

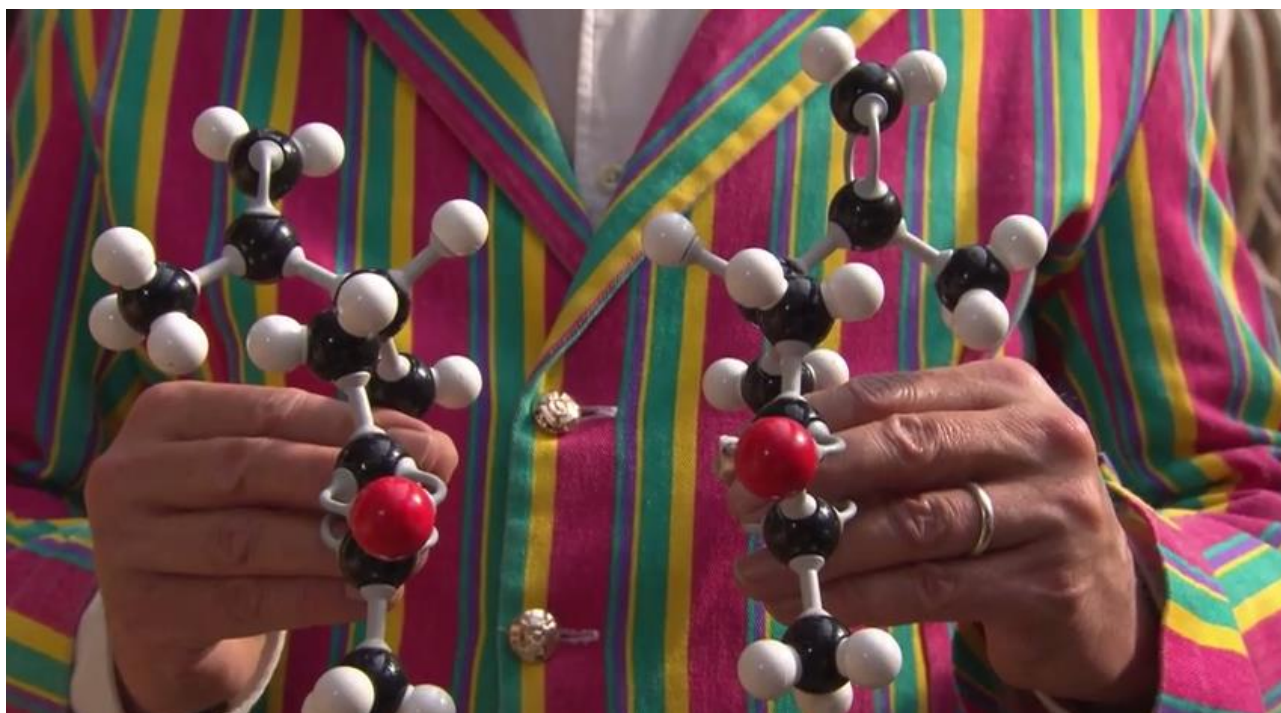
Notes for teachers

At a glance

This activity is an ideal way to introduce the concept of chirality and optical isomerism to students.

The video 'Give us a hand' outlines basic information for students to build their knowledge on. During the lesson they first learn to recognise chiral molecules and then witness a demonstration to see how plane polarised light is rotated in different directions by enantiomers of carvone.

Finally, they apply their knowledge by explaining how the observed angle of rotation can be measured using a polarimeter. There is an optional extra where students can use a homemade polarimeter and carry out a simple calculation to work out the specific rotation of carvone.



Learning Outcomes

- Students state meanings of terms chirality, enantiomer, optical isomer, polarised light.
- Students identify examples of chiral molecules.
- Students describe why chiral molecules are described as optically active.

Each student will need

- 1 copy of the pupil worksheet
- A selection of molymods

You will also need

- Some everyday chiral and achiral objects (see weblink below for examples)
- Samples of (+) carvone and (-) carvone solutions in small beakers. Make up each solution by dissolving 4 g of carvone in 25 cm³ of acetone
- 2 large polarising filters or one large and several small (enough for one between pairs)
- Backlight (upturned OHP, light box or laptop showing a white screen)
- Cardboard to direct light
- Polarimeter (optional). See weblink below for instructions on how to make one
- Distilled water

Possible Lesson Activities

1. Starter activity

- Show the video 'Give us a hand' to the class.
- Demonstrate the concept of chirality by using everyday objects and then molymods. Refer to the weblink below.

2. Main activity: Investigating chirality

- Ask students to read through page 1 of the pupil worksheet to check their understanding of chirality. They carry out the task in pairs which asks them to build models of molecules and work out if they are chiral or not.
- Discuss their answers and that the majority of chiral molecules contain carbon atoms that are bonded to four different groups. Use butan-2-ol as an example and point out the chiral carbon.
- Go through the section *optical activity* on page 2 of the pupil worksheet as a class. Ask students to work in pairs to answer questions 1 and 2. Supply students with polarising filters so they can investigate their properties.
- Carry out a demonstration to show the optical activity of the two enantiomers of carvone: (+) carvone and (-) carvone. The molecule models of these can be seen at 3:05 in the video 'Give us a hand'. Allow students to smell them. They will see that (+) carvone smells like caraway and (-) carvone like spearmint.
- Place the solutions in front of a back light (you can use an upturned OHP, light box or even a laptop showing a white screen) with a polarising filter in between the samples and the light. Use cardboard to block the light so it is directed through the filter and the samples.
- Use another large filter in front of the samples or give students smaller filters. Turn the front filter (or ask students to turn theirs) in order to show how the enantiomers cause rotation of the light in different directions. Make sure students understand that the filters will only block all the light when they are at 90° to each other. They will see that some light can get through as the filter is rotated.
- For an extension, you can also demonstrate the optical activity of glucose, sucrose, fructose and hydrolysed sucrose (see weblinks for further information).
- Students answer questions 3-6 which ask them to apply their understanding to explain how a polarimeter works.

3. Main activity: Using a polarimeter (optional)

- You will need access to a polarimeter or build your own before the lesson. Instructions can be found on the weblink below.

- Students work in pairs to use the polarimeter and measure the angle of rotation of each enantiomer of carvone. You may want to demonstrate how to use it first.
- If you choose to do this then ask students to complete questions 3-6 at this point instead to fill time whilst they are waiting to use the apparatus.
- To convert the observed rotation to a standardised specific rotation this formula can be used:

$$\text{specific rotation} = \frac{\text{observed rotation}}{\text{length of sample (dm)} \times \text{concentration of sample (g/cm}^3\text{)}}$$
- Measurements should be made at 20°C with the light source as a deuterium lamp. Explain that because of this, their measurements will not be 100% accurate.
- Students can then use a calculation to work out the specific rotation of carvone.
- Supply students with the correct answer (61°) and ask them to calculate percentage difference to determine the accuracy of the homemade polarimeter.

4. Plenary

- Go through the answers to questions 1-5 to check student understanding:
 1. *The filter will appear black. The first filter will block all light except for light travelling in one plane. The second will block light travelling in this plane so no light will be able to get through.*
 2. *The rotation would be zero as the rotation from the enantiomers would cancel each other out.*
 3. *You would turn polarising filter B until no light is seen. The direction you turn will determine the direction of the rotation.*
 4. *You could add a protractor and then measure the angle at which you have turned polarising filter B.*
 5. *The concentration of the sample and the length of the sample. These affect the degree of rotation because they change how many molecules the light comes into contact with as it passes through the solution.*

Weblinks

<https://www.youtube.com/watch?v=JS-iAuClExk>

Simple demonstration that can be used to teach the concept of chirality.

<https://www.youtube.com/watch?v=0rupQ6wIUCQ>

A simple demonstration to show the chirality of carvone.

<http://www.rsc.org/education/eic/issues/2012January/chirality-in-sugars.asp>

Demonstrating chirality in sugars.

<http://article.sapub.org/10.5923.j.jlce.20150301.02.html>

Instructions on how to build a simple polarimeter.

<http://www.oxfordsparks.net/animations/give-us-hand>