

# *A Guide to Organic Molecules*

## **Teaching Approach**

In this series we look at the various types of organic molecules, their molecular, structural and condensed structural formula, the rules for their naming and their physical properties. The first lesson introduces the broad concept of organic chemistry and its relevance to our daily lives. Lesson two discusses the homologous series of hydrocarbons highlighting their differences and their nomenclature. Lesson 3 goes further to introduce branched alkanes and isomerism. The IUPAC rules are highlighted in the naming of the branched alkanes. Lesson 3 also introduces the homologous series of haloalkanes (alkyl halides). Lesson 4 introduces the alcohols, carboxylic acids and esters and distinguishes between the primary, secondary and tertiary alcohols. The link between the alcohols, carboxylic acids and esters is briefly described as this will be covered in Organic Reactions. Lesson 5 discusses the aldehydes and ketones and how they are applied in our daily lives. Lesson 6 explains more about isomers. Lesson 7 explains some of the trends in the physical properties of the organic compounds.

Organic Molecules is a very broad topic in the chemistry work schedule so it is important not to go beyond the CAPS requirements. This can actually result in time delays that can affect the overall completion of the syllabus. The sequencing in this series ensures that learners are taken through the basics of organic chemistry, i.e. from the simple hydrocarbons and their nomenclature through branched hydrocarbons and their isomers to the complex esters and their nomenclature.

The IUPAC rules for nomenclature should be introduced early but gradually. It is important that learners learn to identify the various functional groups gradually too. In this series the functional groups are introduced a few at a time in order to avoid overload on the learners with material to memorise. It's unfortunate that learners need to know these by heart and it's important to make sure that they practise writing names and formulae as they go along. Once the functional groups have been identified, a summary table of all the functional groups can be given to learners. These functional groups could be asked as mental activities to learners at the beginning of a lesson.

Organic molecules are part of our daily lives, which is why the introductory lesson (lesson 1) highlights some of the applications, and throughout most lessons, effort has been made to highlight the daily uses of these molecules. Learners tend to recall the concepts which they can associate with their daily lives. When introducing saturated and unsaturated compounds (Lesson 2) it can be worthwhile getting learners to debate the nutritional issues related to the use of butter (saturated fats) and margarine (unsaturated fats). An experiment to distinguish between saturated and unsaturated compounds should be performed where materials are available. The same applies to the last lesson (Lesson 7) on physical properties where boiling points of various compounds of comparable molecular mass can be determined experimentally.

## Video Summaries

Some videos have a 'PAUSE' moment, at which point the teacher or learner can choose to pause the video and try to answer the question posed or calculate the answer to the problem under discussion. Once the video starts again, the answer to the question or the right answer to the calculation is given

Mindset suggests a number of ways to use the video lessons. These include:

- Watch or show a lesson as an introduction to a lesson
- Watch or show a lesson after a lesson, as a summary or as a way of adding in some interesting real-life applications or practical aspects
- Design a worksheet or set of questions about one video lesson. Then ask learners to watch a video related to the lesson and to complete the worksheet or questions, either in groups or individually
- Worksheets and questions based on video lessons can be used as short assessments or exercises
- Ask learners to watch a particular video lesson for homework (in the school library or on the website, depending on how the material is available) as preparation for the next day's lesson; if desired, learners can be given specific questions to answer in preparation for the next day's lesson

### 1. Introduction to Organic Molecules

In this lesson we introduce the concept of organic chemistry as being essentially the chemistry of carbon compounds except carbon dioxide and carbonates. The uniqueness of carbon is explained.

### 2. Hydrocarbons

In this lesson we describe the hydrocarbons and their general formulae. The lesson introduces the basic rules of nomenclature, identifying the prefixes, suffixes, and for unsaturated hydrocarbons, the position of the multiple bonds.

### 3. Hydrocarbons with Branches, and Alkyl Halides

The IUPAC rules are applied to the naming of branched alkanes. The idea of the longest chain is introduced and the positioning of the carbon atoms and we introduce the alkyl halides.

### 4. Organic Compounds containing Oxygen

In this lesson we look at organic compounds that are not hydrocarbons namely alcohols, acids and esters.

### 5. Aldehydes & Ketones

In this lesson we discuss the aldehydes and ketones. We note that the distinguishing feature between these two homologous series is the position of the carbonyl group. We also look at some of the everyday applications of aldehydes and ketones.

## 6. Isomers

Now that we have covered most of the functional groups, the concept of isomerism is explained in more detail. The three types of isomerism; positional, functional and chain isomers are described using specific examples.

## 7. Physical Properties of Organic Compounds

In this lesson we discuss the physical properties namely; physical state, boiling and melting points, vapour pressure, volatility and flammability in relationship to chain length, type of functional group and the degree of branching.

## Resource Material

Resource materials are a list of links available to teachers and learners to enhance their experience of the subject matter. They are not necessarily CAPS aligned and need to be used with discretion.

<b>1. Introduction to Organic Molecules</b>	<a href="http://www.curriki.org/xwiki/bin/view/Coll_siyavula/FHSSTChemistryGrade12MatterandMaterials?bc=:Coll_siyavula.FHSSTChemistryCourse;Coll_siyavula.FHSSTChemistryGrade12ChaptersOnly">http://www.curriki.org/xwiki/bin/view/Coll_siyavula/FHSSTChemistryGrade12MatterandMaterials?bc=:Coll_siyavula.FHSSTChemistryCourse;Coll_siyavula.FHSSTChemistryGrade12ChaptersOnly</a>	This page gives an analysis of organic molecules.
	<a href="http://www.slideshare.net/SiyavulaEducation/organic-molecules-gr12">http://www.slideshare.net/SiyavulaEducation/organic-molecules-gr12</a>	Here organic molecules are defined and different types of reactions are listed.
	<a href="http://www.mindset.co.za/resources//0000078526/0000193214/0000198307/12_PSci_Winter%20School_06%20July_Physical%20Sciences%20(Organic%20Chemistry)_Show%20Notes.pdf">http://www.mindset.co.za/resources//0000078526/0000193214/0000198307/12_PSci_Winter%20School_06%20July_Physical%20Sciences%20(Organic%20Chemistry)_Show%20Notes.pdf</a>	A practical exercise on organic chemistry.
	<a href="http://tiny.cc/zr0t9w">http://tiny.cc/zr0t9w</a>	An image of an organic molecule.
	<a href="http://www.goorulearning.org/#discover&amp;page=course-page&amp;courseId=20573&amp;subject=20001&amp;unitId=20581">http://www.goorulearning.org/#discover&amp;page=course-page&amp;courseId=20573&amp;subject=20001&amp;unitId=20581</a>	This website looks at structure of matter, motion, reactions and force.
	<a href="http://exchange.smarttech.com/search.html?q=%22organic+molecules%22">http://exchange.smarttech.com/search.html?q=%22organic+molecules%22</a>	Images of different molecules.
<b>2. Hydrocarbons</b>	<a href="http://exchange.smarttech.com/details.html?id=72a485d4-b0da-42a6-b0ab-1576fe90dd9f">http://exchange.smarttech.com/details.html?id=72a485d4-b0da-42a6-b0ab-1576fe90dd9f</a>	An image of a hydrocarbon.
	<a href="http://exchange.smarttech.com/details.html?id=39c36a3e-9d30-4650-be9b-2a0a10132172">http://exchange.smarttech.com/details.html?id=39c36a3e-9d30-4650-be9b-2a0a10132172</a>	Another image of a hydrocarbon
	<a href="http://www.curriki.org/xwiki/bin/view/Coll_siyavula/FHSSTChemistryGrade12MatterandMaterials?bc=:Coll_siyavula.FHSSTChemistryCourse;Coll_siyavula.FHSSTChemistryGrade12ChaptersOnly">http://www.curriki.org/xwiki/bin/view/Coll_siyavula/FHSSTChemistryGrade12MatterandMaterials?bc=:Coll_siyavula.FHSSTChemistryCourse;Coll_siyavula.FHSSTChemistryGrade12ChaptersOnly</a>	This page has everything you need to know about organic molecules from its definition to molecular formula. It also contains a section on hydrocarbons.
<b>3. Hydrocarbons with Branches, and Alkyl Halides</b>	<a href="http://www.curriki.org/xwiki/bin/view/Coll_siyavula/FHSSTChemistryGrade12MatterandMaterials?bc=:Coll_siyavula.FHSSTChemistryCourse;Coll_siyavula.FHSSTChemistryGrade12ChaptersOnly">http://www.curriki.org/xwiki/bin/view/Coll_siyavula/FHSSTChemistryGrade12MatterandMaterials?bc=:Coll_siyavula.FHSSTChemistryCourse;Coll_siyavula.FHSSTChemistryGrade12ChaptersOnly</a>	This page has everything you need to know about organic molecules from its definition to molecular formula. It also contains a section on

	<a href="http://oll_siyavula.FHSSTChemistryGrade12ChaptersOnly">oll_siyavula.FHSSTChemistryGrade12ChaptersOnly</a>	hydrocarbons.
<b>4. Organic Compounds containing Oxygen</b>	<a href="http://quizlet.com/4661320/chapter-12-organic-compounds-with-oxygen-sulfur-flash-cards/">http://quizlet.com/4661320/chapter-12-organic-compounds-with-oxygen-sulfur-flash-cards/</a>	This page contains a list of organic molecules that contain oxygen.
<b>5. Aldehydes &amp; Ketones</b>	<a href="http://web.usm.my/chem/LECTURE%20R/KOT%20121%20Dr%20Yam/Chapter%203.pdf">http://web.usm.my/chem/LECTURE R/KOT%20121%20Dr%20Yam/Chapter%203.pdf</a>	Good visuals of organic molecules
<b>6. Isomers</b>	<a href="http://faculty.lacitycollege.edu/boanta/LAB102/Organic%20Isomers.htm">http://faculty.lacitycollege.edu/boanta/LAB102/Organic%20Isomers.htm</a>	A resource that defines isomers and gives different types of isomerism.
<b>7. Physical Properties of Organic Compounds</b>	<a href="http://www.uiowa.edu/~c004121/notes/ch03_2.pdf">http://www.uiowa.edu/~c004121/notes/ch03_2.pdf</a>	Excellent overview of functional groups and their related physical properties.

## Task

### Question 1

Define the terms

- 1.1 hydrocarbon
- 1.2 homologous series
- 1.3 catenation

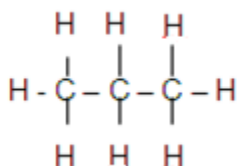
### Question 2

What is the difference between a saturated and an unsaturated compound?

### Question 3

Which of these compounds is/are saturated?

a)



b)  $\text{H} - \text{C} \equiv \text{C} - \text{H}$

c)  $\begin{array}{cccc} \text{H} & - \text{C} & = & \text{C} & - \text{H} \\ & | & & | & \\ & \text{H} & & \text{H} & \end{array}$

d)  $\begin{array}{cccccccc} & \text{H} & \text{H} & \text{H} & \text{H} & & & \\ & | & | & | & | & & & \\ \text{H} & - \text{C} & - \text{C} & - \text{C} & - \text{C} & - \text{H} & & \\ & | & | & | & | & & & \\ & \text{H} & \text{H} & \text{H} & \text{H} & & & \end{array}$

### Question 4

Briefly describe a simple experiment to distinguish between two compounds with the same molecular formula but one is saturated and the other one is unsaturated.

### Question 5

Give the:

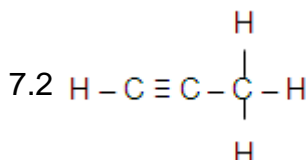
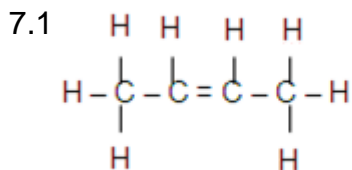
- 5.1 molecular formula
- 5.2 structural formula
- 5.3 condensed structural formula of propane.

### Question 6

What is the general formula for *alkenes*.

### Question 7

State the name of these compounds.



### Question 8

8.1 Define the term *isomerism*.

8.2 What type of isomerism exists between these pairs of compounds;

8.2.1 2-methylpentane and hexane

8.2.2 ethyl methanoate and propanoic acid

8.2.3 2-bromopentane and 3-bromopentane.

### Question 9

9.1 Give the structural formula of functional group of the following homologous series

9.1.1 alcohols

9.1.2 carboxylic acids

9.2 Name a specific example of a primary, a secondary and a tertiary alcohol

9.3 Explain the difference between them.

### Question 10

10.1 State one common use of each of these

10.1 carboxylic acids

10.2 aldehydes

10.3 ketones

10.2 State the names of the alcohol and the carboxylic acid that make up ethyl butanoate.

### Question 11

11.1 Define the following terms

11.1.1 vapour pressure

11.1.2 volatility

11.1.3 viscosity

11.2 Explain in terms of intermolecular forces the effect of chain length of alkanes on

11.2.1 melting/ boiling point

11.2.2 density.



## Task Answers

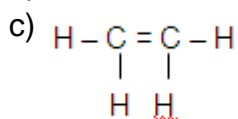
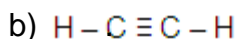
### Question 1

- 1.1 Hydrocarbon - an organic compound consisting of carbon and hydrogen atoms only.
- 1.2 Homologous series - a family or group of compounds that have the same functional group and have the same general formula.
- 1.3 Catenation - the ability of carbon to form long chain, branched chain or cyclic structures through carbon to carbon bonds.

### Question 2

A saturated compound consist of atoms bonded together by single bonds only, whereas an unsaturated compound has at least one multiple bond between two carbon atoms.

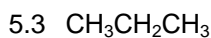
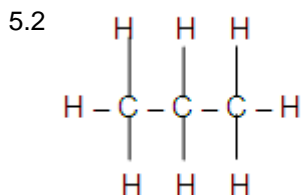
### Question 3



### Question 4

- I. Put a few ml of each compound into separate test tubes.
- II. Add few drops of bromine solution to each test tube.
- III. Gently shake or swirl the test tubes.
  - The unsaturated compound quickly decolourises, i.e. changes colour from red brown to pale yellow or colourless.

### Question 5



### Question 6



### Question 7

- 7.1 but-2-ene or 2-butene
- 7.2 propyne

### Question 8

- 8.1 Isomerism is the existence of organic compounds that have the same molecular formula but have different structural arrangements.
- 8.2
  - 8.2.1 chain isomerism
  - 8.2.2 functional group isomerism

## 8.2.3 positional isomeris

**Question 9**

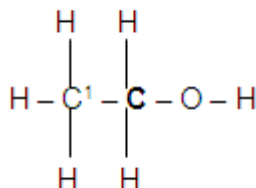
9.1

9.1.1 O – H

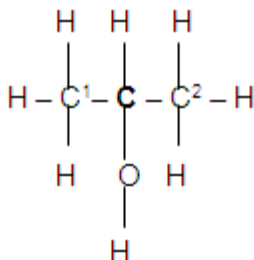
**N.B Take note that in a structural formula the bond between O and H has to be shown as well.**

 9.1.2  $\begin{array}{c} \text{O} \\ || \\ -\text{C}-\text{O}-\text{H} \end{array}$ 

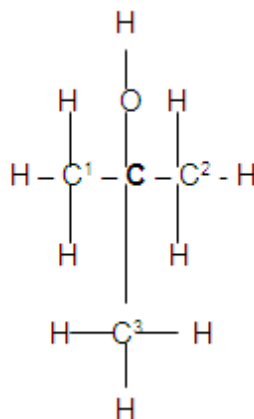
9.2 Primary alcohols are alcohols in which the carbon that is attached to the hydroxyl group is also attached to only one other carbon atom e.g. ethanol



Secondary alcohols are alcohols in which the carbon attached to the hydroxyl group is also attached to two other carbon atoms, e.g. 2-propanol or propan-2-ol.



Tertiary alcohols are alcohols in which the carbon attached to the hydroxyl group is also attached to three other carbon atoms, e.g. 2-methylpropan-2-ol or 2-methyl-2-propanol.


**Question 10**

10.1

10.1.1 Carboxylic acids – weak acids some used as preservatives e.g. benzoic acid, vinegar (ethanoic acid).

- 10.1.2 Aldehydes – as preservative e.g. methanol (formaldehyde/formalin), flavourants e.g. benzaldehyde
- 10.1.3 Ketones – solvent e.g. propanone(acetone), flavourants
- 10.2 The alcohol is ethanol, the carboxylic acid is butanoic acid.

### Question 11

- 11.1
  - 11.1.1 Vapour pressure – the pressure generated by a liquid when it changes from the liquid state to a gas.
  - 11.1.2 Volatility – is the ease with which a substance turns into vapour. It is directly related to the vapour pressure.
  - 11.1.3 Viscosity – a measure of a substance's resistance to flow – solids and 'thick' fluids like oil do not flow so have high viscosity. Gases flow easily hence have low viscosity.
- 11.2
  - 11.2.1 The longer the chain length the greater the surface available for van der Waals' intermolecular interactions. This means that it is more difficult to separate molecules. More heat energy is required hence higher boiling or melting points for the compounds with longer chains.
  - 11.2.2 An increase in chain length implies that the molecular mass of the organic compound increases. This results in an increase in the density since density is equal to the mass divided by the volume. Hence as chain length increases, the density also increases.

## Acknowledgements

Mindset Learn Executive Head	Dylan Busa
Content Manager Classroom Resources	Jenny Lamont
Content Coordinator Classroom Resources	Helen Robertson
Content Administrator	Agness Munthali
Content Developer	Tina Botha
Content Reviewers	Xolani Sithenjwa
	Liz Harris

## Produced for Mindset Learn by Traffic

Facilities Coordinator	Cezanne Scheepers
Production Manager	Belinda Renney
Director	Alriette Gibbs
Editor	Nonhlanhla Nxumalo
Presenter	Banji Longwe
Studio Crew	Abram Tjale
	James Tselapedi
	Wilson Mthembu
Graphics	Wayne Sanderson

## Credits

<http://upload.wikimedia.org/wikipedia/commons/5/58/Methane-3D-balls.png>

<http://0.tqn.com/d/chemistry/1/0/l/e/methane.jpg>

<http://upload.wikimedia.org/wikipedia/commons/8/8a/Pentane-3D-balls.png>

[http://upload.wikimedia.org/wikipedia/commons/c/c9/Pentane St%C3%A4bchenmodell AND space filling model 8272.JPG](http://upload.wikimedia.org/wikipedia/commons/c/c9/Pentane_St%C3%A4bchenmodell_AND_space_filling_model_8272.JPG)

<http://upload.wikimedia.org/wikipedia/commons/5/5a/Ethanol-xtal-1976-3D-balls.png>



This resource is licensed under a [Attribution-Share Alike 2.5 South Africa](https://creativecommons.org/licenses/by-sa/2.5/za/) licence. When using this resource please attribute Mindset as indicated at <http://www.mindset.co.za/creativecommons>