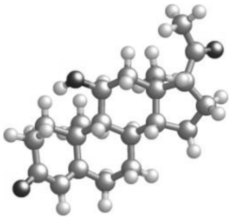

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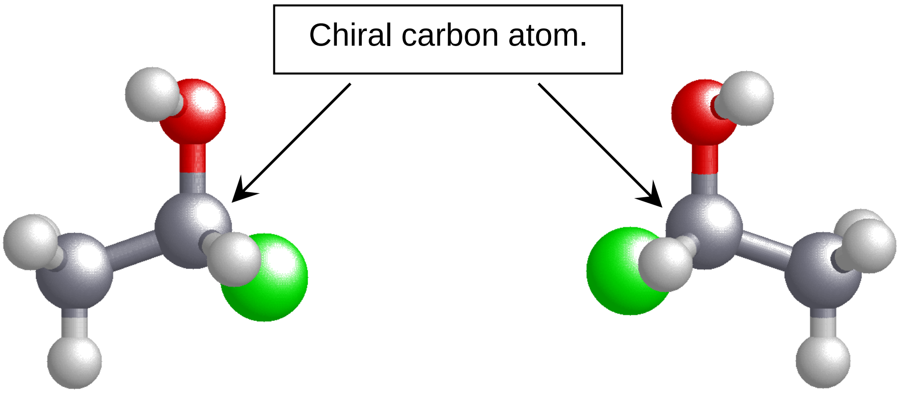
<u>Optical Isomerism</u>

Optical isomers are compounds that share the same molecular formula, but which rotate ***plane polarised light*** in opposite directions, either clockwise or anticlockwise. For a compound to exhibit optical isomerism, it must contain a carbon atom that is covalently bonded to ***four different*** atoms or groups of atoms. This carbon atom is called the ***asymmetric*** carbon atom or ***chiral*** carbon atom. The two optical isomers of a compound are mirror images of each other and are called ***enantiomers***. At first sight, the structures of the two enantiomers may look identical, but they are different because they cannot be superimposed exactly one on top of the other. The enantiomer that rotates plane polarised light ***clockwise*** is known as the ***(+)-isomer***, and the enantiomer that rotates plane polarised light ***anticlockwise*** is known as the ***(–)-isomer***. A mixture that contains equal amounts of the (+)-isomer and (–)-isomer is known as a ***racemic mixture***.
For example, the compound 1-chloroethanol exists as two optical isomers shown below:

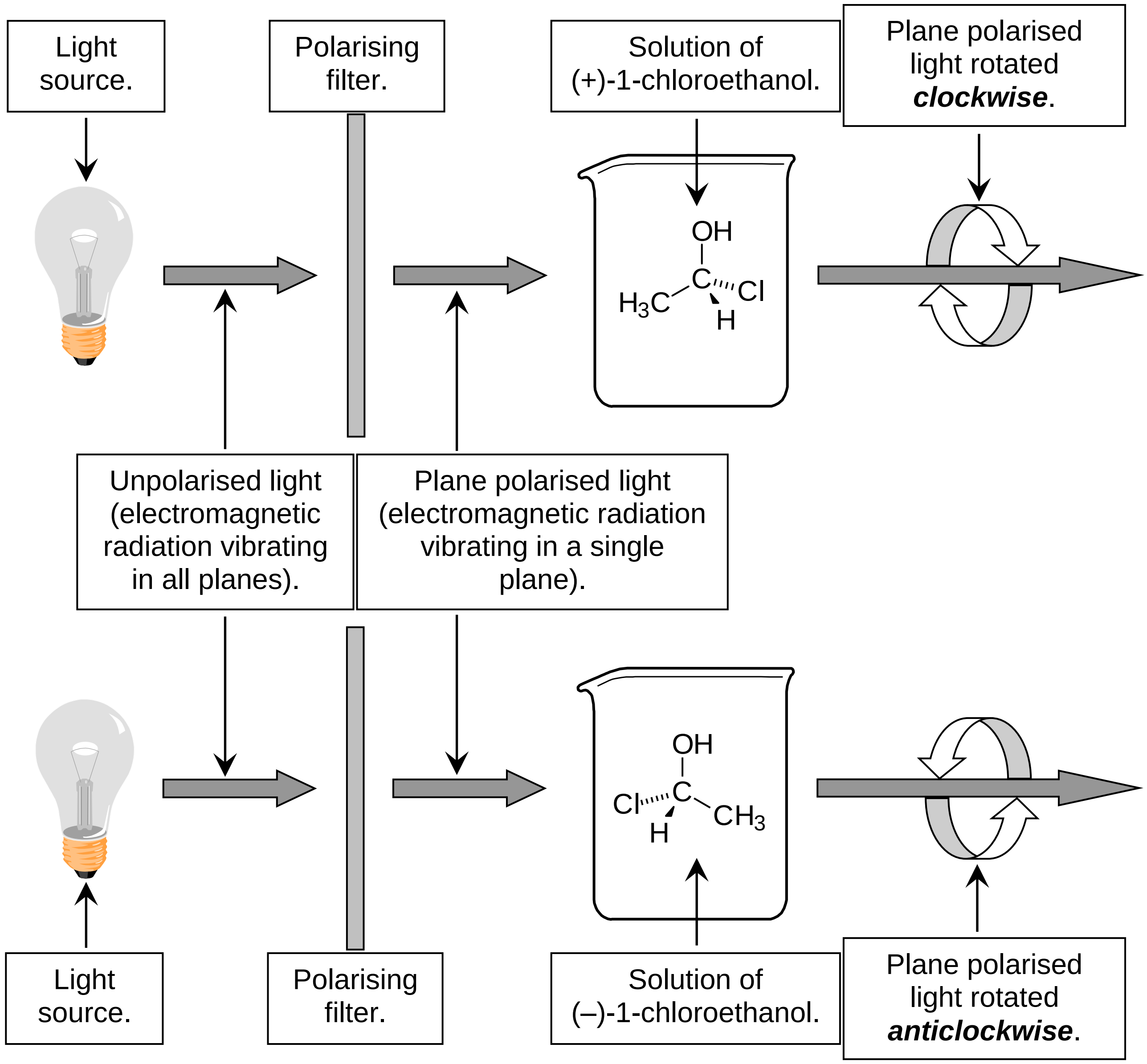
The optical isomers of 1-chloroethanol are mirror images of each other.

Construct molecular models of the two optical isomers of 1-chloroethanol (examples of what the two models should look like are shown below) and satisfy yourself that the two isomers are structurally different and cannot be superimposed one on top of the other.



Molecular models of 1-chloroethanol.

The diagram below shows how two optical isomers can be distinguished from one another:



Questions

1) The word ***chiral*** is derived from the Greek word ***kheir*** meaning hand. Why is this word used to describe the ***asymmetric*** carbon atom in an optical isomer?

……………………………………………………………………………………………

……………………………………………………………………………………………

2) Construct molecular models of the two optical isomers of the amino acid ***alanine*** (formula: $H_2NCH(CH_3)COOH$). Identify the chiral carbon atom. Copy the three-dimensional structures of the two optical isomers into the space provided below:

Structures:

3) Is it possible for the amino acid ***glycine*** (formula: H_2NCH_2COOH) to exhibit optical isomerism? Explain your answer.

…………………………………………………………………………………………………

…………………………………………………………………………………………………

4) **a)** Name the most simple branched chain alkane to exhibit optical isomerism.

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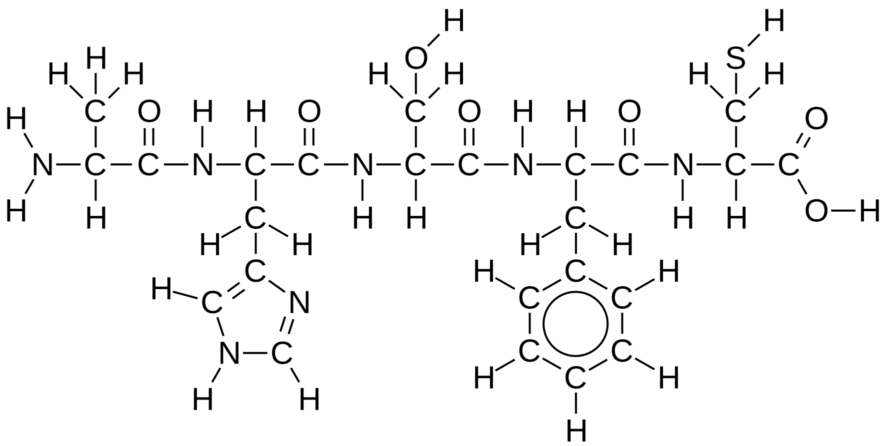
b) Draw the three-dimensional structures of the two optical isomers in the space provided below:

Structures:

5) Identify the chiral carbon atom(s) in the peptide structure shown below. As an extension to this question, you may wish to identify and name the individual amino acids that have joined together to form this peptide.

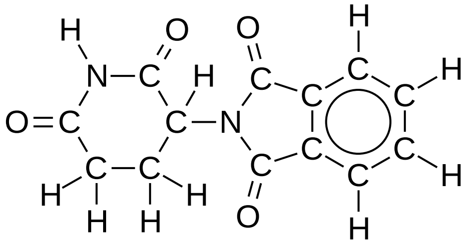
Peptide.



6) The diagram on the following page below shows the structural formula of the drug ***thalidomide***.

Thalidomide was used by pregnant women in the 1950s and 1960s to combat the effects of morning sickness. The drug contains a chiral carbon atom and therefore exists as two optical isomers. One of these isomers is successful in reducing the effects of morning sickness, but the other isomer was found to be ***teratogenic*** (causes deformities in a developing foetus). As a consequence, many of the women who took the drug thalidomide gave birth to children with serious physical deformities.

Structure of the drug ***thalidomide***.



One of thalidomide’s optical isomers was found to be teratogenic, retarding the formation of limbs in the developing foetus.

Identify the chiral carbon atom in the thalidomide molecule and draw two simplified diagrams to show how the four different groups of atoms could be arranged around the chiral carbon atom.

Structures:

Post Script on Chirality

In his *Baltimore Lectures on Molecular Dynamics and the Wave Theory of Light* presented in 1904, Lord Kelvin defined chirality as follows,

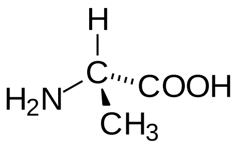
"I call any geometrical figure, or group of points, chiral, and say it has chirality, if its image in a plane mirror, ideally realized, cannot be brought to coincide with itself."

This definition is still universally accepted as *the* definition of chirality.

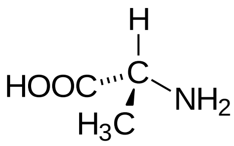
<u>**Answers**</u>

1) Just like two asymmetric carbon atoms, A person's left and right hands are mirror images of each other and cannot be superimposed exactly one on top of the other.

2) Possible structures:



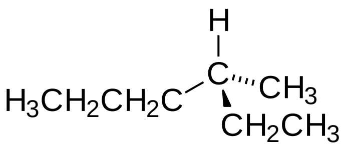
and



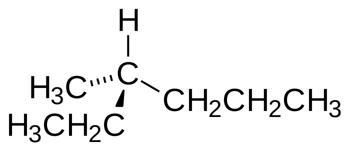
3) It is not possible for glycine to exhibit optical isomerism because it does not contain a chiral carbon atom, *i.e*. it does not contain a carbon atom that has four different atoms or groups of atoms bonded to it.

4) 3-methylhexane.

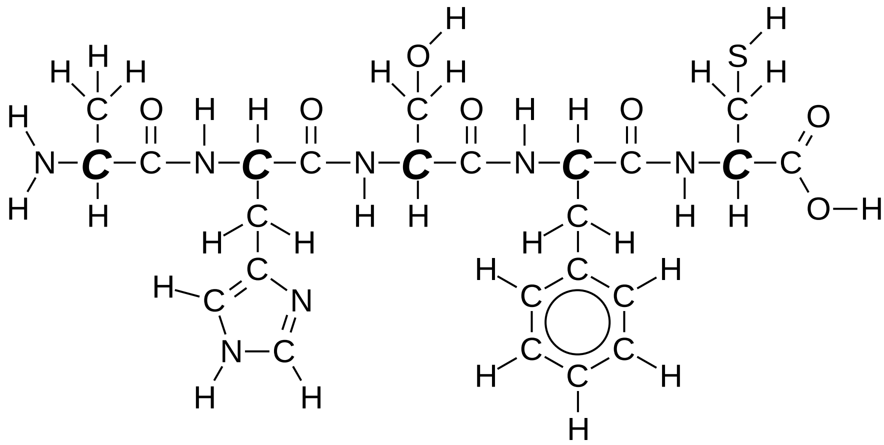
Possible structures:



and

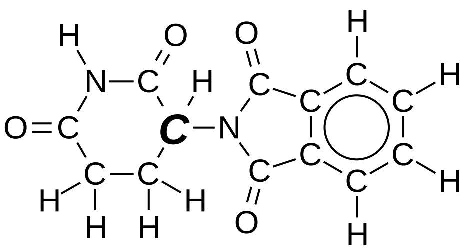


5)

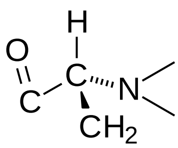


alanine, histidine, serine, phenylalanine, cysteine

6)



Possible structures:



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