

PROPERTIES OF ORGANIC MOLECULES

04 MARCH 2014

Lesson Description

In this lesson we:

- Look at the physical properties of organic molecules

Summary

The physical properties, such as boiling and melting point of a compound are determined by the strength of the intermolecular forces between the molecules.

Intermolecular forces:

Van der Waals forces		Hydrogen bonds
London / dispersion forces	Dipole – dipole forces	
Weak forces between non-polar molecules	Stronger forces between polar molecules	Special form of dipole – dipole forces It is an electrostatic force between H atoms and N, O or F

The strength of the intermolecular force between organic molecules is determined by

- the type of intermolecular force
- the type of functional group
- the chain length
- the number of branches

Boiling point and melting point of a molecule increases when the intermolecular forces between the molecules increases.

Vapour pressure is the pressure at which the vapour and liquid of a substance are in dynamic equilibrium. A high vapour pressure causes a substance to be volatile (evaporate easily). Vapour pressure decreases when the intermolecular force between molecules increases.

The density of a substance is defined as the mass per volume. The greater the intermolecular forces between molecules the greater the density of the compound.

The intermolecular forces between organic molecules can be increased by:

- Increasing the polarity of the functional group
- Increasing the number of same functional groups
- Increasing the chain length which increases the contact surface area



Test Yourself

Select the most correct answer from the options given. Write down only the correct letter

Question 1

Which of the following compounds will have the highest boiling point?

- A $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_3$ B $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{OCH}_3$
 C $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{OH}$ D $\text{CH}_3\text{CH}_2\text{CH}_2\text{C}\ddot{\text{C}}\text{H}_3$

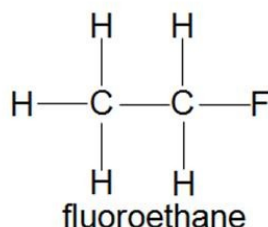
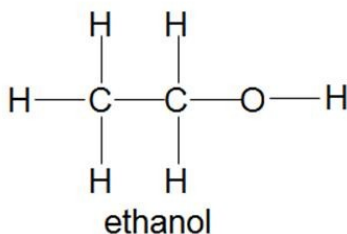
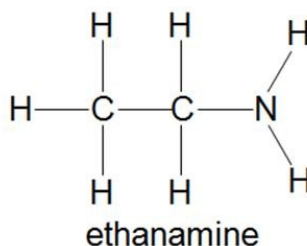
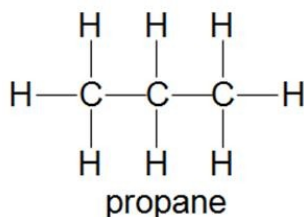
Question 2

The boiling points of branched alkanes are lower than those of straight chain alkanes containing the same number of carbon atoms because branched alkane chains have...

- A. larger molecular masses
 B. short chain lengths
 C. more electrons
 D. smaller effective molecular surface areas

Question 3

Consider the structural formula and IUPAC name of each compound shown below



Which ONE of these compounds has the highest vapour pressure at room temperature?

- A. Propane
 B. Ethanamine
 C. Ethanol
 D. Fluoroethane

Question 4

Which ONE of the following compounds will have the lowest boiling point?

- A. Propanol
 B. Propanoic acid
 C. Propene
 D. Propane

Question 5

Which ONE of the following compounds has the highest melting point?

- A. CH_3CH_3
- B. $\text{CH}_3\text{CH}_2\text{CH}_3$
- C. $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3$
- D. $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_3$



Improve your skills

Question 1

(Adapted from Additional Exemplar 2008 – Paper 2)

Hydrocarbons are simple organic compounds. The homologous series called alkanes is one group of hydrocarbons. One physical property of alkanes is shown in the table below.

Name	Boiling point ($^{\circ}\text{C}$)	Isomer	Boiling point of Isomer ($^{\circ}\text{C}$)
Methane	-161,0	-	-
Ethane	-88,5	-	-
Butane	-1	Methylpropane	-12
Pentane	34	2-methylbutane	28
Hexane	68,7	2,3-dimethylbutane	58

- 1.1. Define the concept homologous series
- 1.2. Explain the change in boiling points of the alkanes from methane to hexane.
- 1.3. How do the boiling points of the straight chain compounds differ from that their corresponding isomers? Give a reason for this difference.

Question 2

(Adapted from February / March 2009 – Paper 2)

There are two structural isomers for the organic compound with molecular formula $\text{C}_2\text{H}_4\text{O}_2$

- 2.1. Define the term structural isomer.
- 2.2. Write down the structural formula of these two isomers and next to each its IUPAC name.
- 2.3. State with reach which ONE of these isomers:
 - 2.3.1. has the higher boiling point
 - 2.3.2. has the higher vapour pressure
- 2.4. Will the vapour pressure of carboxylic acids increase or decrease if the number of carbon atoms in the chain increases? Give a reason for your answer.



Links

- Physical Properties of organic compounds:
http://www.youtube.com/watch?v=DJ8J_W0GoBq
- Boiling points of organic compounds:
http://www.youtube.com/watch?v=EPLAH8_9LqI