UNIT TEST

1. The name *organic* used to imply that these compounds were the product of life, but the name now encompasses all compounds involving carbon, with the exception of oxides and carbon-based ions. However, life requires both organic and inorganic compounds at nearly every level.

   Which of the following essential compounds in the human body can be classified as organic?

   A. H_2O **B.** CO_2

   C. HCO_3^- **D.** $C_2H_5NO_2$

2. Which of the following alcohols is **most readily** used for human consumption?

   A. Ethylene glycol **B.** Isopropanol

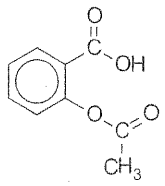
   C. Methanol **D.** Ethanol

3. Petroleum from California contains a class of organic molecules known as naphthenes or cycloparaffins. These organic molecules consist of single bonded cyclic units. Cyclohexane, which has a boiling point of 81°C, is an example of a naphthene.

   The number of carbon and hydrogen atoms in the naphthene cyclohexane is ___ and ___.

4. Acetylsalicylic acid (ASA), found in aspirin, is a derivative of the active ingredient in willow bark tea, namely salicylic acid. Interestingly enough, Compound W™, a proprietary wart remover, is a concentrated aqueous salicylic acid solution. In aspirin, however, it was found necessary to modify salicylic acid to ASA to avoid the burning sensation salicylic acid causes when taken internally.

   The structure of aspirin is

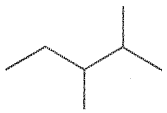
   Two functional groups present in aspirin are

   A. halogen and ester

   B. ester and carboxylic acid

   C. carboxylic acid and alcohol

   D. halogen and carboxylic acid

5. 

   What is the name of this compound?

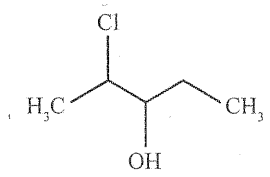
   A. 2-ethyl-3-methylbutane

   B. 2,3-dimethylpentane

   C. 3,4-dimethylpentane

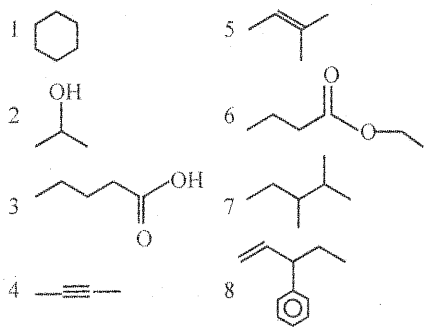
   D. Hexane

6. 1. Hydroxyl
2. Carboxyl
3. Ester linkage
4. Alkyl
5. Halogen



There are ___ functional groups on the given molecule. The numbers that correspond to them on the given list, in numerical order, are ____.

7.

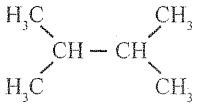


Match the given organic compound structures with the following compounds.

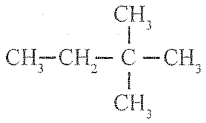
- A saturated and non-cyclic hydrocarbon ___
- A carboxylic acid ____
- An aliphatic alkene ____
- An aromatic ____

8. Crude oil contains over 200 different organic chemicals, some of which are known as paraffins. Paraffins are saturated, non-cyclic molecules connected only by single bonds. Examples of paraffins are 2-methylheptane and 2-methylhexane.

I.



II.



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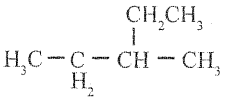
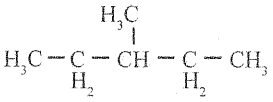


IV.



Which two of the given hydrocarbon structures are identical?

A. Structures I and II

B. Structures I and III

C. Structures II and IV

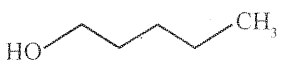
D. Structures III and IV

9. Which of the following alcohols has the **highest** boiling point?

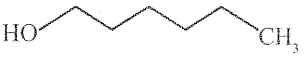
A.

B.

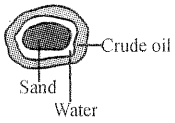
C.



D.



10. Oil sands contain bitumen. Bitumen consists of a sand particle surrounded by a thin layer of water, which is then coated with a layer of oil.



Which of the following solvents would **best** dissolve the oil in order to retrieve it from the bitumen?

A. Water **B.** Ethanol

C. Pentane **D.** Methyl ethanoate

11. Although inert to most reagents, alkanes react readily with chlorine in the presence of ultraviolet light. An example of this reaction is shown below.

$CH_4 + Cl_2 \rightarrow CH_3Cl + HCl$

This reaction is an example of

A. an addition

B. a substitution

C. an elimination

D. an esterification

12. Methanol has many uses. It is used as a fuel in race cars. It is also used in the production of synthetic fibres and plastics. In esterification reactions, methanol can be used to convert carboxylic acids to esters.

The product of the reaction of methanol with propanoic acid is

A. methyl ethyl ester

B. propyl methanoate

C. methyl propanoate

D. methyl proanaldhyde

13. The methane content of the atmosphere appears to be increasing by about 2% annually. This is a concern because methane is a major contributor to global warming. Sources of methane include termites, which are believed to produce 165 million tons per year. On the other hand, methane is consumed by humans in combustion reactions.

The balanced equation for the complete combustion of methane is

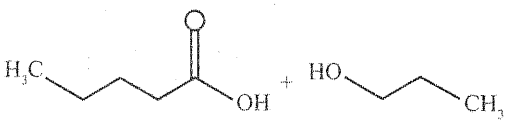
A. $C_2H_{6(l)} + 3\frac{1}{2}O_{2(g)} \rightarrow 2CO_{2(g)} + 3H_2O_{(g)}$

B. $CH_{4(l)} + 2O_{2(g)} \rightarrow 2CO_{(g)} + 2H_2O_{(g)}$

C. $CH_{4(l)} + 2O_{2(g)} \rightarrow CO_{2(g)} + 2H_2O_{(g)}$

D. $CH_{4(l)} + 4O_{(g)} \rightarrow CO_{2(g)} + 2H_2O_{(g)}$

14.



Pentanoic acid Propanol

The molecular weights of the products of the given reaction are ____ and ____ (largest weight first).

15. Polyvinylchloride (PVC) is an important compound as it is one of the most widely used plastics. It is used for such things as cling wrap, bottles, credit cards, and pipes. Polyvinylchloride is made from chloroethene.

Chloroethene is the _*i*_ used to create PVC in _*ii*_ polymerization.

Which of the following tables completes the given statement?

A.

i	ii
monomer	addition

B.

i	ii
monomer	condensation

C.

i	ii
polymer	addition

D.

i	ii
polymer	condensation

16. 1. cyclononane
2. 3,4-dimethylnonane
3. non-2-ene
4. non-3-yne
5. 1,1-diethylcyclopentane
6. 2-methyloct-1-ene
7. 1,2-diethylcyclobutane
8. cyclononene

In increasing numerical order, record the number for each compound that is a structural isomer of 1-ethyl-2-propylcyclobutane.

Answers and Solutions – Unit Test

1. D	5. B	9. D	13. C
2. D	6. 2,1,5	10. C	14. 144.2,18
3. 6,12	7. 7,3,5,8	11. B	15. A
4. B	8. D	12. C	16. 1,3,5,6

1. D

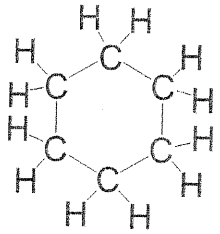
This is the formula for glycine, an amino acid present in nearly all proteins. Carbon dioxide and bicarbonate are important compounds for respiration and maintaining blood pH levels. Water is thought to be essential to all life.

2. D

Ethanol is the alcohol contained in commercially available alcoholic beverages. Methanol is used mostly as fuel, isopropanol is used as rubbing alcohol, and ethylene glycol is used as antifreeze.

3. 6,12

Cycloalkanes have the same general formula as alkenes, namely C_nH_{2n}. Alternatively, cyclohexane has the following structure:



C_6H_{12} corresponds to the general formula C_nH_{2n}.

4. B

The functional groups present in acetylsalicylic acid are a benzene ring, a carboxylic acid group, and an ester.

5. B

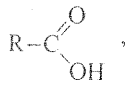
The longest chain is 5 carbons long, so numbering the chain to give the branches the lowest numbers possible gives 2,3-dimethylpentane.

6. 2,1,5

The two functional groups are the chlorine (halogen) and the OH (hydroxyl). This means the compound is an halogenated alcohol.

7. 7,3,5,8

Saturated means that there are no double or triple bonds. Non-cyclic refers to the fact that there is no ring, and a hydrocarbon contains exclusively carbon and hydrogen atoms. Diagram 7 is a saturated and non-cyclic hydrocarbon.

Carboxylic acids have the structure  ,

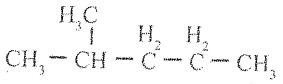
which is shown in diagram 3.

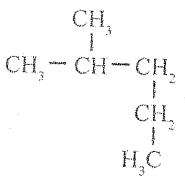
Aliphatic molecules do not contain a benzene ring, and an alkene has a double bond, which is shown in diagram 5.

An aromatic molecule is one that contains a resonant ring structure, such as benzene, or a compound with a phenyl group. Diagram 8 is an aromatic.

8. D

Structural or skeletal isomers have the same chemical formulae but different arrangements of atoms. Moreover, how you actually draw a hydrocarbon structure is open to interpretation. For example, the following structures represent the same molecule.





Often it is easier to label the carbons of the longest continuous chain of carbon atoms and name the molecules involved.

9. D

When looking at a homologous series of functional groups, boiling points can be compared based on molecular weight (assuming the molecules also have the same branching patterns). The highest molecular weight has the highest boiling point. It should also be noted that the longer carbon chains have stronger London dispersion forces.

10. C

Since oil is non-polar, a non-polar solvent, such as pentane, should be used to dissolve the oil.

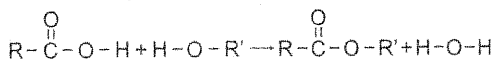
Water, ethanol, and methyl ethanoate are all polar solvents because of their asymmetrical conformational geometry.

11. B

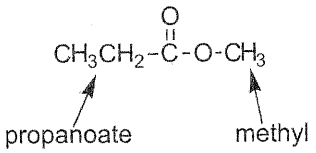
The reaction of a hydrocarbon with a halogen in which one hydrogen on the organic compound is replaced by a single halogen atom is called a radical substitution reaction. One mole of halogen atom (Cl, Br, F) ends up bonded to the organic product per mole of reactant halogen Cl_2, Br_2, F_2 added.

12. C

Esterification, the reaction of an alcohol or alkanol with a carboxylic or alkanoic acid, is as follows:



The oxygen of the water produced originated in the acid reactant. The systematic names for esters are composed of the name of the alkyl group on O (R′) followed by the name of the acid in which the suffix *-ic* is replaced by *-ate*. The product in this question is



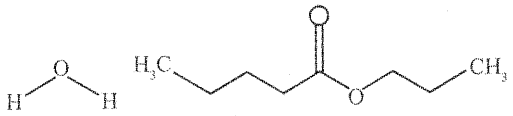
The name of this product is methyl propanoate.

13. C

The products of complete combustion of a hydrocarbon compound are $CO_{2(g)}$ and $H_2O_{(g)}$. Remember to balance the C and H in $CO_{2(g)}$ and $H_2O_{(g)}$ respectively, before balancing the O in $O_{2(g)}$.

14. 144.2,18

Carboxylic acids and alcohols react in esterification reactions to produce an ester and water. In this case, the ester is propyl pentanoate ($C_8H_{16}O_2$).



Water Propyl pentanoate

15. A

Chloroethene is the monomer used to create the polymer PVC.

When chloroethene reacts, it uses the electrons in its double bonds to do an addition reaction with the next monomer, which creates an addition polymer.

16. 1,3,5,6

For the compound to be a structural isomer of 1-ethyl-2-propylcyclobutane, it must have a total of 9 carbons in the following functional groups:

- eth = 2 carbons
- prop = 3 carbons
- +but = 4 carbons

1-ethyl-2-propylcyclobutane is a cyclic hydrocarbon based on a butane molecule, which forms a square-shaped ring. Whereas linear butane has a formula of C_4H_{10}, cyclobutane has a formula of C_4H_8. Because of this ring structure, it must contain one unit of unsaturation. In other words, the final molecular formula of a valid isomer will have two fewer hydrogen atoms than a saturated molecule. The molecules that meet this criteria are 1, 3, 5, and 6.