Unit 2, Lesson 01: Introduction to Organic Chemistry and Hydrocarbons

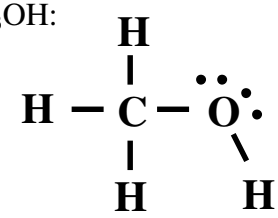
Answers to Homework:

1. Read pages 4 – 9
2. Organic compounds are defined as covalent compounds that usually contain C – C and C – H bonds.
3. What did Friedrich Wohler discover and why was it significant?

   Friedrich Wohler discovered how to synthesize urea, an organic compound. Up until this time, it was believed that organic compounds contained a special life force and could only be synthesized by living things. Because Wohler chemically synthesized an organic compound, it was realized that organic compounds just molecules, like all other molecules.

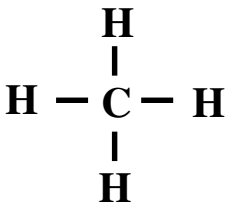
4. Page 10, Q 1:

a) CH_3OH:

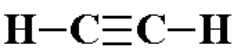


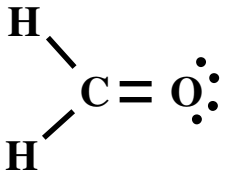
the molecule is tetrahedral around the C atom and bent around the O atom

b) CH_4 :



the molecule is tetrahedral around the C atom

Page 10, Q 2a)  is linear around both C atoms

Page 10, Q 2b) $H_2C=O$ 

the molecule is trigonal planar around the C atom

Page 10, Q 3. The polar bonds in the molecules in questions 1 and 2 are the C – O , O – H , and C = O bonds.

Page 10, Q 4. The polar molecules from questions 1 and 2 are CH_3OH and $H_2C=O$ because they contain polar bonds and are asymmetrical molecules.

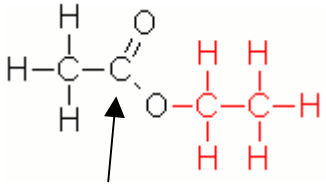
Page 11, Q 1a) The statement "You should only eat organic food." is misleading because all food is organic, according to a chemist. Food is made of protein, fat and carbohydrates, all of which are carbon based covalent compounds. However, when a non-chemist says "organic", they are referring to foods that are grown without the use of chemical (synthetic) fertilizers and pesticides.

Page 11, Q 1b) The statement "All-natural ingredients make our product the healthier choice." is misleading because "all-natural" does not mean better or safer. Synthetic and "natural" forms of a chemical are identical, so natural and man-made vitamins or products are equally safe. And, just because a compound occurs naturally, it doesn't make it healthy. There are many natural chemicals found in plants that are toxic.

Page 11, Q 1c) The statement "Chemicals are harmful." is silly. Everything in the world is made of chemicals, including water, protein, vitamins, carbohydrates and all of the nutrients living things need to build their tissues. While it is true that some chemicals are harmful, many are not.

Page 11, Q 2a) C – O is a polar bond (ΔEN = 0.89)
Page 11, Q 2b) C – C is a non-polar bond (ΔEN = 0.0)
Page 11, Q 2c) C – N is a non-polar bond (barely, ΔEN = 0.49)
Page 11, Q 2d) C = C is a non-polar bond (ΔEN = 0.0)
Page 11, Q 2e) C = O is a polar bond (ΔEN = 0.89)

Page 11, Q 3a) the ethane molecule is tetrahedral around the carbon atom (4 BP, 0 LP)
Page 11, Q 3a) the molecule shown to the right is trigonal planar around the 2nd carbon atom (3 BP, 0 LP)



Page 11, Q 4) the ethane molecule is non-polar because it contains only non-polar bonds and it is symmetrical. The second molecule is polar because it contains polar bonds (C – O) and it is asymmetrical.

5. All of the following compounds contain carbon. Classify and name them. An ion chart may help.

Compound	Ionic or Covalent	Organic or Inorganic	Name of Compound
CO_2	covalent	inorganic	carbon dioxide
$Ca(CN)_2$	ionic	inorganic	calcium cyanide
C_3H_8	covalent	organic	propane
CH_3COOH	covalent	organic	acetic acid (HCH_3COO)
KSCN	ionic	inorganic	potassium thiocyanate
Na_4C	ionic	inorganic	sodium carbide
C_6H_{14}	covalent	organic	hexane
$SrCO_3$	ionic	inorganic	strontium carbonate
$C_6H_{12}O_6$	covalent	organic	glucose
C_8H_{18}	covalent	organic	octane
CO	covalent	inorganic	carbon monoxide

6. Why are the straight chain alkanes called a "homologous series"?

   A homologous series refers to chemicals that differ only by one repeating unit. All alkanes are built of CH_2 units with CH_3 units on each end. They differ only by the number $-CH_2-$ units, so they fit the definition of a homologous series.

7. What is the general formula for the molecular formula of alkanes? What does "n" represent?

   The general formula for alkanes is C_nH_{2n+2}, where "n" represents the number of carbon atoms in the molecule.

8. Write the molecular formulas of the alkanes with:
   a) 15 carbon atoms: $C_{15}H_{32}$
   b) 20 carbon atoms: $C_{20}H_{42}$
   c) 72 hydrogen atoms: $C_{35}H_{72}$

9. Is $C_{18}H_{36}$ an alkane? Explain.

   No, $C_{18}H_{36}$ is not an alkane. It does not fit the general formula for alkanes, C_nH_{2n+2} .

10. Write the molecular formula for dodecane (12 carbon atoms): $C_{12}H_{26}$

11. What is meant by a "saturated" hydrocarbon?

    A saturated hydrocarbon contains the maximum amount of H atoms possible. This means that there are no double or triple bonds in the molecule.

12. What is the significance of the mnemonic "monkeys eat peeled bananas"?

    Monkeys **E**at **P**eeled **B**ananas is just a trick to help remember the names of the first four alkanes:

    Methane, **E**thane, **P**ropane and **B**utane.

13. Are hydrocarbons polar or pure covalent compounds? Justify your answer with reference to electronegativity values. Based on your answer, predict four physical properties of hydrocarbons.

    Hydrocarbons are pure (non-polar) covalent compounds. They contain only H and C, so the only possible types of bonds are H – C ($\Delta EN = 0.35$) and C – C ($\Delta EN = 0.00$). Both of these bonds are non-polar, so they are non-polar bonds. Also, because C forms four bonds with hydrogen, there are no lone pairs, so the molecules are non-polar (regardless of the symmetry of the molecule).

14. What is meant by an "alkyl group"?

    An alkyl group is an alkane "side chain" that can be added to organic molecules. Alkyl groups are named by the number of carbon atoms they contain:

    eg. 1 carbon atom: CH_3- is the methyl group

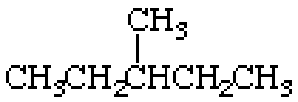
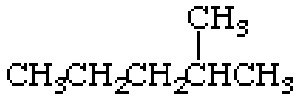
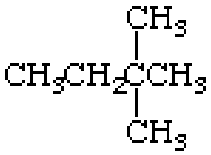
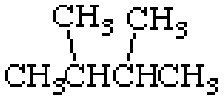
        2 carbon atoms: CH_3CH_2- is the ethyl group

15. What would you name an ***alkyl group*** that contains 5 carbon atoms? pentyl group

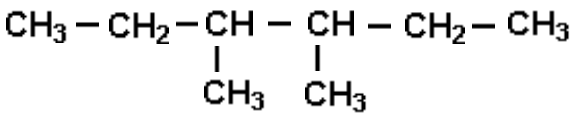
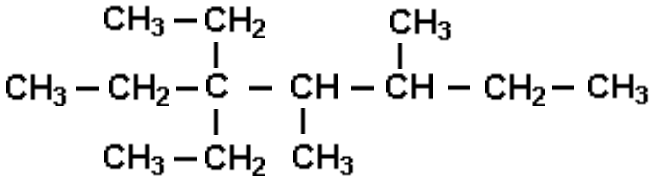
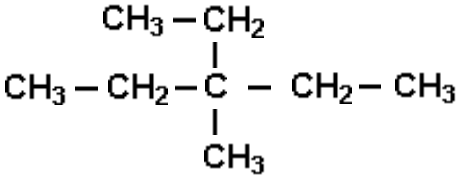
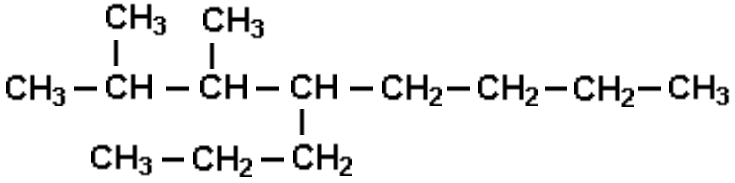
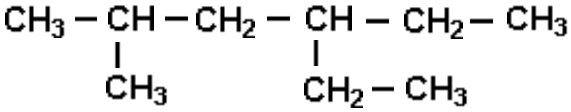
16. Define structural isomer. Draw four structural isomers of hexane. Name each isomer.

    A structural isomer refers to molecules that have the same chemical formulas but have different structural formulas (the atoms are put together in a different arrangement).

    eg. structural isomers of hexane all have the chemical formula C_6H_{14} :

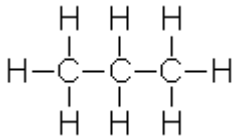
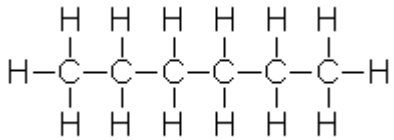
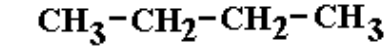
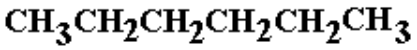
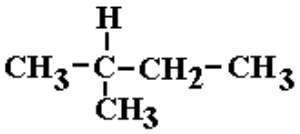
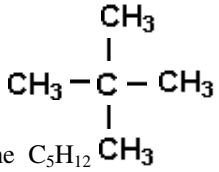
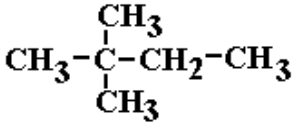
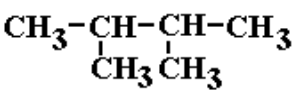
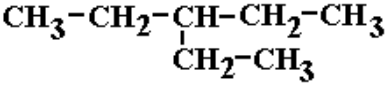
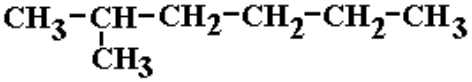
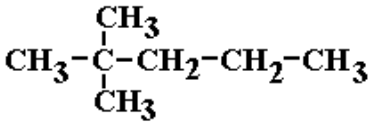
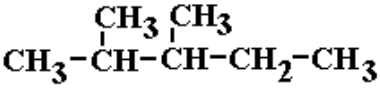
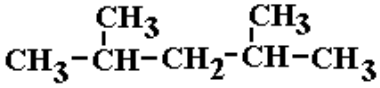
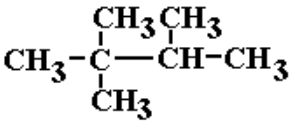
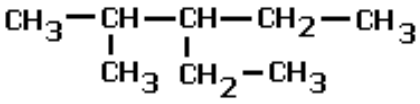
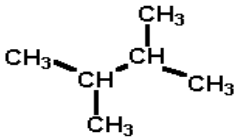
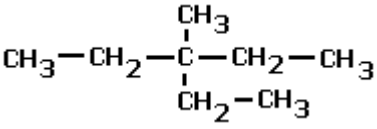
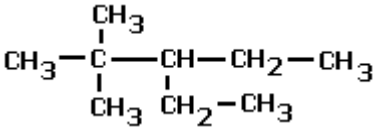
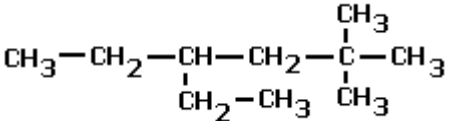
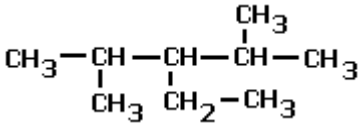
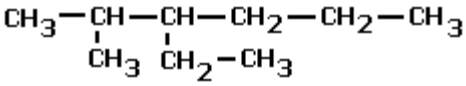
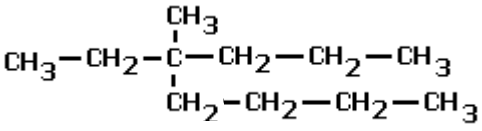
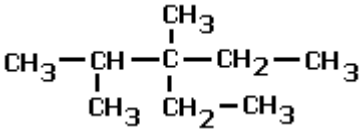
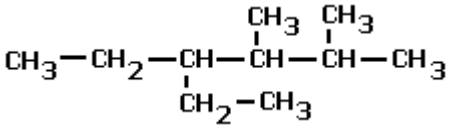
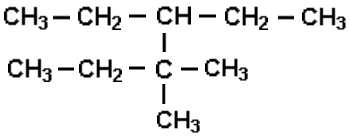
 3-methylpentane	 2-methylpentane
 2,2-dimethylbutane	 2,3-dimethylbutane

17. Draw the condensed structural formulas for the following:

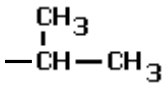
a) 3,4-dimethyl hexane 	d) 3,3-diethyl-4,5-dimethyl heptane 
a) 3-ethyl-3-methyl pentane 	e) 2,3-dimethyl-4-propyl octane 
d) 4-ethyl-2-methyl hexane 	

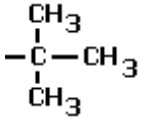
Unit 2, Lesson #1: Practice Naming Alkanes, Answers

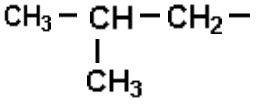
Question 18. Any molecules with the same molecular formulas are structural isomers of each other.

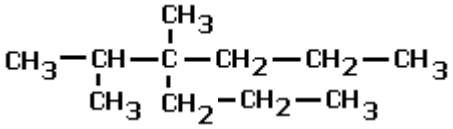
 propane C_3H_8	 hexane C_6H_{14}	 butane C_4H_{10}  hexane C_6H_{14}
 2-methylbutane C_5H_{12}	 2,2-dimethylpropane C_5H_{12}	 2,2-dimethylbutane C_6H_{14}
 2,3-dimethylbutane C_6H_{14}	 3-ethylpentane C_7H_{16}	 2-methylhexane C_7H_{16}
 2,2-dimethylpentane C_7H_{16}	 2,3-dimethylpentane C_7H_{16}	 2,4-dimethylpentane C_7H_{16}
 2,2,3-trimethylbutane C_7H_{16}	 3-ethyl-2-methylpentane C_8H_{18}	 2,3-dimethylbutane C_6H_{14}
 3-ethyl-3-methylpentane C_8H_{18}	 3-ethyl-2,2-dimethylpentane C_9H_{20}	 4-ethyl-2,2-dimethylhexane $C_{10}H_{22}$
 3-ethyl-2,4-dimethylpentane C_9H_{20}	 3-ethyl-2-methylhexane C_9H_{20}	 4-ethyl-4-methyloctane $C_{11}H_{24}$
 3-ethyl-2,3-dimethylpentane C_9H_{20}	 4-ethyl-2,3-dimethylhexane $C_{10}H_{22}$	 4-ethyl-3,3-dimethylhexane $C_{10}H_{22}$

Name each sidechain (text page 14), then name the molecule to the right:

 isopropyl

 tert-butyl

 iso-butyl

 4-isopropyl –4-methylheptane $C_{11}H_{24}$