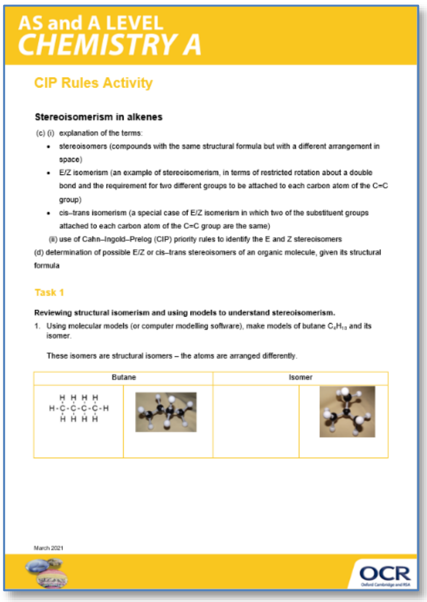
A LEVEL CHEMISTRY A

Lesson Element

CIP Rules

Instructions and answers for teachers

These instructions should accompany the OCR resource* 'CIP rules' *activity *which supports OCR A Level Chemistry A.*


AS and A LEVEL
CHEMISTRY A

CIP Rules Activity

Stereoisomerism in alkenes

(c) (i) explanation of the terms:

- stereoisomers (compounds with the same structural formula but with a different arrangement in space)
- E/Z isomerism (an example of stereoisomerism, in terms of restricted rotation about a double bond and the requirement for two different groups to be attached to each carbon atom of the C=C group)
- cis–trans isomerism (a special case of E/Z isomerism in which two of the substituent groups attached to each carbon atom of the C=C group are the same)

(ii) use of Cahn–Ingold–Prelog (CIP) priority rules to identify the E and Z stereoisomers

(d) determination of possible E/Z or cis–trans stereoisomers of an organic molecule, given its structural formula

Task 1

Reviewing structural isomerism and using models to understand stereoisomerism.

1. Using molecular models (or computer modelling software), make models of butane C_4H_{10} and its isomer.

These isomers are structural isomers – the atoms are arranged differently.

Butane		Isomer	

March 2021

OCR Oxford Cambridge and RSA

The Activity:

Stereoisomerism in alkenes

(i) explanation of the terms:

- *stereoisomers* (compounds with the same structural formula but with a different arrangement in space)
- *E*/*Z isomerism* (an example of stereoisomerism, in terms of restricted rotation about a double bond and the requirement for two different groups to be attached to each carbon atom of the C=C group)
- *cis–trans isomerism* (a special case of *E*/*Z* isomerism in which two of the substituent groups attached to each carbon atom of the C=C group are the same)

(ii) use of Cahn–Ingold–Prelog (CIP) priority rules to identify the *E* and *Z* stereoisomers

- determination of possible *E*/*Z* or *cis–trans* stereoisomers of an organic molecule, given its structural formula

Teachers' Notes

Prior knowledge

Isomerism is not required at GCSE. These resources expect that students understand simple nomenclature of alkanes and alkenes, and already understand structural isomerism in alkanes. It also expects that they can use displayed, structural and skeletal formulae. This resource is primarily designed to develop understanding of stereoisomerism but also develops students' understanding of nomenclature.

Teachers may wish to mention that there will further development of stereoisomerism later in the course with chiral compounds, but should not be sidetracked at this point in the course. Fats and fatty acids also show cis / trans isomerism.

Each group of students will need access to a molecular model kit (e.g. Molymod) with 4 carbons, 10 hydrogen, 2 chlorine, 1 bromine, 1 iodine, 13 single bonds and a double bond pair.

Misconceptions

Two dimensional diagrams of three dimensional structures often lead to misconceptions, and some students may still struggle to link the neat diagrams with right angles to the tetrahedral structures of many carbon atoms. This is a bigger problem with structural isomerism, as alkenes are planar.
Use of simple molecular models like "Molymods" will help to emphasise the three dimensional nature of chemistry and stereoisomerism.

Students find it difficult to remember which way round the E and Z isomers are, unless they have learnt German. Using the German words will create a stronger link between structure and letter. The letters derive from German, Z stands for zusammen (together), while E stands for entgegen (opposite).

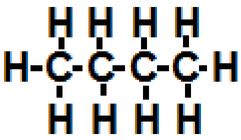
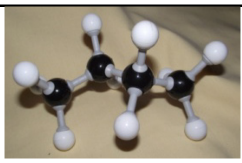
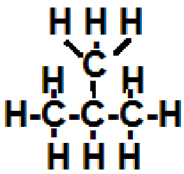
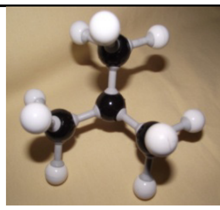
A few students may try to make a stereoisomer by swapping groups on both carbon atoms in the double bond. This of course just turns the molecule over. Such students need to look at the model of another group, do a double swap and then discover that they still have their starting molecule.

Activities 1 and 2 are designed to review the difference between structural isomerism and stereoisomerism. Students do not normally find this a problem. Students normally appreciate that rotation round a double bond requires a lot of energy and this is normally shown by commercial ball and stick models. Students then assign E/Z labels to simple compounds.

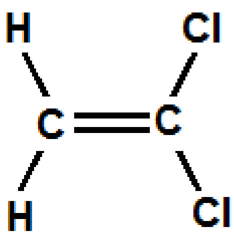
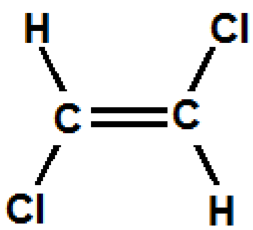
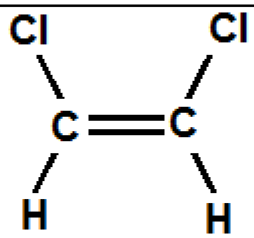
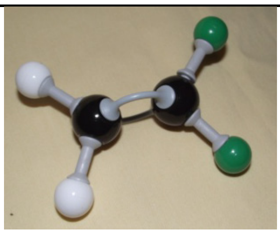
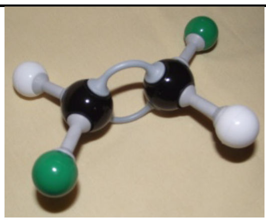
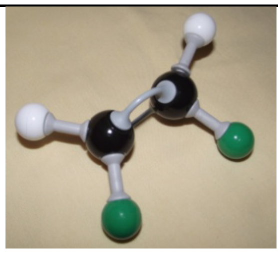
The specification now includes Cahn, Ingold, and Prelog (CIP) rules. These give scope for assigning E/Z isomerism when the molecule is more complex with 4 different groups on the two atoms. Activities 4 and 5 are designed give learners an opportunity to use the rules to assign isomers to more complex alkenes.

Task 1

1.

Butane		methylpropane	
			

2. You should have 1,1 dichloroethene, and two different versions of 1,2 dichloroethene. 1,1 dichloroethene is a structural isomer of 1,2 dichloroethene. The two isomers of 1,2 dichloroethene are called stereoisomers – the atoms are bonded in the same way to each other, but the arrangement of atoms around the double bond is different.

1,1 dichloroethene	1,2 dichloroethene E isomer	1,2 dichloroethene Z isomer
		
		

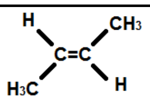
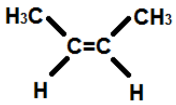
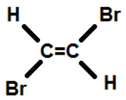
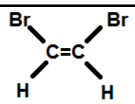
3. Single bonds allow rotation. Double bonds do not, so the arrangement of atoms at opposite ends of the double bond is fixed.

Task 2

Test 1

1. Isomers b and d show stereoisomerism, a, c and e do not show stereoisomerism

2. If one of the carbons has 2 identical groups (e.g. $=CH_2$) then stereoisomerism cannot happen

E	Z
	
	

Task 3

Formative Assessment – Students Own Response

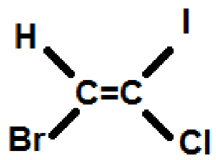
How well did you do?	**I can do this**	**I struggled**	**I am lost**
I understand what structural isomers are and can show this by drawing diagrams.			
I understand the difference between structural isomers and stereoisomers			
I can draw diagrams to show stereoisomers			
I can name isomers as cis, trans, E or Z			

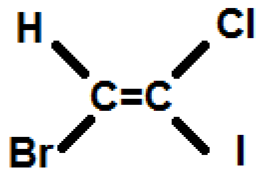
Task 4

Cahn, Ingold, Prelog (CIP) Rules

	Priority
1	I
2	Br
3	Cl
4	H

I and Br have the greatest formula masses, and are on separate carbon atoms so determine the name.



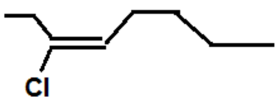
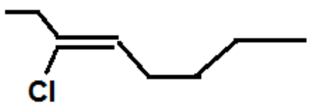
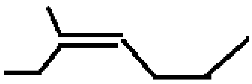
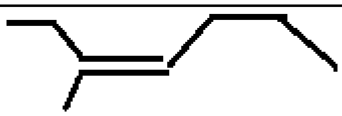
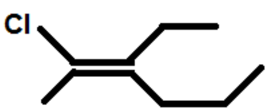
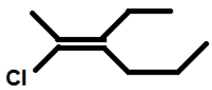


(E) 1-bromo 2-chloro 2-iodoethene.

(Z) 1-bromo 2-chloro 2-iodoethene.

Task 5

Test 2

E	Z	Comments
		Chloro group and butyl take priority
		Ethyl group takes priority over methyl group
		Propyl takes priority over ethyl. Chlorine takes priority over carbon

Task 6

Formative Assessment – Students Own Response

How well did you do?	I can do this	I struggled	I am lost
I can draw diagrams to show the difference between more complex stereoisomers.			
I can use atomic masses to decide on the priorities of groups			
I can use the location of the two highest priority groups to assign E and Z labels.			