Name: _____ ( ) Class: _____ Date: _____

Organic Chemistry –
Introduction to Organic Chemistry

Syllabus

At the end of this topic, students should be able to:

11.1a Name natural gas, mainly methane, and petroleum as sources of energy.

11.1b Describe petroleum as a mixture of hydrocarbons and its separation into useful fractions by fractional distillation (see also 1.2(a)).

11.1c Name the following fractions and state their uses
- (i) petrol (gasoline) as a fuel in cars.
- (ii) naphtha as the feedstock and main source of hydrocarbons used for the production of a wide range of organic compounds in the petrochemical industry (see also 11.1(d)).
- (iii) paraffin (kerosene) as a fuel for heating and cooking and for aircraft engines.
- (iv) diesel as a fuel for diesel engines.
- (v) lubricating oils as lubricants and as a source of polishes and waxes.
- (vi) bitumen for making road surfaces.

11.1d Describe the issues relating to the competing uses of oil as an energy source and as a chemical feedstock (see also 11.1(c)(ii)).

11.2a Describe a homologous series as a group of compounds with a general formula, similar chemical properties and showing a gradation in physical properties as a result of increase in the size and mass of the molecules, e.g. melting and boiling points; viscosity; flammability

Introduction

Before 1828, all organic compounds were obtained from organisms or their remains. The belief then was that the synthesis of organic compounds from inorganic compounds in the laboratory was impossible. Things changed with the synthesis of urea from inorganic substances in 1828.

All organic compounds contain carbon atoms, and most of them contain hydrogen atoms as well. The simplest organic compounds made up of **carbon and hydrogen atoms only** are known as **hydrocarbons**. Organic compounds may also contain other elements such as oxygen, chlorine and nitrogen. However, not all carbon containing compounds are considered organic compounds (i.e. carbon dioxide, carbon monoxide and carbonate ions)

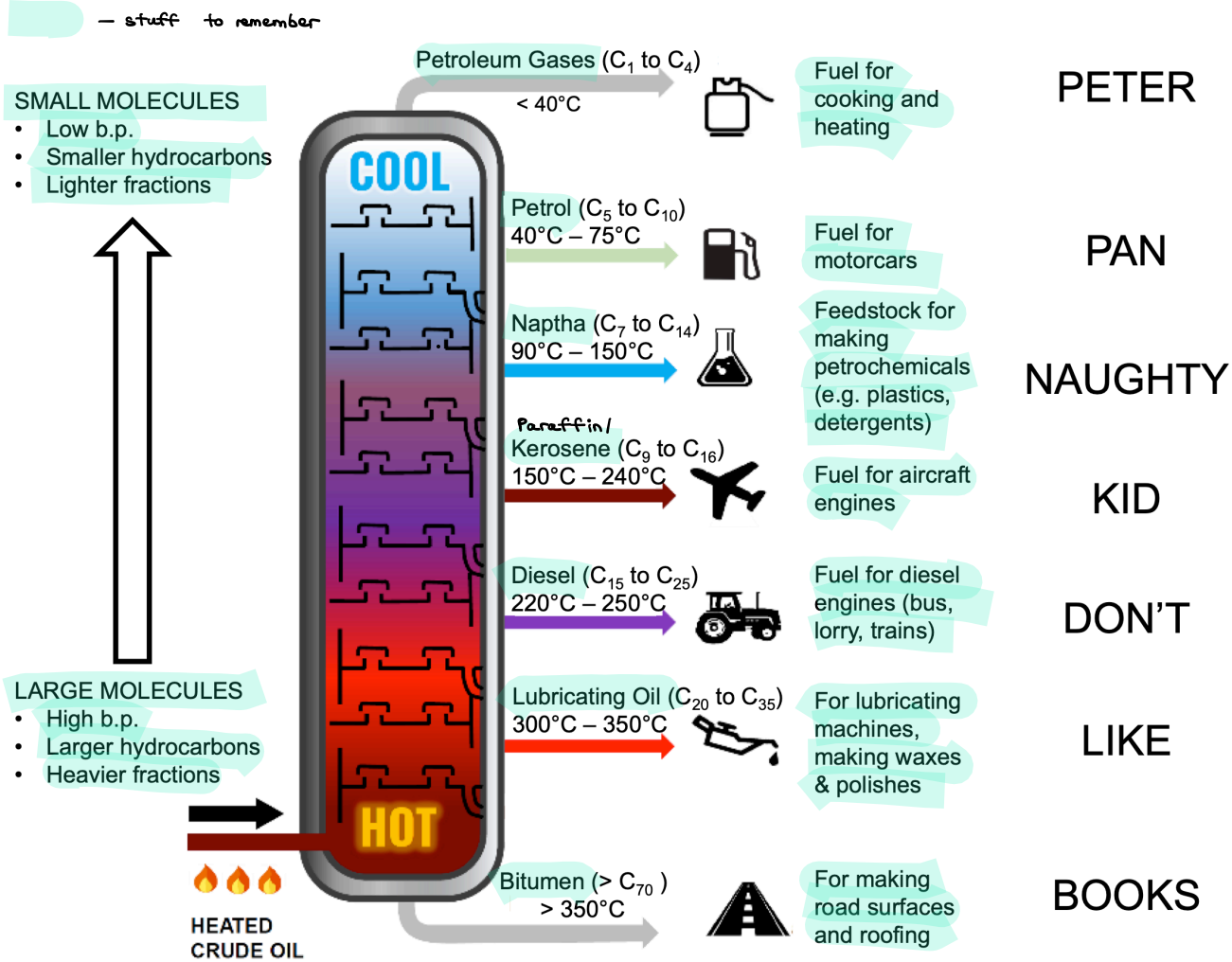
hydrocarbons are immiscible in water

Fuels and Crude Oil

Two main types of fuels which are used today to generate energy – fossil and nuclear. These are used as they produce a large amount of heat energy during burning. Examples of fossil fuels which are used as sources of energy are **natural gas (mainly methane)**, **coal** and **petroleum (mixture of hydrocarbons with different boiling points)**.

Petroleum

Since petroleum is a mixture of hydrocarbons with different boiling points, the unrefined petroleum (crude oil) is first sepatated into different fractions by fractional distillation.



The larger the molecule, the greater the energy required the overcome the intermolecular forces of attraction between the molecules.

Issues Relating to Competing Uses for Oil

As petroleum is a non-renewable energy source, global supplies will eventually run out. Because there are competing uses for oil, oil as a resource gets depleted in a shorter time. Using oil as a chemical feedstock in industries also leads to air and water pollution.

To reduce reliance on oil, countries have begun to experiment with using alternative energy sources. However, a viable, long term solution to the oil problem has not yet been found.

Organic Compounds – Homologous Series

Because there are so many organic compounds, there has to be a way to classify them into groups or families called **homologous series**.

Examples of homologous series

- Alkane
- Alkene
- Alcohol
- Carboxylic Acid

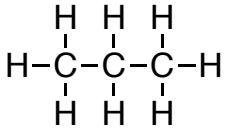
General Characteristics of a Homologous Series

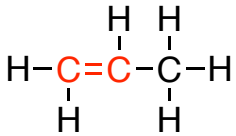
Organic compounds in the same homologous series have the following characteristics:

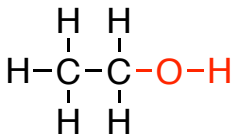
- They have the same functional group
- They have the same general formula
- They have similar chemical properties
- There is a gradual change in their physical properties (e.g. melting and boiling point, viscosity and flammability) as the size and mass increases down the series from one member to the next.

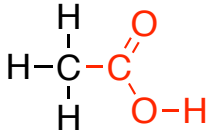
Functional Group

A functional group is an atom or group of atoms that gives a family of organic molecules their chemical properties. This means that molecules belonging to the same homologous series undergo the same type of chemical reactions.

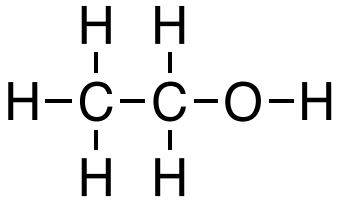
Alkanes	
Functional Group: Contains only C–C (carbon–carbon single bond) or C–H	Example: 

Alkenes	
Functional Group: Contains at least 1 C=C (carbon-carbon double bond)	Example: 

Alcohols	
Functional Group: Contains hydroxyl group, –OH	Example: 

Carboxylic Acid	
Functional Group: Contains carboxyl group, –COOH	Example: 

Representations of Organic Molecules

	Molecular	Structural	General
Explanation	Displays the types of elements and total number of atoms in a molecule. Does not show how these atoms are arranged Shows functional groups (i.e. –OH & –COOH)	Full Structural Formula – all bonds between atoms are displayed. Each line shows a covalent bond (a pair of shared electrons) between atoms. Condensed Structural Formula – shows the arrangement of the atoms written on in a left-to-right manner.	Algebaric represenation for all the molecular formulae in the homologous series, regardless of the number of carbon and hydrogen atoms in each molecule.
Example (Ethanol)	C_2H_5OH	Structural Formula: CH_3CH_2OH Full Structural Formula: 	Alcohol: $C_nH_{2n+1}OH$

Naming Organic Molecules

The name of an organic molecule is made up of a prefix and a suffix. The **prefix** indicates the **number of carbon atoms** in the compound, whilst the **suffix** indicates the **homologous series** the organic molecule belongs to.

Prefix	Number of carbon atoms
Meth	1
Eth	2
Prop	3
But	4
Pent	5

Suffix	Homologous Series
–ane	Alkane
–ene	Alkene
–anol	Alcohol
–anoic acid	Carboxylic Acid

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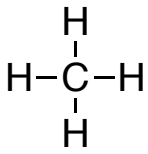
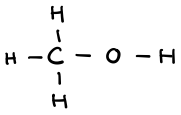
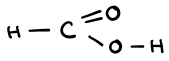
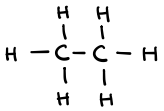
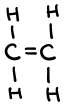
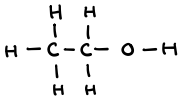
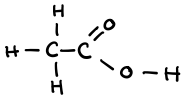
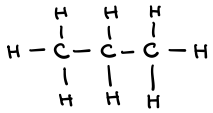
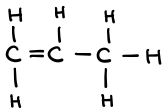
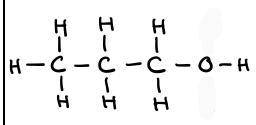
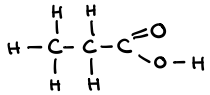
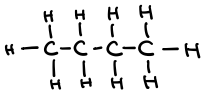
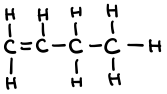
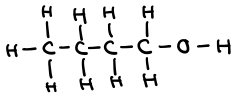
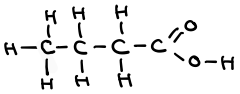
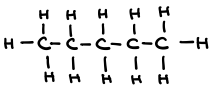
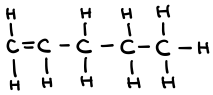
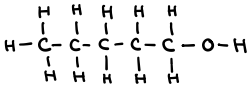
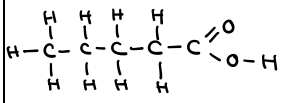
Combining the prefix and suffix together gives the name of the organic molecule

Practice!

Fill in each blank in the table with the correct name, full structural formula, and molecular formula. The first cell has been completed for you as a reference.

Number of Carbon Atoms	Homologous Series			
	Alkanes	Alkenes	Alcohol	Carboxylic Acid
1	methane  CH_4		methanol  CH_3OH	methanoic acid  $HCOOH$
2	ethane  C_2H_6	ethene  C_2H_4	ethanol  C_2H_5OH	ethanoic acid  CH_3COOH
3	propane  C_3H_8	propene  C_3H_6	propanol  C_3H_7OH	propanoic acid  C_2H_5COOH
4	butane  C_4H_{10}	butene  C_4H_8	butanol  C_4H_9OH	butanoic acid  C_3H_7COOH
5	pentane  C_5H_{12}	pentene  C_5H_{10}	pentanol  $C_5H_{11}OH$	pentanoic acid  C_4H_9COOH
General Formula	C_nH_{2n+2}	C_nH_{2n}	$C_nH_{2n+1}OH$	$C_{n-1}H_{2n-1}COOH$

Increase in $-CH_2$ down the homologous series