Sequence 1: spatial structure of chemical species

Fiches de synthèse mobilisées (collection en français) :

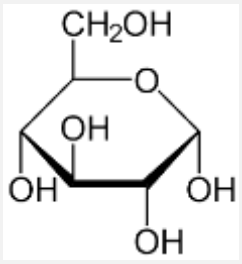
- Fiche n°1 : structure spatiale des espèces chimiques

Sommaire des activités ETLV :

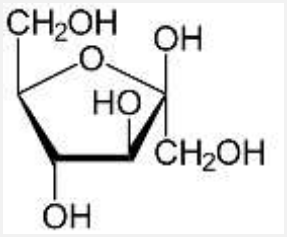
ACTIVITY 1: Chirality in sugars

Objective: understanding optical properties of chiral molecules

DOCUMENT 1: Representations of glucose and fructose



Glucose

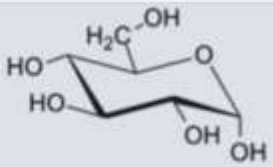
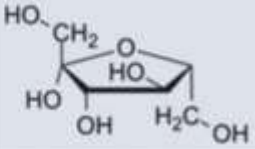


Fructose

The intersections each symbolize a carbon atom.

Source: Wikimedia commons

DOCUMENT 2: Specific rotation of sugars

Sugar	Structure	Specific Rotation
Glucose a.k.a 'D-glucose' or 'dextrose'		+52.7°
Fructose a.k.a. 'levulose'		-92°

Source: Royal Society of Chemistry

DOCUMENT 3: Materials for the experiment

Polarising filters (at least one should be a minimum of 15 cm wide for best effect).

100 cm^3 beakers

D-glucose

Fructose (available from supermarket sugar sections as 'fruit sugar')

A backing light consisting of an overhead projector or light box.

Source: Royal Society of Chemistry

DOCUMENT 4: Optical rotation of sugars

Watch video from 0-2'09s

https://www.youtube.com/watch?v=GchTURvBz68&t=101s

Source: Royal Society of Chemistry

Acquiring vocabulary:

Using the previous documents, find a translation for the following expressions:

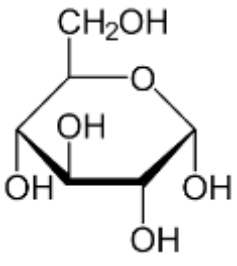
English	French
specific rotation	
chirality	
sugar	
polarising filter	
beaker	

Reinvesting:

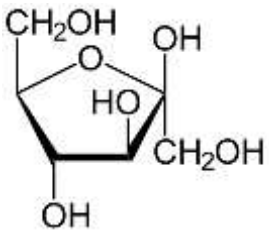
Explain why fructose and glucose are chiral molecules. Mark the asymmetric carbon atoms with a *:

_____

Glucose



Fructose



Understanding:

Watch the video in document 4 from 0-2'09s. Which physical property of chiral molecules is illustrated in the video?

_____
_____
_____
_____
_____
_____

What happens when the scientist rotates the polarising filter behind the two samples? Do both samples behave the same?

_____
_____

During the experiment where is the fructose sample located?

_____
_____

Activity summary

What you must remember:
- specific rotation
- chirality
- sugar

Skills linked to the curriculum**:**

Compétences	Capacités à maîtriser	Où dans cette séquence ?
APP	Utiliser du vocabulaire spécifique	Activités 1 et 2
	Lire et comprendre des documents scientifiques	Activités 1 et 2
ANA	Mettre en lien des documents pour émettre des hypothèses en réponse à une question scientifique	Activités 1 et 2
COM	S'exprimer à l'écrit en utilisant le vocabulaire adapté	Activités 1 et 2
REA	• Repérer une molécule chirale.	Activité 1

ACTIVITY 2: Stereoisomerism and molecular machines!

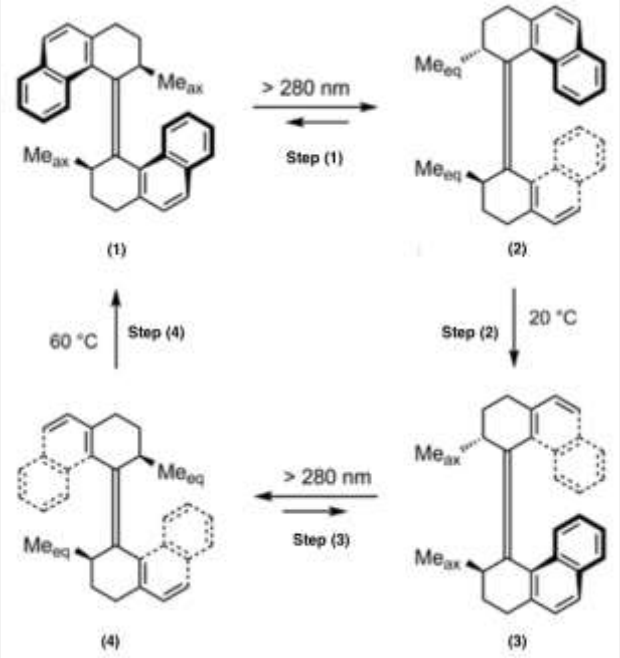
Fiches de synthèse mobilisées (collection en français) :

- Fiche n°1 : structure spatiale des espèces chimiques

Sommaire des activités ETLV:

DOCUMENT 1: About Nobel Prize in Chemistry 2016

Natural molecular machines or motors power our muscles, the transport of molecules across our cell membranes or DNA synthesis for example. Chemists have been experimenting for many years the synthesis of molecular motors that mimic those found in biology. The Nobel Prize in Chemistry 2016 was awarded to Jean-Pierre Sauvage, J. Fraser Stoddart and Bernard L. Feringa for their design and production of molecular machines: a tiny lift, artificial muscles or nanomotors such as nanocar. In 1999, B. Feringa developed a molecular motor: he synthetized a molecular rotor blade able to spin continually in the same direction.

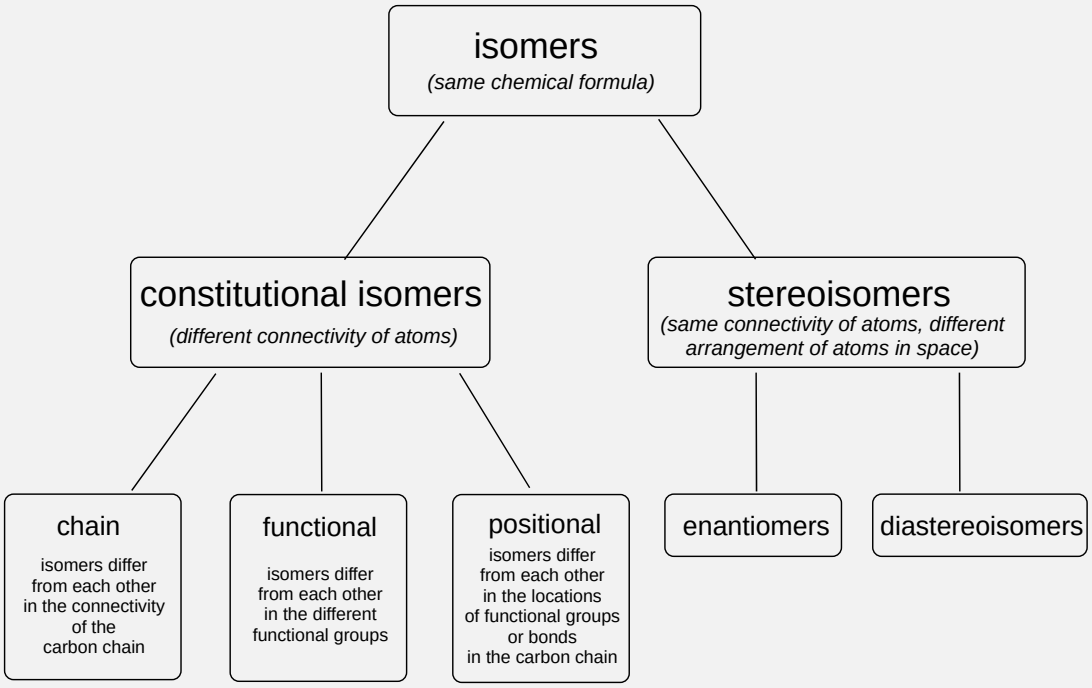


Source: adapted from Wikimedia commons

DOCUMENT 2: Constitutional isomers vs stereoisomers

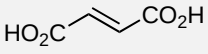
Isomers are compounds that contain the same atoms bonded together in different ways: isomers have the same chemical formula. If the connectivity of the atoms in the two isomers is different, they are **constitutional** isomers. Three types of constitutional isomers exist: chain, positional and functional.

If the connectivity of the atoms in the two isomers is the same, they are **stereoisomers**. Stereoisomers are isomers that show a different arrangement of the atoms in space.

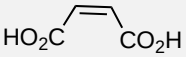


DOCUMENT 3: E/Z isomers: geometrical isomers

Around a C=C double bond, rotation is restricted. Thus, alkenes can exist as **stereoisomers** if there are two different groups attached to each carbon atom in the double bond:



fumaric acid
melting point : 300°C
E isomer



maleic acid
melting point : 141°C
Z isomer

This type of stereoisomerism is called **geometric isomerism**. To describe the arrangement of groups across a double bond, E/Z isomerism is usually used:

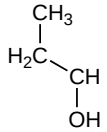
- **E isomer** → **E** stands for ***E**ntgegen* which means opposite in german: the highest priority group on each carbon atom is on **opposite** sides.
- **Z isomer** → **Z** stands for ***Z**usammen* which means together in german: the highest priority group on each carbon atom is on **the same** sides.

The priority of a group is based on **atomic number**. The atom attached to the alkene carbon atom with the highest atomic number is given the highest priority.

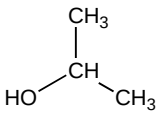
1. Match each following molecule with its semi-structural formula: (a), (b), (c), (d), (e) or (f).

ethanal	
2-methylpropane	
propanone	
ethanol	
butane	
propan-2-ol	

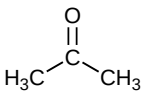
2. According to **document 2**, determine for each following couple (**(a)**; **(b)**), (**(c)**; **(d)**), (**(e)**; **(f)**), whether they show **constitutional isomerism** or **stereoisomerism**.
3. According to **document 2**, determine for each following couple whether they show **functional**, **chain** or **positional isomerism**.



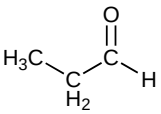
Chemical Formula: C_3H_7O
(a)



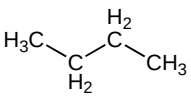
Chemical Formula: C_3H_8O
(b)



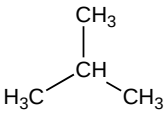
Chemical Formula: C_3H_6O
(c)



Chemical Formula: C_3H_6O
(d)

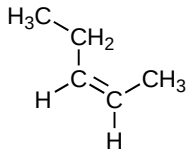


Chemical Formula: C_4H_{10}
(e)

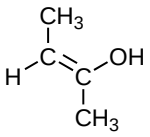


Chemical Formula: C_4H_{10}
(f)

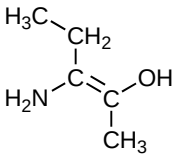
4. Label the **E** and **Z** isomers of each of the following molecules.



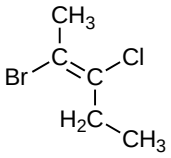
( )-pent-2-ene



( )-but-2-en-2-ol

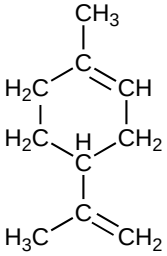


( )-3-aminopent-2-en-2-ol

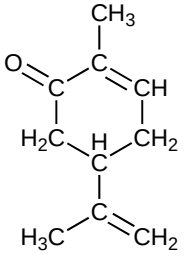


( )-2-bromo-3-chloropent-2-ene

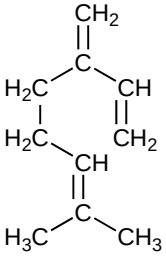
Terpenes are naturally occurring hydrocarbons produced by a wide variety of plants and animals. Oils distilled from plants, which often contain perfumery or flavouring materials, contain terpenes: they are usually called essential oils. The following molecules are terpenes.



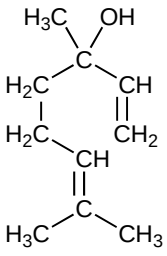
limonene



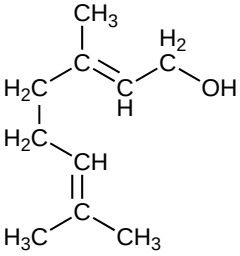
carvone



myrcene



linalol



geraniol

5. According to **document 2**, identify which alkene functional group can exhibit **E/Z isomerism**.
6. For each alkene, state whether we are in presence of **E** or **Z isomerism**.
7. According to **document 3**, label each structure in **document 1** as having either **E** or **Z** geometry around the double bond.
8. Identify in which of steps **A**–**D** the double bond undergoes **E/Z** isomerisation.

Activity summary

What you must remember:

- **constitutional isomerism**
- **functional**, **chain** or **positional isomerism**
- **stereoisomerism**
- **E/Z isomerism**

molecular machines	machines moléculaires
tiny lift	minuscule ascenseur
flavour	saveur

rotor blade	pale de rotor
to spin	tourner
to undergo	subir

Skills linked to the curriculum:

Compétences	Capacités à maîtriser	Où dans cette séquence ?
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ANA	Mettre en lien des documents pour émettre des hypothèses en réponse à une question scientifique	Activités 1 et 2
COM	S'exprimer à l'écrit en utilisant le vocabulaire adapté	Activités 1 et 2
REA	• associer le nom d'une molécule organique non cyclique à sa formule semi-développée • identifier des isomères de chaîne, de position ou de fonction • représenter et identifier des diastéréoisomères • déterminer les isomères Z et E	Activité 2