

# Answers

## Naming Organic Compounds

- Because there are several million organic compounds known, the IUPAC system of naming has been developed (IUPAC stands for International Union of Pure and Applied Chemistry).
- Each compound is named according to the number of carbon atoms it has in the longest continuous chain and the position of any functional groups or side chains.
- Prefixes and suffixes are used to identify the functional groups present
- The naming of the longest continuous chain is based on the root name:
- The Root name is a code which tells the number of carbons.

### The Alkanes

- The alkane family represent the simplest of the hydrocarbons.
- General formula is  $C_nH_{2n+2}$  where 'n' equals the number of carbon atoms in the molecule
- The prefix in the name of each compound indicates the number of carbon atoms present.
- All alkanes have a suffix of *-ane*

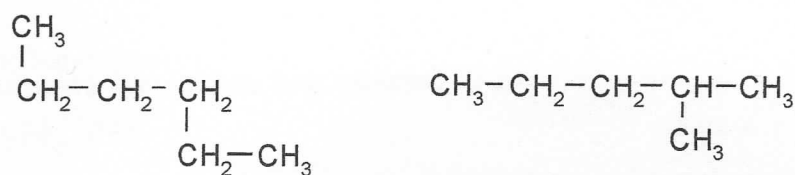
Give the name, molecular formula, structural formula and condensed structural formula of each of the first 8 alkanes:

Prefix	No. of carbons	Name	Molecular Formula	Condensed Structural Formula
Meth	1	methane	$CH_4$	$CH_4$
Eth	2	ethane	$C_2H_6$	$CH_3CH_3$
Prop	3	propane	$C_3H_8$	$CH_3CH_2CH_3$
But	4	butane	$C_4H_{10}$	$CH_3CH_2CH_2CH_3$
Pent	5	pentane	$C_5H_{12}$	$CH_3CH_2CH_2CH_2CH_3$

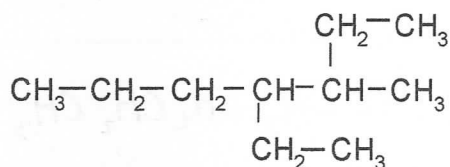
Hex	6	hexane	$C_6H_{14}$	$CH_3CH_2CH_2CH_2CH_2CH_3$
Hept	7	heptane	$C_7H_{16}$	$CH_3CH_2CH_2CH_2CH_2CH_2CH_3$
Oct	8	octane	$C_8H_{18}$	$CH_3CH_2CH_2CH_2CH_2CH_2CH_2CH_3$

### Alkyl Groups

- Carbon chains are not rigid structures. When we say that an alkane has a "straight" chain, we don't really mean straight. We mean it is a continuous chain, rather than a branched chain. The two structures below have 6 carbon atoms. The one on the left is "straight" while the one on the right is "branched"



- Most alkanes exist as "branched" molecules. The longest continuous chain is the parent chain and it doesn't have to be straight!
- Once the parent is identified, the side chains are then named. These are called alkyl groups. Their general formula is  $C_nH_{2n+1}$ .
- Alkyl groups are named with the same prefixes as the alkanes. The suffix is changed from "ane" to "yl".



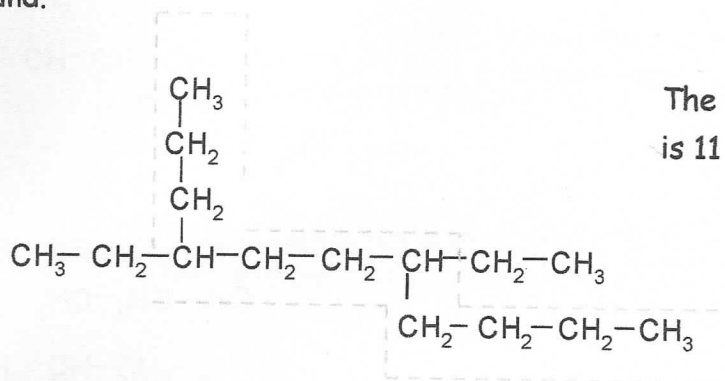
The longest continuous chain is 7 carbons  
 $\Rightarrow$  heptane

On carbon 3 is a methyl group and carbon 4 has an ethyl group so it is named 4 ethyl, 3 methyl heptane

- To name any alkane we need to follow a few rules

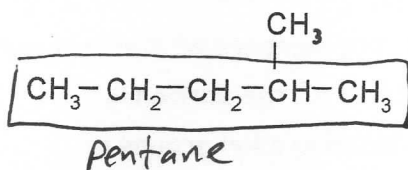
### Rule 1:

Locate the longest continuous chain of carbon atoms. This will give you the name of the "parent" compound.

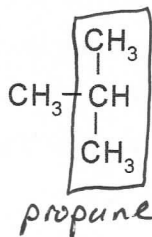


Draw a box around the longest continuous chain of carbon atoms in the structures below and name the parent compound for each one:

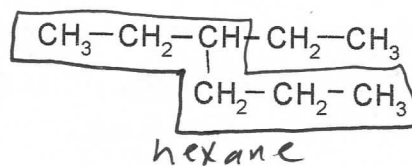
2 right answers



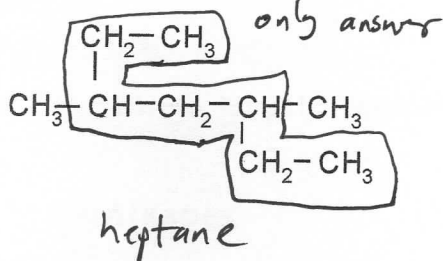
3 right answers



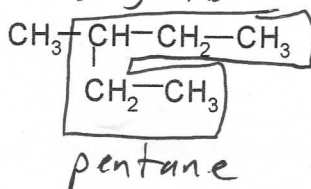
2 right answers



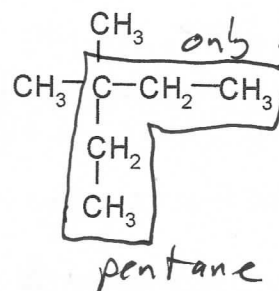
only answer



only answer



only answer

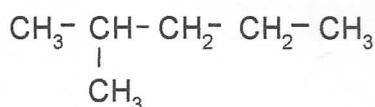


### Rule 2:

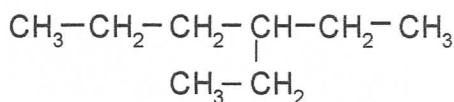
The name of the parent compound is modified by noting what alkyl groups are attached to the chain. Number the longest chain so that the alkyl group(s) will be on the lowest numbered carbon.

Name the following alkanes given the first one:

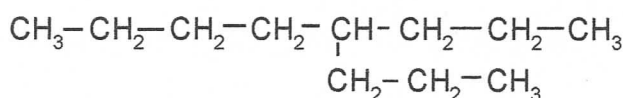
2 methyl pentane



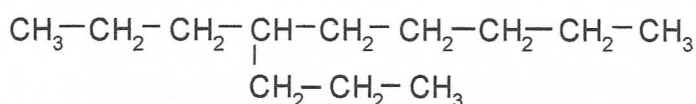
3-ethylhexane



4-propyloctane

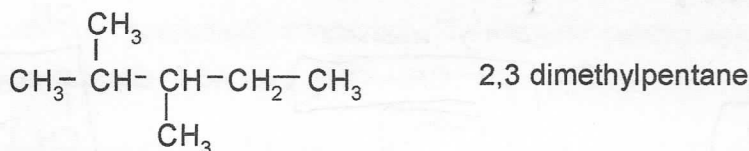


4-propylnonane



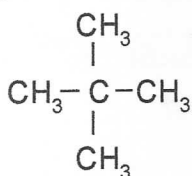
**Rule 3:**

When the same alkyl group occurs more than once in a molecule, the numbers of the carbons to which they are attached are all included in the name. The number of the carbon is **repeated** as many times as the group appears. The number of repeating alkyl groups is indicated by the use of prefixes; di, tri, tetra, etc....

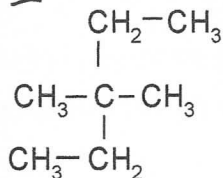


Name the four molecules whose structures are drawn below:

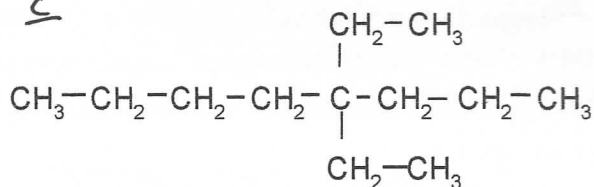
A



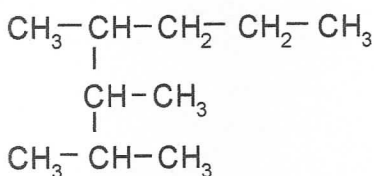
B



C



D



A 2,2-dimethylpropane

B 3,3-dimethylpentane

C 4,4-diethyloctane

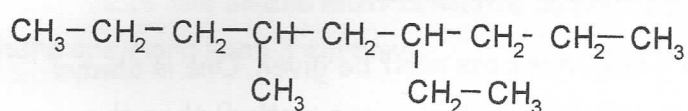
D 2,3,4-trimethylheptane

### Rule 4:

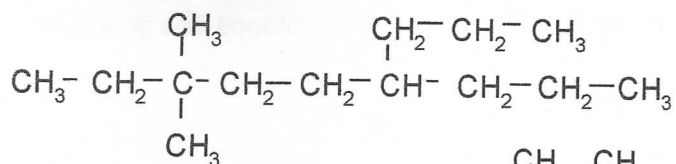
If there are two or more different kinds of alkyl groups attached to the parent chain, name them in alphabetical order. (di, tri, etc do not factor in alphabetically. see 0 below)



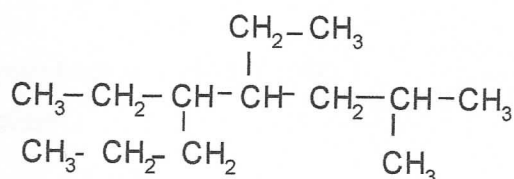
### Name these four molecules



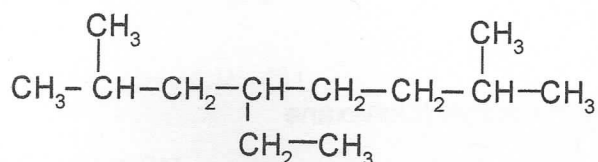
A: 4-ethyl-6-methylnonane



B: 6-propyl-3,3-dimethylnonane



C: 4-ethyl-2-methyl-5-propyloctane

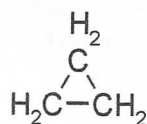


D:

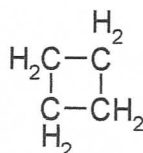
4-ethyl-2,7-dimethyloctane

### Cyclic Alkanes

- Carbon atoms can form rings which result in the formation of cyclic alkane molecules with the general formula  $C_nH_{2n}$



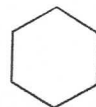
cyclopropane



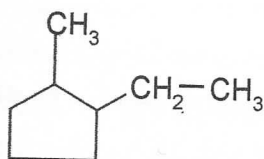
cyclobutane

- The name of a cyclic molecule requires the addition of the prefix "cyclo"

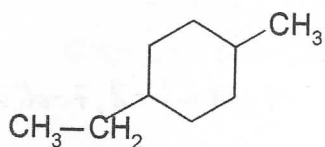
- To make cyclic compounds easier to draw, a shorthand is used in which the hydrogens and carbons which are part of the ring are not represented at all. The proper number or hydrogens is assumed to be attached to each carbon.



- Like the straight chained compounds, cyclic molecules can contain alkyl side chains. The carbon on which the alkyl group is **automatically** assumed to be number 1 and is not needed in the naming **unless** there is more than one alkyl group!
- If there is more than one substituent on a ring, numbers must be given. One is always assigned number 1 (usually the first alphabetically ie ethyl before methyl) then the chain is numbered clockwise or anticlockwise so as to give the other alkyl groups the smallest possible number.

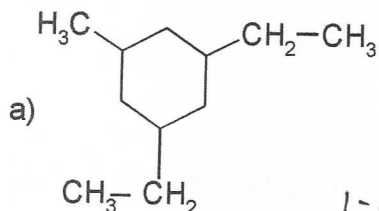


1 ethyl 2 methylcyclopentane

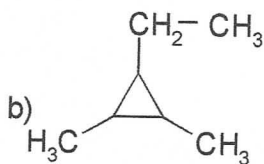


1 ethyl 4 methylcyclohexane

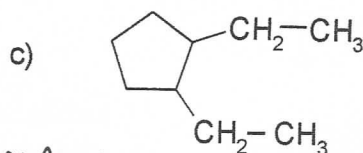
Name the following molecules:



1,3-diethyl-5-methylcyclohexane



1-ethyl-2,3-dimethylcyclopropane



1,2-diethylcyclopentane

## Naming alkenes

- Alkenes contain at least one double bond which exists between a pair of carbon atoms.
- The general formula is  $C_nH_{2n}$
- The suffix used is "-ene"

### Rule 1:

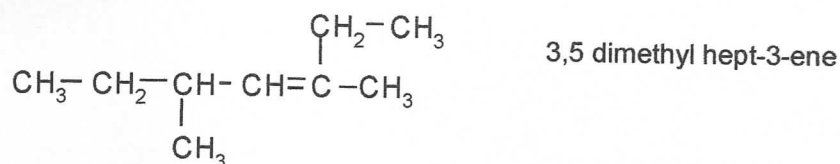
The chain chosen as the parent must contain the double bond

### Rule 2:

The parent chain must be numbered to give the double bond the lowest possible number

### Rule 3:

The name of the alkene must contain a number to indicate the position of the double bond if there are more than 3 carbons

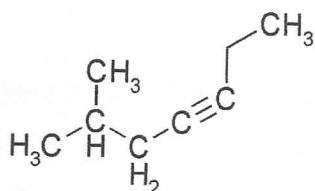


Name the alkenes below:

- A  $\text{CH}_3-\text{CH}_2-\text{CH}=\text{CH}_2$       A but-1-ene
- B  $\text{CH}_3-\text{CH}=\text{CH}-\text{CH}_3$       B but-2-ene
- C  $\text{CH}_2=\text{CH}_2$       C ethene
- D  $\begin{array}{c} \text{CH}_3 \\ | \\ \text{CH}_3-\text{CH}-\text{CH}_2-\text{CH}-\text{CH}=\text{CH}_2 \\ | \\ \text{CH}_3 \end{array}$       D 3,5-dimethyl hex-1-ene
- E  $\begin{array}{c} \text{CH}_3-\text{C}=\text{CH}-\text{CH}_3 \\ | \\ \text{CH}_2-\text{CH}_3 \end{array}$       E 3-methylpent-2-ene

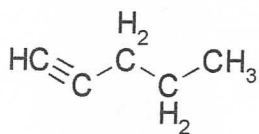
## Naming Alkynes

- The functional group is a triple bond
- The general formula is  $C_nH_{2n-2}$
- The triple bond must be in the parent chain and assigned the lowest possible number

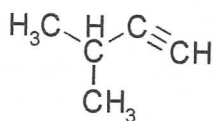


5 methyl hex-2-yne

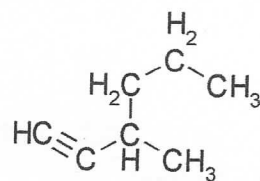
Name the alkynes below:



pent-1-yne



3-methylbut-1-yne



3-methyl hex-1-yne



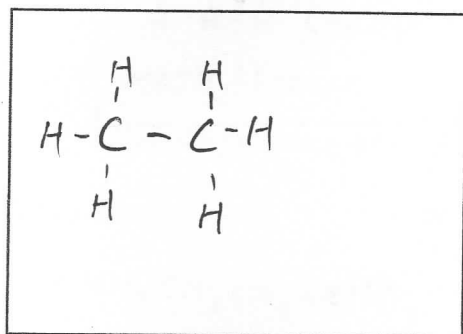
# Condensed Structural Formula

The Structural formula represents how the atoms in an organic compound are joined to each other.

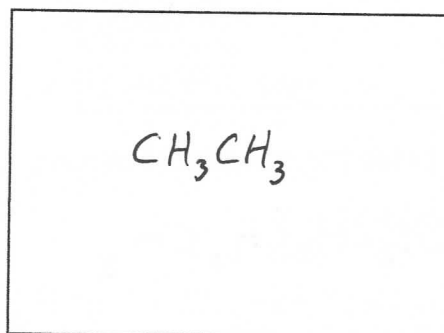
The structural formulas can be drawn in a Condensed form

Each carbon atom in the longest chain is written with atoms attached to it to the right of it.

Structural formula

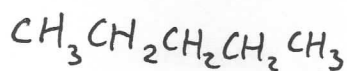
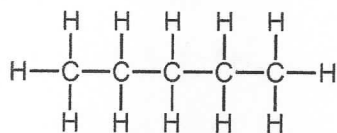


Condensed Structural formula

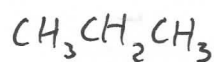
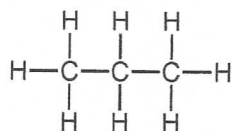


3. Draw the condensed structural formula for the following molecules

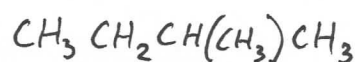
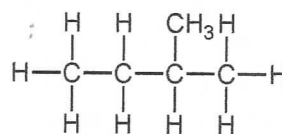
a)



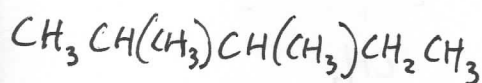
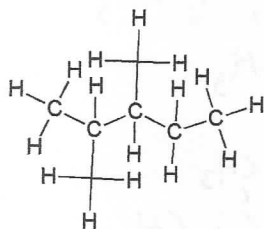
b)



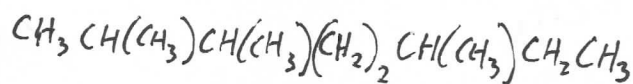
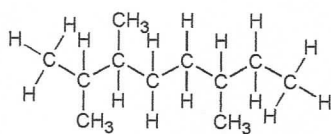
c)



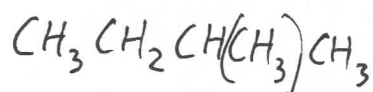
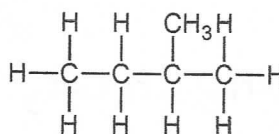
d)



e)



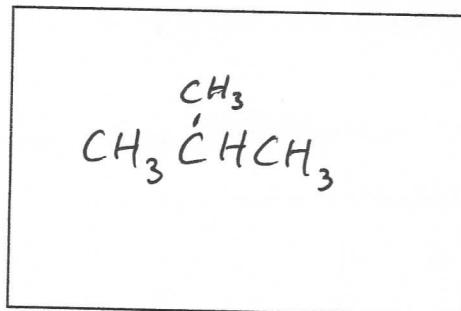
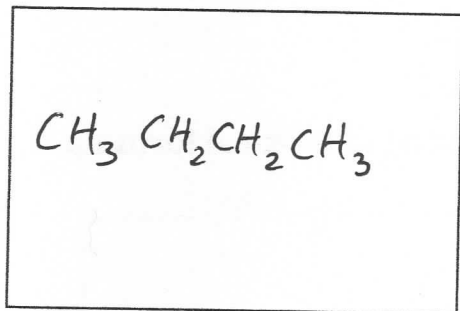
f)



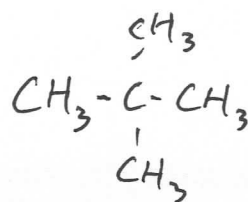
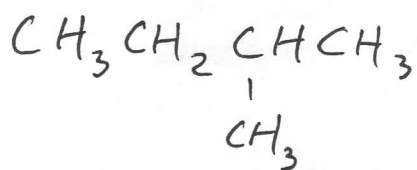
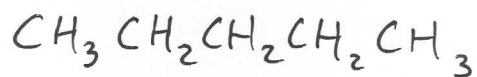
# Isomers

The atoms for any given molecular formula can be arranged in different ways. The different structures that can be made from the molecular formula are called Structural isomers.  
Constitutional isomers

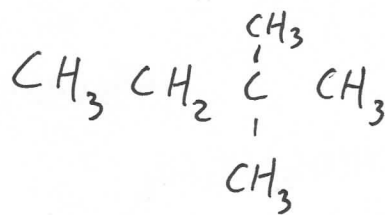
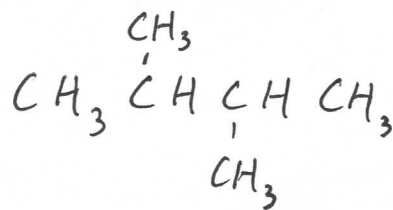
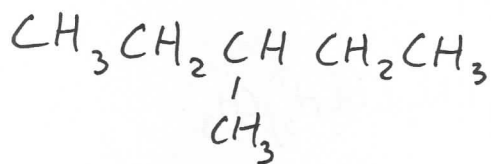
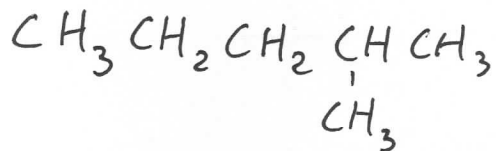
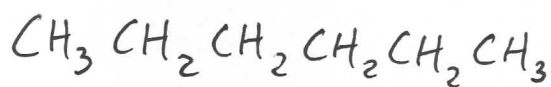
The structural isomers of  $C_4H_{10}$  are



1. Draw the structural isomers of  $C_5H_{12}$

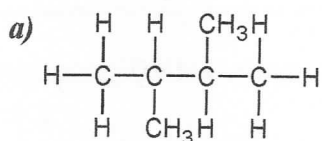


2. Draw the structural isomers of  $C_6H_{14}$

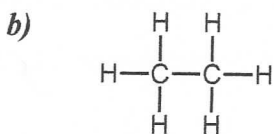


# More naming exercises

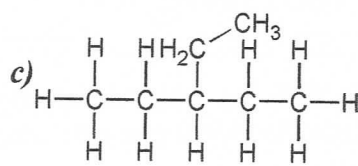
1. Name the following molecules



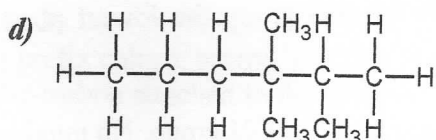
2,3-dimethylbutane



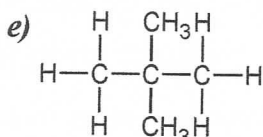
ethane



3-ethylpentane



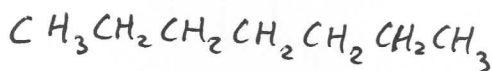
2,3,3-trimethylhexane



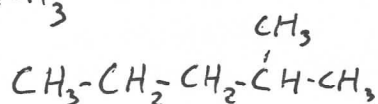
2,2-dimethylpropane

2. Draw the following molecules

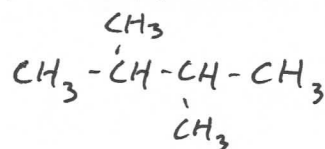
a) heptane



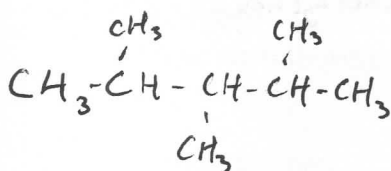
b) 2 methyl pentane



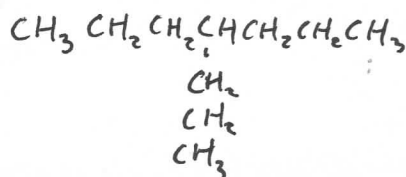
c) 2,3 dimethyl butane



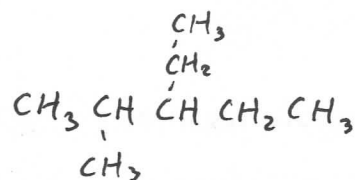
d) 2,3,4 trimethyl pentane



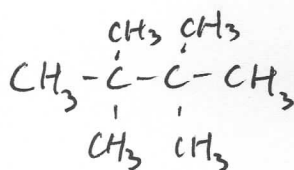
e) 4 propyl heptane



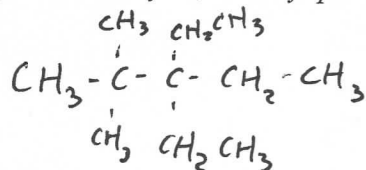
f) 2 methyl 3 ethyl pentane \*



g) 2,2,3,3 tetra methyl butane



h) 2,2 dimethyl 3,3 diethyl pentane \*



\* the name should be

h) 3,3-diethyl-2,2-dimethylpentane

f) 3-ethyl-2-methylpentane

# Naming Alcohols

Alcohols are molecules in which an alkyl group is attached to a *hydroxy (OH)* group, which is the functional group for alcohols.

## Rule 1:

Locate the longest continuous chain of carbon atoms which contains the OH group. This will identify the parent compound

## Rule 2:

Number the chain so as to give the carbon atom with the OH group the lowest possible number

## Rule 3:

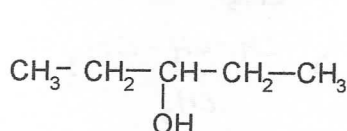
A number is included before the "-ol" to indicate the position of the OH group. No number is included for molecules with only 1 or 2 carbon atoms.

## Rule 4:

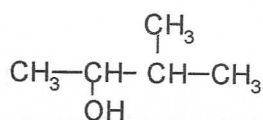
The suffix "-ol" is added to the name to indicate that the molecule is an alcohol

## Activity:

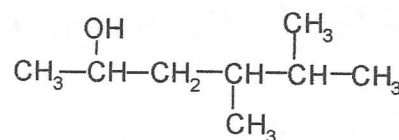
Name the alcohols below:



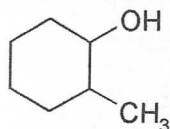
pentan-3-ol



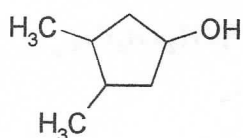
3-methylbutan-2-ol



4,5-dimethylhexan-2-ol



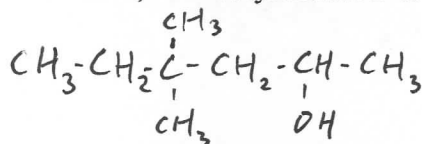
2-methylcyclohexanol



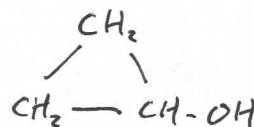
3,4-dimethylcyclopentanol

Draw the condensed structural formulas for the following:

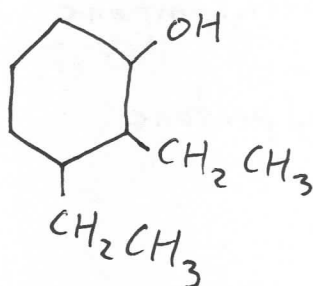
a. 4,4 dimethyl hexan-2-ol



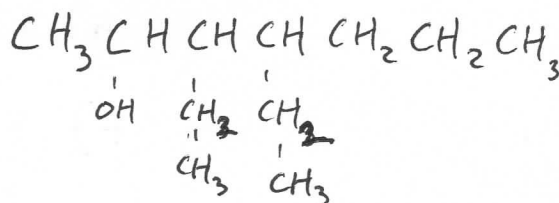
b. cyclopropanol



c. 2,3 diethylcyclohexanol



d. 3,4 diethyl heptan-2-ol



# Naming Haloalkanes

Haloalkanes contain one or more halogens as the functional group.

**Rule 1:**

The longest continuous chain containing the halogen group is considered to be the parent compound

**Rule 2:**

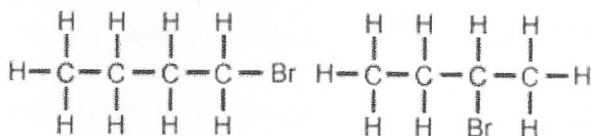
The chain is counted to give the carbon attached to the halogen the lowest number

**Rule 3:**

The prefix chloro, bromo, iodo etc is added to the parent compound together with the number of the carbon attached to the halogen

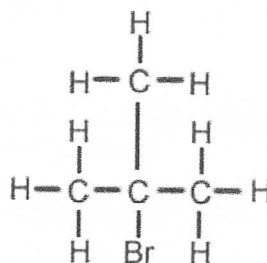
**Activity:**

Name the haloalkanes below:



1-bromobutane

2-bromobutane

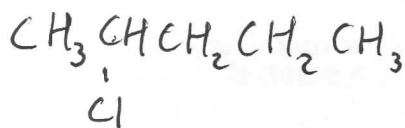


2-bromo-2-methylpropane

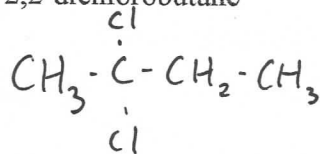
**Activity:**

Draw the following haloalkanes:

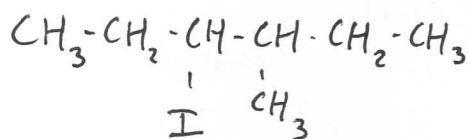
2-chloropentane



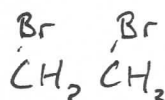
2,2-dichlorobutane



3-iodo 4-methylhexane



1,2-dibromoethane



# Naming Carboxylic Acids

Organic acids contain a *carboxyl group* plus an hydroxy group (COOH) as its functional group.

**Rule 1:**

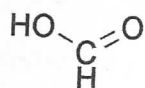
The longest continuous chain containing the carboxyl group is considered to be the parent compound

**Rule 2:**

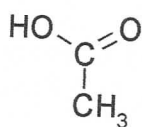
The carboxyl carbon is part of the parent chain and is always considered to be in the number 1 position

**Rule 3:**

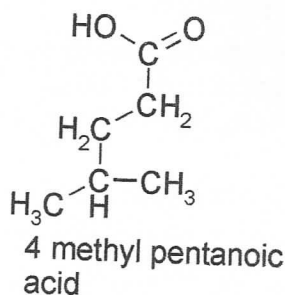
The suffix "-oic acid" is added to the parent compound



methanoic acid



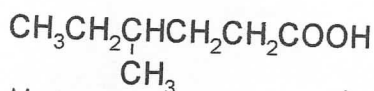
ethanoic acid



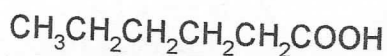
4 methyl pentanoic acid

**Activity:**

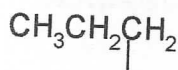
Name the carboxylic acids below



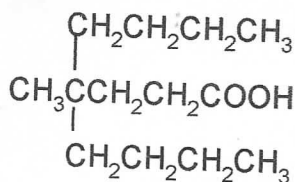
4-methylhexanoic acid



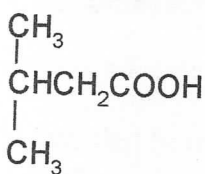
hexanoic acid



3-ethylhexanoic acid



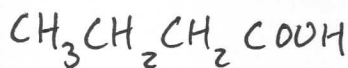
4-butyl-4-methyloctanoic acid



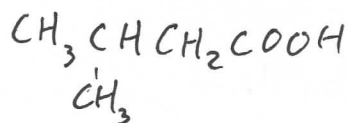
3-methylbutanoic acid

**Activity:**

Draw the following structures  
butanoic acid



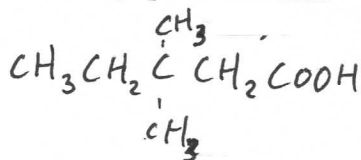
3-methyl butanoic acid



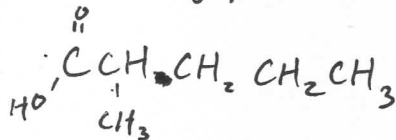
2,4-dimethyl butanoic acid

Does not exist

3,3-dimethyl pentanoic acid



2-methyl pentanoic acid



# Naming Amines

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Amines are near relatives of ammonia,  $\text{NH}_3$  where hydrogen atoms in the ammonia have been replaced by a hydrocarbon group.

Amines can be named in two ways.

First, they can be viewed as having an amino group, an  $-\text{NH}_2$  group, attached to an alkane. This approach is used for the IUPAC names.

Second, they can be seen as having an alkyl group attached to the nitrogen in the amine. This approach is used in creating common names.

## IUPAC method

### Rule 1:

The longest continuous chain containing the amino group is considered to be the parent compound

### Rule 2:

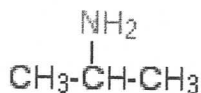
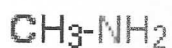
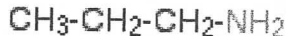
The prefix "amino" is added to the parent compound

### Rule 3:

A number is included before the "amino" to indicate the position of the  $\text{NH}_2$  group. No number is included for molecules with only 1 or 2 carbon atoms.

aminomethane

1-aminopropane



2-aminopropane

## Common name method

### Rule 1:

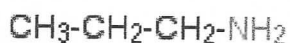
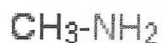
Count the carbon atoms on the alkyl chain

### Rule 2:

Add the alkyl prefix to 'amine'

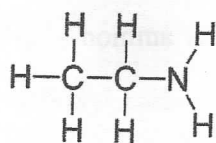
methylamine

propylamine

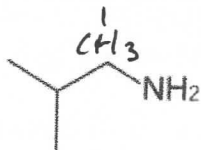
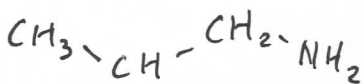


**Activity:**

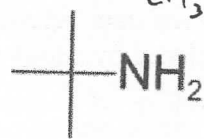
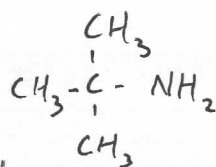
Name the amines below:



aminoethane



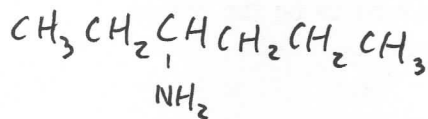
1-amino-2-methylpropane



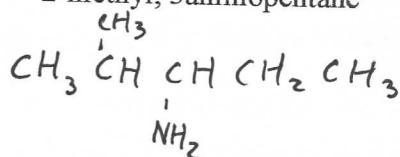
2-amino-2-methylpropane

Draw the following amines

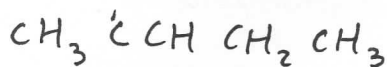
3-aminohexane



\* 2-methyl, 3aminopentane

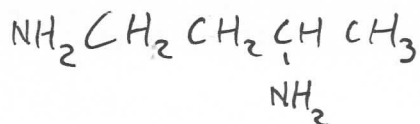


\* 2,3-dimethyl, 3-aminopentane



2,4 diaminobutane

should be 1,3 diaminobutane



\* "amino" should be first alphabetically