CHARACTERISTICS OF ORGANIC COMPOUNDS

Organic compounds have all covalent bonds (shared electron pairs). Their physical and chemical properties are generally those of molecular compounds, as contrasted to ionic compounds.

Some important properties include the following:

1. Organic compounds are generally nonpolar.
2. Only a few organic compounds will dissolve in water. These include ethanoic acid, various sugars, and certain alcohols. Acids, alcohols, and sugars have –OH on them as does water. They form hydrogen bonds to water which is a relatively strong intermolecular force. Many organic compounds are soluble in nonpolar solvents. These solvents are usually organic compounds themselves.
3. Most organic compounds are nonelectrolytes. Organic acids are exceptions — they are weak electrolytes.
4. Organic compounds have low melting points, due to the fact that the compounds are held together by weak intermolecular forces.
5. Reaction rates of organic compounds are slower than those of inorganic compounds. In contrast to their weak intermolecular forces, the covalent bonds within the organic molecules are very strong. Activation energy, therefore, is very high, and catalysts are often used to increase reaction rates.

Answer the following questions using Tables P and Q of the *Reference Tables for Physical Setting/Chemistry.*

1. All organic compounds must contain the element

(1) hydrogen (2) nitrogen (3) carbon (4) oxygen

2. The four single bonds of a carbon atom are spatially directed toward the corners of a regular

(1) triangle (2) rectangle (3) square (4) tetrahedron

3. Which pair of compounds are isomers?

(1) C_6H_6 and C_6H_{12}
(2) C_2H_4 and C_2H_6
(3) CH_3CH_2OH and CH_3COOH
(4) CH_3CH_2OH and CH_3OCH_3

4. Which compound is an isomer of C_4H_9OH?

(1) $C_3H_7CH_3$ (2) $C_2H_5OC_2H_5$ (3) $C_2H_5COOC_2H_5$ (4) CH_3COOH

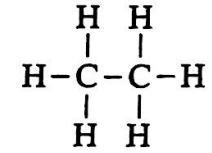
5. As the number of carbon atoms in a hydrocarbon molecule increases, the number of possible isomers generally

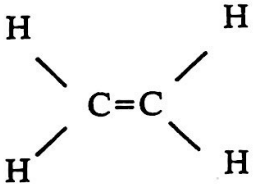
(1) decreases (2) increases (3) remains the same

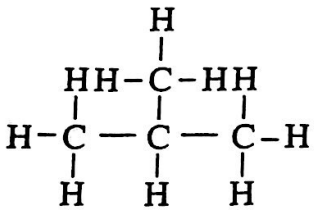
6. In the alkane series, each molecule contains

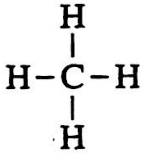
(1) only one double bond
(2) two double bonds
(3) one triple bond
(4) all single bonds

7. Which is the structural formula of methane?

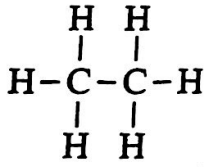
(1) 

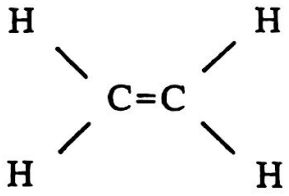
(2) 

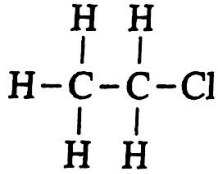
(3) 

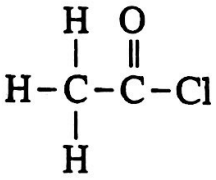
(4) 

8. Which structural formula represents a saturated hydrocarbon?

(1) 

(2) 

(3) 

(4) 

9. What is the formula of pentene?

(1) C_4H_8 (2) C_4H_{10} (3) C_5H_{10} (4) C_5H_{12}

10. What is the total number of pairs of electrons that one carbon atom shares with the other carbon atom in the molecule C_2H_4?

(1) 1 (2) 2 (3) 3 (4) 4

11. Which formula represents an alkene?

(1) CH_4 (2) C_2H_2 (3) C_3H_6 (4) C_4H_{10}

12. In which hydrocarbon series does each molecule contain one triple bond?

(1) alkane (2) alkene (3) alkyne (4) methane

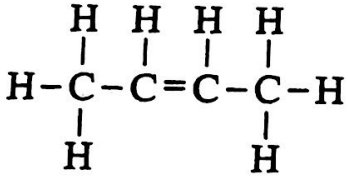
13. Which set of formulas represents members of the same homologous series?

(1) C, CH_4, CH_4O
(2) C_2H_4, C_3H_6, C_4H_8
(3) C_2H_2, C_2H_4, C_2H_6
(4) CH_2, CH_3, CH_4

14. Which hydrocarbon is a member of the series with the general formula C_nH_{2n-2}?

(1) ethyne (2) ethene (3) butane (4) pentene

15. Given the compound:



What is the general formula of the hydrocarbon series of which this compound is a member?

(1) C_nH_{2n+2} (2) C_nH_{2n} (3) C_nH_{2n-2} (4) C_nH_{2n-6}

16. Given the compounds:

$CH_3CH_2CH_2CH_3$ and CH_3CHCH_3 (with CH_3 branch)

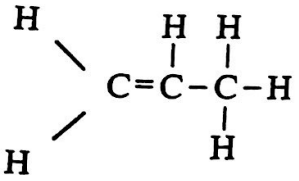
These compounds are both

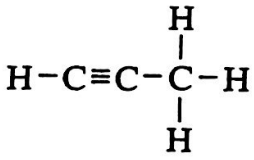
(1) alkynes
(2) alkenes
(3) isomers of butane
(4) isomers of propane

17. The compound $CH_3CH_2CH_2CH_3$ belongs to the series that has the general formula

(1) C_nH_{2n-2} (2) C_nH_{2n+2} (3) C_nH_{n-6} (4) C_nH_{n+6}

18. Which structural formula represents a saturated compound?

(1)


(2)


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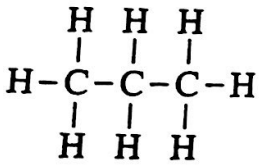

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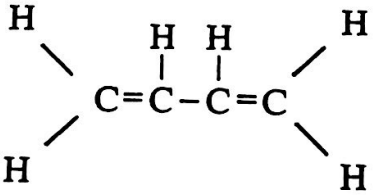


19. Which kind of bond is most common in organic compounds?

(1) covalent (2) ionic (3) hydrogen (4) electrovalent

OTHER ORGANIC COMPOUNDS

Other homologous series of organic compounds are formed by the replacement of one or more hydrogen atoms of a hydrocarbon by atoms of other elements. Members of these series are named from their corresponding hydrocarbons. However, they are not necessarily prepared directly from the compounds from which their names have been derived. Many of these groups have been classified according to the presence of some common particular arrangement of atoms known as functional groups. These groups provide characteristic properties to the compounds that contain them. See *Reference Tables for Physical Setting/Chemistry* Table R.

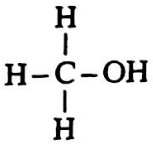
ALCOHOLS

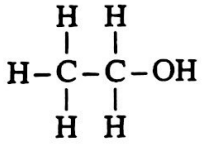
The functional group for this class of organic compounds is the (−OH) group. In alcohols, one or more hydrogens of a hydrocarbon have been replaced by this –OH group. Under ordinary conditions, no more than one –OH group can be attached to a single carbon atom. It should be noted that the –OH group of alcohols does not form the hydroxide ion in aqueous solutions. Therefore, alcohols are not bases.

Alcohols can be classified according to the number of –OH groups contained in each molecule. Monohydroxy (ℓ) alcohols contain one –OH group. Dihydroxy (ℓ) alcohols contain two –OH groups. Those alcohols containing three –OH groups are known as trihydroxy (ℓ) alcohols.

Since the functional group can be attached to any hydrocarbon, it is customary, when describing the classes of compounds to use the letter "R" to represent the rest of the molecule. Following this convention, the general formula for any alcohol is R–OH.

In the IUPAC system, alcohols are named from the corresponding hydrocarbon by replacing the final *-e* with *-ol*. Methanol, CH_3OH, the simplest primary alcohol, is formed by replacing one hydrogen of methane with an –OH group. Ethanol, C_2H_5OH, is formed by replacing one hydrogen of ethane with an –OH group. The structural formulas of these two alcohols are

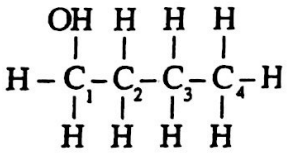




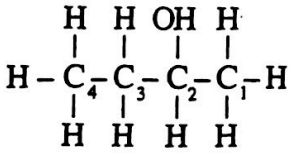
ethanol

Some other alcohols are propanol, C_3H_7OH, butanol, C_4H_9OH, and pentanol, $C_5H_{11}OH$.

On longer chain alcohols, isomers are possible. The OH can be bonded to different carbons in the chain. As in the case with unsaturated hydrocarbons, the carbons in the chain are numbered from one end to the other. Start numbering from the end nearest the functional group. The number of the carbon with the OH preceeds the name of the alcohol.



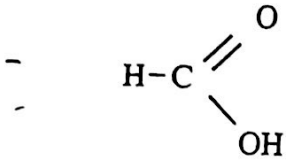
1-butanol



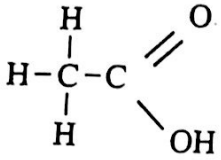
2-butanol

ORGANIC ACIDS

The group of organic compounds known as the organic acids contain the functional group –COOH. Their general formula is RCOOH. Organic acids are named by replacing the final -e of the corresponding hydrocarbon with -oic, and adding the name acid. The first two members of this group are methanoic acid, HCOOH and ethanoic acid , CH_3COOH



methanoic acid

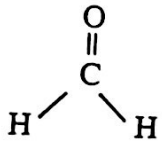


ethanoic acid

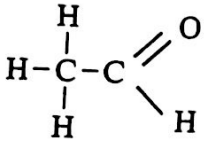
ALDEHYDES

Aldehydes contain the functional group $-C(=O)H$. Their general formula is RCHO They are named by replacing the -e of the corresponding hydrocarbon with -al.

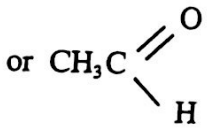
The functional group for aldehydes always comes at the end of the carbon chain. The first two aldehydes are methanal, HCHO, and ethanal, CH_3CHO.



methanal



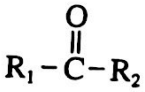
ethanal



ethanal

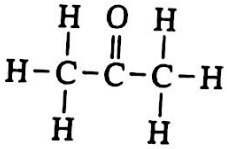
KETONES

The general formula for ketones is



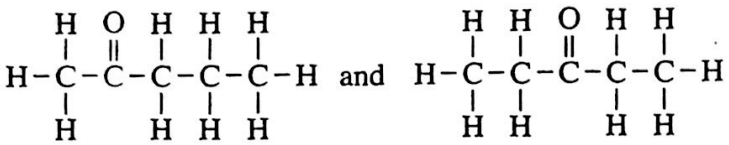
The functional group is $-C(=O)-$ They are named by replacing the *-e* of the corresponding hydrocarbon with *-one*.

The simplest ketone is one in which both R_1 and R_2 are methyl (CH_3) groups.



propanone

Ketones are isomers of aldehydes. The functional group is at the end of the chain for aldehydes but in the middle for ketones. Other examples of ketones are

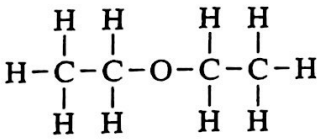


2-pentanone

3-pentanone

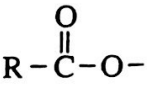
ETHERS

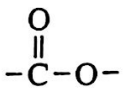
The general formula for the ethers is $R_1 - O - R_2$. The functional group is —O—. Diethyl ether, $C_2H_5OC_2H_5$, is commonly used as a solvent and anesthetic.



diethyl ether

ESTERS

Esters have the general formula  . The functional group is



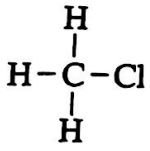
similar to acids, but the oxygen is bonded to R^1 instead of hydrogen. The condensed structural formula would be $RCOOR^1$.

The ester's name uses both the R and the R^1 from its formula. The hydrocarbon R^1 comes first. The *–ane* ending is replaced by *–yl*. The acid resembling RCOO is named last. The *–ic* ending of the acid derivative is replaced by *–ate*.

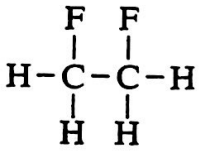
In general:	$RCOOR^1$	is	R^1–*yl* R –*ate*
	$C_2H_5COOCH_3$	is	methyl propanoate
	$HCOOC_2H_5$	is	ethyl methanoate

HALIDES

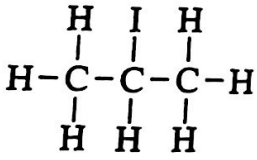
The halogens F, Cl, Br, and I are common addition or substitution products of hydrocarbons. There can be one , two (*di*), three (*tri*), four (*tetra*), or more halogens on one molecule. The halogen name shortens and ends in – o when used as a functional group. Some examples are:



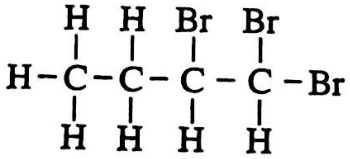
chloromethane



1, 2 – difluoroethane



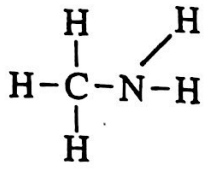
2-iodopropane



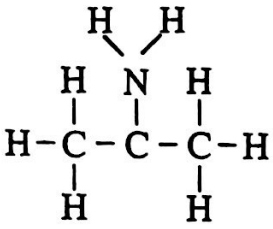
1,1,2-tribromobutane

AMINES

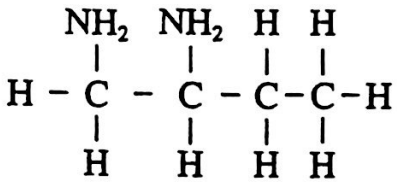
Amines have the functional group $-NH_2$. The general formula for an amine is RNH_2. They are named by dropping the *–e* of the hydrocarbon followed by *–amine*. Some examples are:



methanamine



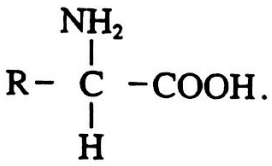
2-propanamine



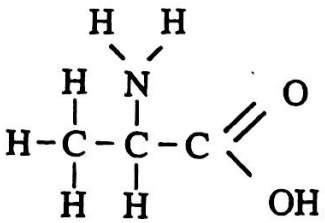
1,2-butandiamine

AMINO ACIDS

Amino acids combine the functional group of acids and amines on the same molecule. They have the general formula :



Proteins are formed by reacting amino acid forming long chains. Simple amino acids can be named using the IUPAC system, but most are complex and common names are used.



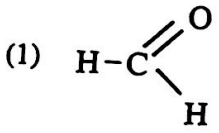
2 – aminopropanoic acid

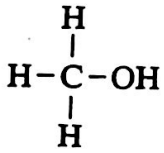
Answer the following questions using Tables P, Q, and R of the *Reference Tables for Physical Setting/Chemistry.*

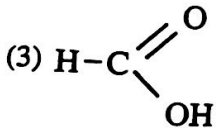
1. Which compound is an electrolyte?

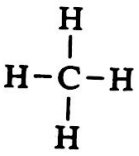
(1) C_2H_5OH (2) $C_3H_5(OH)_3$ (3) CH_3OH (4) CH_3COOH

2. Which is the formula of methanal?

(1) 

(2) 

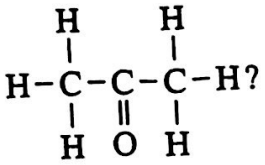
(3) 

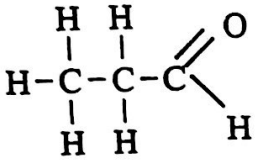
(4) 

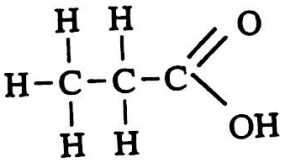
3. Which formula represents an organic acid?

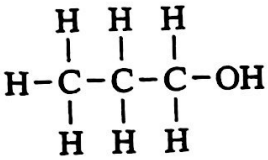
(1) $HCOOCH_3$ (2) CH_3CH_2OH (3) CH_3COCH_3 (4) $HCOOH$

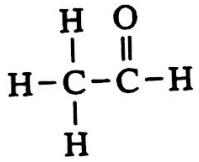
4. Which compound is an isomer of propanone



(1) 

(2) 

(3) 

(4) 

5. Which formula could represent 1,2-ethanediol?

(1) $C_2H_4(OH)_2$ (2) $C_3H_5(OH)_3$ (3) $Ca(OH)_2$ (4) $Co(OH)_3$

6. Which class of compounds has the general formula $R_1–O–R_2$?

(1) esters (2) alcohols (3) ethers (4) aldehydes

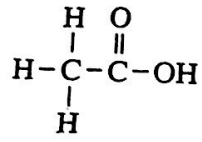
7. What is the minimum number of carbon atoms a ketone may contain?

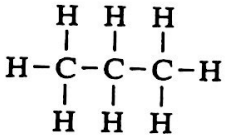
(1) 1 (2) 2 (3) 3 (4) 4

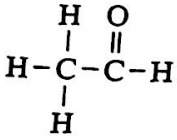
8. Which is the formula for methanoic acid?

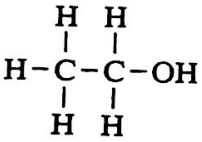
(1) CH_3OH (2) C_2H_5OH (3) HCOOH (4) $HC_2H_3O_2$

9. Which structural formula represents an aldehyde?

(1) 

(2) 

(3) 

(4) 

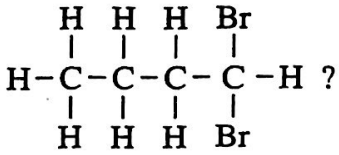
10. Molecules of 1-propanol and 2-propanol have different

(1) percentage compositions
(2) molecular masses
(3) molecular formulas
(4) structural formulas

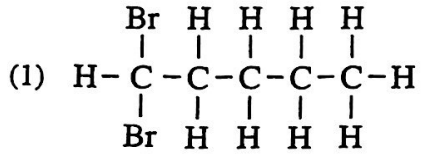
11. In an aqueous solution, which compound will be acidic?

(1) CH_3COOH (2) CH_3CH_2OH (3) $C_3H_5(OH)_3$ (4) CH_3OH

12. Which structural formula represents a compound that is an isomer of



(1)



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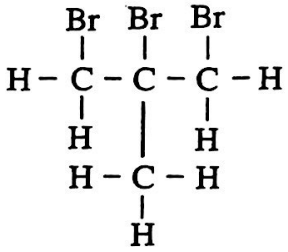

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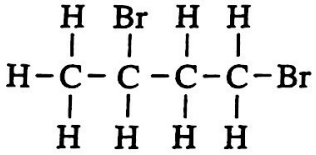

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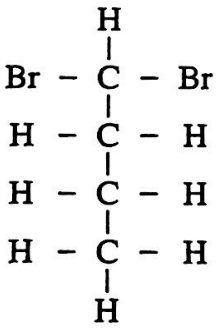


13. A general characteristic of organic compounds is that they all

(1) react vigorously
(2) dissolve in water
(3) are strong electrolytes
(4) melt at relatively low temperatures

14. Compared with the rate of an inorganic reaction the rate of an organic reaction is usually

(1) faster, because the organic particles are ions
(2) faster, because the organic particles are molecules
(3) slower, because the organic particles are ionic
(4) slower because the organic particles are molecules

15. Which is an isomer of $CH_3CH_2CH_2COOH$?

(1) $CH_3CH_2OCH_2CH_3$
(2) $CH_3CH_2CH_2OCH_3$
(3) $CH_3CH_2CH_2CH_2OH$
(4) $CH_3COOCH_2CH_3$

16. Which of the following is an amino acid?

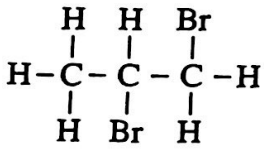
(1) $C_2H_5CH(NH_2)COOH$

(2) HCOOH

(3) $CH_3-\overset{\overset{O}{\|}}{C}-NH_2$

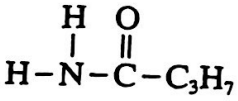
(4) $CH_3CH_2NH_2$

17. What is the name of the following compound?



(1) bromopropane
(2) 1,2-dibromopropane
(3) 3,4-dibromopropane
(4) 3,4-dibromoethane

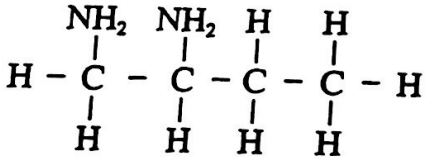
18. What is the class of the following compound?



(1) amine (2) acid (3) amide (4) aldehyde

19. Which of the following is a 2-butanamine?

(1)



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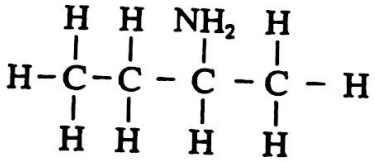

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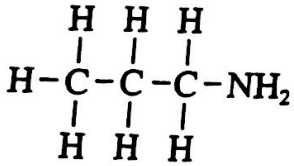

(4)