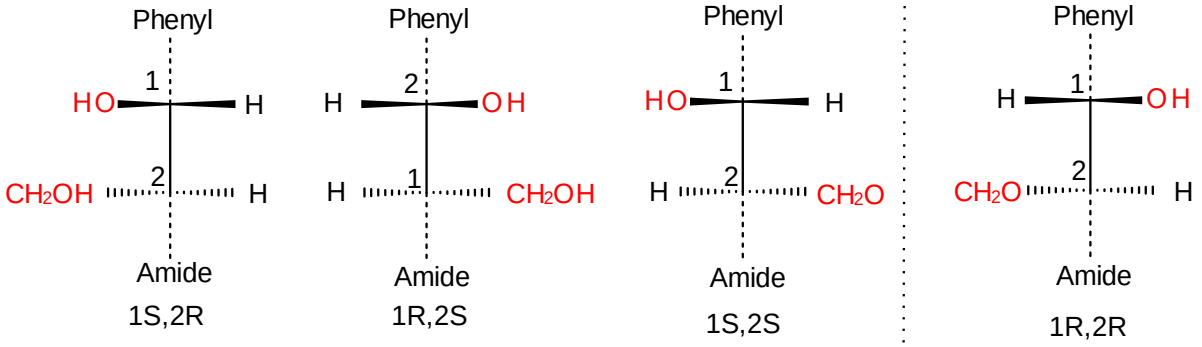
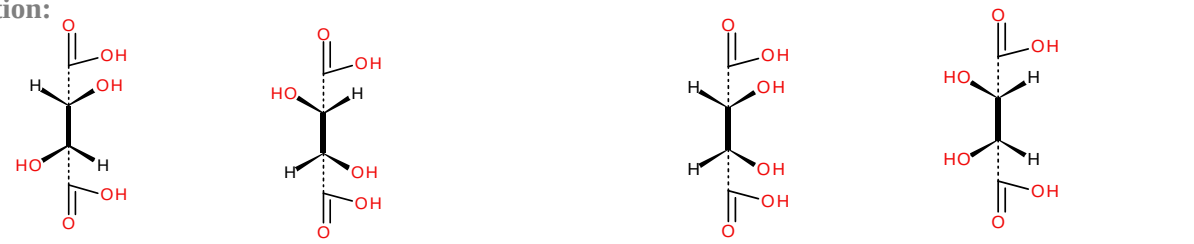
The two 3D images of chloramphenicol are views of carbon atoms C1 and C2 in which the less priority group (hydrogen atom) is pointing the backwards. So it is easy to determine that C1 is S and C2 is R.



7. Look for the chemical structure of tartaric acid and draw the different stereoisomers. Which are diasteromers?

Solution:



(2R,3R)-2,3-dihydroxybutanedioic acid (2S,3S)-2,3-dihydroxybutanedioic acid (2R,3S)-2,3-dihydroxybutanedioic acid (2S,3R)-2,3-dihydroxybutanedioic acid

8. Which is more acid Cl-CH_2-COOH or Cl_3-C-COOH? Why?

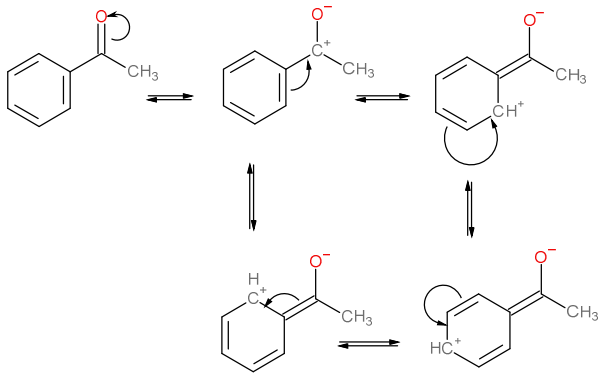
Solution: Cl_3-C-COOH because the more pronounced inductive effect

9. Sort by acidity the following CH≡C-COOH, CH_3-CH_2-COOH, CH_2=CH-COOH.

Solution: Triple bonds attract electrons more tightly than double bonds or single bonds increasing acidity by inductive effect. CH≡C-COOH > CH_2=CH-COOH > CH_3-CH_2-COOH

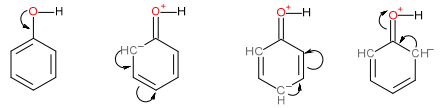
10. Draw resonance structures in methyl-phenylketone. Is the substituent +R or –R?

Solution:



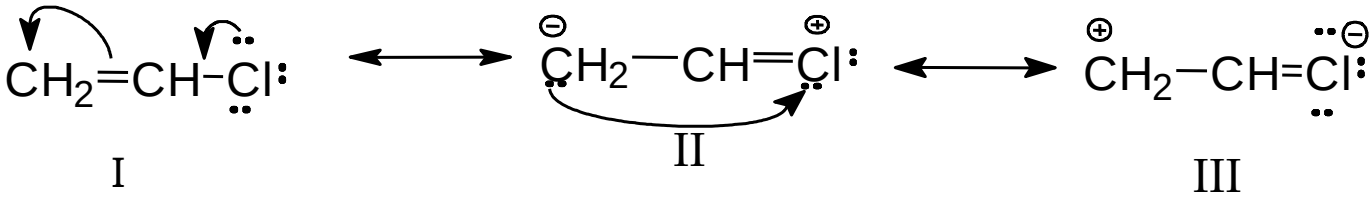
11. Draw resonance structures in phenol. Is the hydroxy group +R or –R?

Solution:



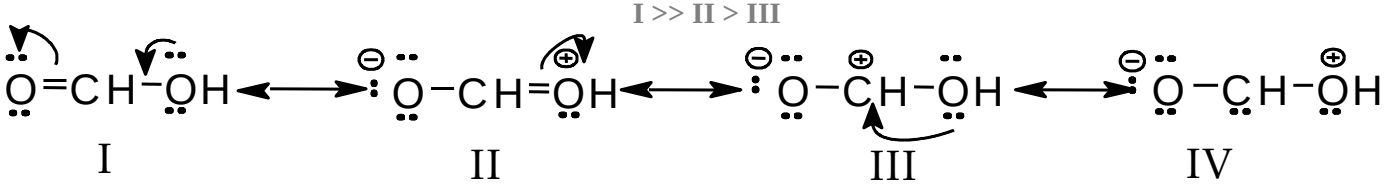
12. Order by increased stability the resonant structures of a) chloroethene and b) methanoic acid

Solution:



I II III

I >> II > III



I II III IV

I > II >> III > IV

13. Order by increasing stability the following cationic structures: $(C_6H_5)_2CH^+$; $(CH_3)_2CH^+$; $CH_2{=}CH^+$; $CH_2{=}CH\text{-}CH_2{}^+$; $CH_3CH_2{}^+$; $C_6H_5\text{-}CH_2{}^+$; p-$CH_3O\text{-}C_6H_4\text{-}CH_2{}^+$

Solution: $(C_6H_5)_2CH^{\oplus}$ > 3-$CH_3O(C_6H_4)CH_2{}^{\oplus}$ > $C_6H_5CH_2{}^{\oplus}$ > $CH_2{=}CH\text{-}CH_2{}^{\oplus}$ > > $(CH_3)_2CH$ > $CH_3CH^{\oplus}$ > $CH_2{=}CH^{\oplus}$

14. Predict the relative acidity of the following substituted benzoic acids: a) 3-fluoro, b) 3-ethoxy, c) 4-methyl, d) 4-nitro.

Solution: 4-nitro > 3-fluoro > 3-ethoxy > 4-methyl . Ethoxy and methyl substituents are activating while nitro and fluoro are deactivating.