

Bioethanol: Johnstone's triangle

Learning objectives

- 1 Recognise a use and benefit of bioethanol.
- 2 Explain why the properties of ethanol are different to the elements carbon, oxygen and hydrogen.
- 3 Recognise what information is and is not provided by a particle diagram of an ethanol molecule.

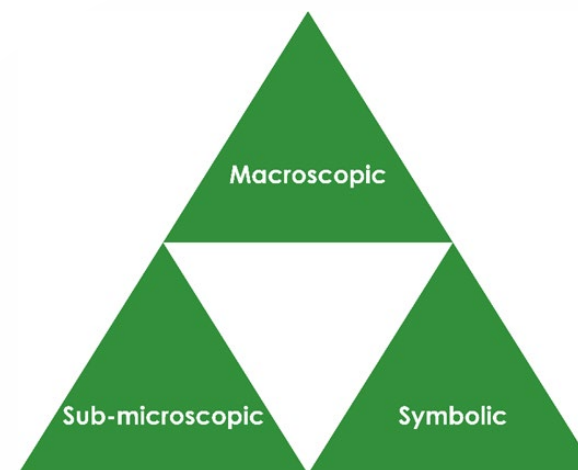
Introduction

Bioethanol is a form of ethanol produced from biological sources such as sugar cane. Ethanol molecules are made of carbon, oxygen and hydrogen atoms. The compound ethanol has totally different properties to the elements carbon, oxygen and hydrogen.

Johnstone's triangle

In chemistry we make sense of the things that we can see by representing what we can't see using formulas, equations, diagrams and models.

Johnstone's triangle is a way of thinking about these different concepts as different corners of a triangle:



- Macroscopic – what we can see. Think about the properties we can observe, measure and record.
- Sub-microscopic – smaller than we can see. Think about the particle or atomic level.
- Symbolic – representations. Think about how we represent chemical ideas, including symbols and diagrams.

Being able to connect and move between these three different levels is important for scientific understanding.

Macroscopic – what we can see

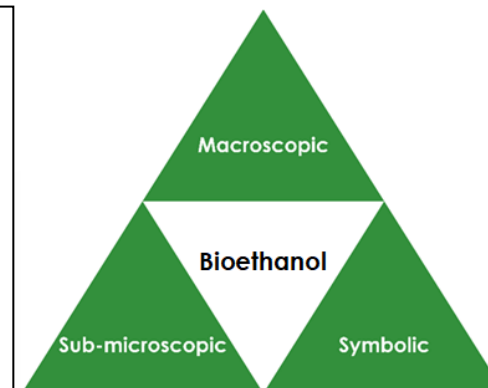
Bioethanol is a form of the compound ethanol that has been produced from biological sources such as sugar cane.

Bioethanol can be used as a fuel for vehicles. Suggest the state of bioethanol at room temperature.

Give one advantage of using bioethanol instead of a fossil fuel. _____



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**Sub-microscopic – smaller than we can see**

Ethanol is made up of atoms of carbon, oxygen and hydrogen.

Complete the sentences to explain why the properties of ethanol are different to the properties of the elements carbon, oxygen and hydrogen. Use the words **gases**, **solid**, **atoms** and **molecule**.

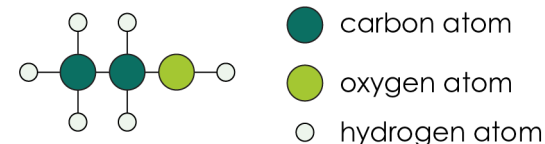
The element carbon is often found as a black _____. It is made up of lots of carbon _____ joined together.

The elements oxygen and hydrogen are formed of molecules that are made of pairs oxygen or hydrogen _____. Both elements are colourless _____.

Atoms of an element do not have the same properties as the actual element, so ethanol does not share any of these properties. The properties of ethanol arise from the number and arrangement of carbon, oxygen and hydrogen _____ that make up each ethanol _____.

Symbolic – representations

Tick (✓) or cross (x) for each statement to show what information the particle diagram of an ethanol molecule does or does not provide.



The diagram shows:

- ☐ which atoms are connected to which.
- ☐ the 3D arrangement of the atoms.
- ☐ the number of each type of atom.

Diagrams often represent carbon atoms as black circles. Suggest why this could cause misunderstandings.
