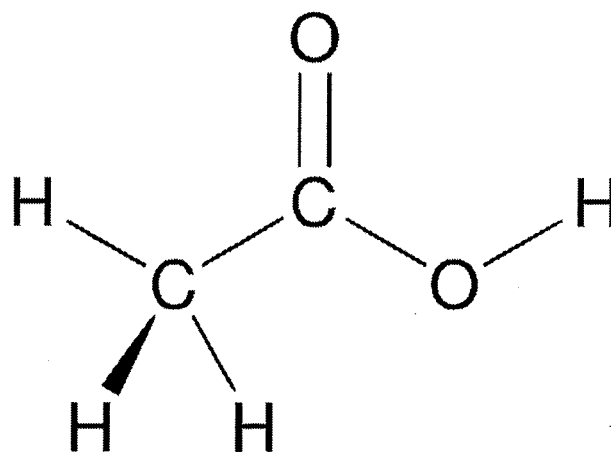
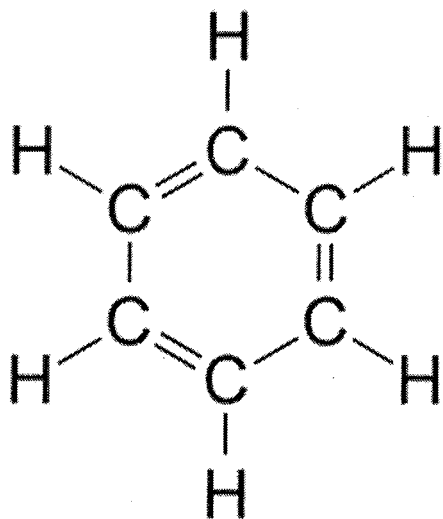
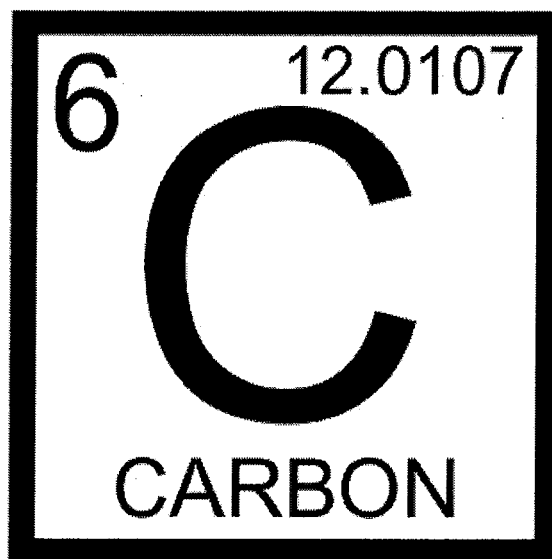


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Mr. GARDNER

Unit #10: ORGANIC CHEMISTRY



Organic Chemistry Vocabulary Terms to know

addition polymerization joining of monomers of unsaturated compounds

addition reaction an organic reaction in which a substance such as hydrogen or a halogen is added to the site of a double or triple bond

alcohol an organic compound containing the hydroxyl group (-OH) as the functional group

aldehyde an organic compound in which the carbonyl group (-C=O) is at the end of a carbon chain

alkane one of a homologous series of saturated hydrocarbons

alkene one of a homologous series of hydrocarbons that contain one double covalent bond

alkyl group a group that contains one less hydrogen atom than an alkane with the same number of carbon atoms

alkyne one of a homologous series of hydrocarbons that contain one triple covalent bond

amide the product obtained from the reaction of an organic acid with an amine

amine an ammonia derivative in which one or more of the hydrogen atoms are replaced by an alkyl group

amino acid an organic compound containing both the amine group (-NH₂) and the carboxylic group (-COOH)

ester the organic product of an esterification reaction containing -COOC- as the functional group

esterification a chemical reaction between an alcohol and an acid to produce an ester and water

ether an organic compound in which oxygen is bonded to two carbon atoms (R₁-O-R₂)

fermentation an organic reaction in which ethanol and carbon dioxide are produced from a carbohydrate

functional group the atom or atoms that replace a hydrogen atom in a hydrocarbon and give a class of organic compounds characteristic properties

homologous series a group of related compounds in which each member differs from the one before it by the same additional unit

hydrocarbon organic compound containing only hydrogen and carbon atoms

hydroxyl group the group comprised of an oxygen atom and a hydrogen atom (-OH) responsible for the properties of alcohols

isomers compounds with the same molecular formula but different structural arrangement

ketone an organic compound in which the carbonyl group (-C=O) is joined to two other carbon atoms

organic acid an organic compound containing one or more carboxyl groups (-COOH)

organic halide an organic compound in which one or more hydrogen atoms have been replaced by an atom of a halogen; also known as a halocarbon

polymer organic compound made up of chains of smaller units bonded together

polymerization an organic reaction in which many small units are joined together to form a long chain

primary alcohol an alcohol with a hydroxyl group attached to a carbon atom at the end of a chain

saponification the reaction of an alkali and a fat to produce glycerol and a soap

saturated (in regard to organic chemistry) organic compounds containing only single covalent bonds

secondary alcohol an alcohol with a hydroxyl group attached to a carbon atom that is attached to two other carbon atoms

substitution reaction one or more hydrogen atoms is removed from a saturated hydrocarbon and replaced by another atom

tertiary alcohol an alcohol with a hydroxyl group attached to a carbon atom that is attached to three other carbon atoms

unsaturated (in regard to organic chemistry) an organic compound containing one or more double or triple covalent bond



Organic Chemistry Key Objectives: You should be able to accomplish these in order to master this topic:

- Define terms on previous page and relate how they fit into organic chemistry
- Compare general properties of organic compounds with those of inorganic (without Carbon) compounds
- Describe the bonding of carbon and write structural formulas for compounds
- Describe how hydrocarbons are obtained from petroleum
- Describe the alkane, alkene, alkyne and benzene series in regards to their formulas, isomers and IUPAC names
- Define and describe the functional groups: alkyl halides, alcohols, ethers, aldehydes, ketones, organic acids, esters, amines, amides and amino acids
- Describe polymers and their production
- Describe the following organic reactions: substitution, addition, fermentation, esterification, saponification, condensation polymerization and addition polymerization

1 **Organic Chemistry**2 **Tables P/Q/R**3 **Organic Chemistry**

- The study of carbon containing compounds.
- All atoms are bonded covalently
- Why is Carbon so special?
 - Has 4 valence electrons
 - Can form 4 bonds with other elements or other C atoms
 - Large #'s of different compounds are possible when chains, rings or networks are formed
 - Catenation=when an atom bonds to other atoms of the same element to form a ring

4 **You use organics in your everyday lives**

- Naturally occurring: petroleum, coal, wood, plant and animals, olive oil, citric acid etc.
- Synthetic: aspirin, plastics, paraffin (wax)
 - Come from petroleum in a process called fractional distillation
 - crude oil is separated into many parts based on boiling points
 - Split into hydrocarbon products such as methane, propane, butane, oils, kerosene, gasoline, etc.

5 **Fractional Distillation**6 **Properties of Organics**

- Saturated: compound with all single bonds
- Unsaturated: compound containing 1 or more multiple bond (double or triple bond)
- Solubility: generally non-polar (when saturated)
 - Soluble in non-polar solvents, or other organics
 - Ex. gasoline is insoluble in water
- Conductivity: generally not good conductors of electricity
 - Some organic acids are weak conductors

7 **Properties of Organics continued**

- Melting Point: relatively low due to weak intermolecular forces (below 300°C)
 - As molecule size ↑, the MP/BP ↑ due to ↑ vanderwaals force between molecules
- Reactivity: generally slow
 - High activation energy required to start rxn
 - Unsaturated organics are more reactive than saturated ones
-

8 **Properties of Organics continued**

- Hydrocarbons: compounds/chains with only C-H and C-C bonds
- Homologous series: Where adjacent members vary by a constant unit (1 extra CH₂ for

alkanes).

- These compounds have similar structures and properties
- Alkane, alkene and alkyne series

■

9 Alkanes: Saturated with all single bonds

- Also called the methane or paraffin series
- General formula $\rightarrow C_nH_{2n+2}$ ($n = \#$ of C atoms)
 - Ex. CH_4, C_2H_6, C_3H_8
 - What is the formula for a compound with 22C atoms or one with 38H atoms
- Structural formula \rightarrow shows all atoms and bonds within a molecule
- Condensed structural formula \rightarrow does not show all the bonds, but is similar to a structural formula
 - Ex. #1 $\rightarrow CH_3CH_2CH_2CH_2CH_2CH_2CH_3$
 - Ex. #2 $\rightarrow CH_3(CH_2)_5CH_3$

10 Alkanes: (C_nH_{2n+2}) all single bonds

- Nomenclature (naming alkanes)
- number of C atoms \rightarrow prefix from table P
- ending added is ane
 - Ex. 5 carbons would be pentane
 - Formula $\rightarrow C_5H_{12}$
 - Ex. 7 carbons would be heptane
 - General formula $\rightarrow C_7H_{16}$

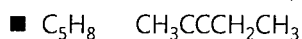
11 Alkenes: (C_nH_{2n})

- contain 1 (or more) double bond
- number of C atoms \rightarrow prefix from table P
- ending added is ene
- Double bond does not have to exist at the end of a chain
 - Ex. 4 carbons would be butene
 - C_4H_8 $CH_2CHCH_2CH_3$
 - 1-butene
 - C_4H_8 $CH_3CHCHCH_3$
 - 2-butene

12 Alkynes: (C_nH_{2n-2})

- or the acetylene series
- contain 1 (or more) triple bond
- number of C atoms \rightarrow prefix from table P
- ending added is yne
- Triple bond does not have to exist at the end of a chain

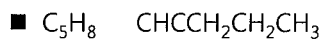
- Ex. 5 carbons would be pentyne



- 2-pentyne

-

-



- 1-pentyne

13 **Multiple Bonds within a compound:**

- Will alternate between single and double bonds

- Diene → 2 double bonds present

- Ex. Butadiene

- Triene → 3 double bonds present

- Ex. Heptatriene

14 **Cyclic or Ring structures:**

- chains can double back and connect with themselves to form a ring

- Cyclopropane cyclooctane

-

-

- Naming Ring Structures:

- cyclo +

- #C atoms(prefix)

- bonding within ring will designate ending (ane/ene/yne)

15 **Benzene Series (Aromatic compounds/Odorous)**

- A six carbon ring with alternating double bonds

- Some representative structures (C_6H_6)

-

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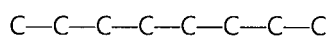
- Toluene or methylbenzene C_7H_8

16 **Benzene derivative:**

17 **Naming Hydrocarbons**

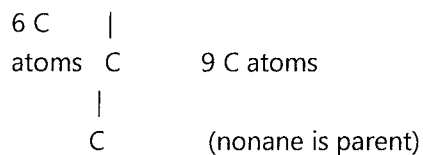
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8 C atoms



|

C

18 **Naming Hydrocarbons continued**

Short branched chains listed at a prefix

19 **Naming Hydrocarbons continued**

If more than 1 of the same type of branch exists, another prefix is needed

20 **Naming Hydrocarbons continued**

Number 'C' atoms so that the branches will occur at the lowest numbered carbons of a chain

- Is it best to have branches at the 2nd, 3rd and 6th carbons or 3rd, 6th and 7th carbons?
- Green group is best choice = 2,3,6-trimethyloctane

21 **Naming Hydrocarbons continued**

- If a chain has no branches, it is known as 'n' or 'normal'
- Ex. n-pentane = or pentane

22 **Naming Alkenes**

- Longest chain = parent
- Number 'C' atoms so that the double bond starts at the lowest #C possible
 - 1-hexene → C=C—C—C—C—C
 - 2-hexene → C—C=C—C—C—C
 - 3-hexene → C—C—C=C—C—C
 - 4-hexene → ?
- Branches are listed after the double bond has been given a number, but are listed at the beginning of the name

23 **Naming Alkynes**

- Same rules as Alkenes
 - 1-butyne → C≡C—C—C
 - 2-butyne → C—C≡C—C
 - 3-butyne → ?

24 **Functional Groups**

- An arrangement of a few atoms that give characteristic properties to an organic molecule
 - See Table R
- An 'H' or hydrogen atom is typically replaced with an atom from another element

(6)

25 **Alkyl Halides or Halogenides (group 17 elements)**

-
- Typical formula R-X (where X is a halogen)
- Naming → Longest chain is the parent
 - halogen listed as prefix
 - 'ine' ending of halogen dropped, 'o' added
 - ex. Iodine → iodo/Chlorine → Chloro

26 **Alkyl Halides continued**

- 2 methods to form these molecules
 - Substitution Rxn: replacement of a hydrogen, in a saturated hydrocarbon, with a halogen
 - $\text{CH}_4 + \text{Cl}_2 \rightarrow \text{HCl} + \text{CH}_3\text{Cl}$ (chloromethane formed)
 -
 - $\text{C}_2\text{H}_6 + \text{Cl}_2 \rightarrow \text{HCl} +$

27 **Alkyl Halides continued**

- Addition Rxn: adding halogens at the site of a multiple bond of an unsaturated hydrocarbon
 - $\text{C}_2\text{H}_4 + \text{Cl}_2 \rightarrow$

- Ethene plus chlorine yields 1,2-dichloroethane
- CFC's (Chlorofluorocarbons) responsible for some ozone depletion

28 **Alcohols**

- Alcohols → O-H group attached
- Primary (1°): O-H is attached at the end of a chain of carbons
 - This 'C' has only 1 other carbon bonded to it
 - R-OH (where R=rest of the molecule/branch)

29 **Alcohols continued**

- Naming
 - Parent = longest 'C' chain
 - Drop 'e' ending and add 'ol'
 - diagram (i) would be methanol
 - also known as methyl alcohol
 - diagram (ii) would be butanol
 - also known as butyl alcohol

i

ii

30 **Secondary (2°)**

- O-H group is attached to a carbon with 2 other carbons bonded to it
 -
 -
 -
- Naming
 - # 'C' atoms and placement of OH group
 - above ex. is 2-propanol
 - also known as isopropanol and *isopropyl alcohol* (rubbing alcohol)

31 Tertiary (3°)

- O-H group is attached to a carbon with 3 other carbons bonded to it.
 -
 -
- Naming
 - Branches named in addition to the OH group
 - Above ex. is 2-methyl 2-propanol or tert butanol or tert-butyl alcohol

32 Diols and Triols

- Dihydroxy Alcohols: diols or glycols
 - Have 2 OH groups attached
 - 1,2-ethanediol or *ethylene glycol (antifreeze)
 -
- Trihydroxy Alcohols: triols
 - Have 3 OH groups attached
 - 1,2,3-propanetriol or *glycerol* (glycerine)

33 Ethers

- 2 carbon chains connected by an oxygen atom
- R_1-O-R_2
- Formed by the addition of 2 alcohols
 - Process known as dehydration synthesis
 - Sometimes called a condensation rxn as water is a byproduct

34 Naming Ethers

- Both Alkyl groups listed alphabetically.
 - Followed by term 'ether'
 - If alkyl groups are the same= di prefix used
 - Ex. dipropyl ether → C-C-C-O-C-C-C
- You may also also see ethers named in order of branch size (not alphabetical)
 - Both can be correct
 - Ex. C-C-C-C-O-C-C could be butylethyl ether or ethylbutyl ether

35 Carbonyl Groups: Aldehydes

(8)

- Contain a C=O double bond (carbonyl)
- Aldehyde: Carbonyl is at the end of a chain
 -
 -
 - R H
 - Naming: drop 'e' of parent and add 'al'
 -
 -
 - Ex. C-C-C-C-C-C H = heptanal

36 Carbonyl groups continued: Ketones

- Ketone: Carbonyl is on an interior 'C' atom
 -
 -
 - R₁ R₂
 - Naming: drop 'e' of parent and add 'one'
 -
 - # the placement of the
 -
 -
 - C-C C-C-C-C-C-C-C = 3-decanone

37 Carbonyl groups continued: Organic or Carboxylic Acids

- Contain a carbonyl and an OH group at the end of a chain
 -
 -
 - R O-H
 - Naming: drop 'e' of parent and add 'oic acid'
 - If more than one= dioic acid etc.
 -
 -
 - Ex. C-C-C O-H = butanoic acid

38 Organic Acids continued

- These are weak acids
 - Acetic acid (vinegar)
 - citric acids (fruits)
 - lactic acid (muscle's in regards to cramping during anaerobic respiration/fermentation)
- Weak electrolytes when dissolved in water
 -
 -
 - O-H is a polar end, thus they are miscible in water

39 **Carbonyl groups continued: Esters**

- Ester: Similar to the acid, but end 'H' has been replaced with another Carbon chain
-
-
- $R_1 \quad O-R_2$
- Esterification: process used to make them
 - A form of dehydration synthesis
 - Organic Acid + alcohol \rightarrow ester + water
-
-
- $C-C-C-C \quad O-H + H-O-C-C \rightarrow C-C-C-C \quad O-C-C + H_2O$

40 **Esters continued**

- Pleasing fragrances/aromas released
 - pineapple, wintergreen etc
- Naming: Drop 'oic acid' and add 'oate'
 - Add alkyl group that is attached to the non-carbonyl oxygen (as a prefix)
 -
 -
 - $O-R$ (alkyl group)
 - What would this be called?

41 **Carbonyl groups continued: Amines**

- Amines: Ammonia (NH_3) derivatives where hydrogen has been replaced with an alkyl group
- Naming: branches listed alphabetically (di, tri etc)
 - Ending of 'amine'
 - 1° , 2° and 3° amines based on the # of alkyl groups present
- (trimethylamine= 3°) (dimethylamine= 2°)
- (ethylmethyl amine= 2°)
-
- Are weak bases in aqueous solutions
- Found in nature and associated with breakdown of proteins in animals

42 **Carbonyl groups continued: Amides**

-
- Amides: contain a $C-N$ bond in the chain
- results from a condensation reaction between an amine and an organic acid
- Naming: 'oic acid' dropped 'amide' added
- Acid + Amine \rightarrow Amide + water

-
-
- R O-H + → + H₂O

43 Carbonyl groups continued: Amino Acids

- Amino Acids: Contain an amine and organic acid
- Are building blocks of proteins
- Molecules will bond together to form long polypeptide chains
-
-
-
- Ex. Glycine Alanine

44 Organic Reactions:

- Substitution: replacement of an atom in a saturated compound
 - $\text{CH}_4 + \text{Cl}_2 \rightarrow \text{CH}_3\text{Cl} + \text{HCl}$
- Addition: adding atoms to an unsaturated compound
 - $\text{CH}_2\text{CH}_2 + \text{Br}_2 \rightarrow \text{CH}_2\text{BrCH}_2\text{Br}$
 - Adding 'H' to an unsaturated = hydrogenation
 - Changing oil (liquid) into fat (solid)
- Condensation/Dehydration synthesis: two molecules combine with loss of water

45 Organic Reactions continued

- Combustion: organic burning in presence of Oxygen
 - Complete: CO₂ and H₂O are products
 - Incomplete: CO, CO₂, C and H₂O result
 - Faulty gas furnace, vehicles etc
- Saponification: addition of an ester and an inorganic base to form a soap and glycerol
 - Ester + Base → glycerol + soap

46 Organic Reactions continued

- Fermentation: decomposition of sugar in the presence of yeast (enzyme = zymase) to produce ethanol and CO₂
 - $\text{C}_6\text{H}_{12}\text{O}_6 \rightarrow 2\text{C}_2\text{H}_5\text{OH} + 2\text{CO}_2$
- Cracking: large molecule broken down due to heat being applied (more useful molecule made)
 - $\text{C}_{20}\text{H}_{40} \rightarrow 5\text{C}_4\text{H}_8$

47 Organic Reactions continued

- Polymerization:
 - Monomer: small/single unit
 - Polymer: large molecule made of joined monomers
 - Addition polymers: chain reaction occurring between monomers with double

bonds.

- ethene → polyethene (polyethylene)
- reaction can be repeated many times

48  **Polymerization continued**


- Condensation polymers: removal of water to form a polymer (dehydration synthesis)
 - may be co-polymers (2 different monomers together)
 - Dimer: when two monomers join

49  **Polymerization continued**

- Natural Polymers: proteins, cellulose, rubber
- Man-made: nylon, Kevlar, polyester
- Three possible structures of polymer chains
 - Linear, branched, cross-linked(network)
 - Linear= HDPE; high density polyethylene (#1,2 recyclables)
 - Branched=LDPE; low density polyethylene (trash bags)
 - Cross-Linked/network= CDPE; cross-linked polyethylene (sturdy crates)

C.7 FUNCTIONAL GROUPS

A functional group is a cluster of atoms that is found in various molecules. The group gives the molecule characteristic properties. Several groups may occur in one molecule giving it a mixture of properties.

Name	General Formula	Structural Formula	Name	Suffix (IUPAC)	Condensed Formula
Alkane	C_nH_{2n+2}	C-C	Ethane	-ane	CH_3CH_3
Alkene	C_nH_{2n}	C=C	Ethene	-ene	CH_2CH_2
Alkyne	C_nH_{2n-2}	$C\equiv C$	Ethyne	-yne	CHCH
Amine	RNH_2	C-C-N	Ethyl amine	amine	$C_2H_5NH_2$
Ether	ROR'	C-O-C	Dimethyl ether	---	CH_3OCH_3
Alcohol	ROH	C-C-OH	Ethanol (ethyl alcohol)	-ol	CH_3CH_2OH
Aldehyde	RCHO	C-C=O	Ethanal (ethyl aldehyde)	-al	CH_3CHO
Ketone	$RCOR'$	$\begin{array}{c} O \\ \\ C-C-C-C \end{array}$	Butanone (methyl ethyl ketone)	-one	$CH_3COC_2H_5$
Carboxylic acid	$RCOOH$	$\begin{array}{c} O \\ // \\ C-C \\ \\ OH \end{array}$	Ethanoic acid (acetic acid)	-oic acid	CH_3COOH
Aromatic	C_nH_n		Benzene	Benzene	C_6H_6
Ester	$RCOOR'$	$\begin{array}{c} O \\ // \\ C-C-C \\ \\ O-C \end{array}$	Methyl propionate (propanoic acid methyl ester)	-oate	$C_2H_5COOCH_3$

R or **R'** stands for the rest of the molecule, other than the functional group, and signifies a group of atoms including at least one carbon atom bonded to the functional group. **R** and **R'** can be the same formula or different, depending on the compound.

Applications of Organic Functional Group Compounds

Simple hydrocarbons	Fuels, reactants
Alcohols	Solvents, reactants
Aldehydes and ketones	Flavorings, adhesives
Carboxylic acids	Preservatives, reactants
Aromatics	Medicines, plastics

C.7 GENERAL IUPAC RULES

General IUPAC Rules

1. Select the longest continuous chain of carbon atoms as the parent compound, and consider all alkyl groups attached to it as branched chains or substituents that have replaced hydrogen atoms of the parent hydrocarbon. If two chains of equal length are found, use the chain that has the larger number of substituents attached to it. The name of the alkane consists of the name of the parent compound prefixed by the names of the alkyl groups attached to it.
2. Number the carbon atoms in the parent carbon chain starting from the end closest to the first carbon that has an alkyl or other group substituted for a hydrogen atom. If the first substituent from each end is on the same-numbered carbon, go to the next substituent to determine which end of the chain to start numbering.
3. Name each alkyl group and designate its position on the parent carbon chain by a number (e.g., 2-methyl means a methyl group attached to carbon number 2).
4. When the same alkyl-group branch chain occurs more than once, indicate this repetition by a prefix (di-, tri-, tetra-, and so forth) written in front of the alkyl group name (e.g., dimethyl indicates two methyl groups). The numbers indicating the positions of these alkyl groups are separated by a comma and followed by a hyphen and are placed in front of the name (e.g., 2,3-dimethyl).
5. When several different alkyl groups are attached to the parent compound, list them in alphabetical order (e.g., ethyl before methyl in 3-ethyl-4-methyloctane). Prefixes are not included in alphabetical ordering (ethyl comes before dimethyl).

Some Examples of Naming Hydrocarbons with Functional groups (IUPAC suffix listed first)

CH_3CH_3	ethane
CH_2CH_2	ethene
CH_3CCCH_3	butyne
$\text{CH}_3\text{CH}_2\text{NH}_2$	ethyl amine, or ethanamine
$\text{CH}_3\text{CH}_2\text{OCH}_3$	ethyl methyl ether (EME), or methoxyethane
$\text{CH}_3\text{CH}_2\text{OH}$	ethanol, ethyl alcohol, or ethyl hydroxide
$\text{CH}_3\text{CH}(\text{OH})\text{CH}_3$	2-propanol, 2-propyl alcohol, or isopropyl alcohol
CH_3CHO	ethanal, or ethylaldehyde
$\text{CH}_3\text{COCH}_2\text{CH}_3$	2-butanone, or methyl ethyl ketone (MEK)
$\text{CH}_3\text{CH}_2\text{CH}_2\text{COOH}$	butanoic acid, butyric acid, or ethylacetic acid
C_6H_6	benzene, or cyclohexatriene
$\text{C}_6\text{H}_5\text{OH}$	phenol, phenyl hydroxide, or hydroxybenzene
$\text{C}_6\text{H}_5\text{NH}_2$	benzenamine, phenylamine, or aminobenzene

Unit 3

A.7 SUPPLEMENT: NAMING BRANCHED ALKANES

Introduction

In this activity, you will either give the name for a molecule or write a condensed formula for the name.

Example 1: $\text{CH}_3-\underset{\text{CH}_2-\text{CH}_3}{\text{CH}}-\text{CH}_2-\text{CH}_3$ **Answer:** The longest chain is 5 carbons with a 1-carbon branch on the third carbon. 3-methylpentane

Example 2: 3-ethylhexane **Answer:** $\text{CH}_3-\text{CH}_2-\underset{\text{CH}_2-\text{CH}_3}{\text{CH}}-\text{CH}_2-\text{CH}_2-\text{CH}_3$

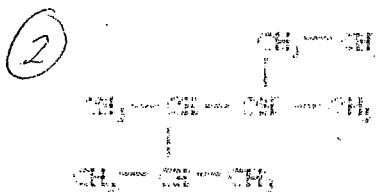
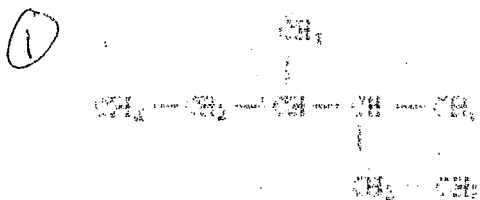
ANSWERS

1. $\text{CH}_3-\underset{\text{CH}_3}{\text{CH}}-\text{CH}_2-\text{CH}_2-\text{CH}_2-\text{CH}_2-\text{CH}_2-\text{CH}_3$ 1. _____
2. $\text{CH}_3-\text{CH}_2-\underset{\text{CH}_2-\text{CH}_3}{\text{CH}}-\text{CH}_2-\text{CH}_2-\text{CH}_2-\text{CH}_3$ 2. _____
3. $\text{CH}_3-\text{CH}_2-\underset{\text{CH}_3}{\text{CH}}-\text{CH}_3$ 3. _____
4. $\text{CH}_3-\text{CH}_2-\text{CH}_2-\underset{\text{CH}_3}{\text{CH}}-\text{CH}_2-\underset{\text{CH}_3}{\text{CH}}-\text{CH}_2-\text{CH}_2-\text{CH}_3$ 4. _____
5. 2-methylpentane 5. _____
6. 3-ethyldecane 6. _____
7. 4-propylheptane 7. _____
8. 2,3-dimethyloctane 8. _____

Name _____

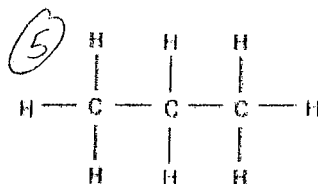
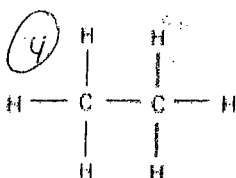
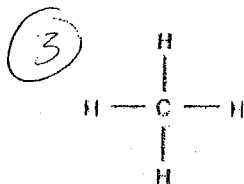
Part I: Name the following alkanes: Remember the key rules

- Find the parent first; this is the longest chain
- Look for branches; number them (to give the lowest amount)
- If more than one of the same branch exists, a prefix such as di or tri is needed



① _____

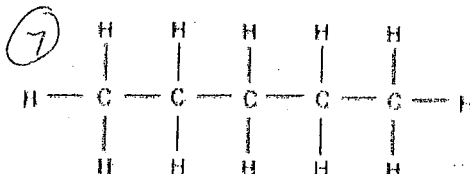
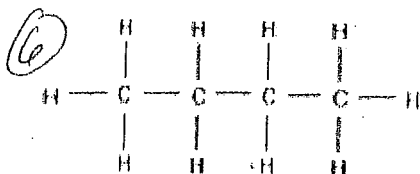
② _____



③ _____

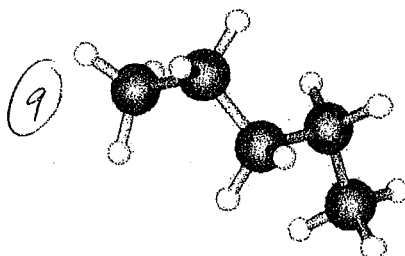
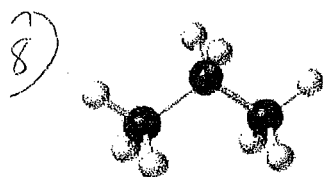
④ _____

⑤ _____



⑥ _____

⑦ _____

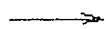
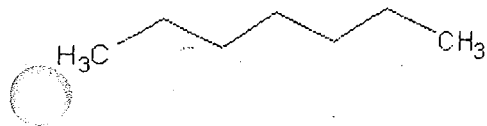


⑧ _____

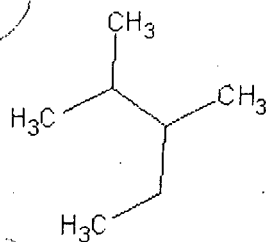
⑨ _____

⑩

10



11



10

11

Part II: Draw the following using structural formulas. Be sure to show all hydrogen atoms.

1) 2,3,5-trimethyloctane

2) 3-propylhexane

3) 2-ethyl, 3-methyl pentane

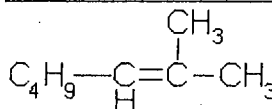
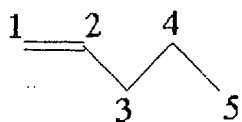
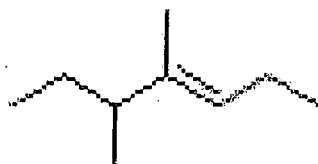
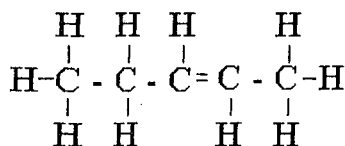
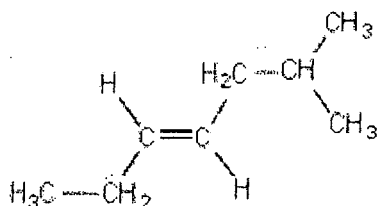
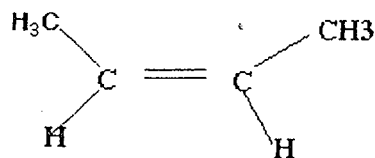
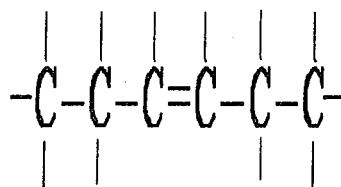
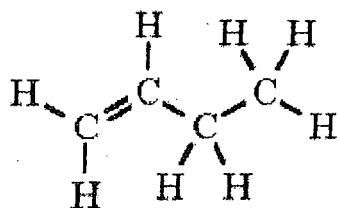
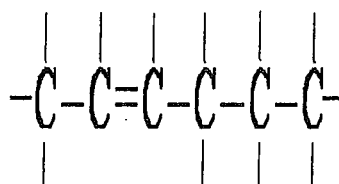
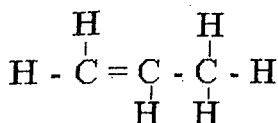
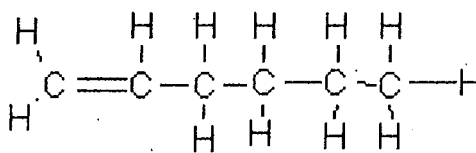
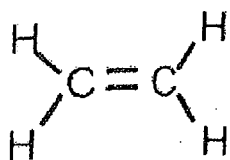
4) 4,4-diethylnonane

5) 2,5-dimethyldecane

17

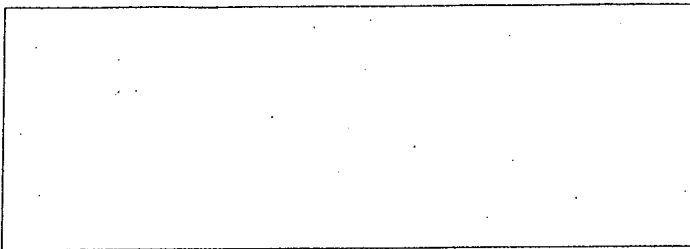
Name _____

Name the Following Alkenes (these are unsaturated hydrocarbons containing at least one double bond)

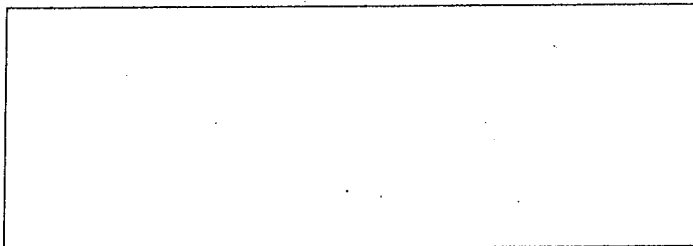


Draw the following Alkene skeletal structures

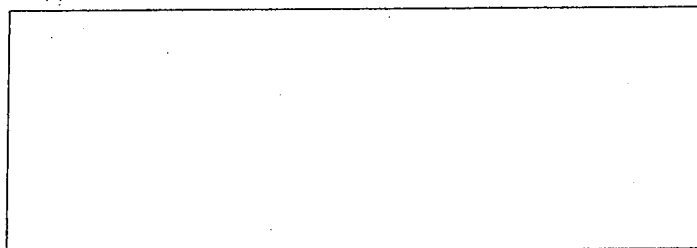
1) 3-octene



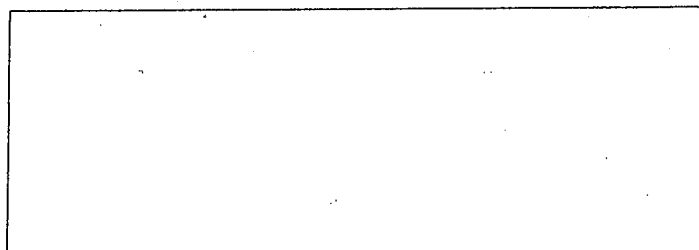
2) 3-ethyl, 4-octene



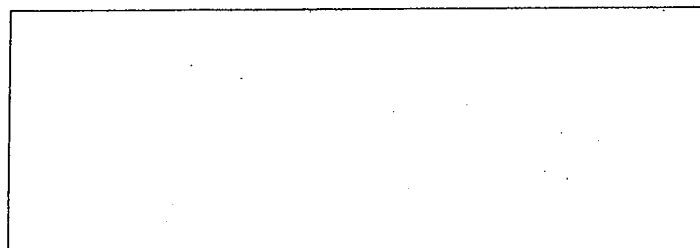
3) 2,6-dimethyl, 3-nonene



4) 4-propyl, 3-heptene



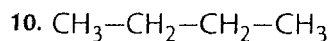
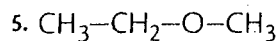
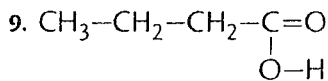
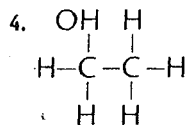
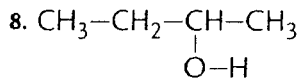
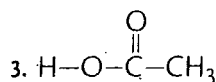
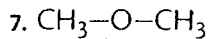
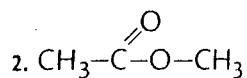
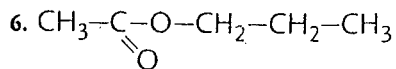
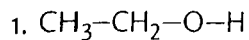
5) 2-methyl, 2-butene



Unit 3

C.4 SUPPLEMENT: BUILDERS

Compounds are classified according to the functional group that is present in their molecular structure. Find and circle the functional group in each molecule, and identify it as either a carboxylic acid, alcohol, ester, ether, or none of the above.



○ Draw the following

① 2-octyne

② cyclononane (yes w/ all Hydrogens)

③ 3-hexanol

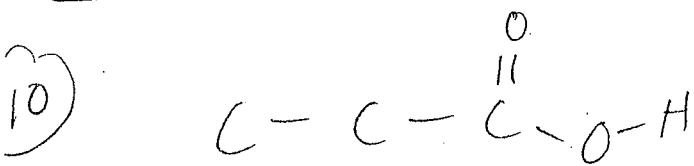
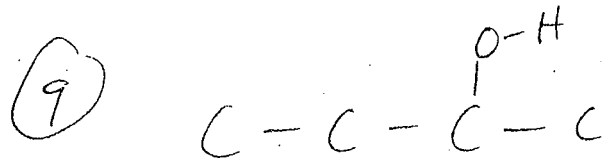
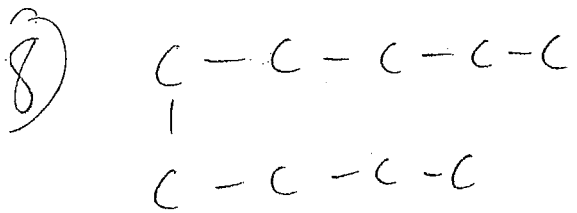
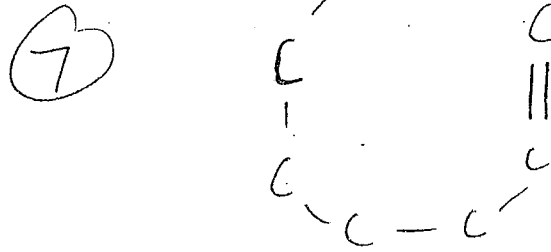
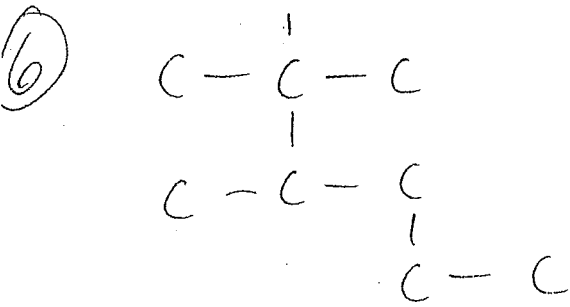
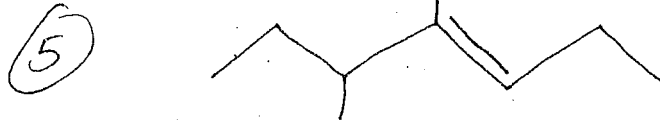
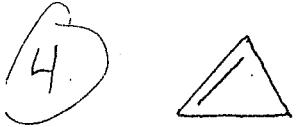
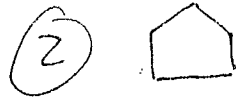
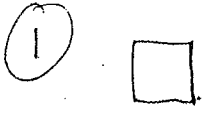
④ heptanoic acid

⑤ 2,4-dimethyl 2-pentene

②

Name _____

Name the Following materials



Draw the following: (show structural formula, condensed structural formula and skeletal formula for each)

1) 2,2-dimethyl 4-ethylnonane

Structural	Condensed Structural	Skeletal

2) cyclohexene

Structural	Condensed Structural	Skeletal

3) 2-pentene

Structural	Condensed Structural	Skeletal

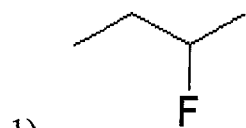
4) 2-propyl 3-heptene

Structural	Condensed Structural	Skeletal

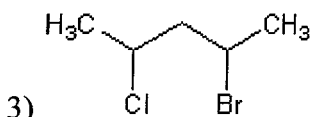
Name _____

Alkyl Halides

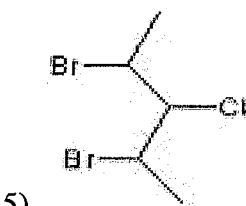
Name the following structures



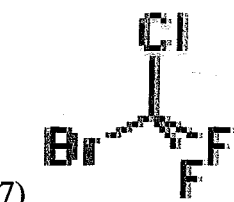
1)



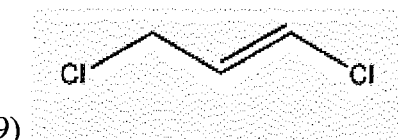
3)



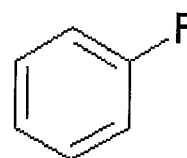
5)



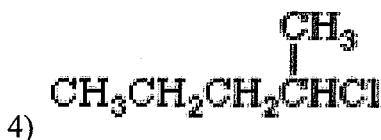
7)



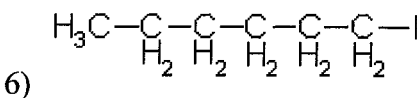
9)



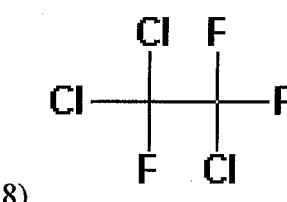
2)



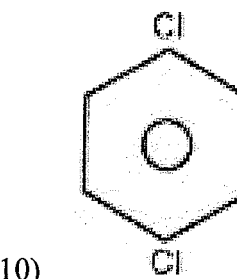
4)



6)



8)



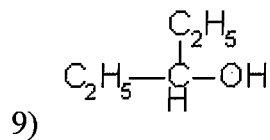
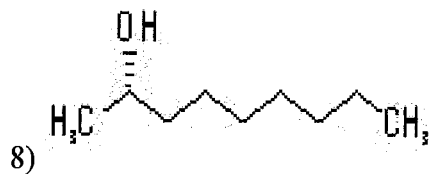
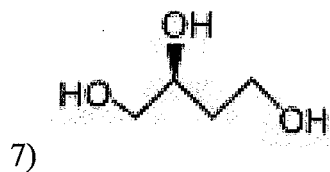
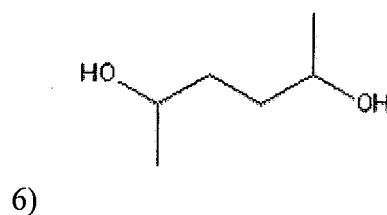
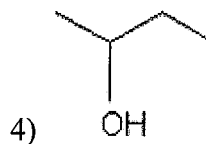
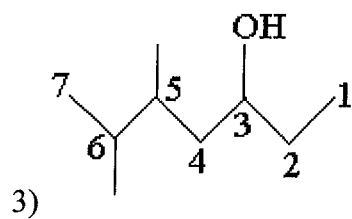
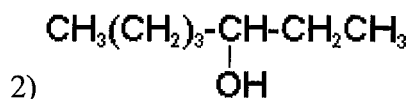
10)

Name _____

Alcohols

Alcohols:

Name the following alcohols



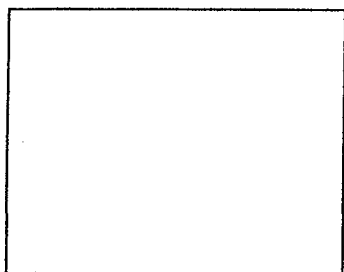
Name _____

A.6 Modeling Alkanes (Text p. 185 for reference)

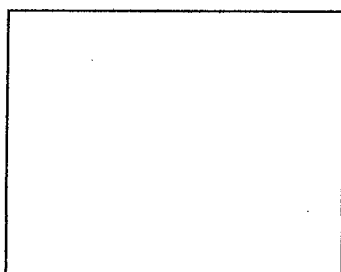
Introduction: In this activity you will draw and assemble models of several simple hydrocarbons. Your goal is to associate the 3-dimensional shapes of these molecules with the names, formulas and pictures used to represent them on paper.

KEY: Black spheres : Carbon
Yellow spheres: Hydrogen

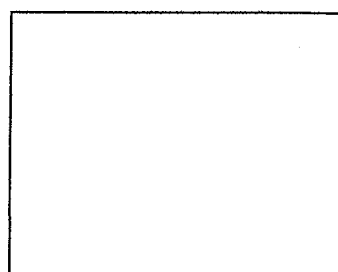
1) Draw the electron dot and structural formulas of methane (CH_4) in the spaces provided. Now assemble a model of methane. Note the angles defined by the bonds are not 90° as you might think. The actual 3D shape of the methane molecule is of a tetrahedron. Draw a representation of this below



Electron dot



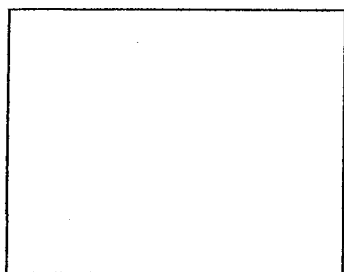
Structural Formula



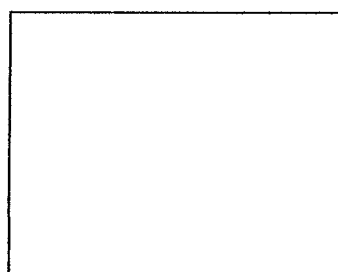
3D tetrahedral appearance

QUESTION: Why would the shape of a methane molecule be tetrahedral? (Hint: consider their angles)

2) Assemble models of a two-carbon and three-carbon alkane molecule. Recall that each carbon atom in an alkane is bonded to four (4) other atoms. For each structure draw a 3D diagram of your molecule and determine the number of each type of atom present.

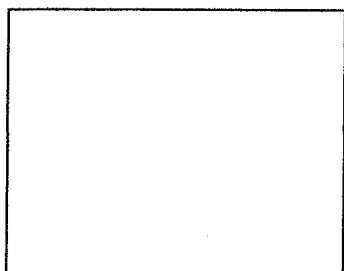


2 carbon alkane
#C ____ #H ____

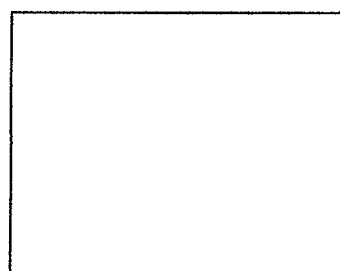


3 carbon alkane
#C ____ #H ____

3) Draw electron dot structures of the 2 above molecules. Include octet/duet circles for Carbon and Hydrogen respectively.



2 carbon alkane



3 carbon alkane

QUESTION: If methane is CH_4 , what are the formulas for these next two alkanes? _____ + _____

(26)

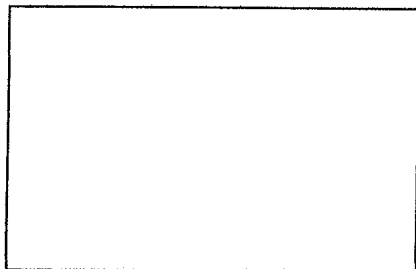
USE TABLE P in your Reference Tables to assist with the following questions

4) Methane (CH_4) is the name for a one-carbon alkane, while the two-carbon alkane is called ethane and the three-carbon alkane is called propane. Using this information and the general formula for alkanes, $\text{C}_n\text{H}_{2n+2}$ (where 'n' is equal to the number of carbon atoms present), predict the formulas and give names for the rest of the first ten alkanes.

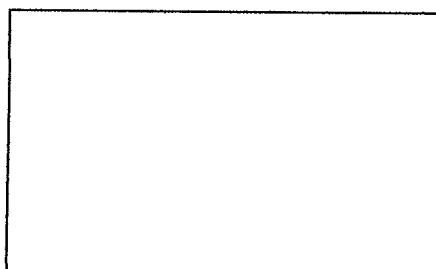
Number of Carbon Atoms	Formula	Name
4		
5		
6		
7		
8		
9		
10		

What is the formula for an alkane with 25 carbon atoms? _____

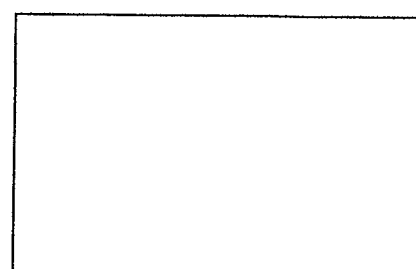
5) Draw structural formulas for the following alkanes



Pentane

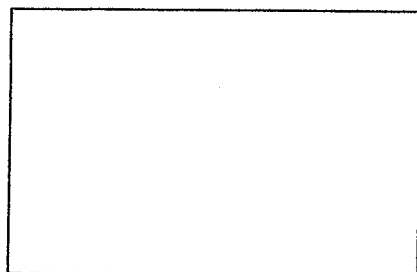


Heptane

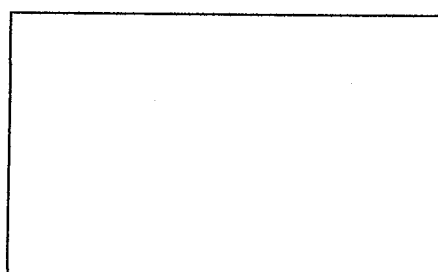


Decane

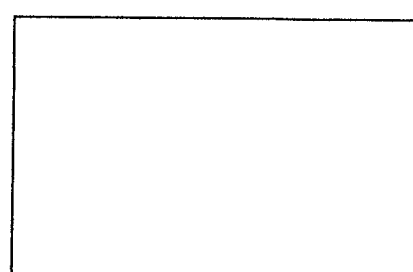
6) Draw electron dot structures for the following alkanes



Butane



Hexane



Octane

7) Knowing that a carbon has a mass of 12 g/mol and Hydrogen has a mass of 1 g/mol, a mole of Methane (CH_4) must have a mass of 16 g/mol. Use this knowledge to determine the alkanes with the following mass (Hint: they are not just multiples of 16g/mol)

- a) The alkane with a mass of 30g/mol is _____
b) The alkane with a mass of 58g/mol is _____
c) The alkane with a mass of 114g/mol is _____

Name _____

Period _____ Day _____

Substituted Hydrocarbons

Directions for the following Organic Functional Groups:

- 1) Give the structural formula for each of the following molecules
- 2) Give the IUPAC name for each of the following
- 3) Give the common name for those structures with appropriate space provided

Alkyl halides

CH_3Cl IUPAC _____	CHCl_3 IUPAC _____	CCl_4 IUPAC _____
---	--	---

Alcohols

Primary Alcohol CH_3OH IUPAC _____	Primary Alcohol $\text{C}_2\text{H}_5\text{OH}$ IUPAC _____	Dihydroxy Alcohol $\text{CH}_2\text{OHCH}_2\text{OH}$ IUPAC _____ Common Name _____
Secondary Alcohol $\text{CH}_3\text{CHOHCH}_3$ IUPAC _____ Common Name _____	Secondary Alcohol $\text{CH}_3\text{CHOHCH}_2\text{CH}_3$ IUPAC _____	Trihydroxy Alcohol $\text{CH}_2\text{OHCHOHCH}_2\text{OH}$ IUPAC _____ Common Name _____

Ethers

$\text{C}_2\text{H}_5\text{OC}_2\text{H}_5$ IUPAC _____	$\text{C}_2\text{H}_5\text{OCH}_3$ IUPAC _____	$\text{C}_3\text{H}_7\text{OC}_4\text{H}_9$ IUPAC _____
--	---	--

Aldehydes

HCHO	CH_3CHO	$\text{C}_3\text{H}_7\text{CHO}$
IUPAC _____ Common Name _____	IUPAC _____	IUPAC _____

Ketones

CH_3COCH_3	$\text{C}_2\text{H}_5\text{COCH}_3$	$\text{C}_2\text{H}_5\text{COC}_3\text{H}_7$
IUPAC _____ Common Name _____	IUPAC _____	IUPAC _____

Organic/Carboxylic Acids

HCOOH	CH_3COOH	$\text{C}_2\text{H}_5\text{COOH}$
IUPAC _____ Common Name _____	IUPAC _____ Common Name _____	IUPAC _____

Esters

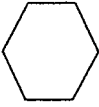
$\text{CH}_3\text{COOCH}_3$	$\text{CH}_3\text{COOC}_3\text{H}_7$	$\text{C}_2\text{H}_5\text{COOCH}_3$
IUPAC _____	IUPAC _____	IUPAC _____

Procedure

- For each of the following compounds, build a model of the compound.
Remember: Carbon = Black Hydrogen = Yellow
Single Bond = 1 Stick Double Bond = 2 Springs Triple Bond = 3 Springs
- Give the chemical formula and the structural formula

2-pentene	1-butene	propene
3-hexene	3-heptene	ethene
2-hexyne	1-pentyne	2-heptyne
2-butyne	cyclobutane	cyclopentane

Give the names of the following structures

$ \begin{array}{c} \text{CH}_2 \\ / \quad \backslash \\ \text{H}_2\text{C} \quad \text{CH}_2 \\ \quad \\ \text{H}_2\text{C} \quad \text{CH}_2 \\ \backslash \quad / \\ \text{CH}_2 \end{array} $	$\text{CH}_3\text{CH}_2\text{C}\equiv\text{CCH}_3$	$\text{CH}_3\text{CH}=\text{CHCH}_3$
$\text{CH}\equiv\text{CCH}_3$	$\text{CH}_3\text{C}\equiv\text{CCH}_2\text{CH}_2\text{CH}_3$	$\text{CH}\equiv\text{CH}$
	$\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}=\text{CHCH}_3$	$\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}=\text{CH}_2$
$\text{CH}_3\text{CH}_2\text{C}\equiv\text{CH}$	$\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}=\text{CH}_2$	$\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}=\text{CH}_2$

Name _____

Isomers

Introduction: In this activity you will use the ball and stick models to investigate the variations that may occur in alkane structure, which may lead to different properties.

Procedure:

- 1) Assemble a model of C_4H_{10} . Compare your model with those built by others.
 - a. How many possible structures of C_4H_{10} are there? _____
 - b. Draw structural formulas of the possible combinations.

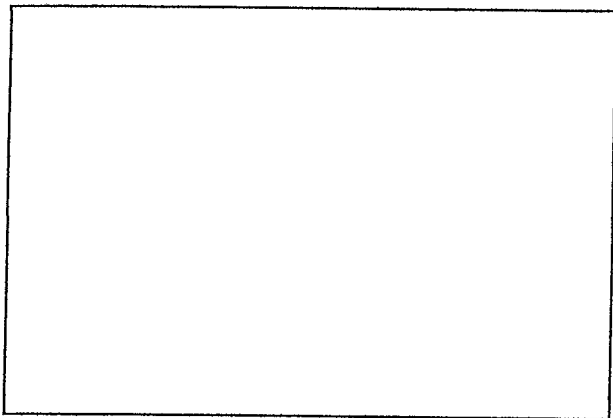
Molecules with identical molecular formulas, but different arrangements of atoms are called **isomers**. The formation of isomers allows for very large numbers of organic compounds.

- 2) Draw an electron dot formula for each isomer of C_4H_{10} . (include all electrons and overlapping circles showing the octets/duets)

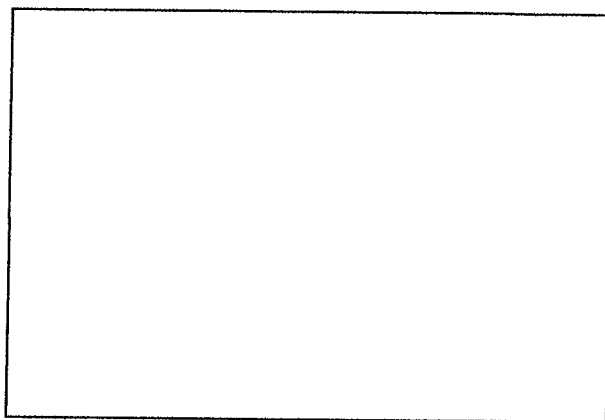
- 3) The number of different isomers increases rapidly as the number of carbon atoms increases. For example, there are 3 isomers of propane (C_5H_{12}). Build and then draw the structural formulas for these isomers.

4) Now consider hexane, C_6H_{14} .

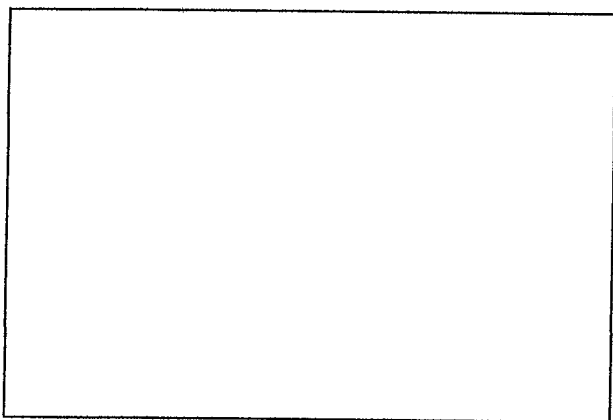
- a. Draw the 5 isomers that are possible. Remember to keep in mind the longest chains and possible branches, so as to not repeat any structures. Make them if you need a visual model.
- b. Try to name each structure following proper naming rules.



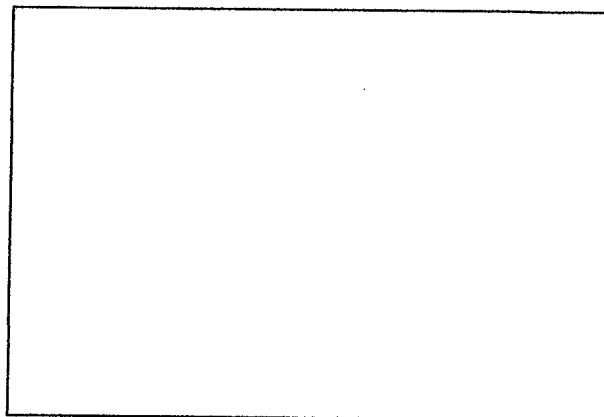
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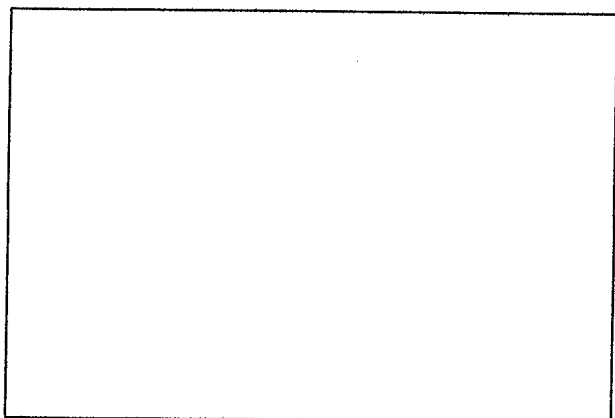
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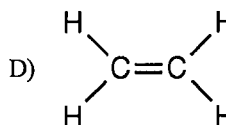
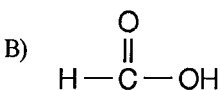
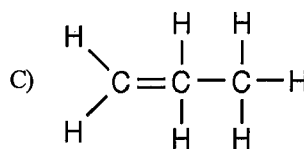
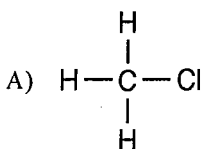
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Name: _____

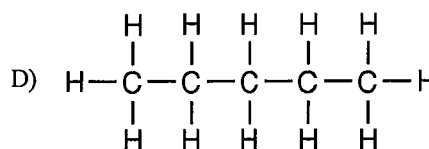
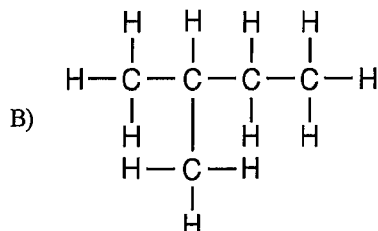
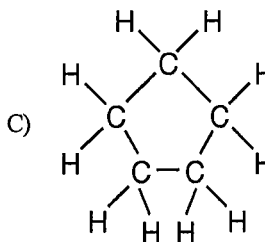
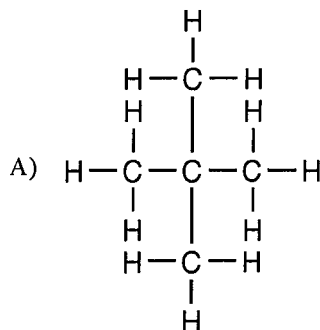
- ___ 1) All organic compounds must contain the element
 A) phosphorus B) carbon C) nitrogen D) oxygen
- ___ 2) An unknown substance, liquid *X*, is tested in the laboratory. The chemical and physical test results are listed below.
- d Nonconductor of electricity
 - d Insoluble in water
 - d Soluble in hexane
 - d Low melting point as a solid
 - d Combustion produces only CO_2 and H_2O

Based on these results, a student should conclude that liquid *X* is

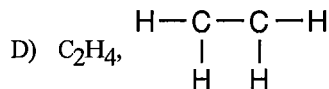
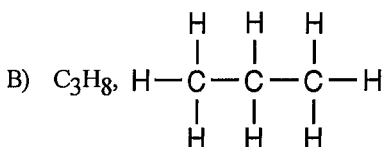
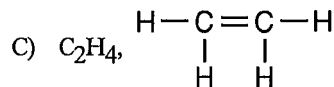
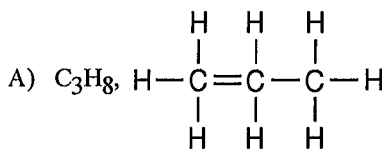
- A) covalent and inorganic
 - B) ionic and inorganic
 - C) ionic and organic
 - D) covalent and organic
- ___ 3) Which structural formula is incorrect?



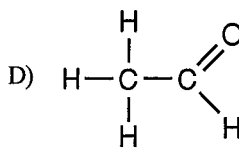
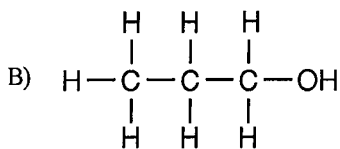
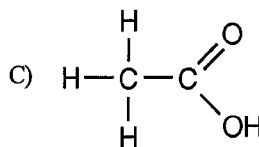
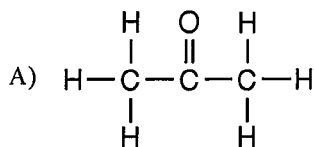
- ___ 4) Molecules of 2-methyl butane and 2,2-dimethyl propane have different
- A) numbers of covalent bonds
 - B) numbers of carbon atoms
 - C) molecular formulas
 - D) structural formulas
- ___ 5) The compounds CH_3OCH_3 and $\text{CH}_3\text{CH}_2\text{OH}$ are isomers of each other. These two compounds *must* have the same
- A) melting point
 - B) molecular formula
 - C) reactivity
 - D) density
- ___ 6) Which structural formula represents a molecule that is *not* an isomer of pentane?



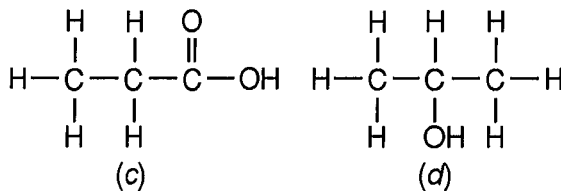
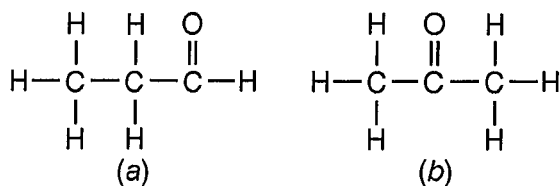
- ___ 7) In saturated hydrocarbons, carbon atoms are bonded to each other by
 A) alternating double and triple covalent bonds
 B) alternating single and double covalent bonds
 C) single covalent bonds, only
 D) double covalent bonds, only
- ___ 8) Which formula represents a molecule of a saturated hydrocarbon?
 A) C_2H_2
 B) C_6H_6
 C) C_4H_{10}
 D) C_5H_8
- ___ 9) Which organic compound is unsaturated?
 A) 2-chloropropane
 B) 2-hexanol
 C) 2-methylbutane
 D) 2-pentene
- ___ 10) The empirical formula of a compound is CH_2 . Which molecular formula is correctly paired with a structural formula for this compound?



- ___ 11) What is the total number of electron pairs that are shared between the two carbon atoms in a molecule of ethyne?
 A) 1
 B) 2
 C) 3
 D) 4
- ___ 12) Which formula represents propyne?
 A) C_3H_6
 B) C_3H_4
 C) C_5H_{10}
 D) C_5H_8
- ___ 13) Which compound is an alcohol?
 A) ethyne
 B) butane
 C) methanol
 D) propanal
- ___ 14) Which structural formula represents an alcohol?



___ 15) Given the formulas of four organic compounds:



Which pair below contains an alcohol and an acid?

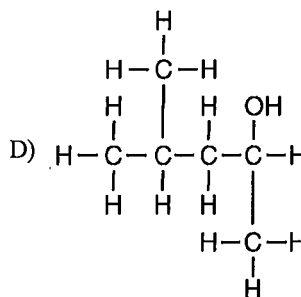
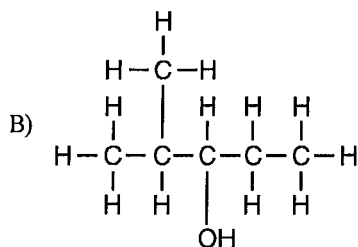
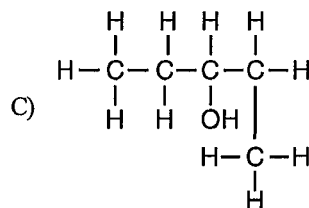
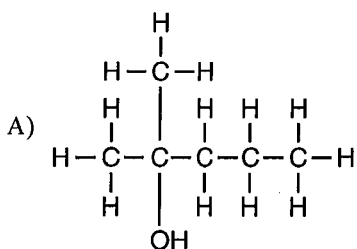
A) *a* and *c*

B) *c* and *d*

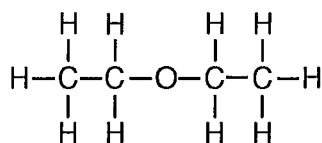
C) *a* and *b*

D) *b* and *d*

___ 16) Which structural formula is correct for 2-methyl-3-pentanol?



___ 17) Given the structural formula:



The compound represented by this formula can be classified as an

A) organic acid

B) aldehyde

C) ether

D) ester

___ 18) The functional group -COOH is found in

A) organic acids

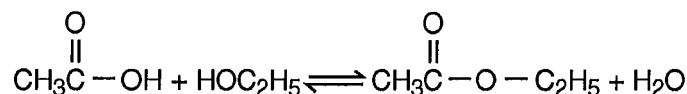
B) aldehydes

C) esters

D) alcohols

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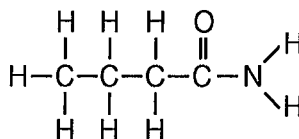
___ 19) Given the reaction:



This reaction is an example of

- A) esterification
B) saponification
C) fermentation
D) hydrogenation

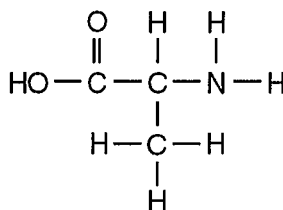
___ 20) Given the formula:



This compound is classified as

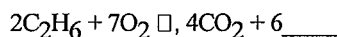
- A) an aldehyde
B) a ketone
C) an amide
D) an amine

___ 21) The molecule below belongs to which class of compounds?



- A) aldehyde
B) amino acid
C) ester
D) alcohol

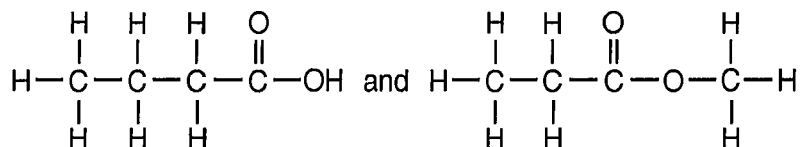
___ 22) Given the incomplete equation for the combustion of ethane:



What is the formula of the missing product?

- A) H_2O
B) H_2O_2
C) CH_3OH
D) HCOOH

___ 23) Given the structural formulas for two organic compounds:



The differences in their physical and chemical properties are primarily due to their different

- A) number of carbon atoms
B) number of hydrogen atoms
C) functional groups
D) molecular masses

___ 24) The process of joining many small molecules into larger molecules is called

- A) polymerization
B) substitution
C) neutralization
D) saponification

___ 25) In which reaction is soap a product?

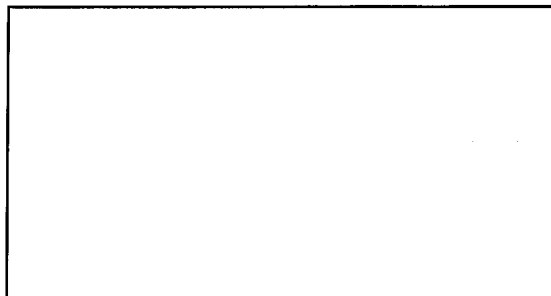
- A) polymerization
B) substitution
C) addition
D) saponification

___ 26) Identify the homologous series of hydrocarbons to which CH_3CHCH_2 belongs.

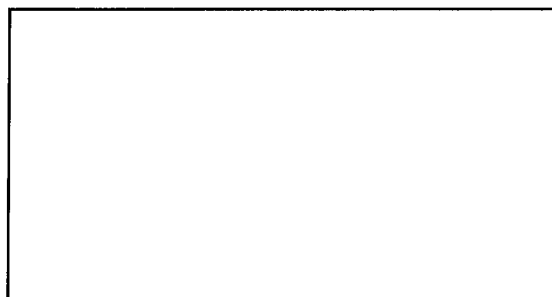
(31)

___ 27) Diethyl ether is widely used as a solvent.

Draw the structural formula for diethyl ether.

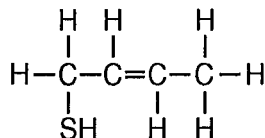


___ 28) Draw the structural formula for butanoic acid.



Questions 29 and 30 refer to the following:

A thiol is very similar to an alcohol, but a thiol has a sulfur atom instead of an oxygen atom in the functional group. One of the compounds in a skunk's spray is 2-butene-1-thiol. The formula of this compound is shown below.

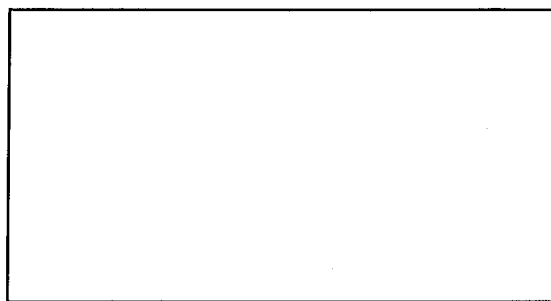


___ 29) Explain, in terms of composition, why the compound described is a thiol.

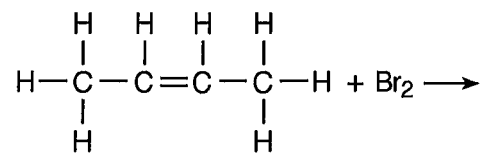
___ 30) Explain, in terms of electron configuration, why oxygen atoms and sulfur atoms form compounds with similar molecular structures.

___ 31) How is the bonding between carbon atoms different in unsaturated hydrocarbons and saturated hydrocarbons?

___ 32) Draw the structural formula for the hydrocarbon $\text{CH}_3\text{CH}_2\text{CHCH}_2$.



___ 33) In the space to the right of the reactants and arrow below, draw the structural formula for the product of the reaction shown.



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Slime Lab

Name _____

Purpose: To create slime and test its properties.

Slime # 1 procedure:

1. Add 2 teaspoons of glue into a paper cup.
2. Add 2 teaspoons of water and stir well.
3. Add 1 or 2 drops of food coloring if desired and mix well.
4. Add 1 1/2 teaspoons of borax solution and stir well.
5. When slime has mostly formed, reach in and take it out of the cup
6. Knead the slime to make a consistent texture.
7. If slime is too sticky add a very small amount of borax and stir well.
8. If slime is way too sticky add more glue.

Slime #2 procedure:

1. Add 2 teaspoons of glue into a paper cup.
2. Add 1 or 2 drops of food coloring if desired and mix well.
3. Stir in about 1 teaspoon of liquid starch and stir well.
4. Slime will be a little runnier than silly putty. If it is too sticky to handle, add a small amount of liquid starch and stir well.
5. Knead the slime to a consistent texture.

For each of the two slimes, try the following:

1. Stretch the slime slowly. What happens?

#1 _____

#2 _____

2. Compress the slime back into a ball and stretch it quickly. What happens?

#1 _____

#2 _____

3. Put the slime down on the table and leave it for 1 or 2 minutes. What happens?

#1 _____

#2 _____

4. Shape the slime into a ball. Drop the ball onto the table. What happens?

#1 _____

#2 _____

5. Shape the slime into a ball. Poke it with your finger slowly. What happens?

#1 _____

#2 _____

6. Shape the slime into a ball. Poke it with your finger quickly. What happens?

#1 _____

#2 _____

Non-Newtonian Fluids

A fluid is a substance that flows. Gases and liquids are fluids. The ability to flow is called viscosity. Some fluids have low viscosity, like water, and flow with very little resistance. Some fluids have high viscosity, like molasses, and flow slowly.

Sir Isaac Newton thought that viscosity was dependent only on temperature. He was right that fluids do have higher viscosity at lower temperatures. However, some fluids also depend on how much force is applied to them. For these substances, called non-Newtonian fluids, gentle, slow forces placed on them result in lower viscosities and fast, strong forces placed on them result in higher viscosities. Examples of non-Newtonian fluids are quicksand and yogurt.

7. After reading the above, look at your responses to questions 1 – 6. Are the two slimes non-Newtonian fluids? Explain your answer.

#1 _____

#2 _____

NOTE: Organic Chemistry can be hard as there is a lot of naming and groups or compounds...Be sure to use your reference tables to help as a guide when naming these.

Remember...You get out of it what you put into it!

Organic Chem

Mr. Gardner