Organic Chemistry Part 1

Juffrou Karen

- Organic molecules consist of C – atoms
- C is the basic building block of organic compounds

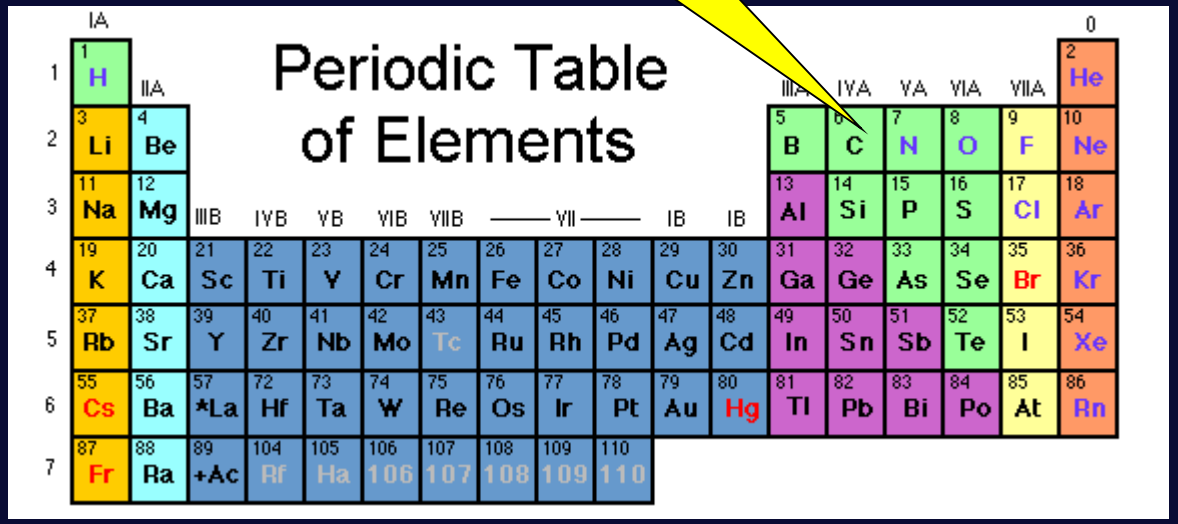
Carbon

- Atomic number of 6
- Group IV
- Valency of 4

12

C

6



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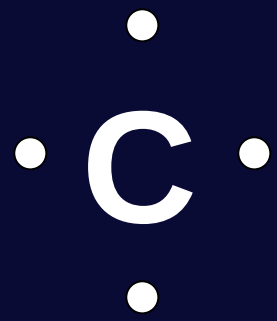
Lewis structure for Carbon



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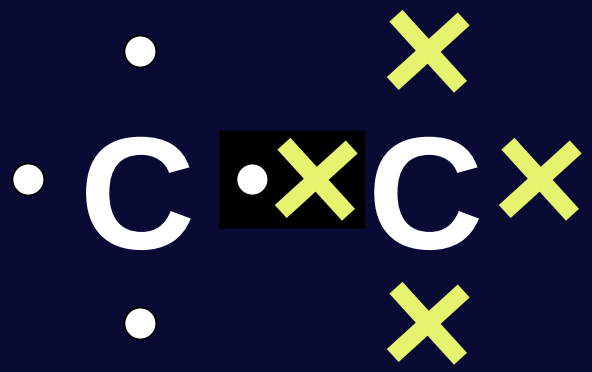
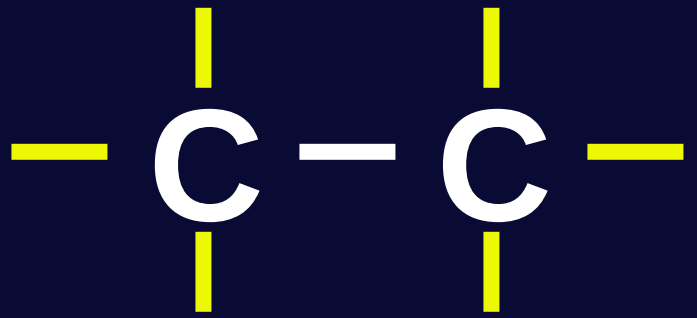
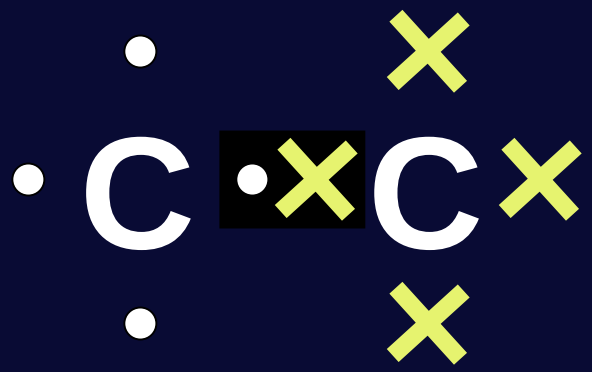
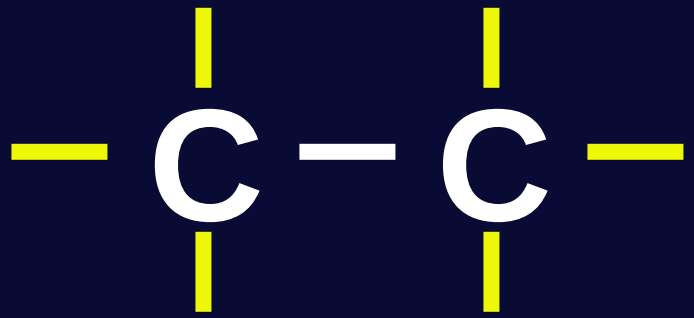
Single bond:



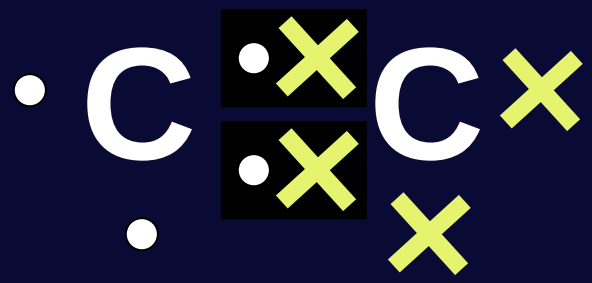


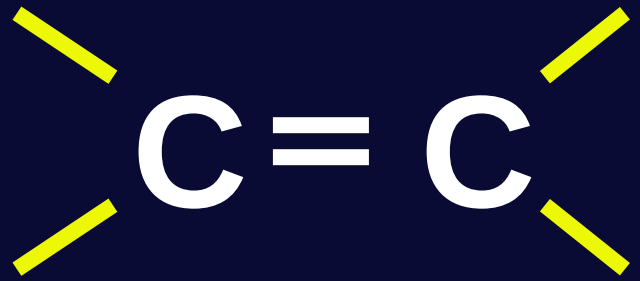
Single bond:





Double bond:





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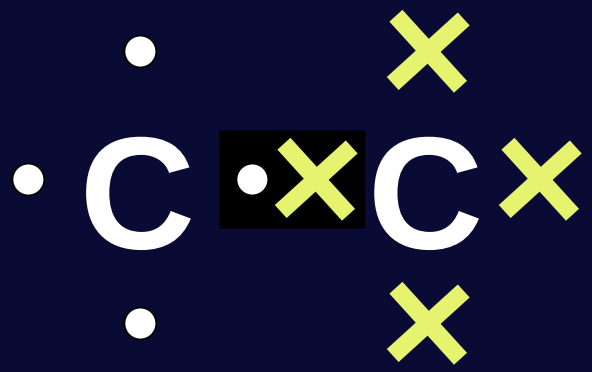
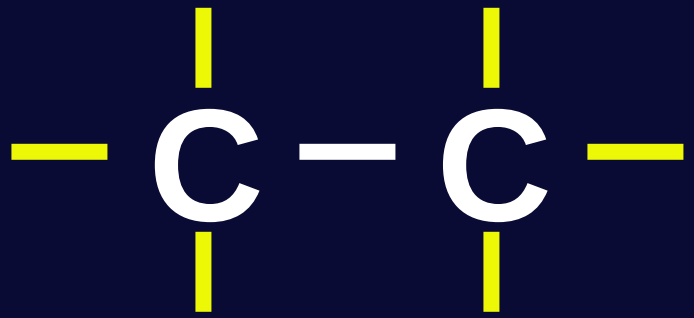
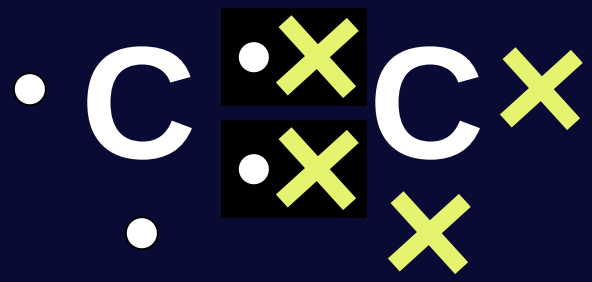
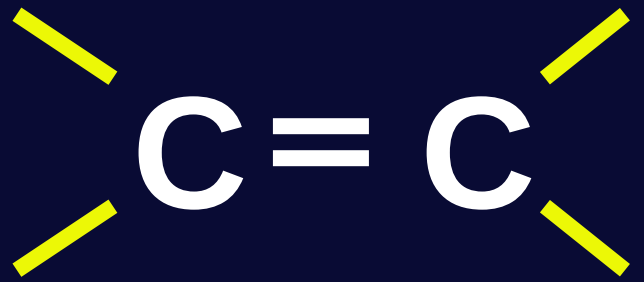
Single bond:



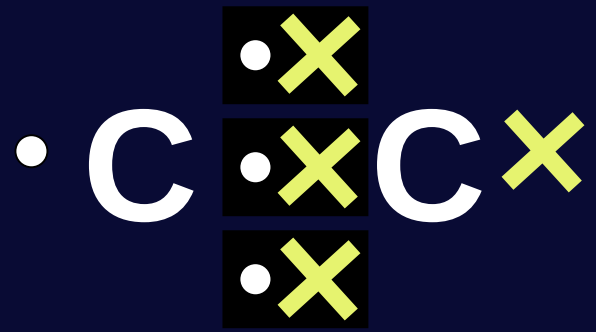


Double bond:





Triple bond:



Organic chemistry

Molecules of: C—H

These bonds can also include:

O N F I

Cl P S Br

Juffrou Karen

Chains, branches and cyclic structures

Juffrou Karen

Homologous series

a series of organic compounds that can be described by the same general formula

Representation of organic molecules:

General formula (Homologous series)

Formula for a group of similar compounds

Alkene: $\mathbf{C_nH_{2n}}$

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Representation of organic molecules:

Molecular formula

Shows the number of atoms in the molecule

Butene: C_4H_8

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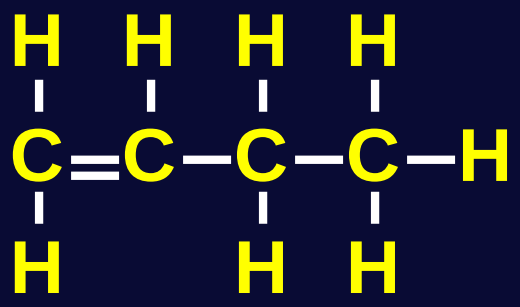
Representation of organic molecules:

Structural formula

Illustrates bonds and atoms in a molecule

Butene:



or $CH_2CHCH_2CH_3$

Condensed

Juffrou Karen

Functional groups

a bond or an atom or a group of atoms which determine(s) the physical and chemical properties of a group of organic compounds

Alkanes – Single bonds

Alkenes – Double bonds

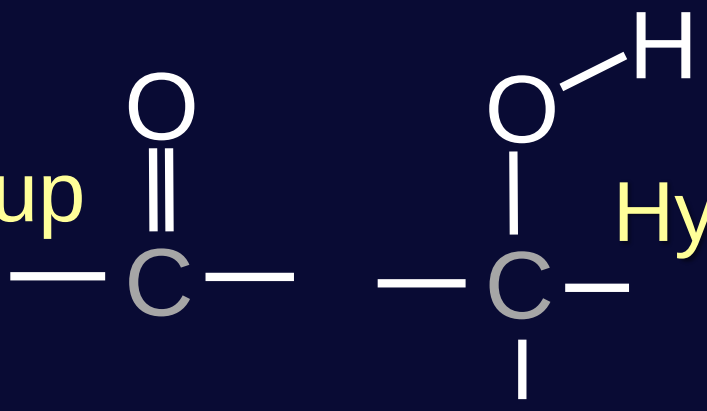
Alkynes – Triple bonds

Functional groups

Know the functional group of each homologous series in the examination guidelines

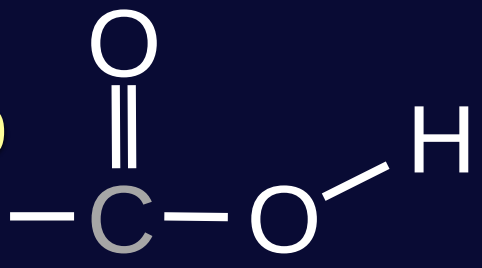
Important structures

Carbonyl – group

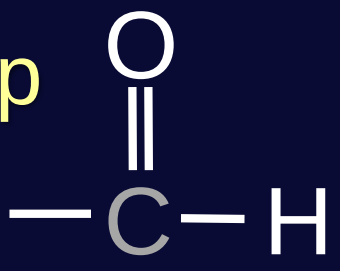


Hydroxyl – group

Carboxyl - group



Formic - group



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Functional groups

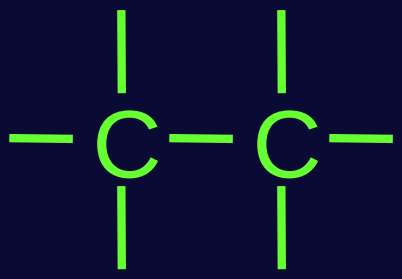
Homologous series:

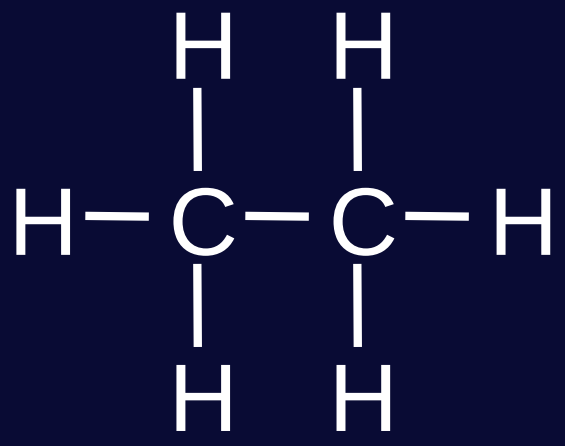
Alkanes

General formula:

C_nH_{2n+2}

Functional group:





Ethane

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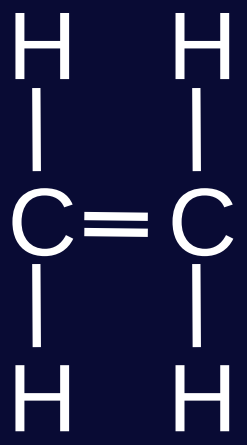
Functional groups

Homologous series:

Alkenes

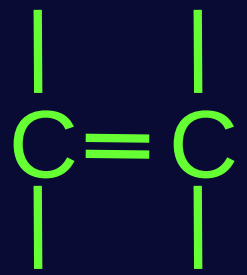


Ethene

General formula:

C_nH_{2n}

Functional group:



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Functional groups

Homologous series:

Alkynes

Ethyne

General formula:

C_nH_{2n-2}

Functional group:

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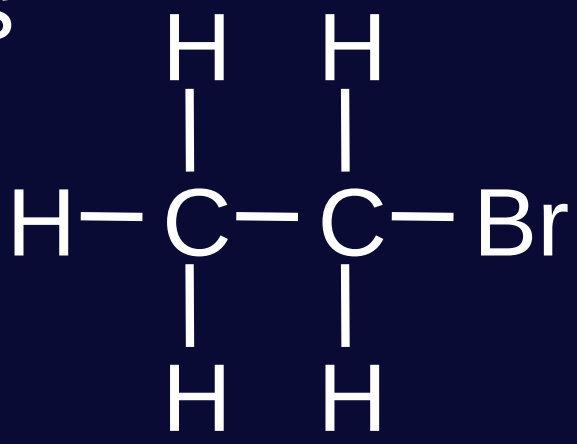
Functional groups

Homologous series:

Halo-alkanes / Alkyl halides



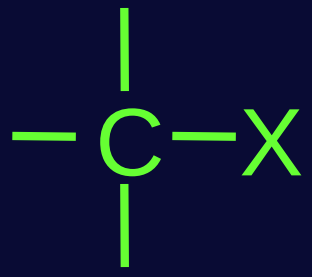
Bromoethane

General formula:

$C_nH_{2n+1}X$

with X = Cℓ, Br, I, F

Functional group:



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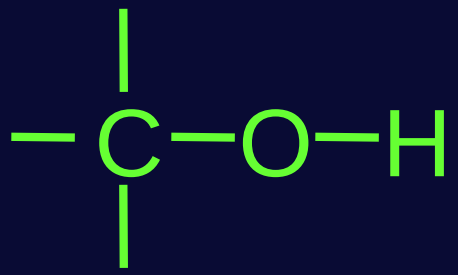
Functional groups

Homologous series:
Alcohols

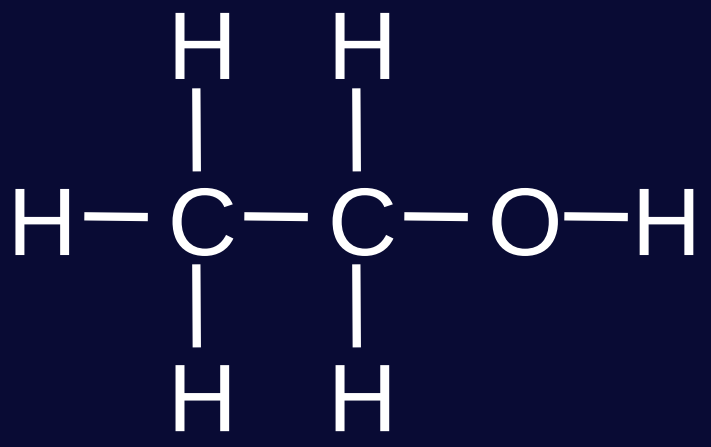
General formula:

$C_nH_{2n+1}OH$

Functional group:



Ethanol



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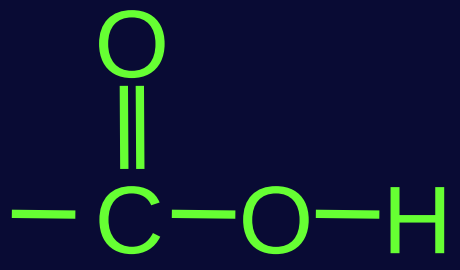
Functional groups

Homologous series:
Carboxylic acid

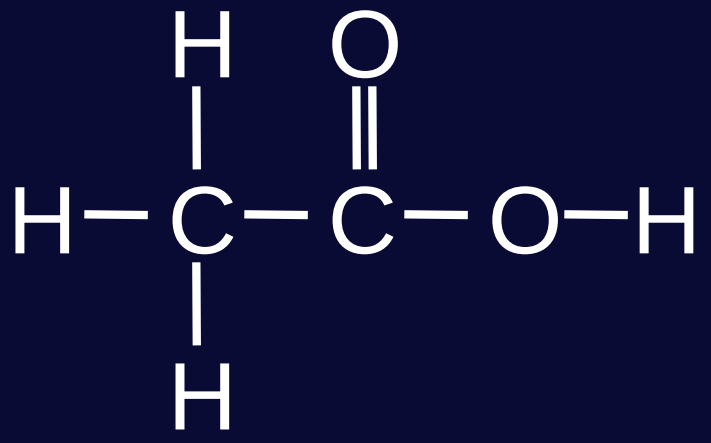
General formula:

$C_nH_{2n}O_2$

Functional group:



Ethanoic acid



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Functional groups

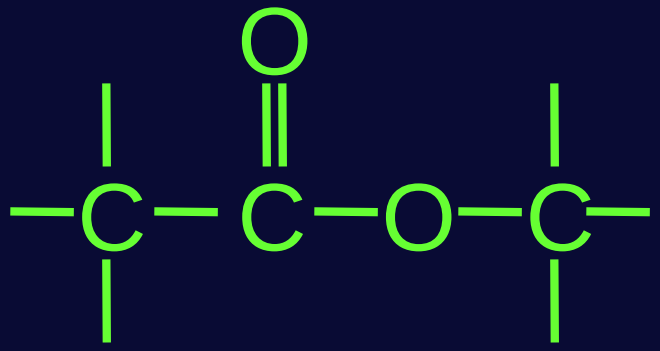
Homologous series:

Esters

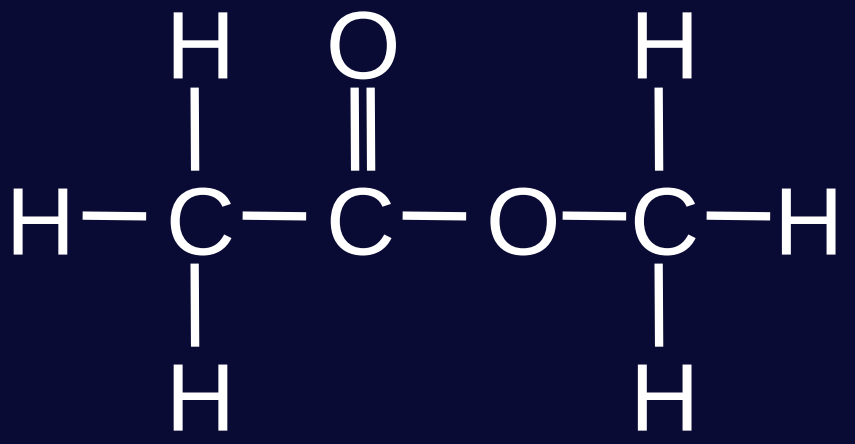
General formula:

$C_nH_{2n}O_2$

Functional group:



Methyl ethanoate



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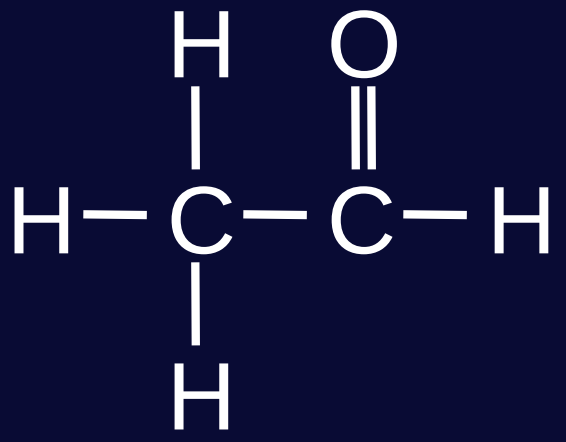
Functional groups

Homologous series:
Aldehydes

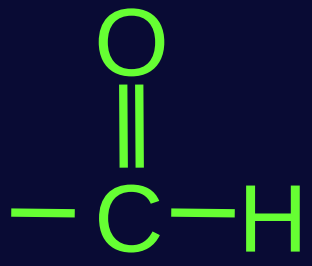
Ethanal



General formula:

$C_nH_{2n}O$

Functional group:



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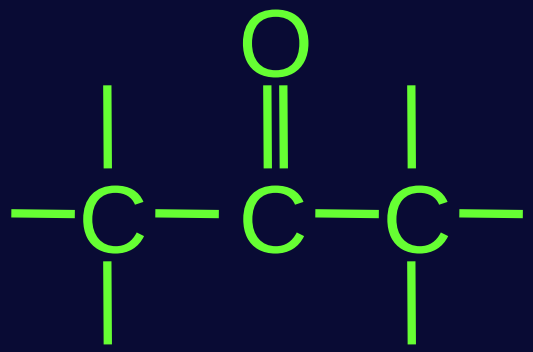
Functional groups

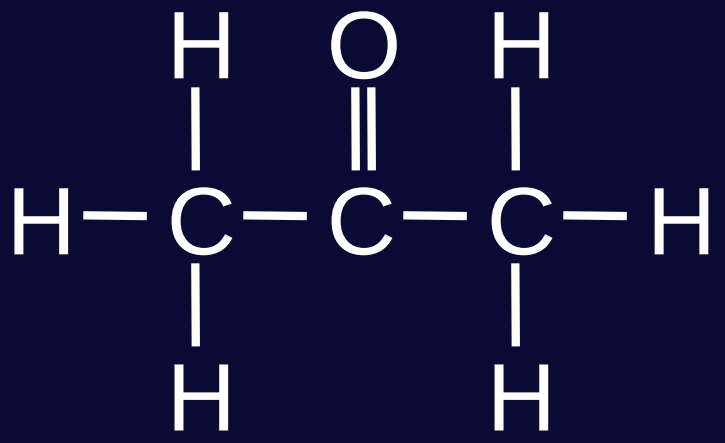
Homologous series:
Ketones

General formula:
$C_nH_{2n}O$

Functional group:



Propanone



Juffrou Karen

Hydrocarbons and isomers

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Hydrocarbons

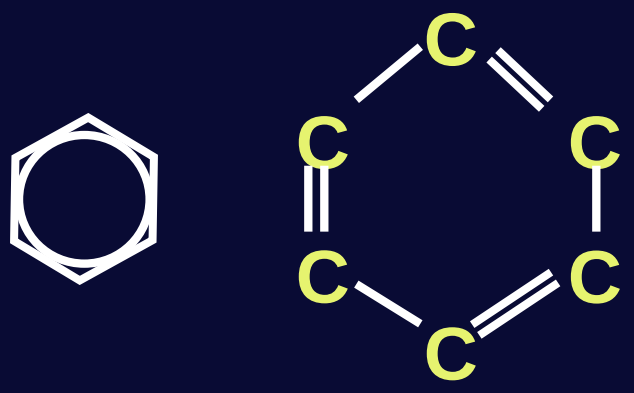
are organic compounds that consist only of carbon and hydrogen

C_3H_8 or CH_4

Hydrocarbons

Aliphatic

Aromatic



1 or more Benzene ring(s)

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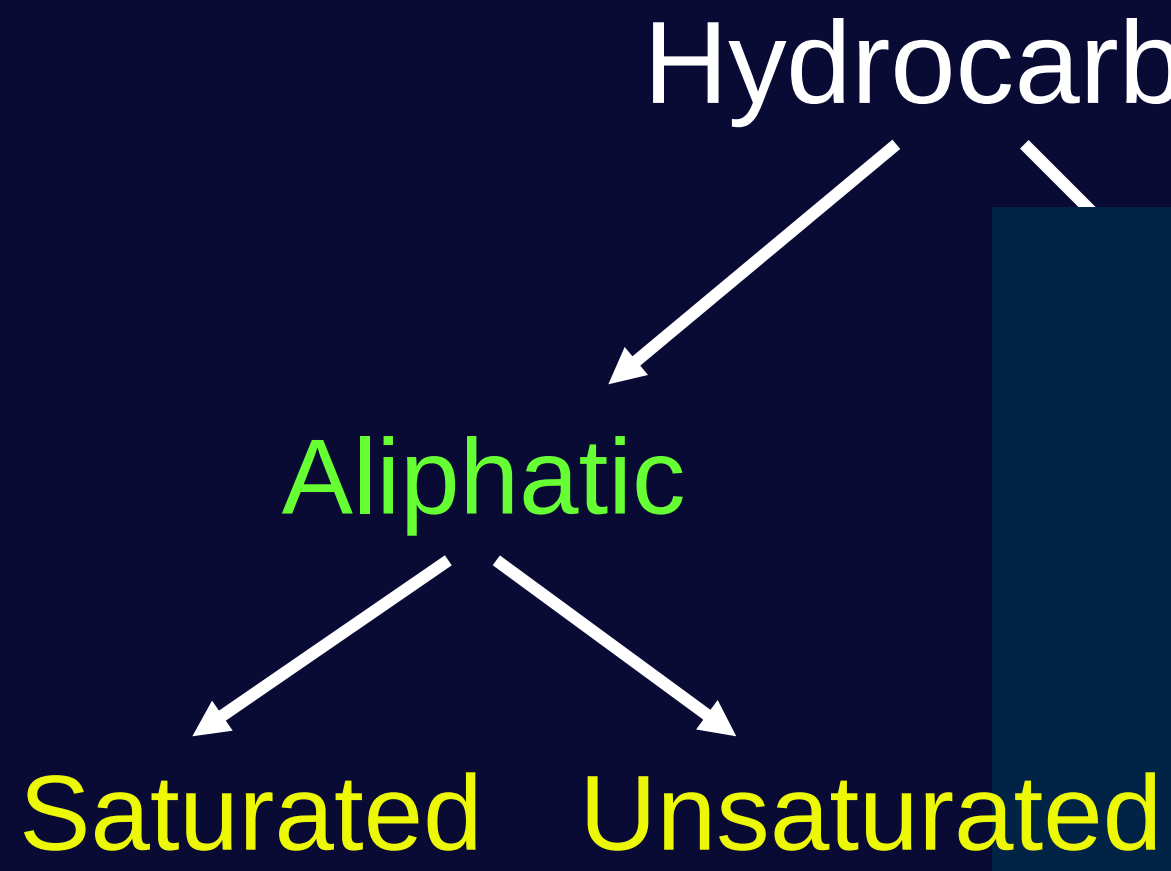

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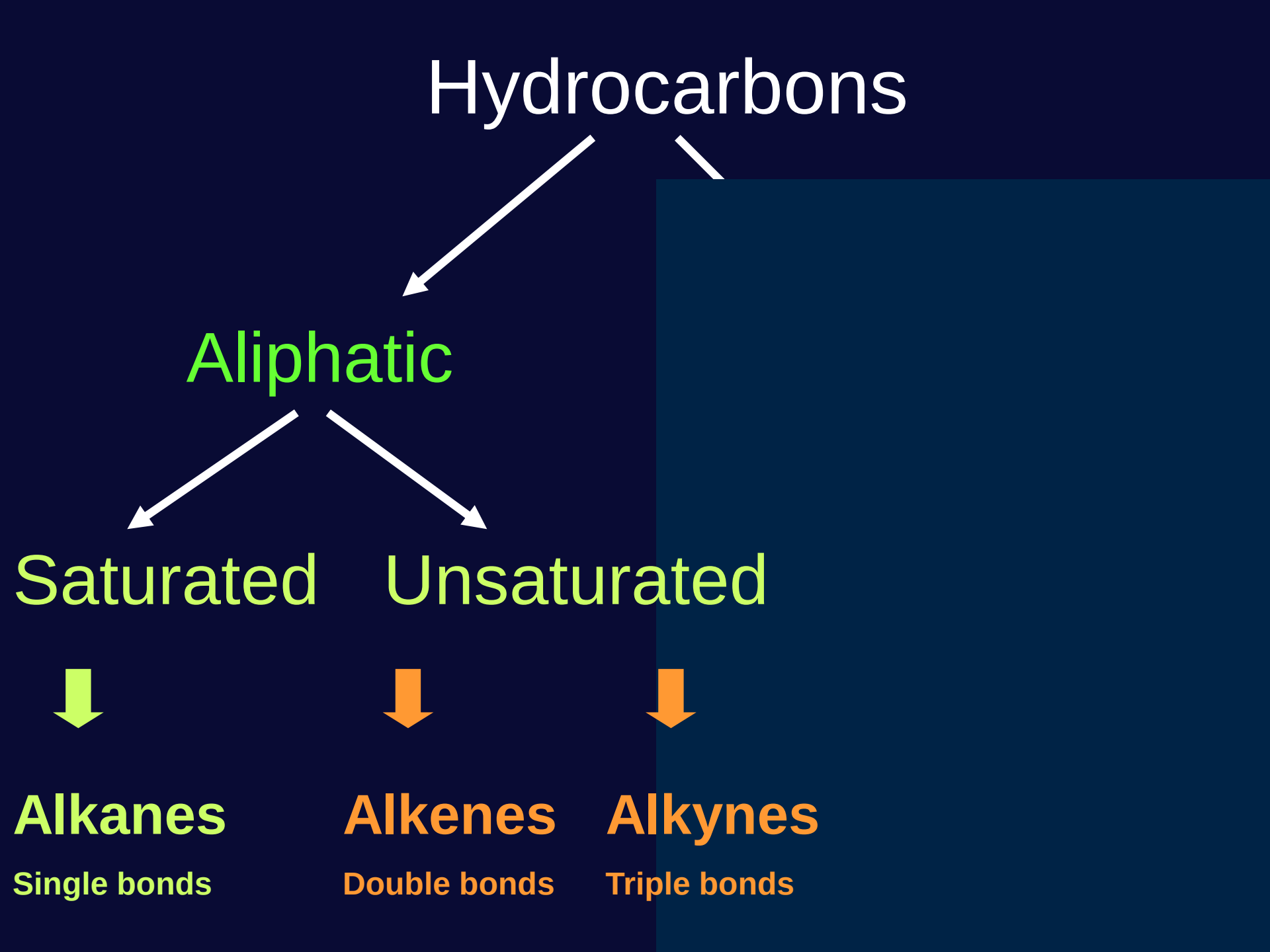
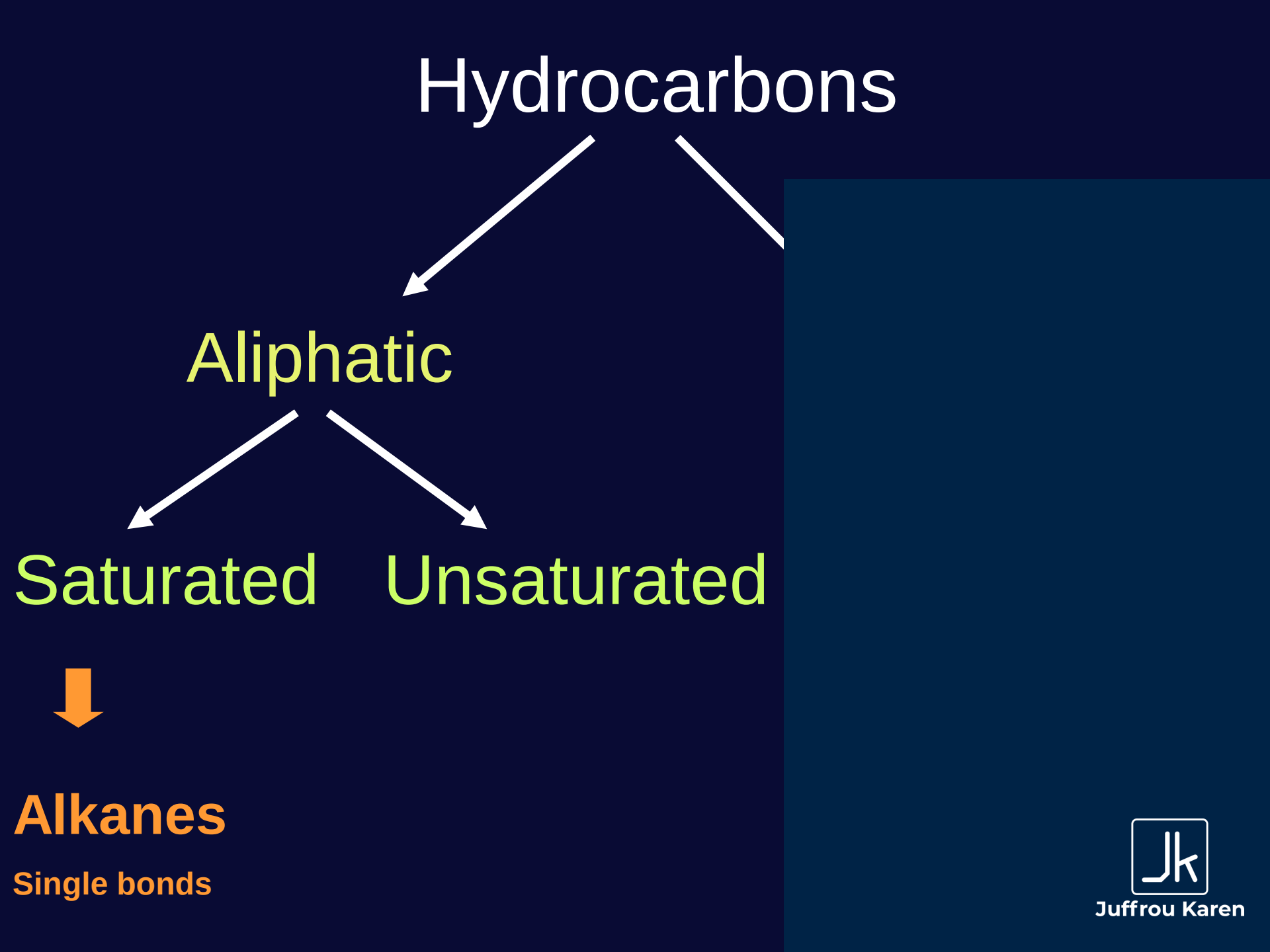

Hydrocarbons
Aliphatic
Saturated
Unsaturated
Alkanes
Single bonds
Alkenes
Double bonds
Alkynes
Triple bonds



Juffrou Karen

Saturated hydrocarbons

organic compounds consisting of only carbon and hydrogen, with no multiple bonds between C-atoms (only single bonds)

Unsaturated hydrocarbons

organic compounds with one or more multiple covalent bonds between C-atoms

Test for saturated hydrocarbon

Add Brown bromine water (or $KMnO_4$)

- If saturated – colour remain unchanged
- If unsaturated – colour changes quickly

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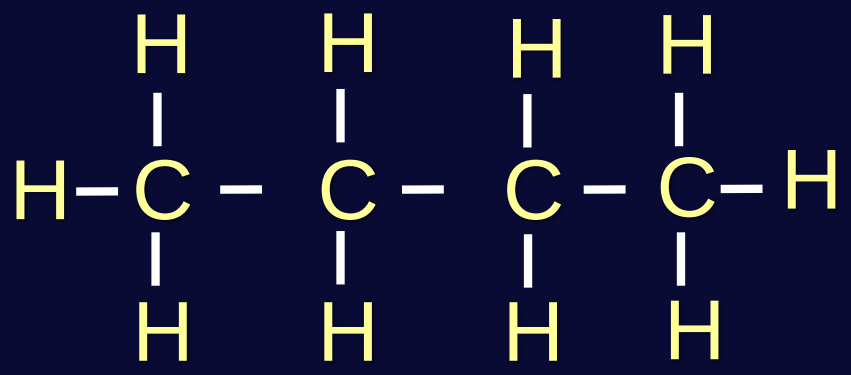
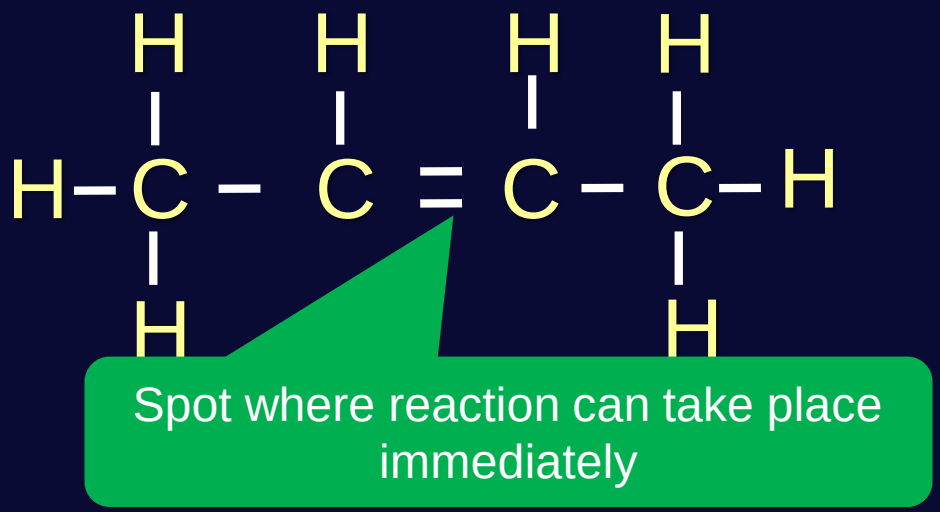
Test for saturated hydrocarbon





Juffrou Karen

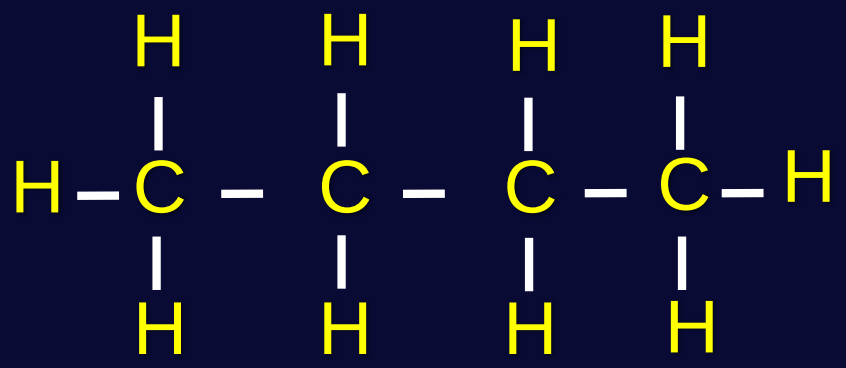
Isomers

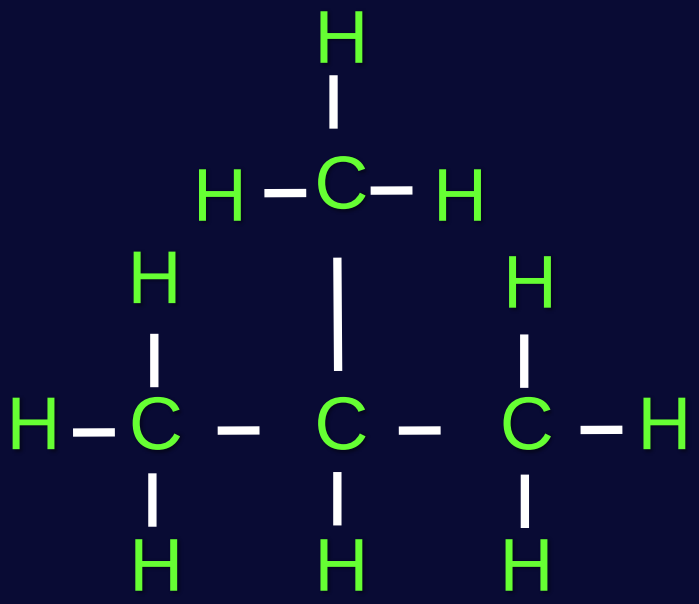
Organic molecules with the same molecular formula, but different structural formulas

Chain-isomers

Different chains

C_4H_{10}



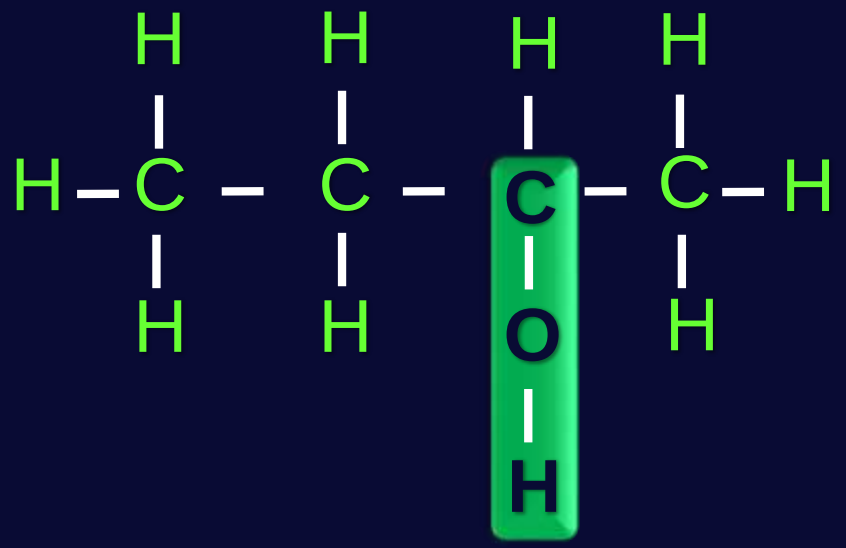


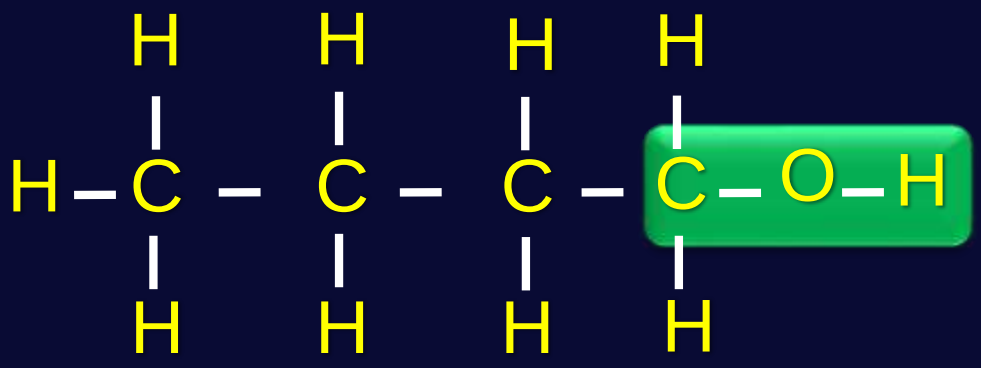
Juffrou Karen

Positional-isomers

Different positions of the same functional group

C_4H_9OH



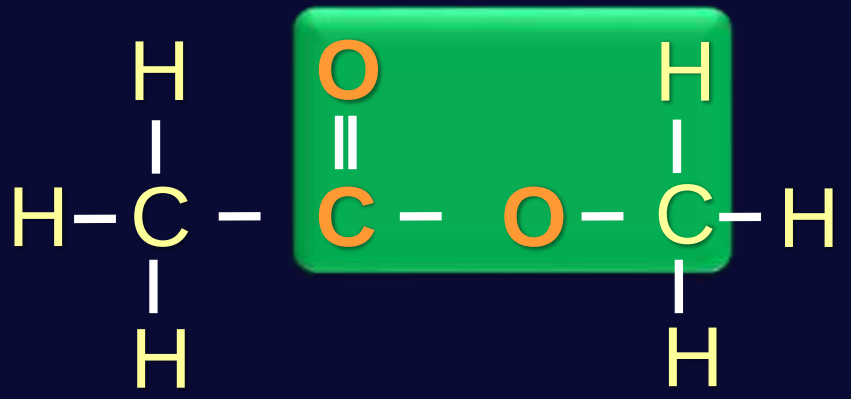


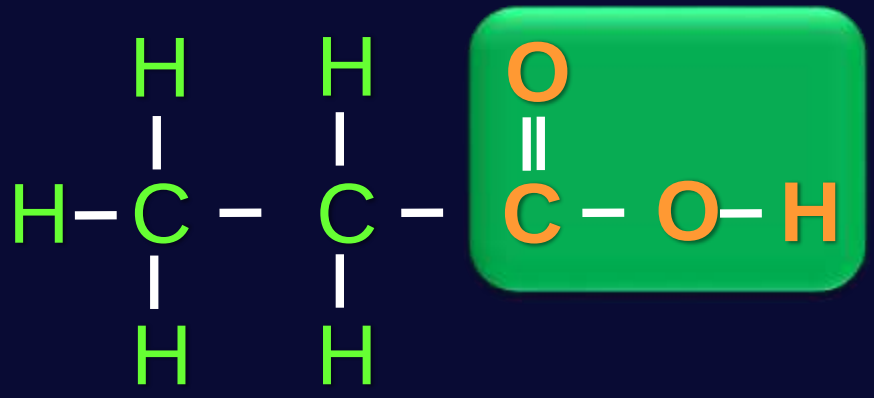
Juffrou Karen

Functional-isomers

Different
functional groups

$C_3H_6O_2$

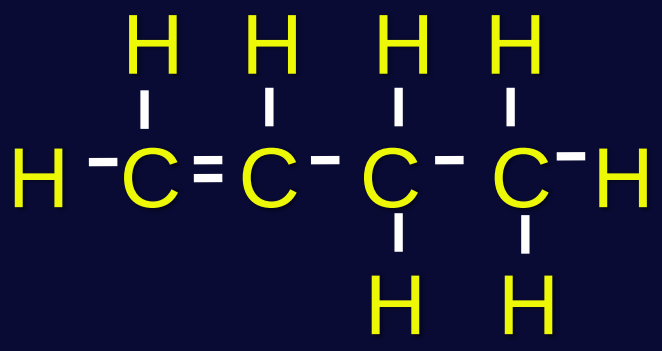




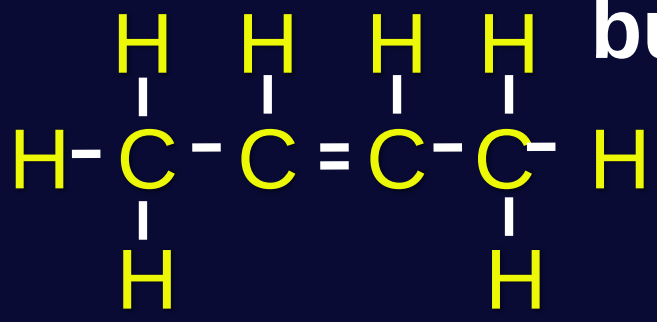
Juffrou Karen

Butene has the molecular formula of C_4H_8 and the following isomers

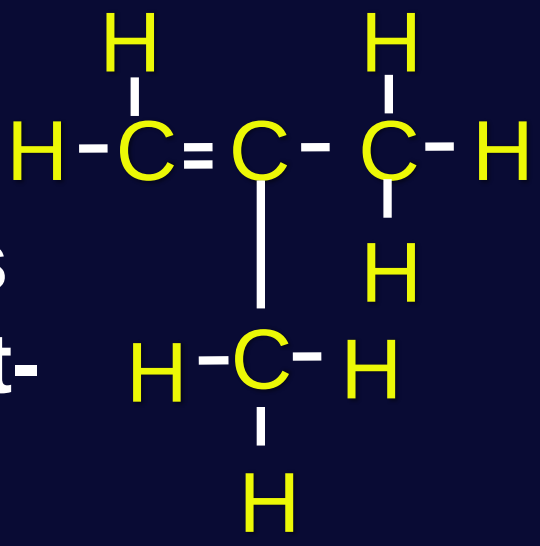
but-1-ene



but-2-ene



methylpropene

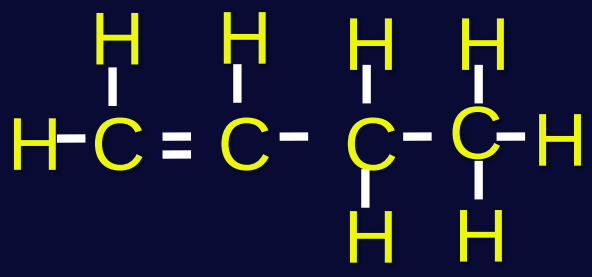


What type of isomers are but-1-ene and but-2-ene?

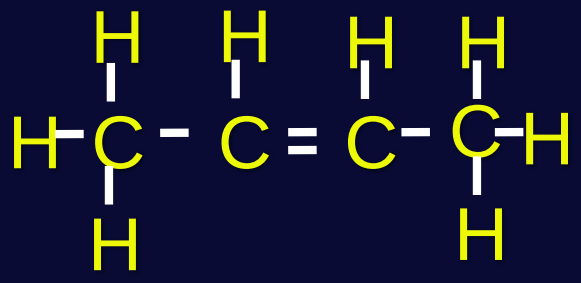
Positional isomers

Juffrou Karen

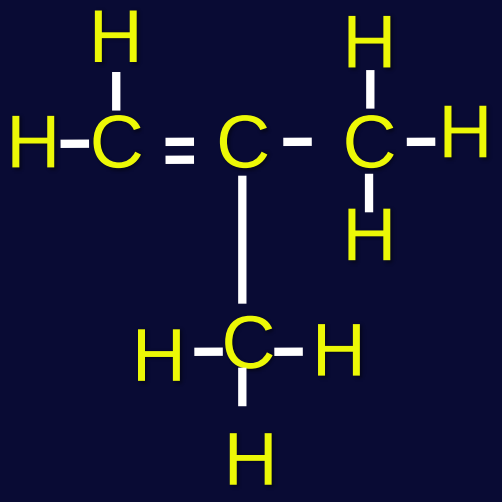
Butene has the molecular formula of C_4H_8 and the following isomers.



but-1-ene



but-2-ene



methylpropene

What type of isomers are methylpropene and but-1-ene?

Chain isomers

Juffrou Karen

Alkanes and substituents

Juffrou Karen

Alkanes

Saturated hydrocarbons

Only single bonds
between carbons

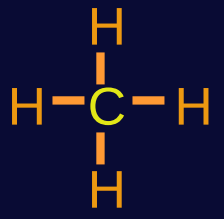
Alkanes

- Carbons are bonded with single bonds
- Low reactivity
- Saturated hydrocarbons
- General formula: C_nH_{2n+2}

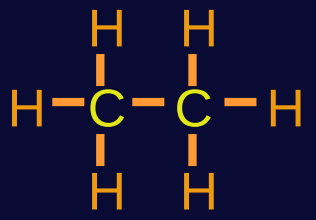
Juffrou Karen

Alkanes

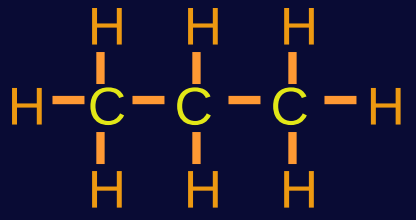
Meth = 1 carbon → methane



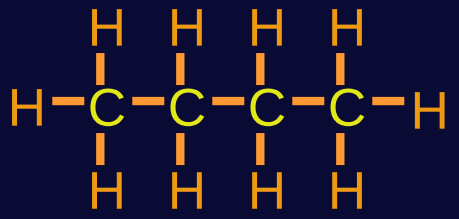
Eth = 2 carbons → ethane



Prop = 3 carbons → propane

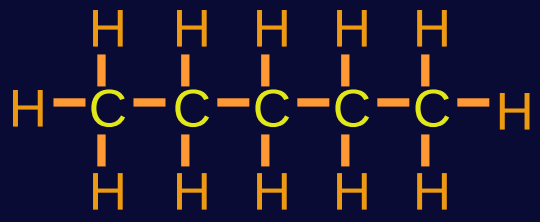


But = 4 carbons → butane

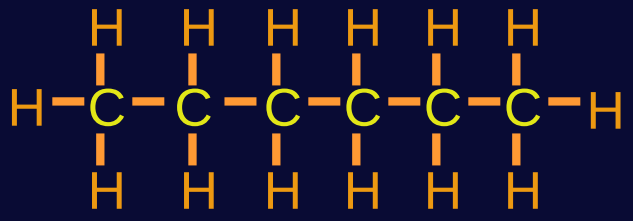


Alkanes

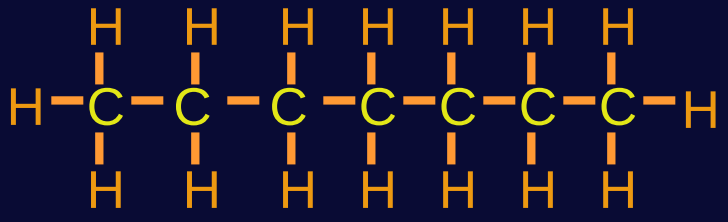
Pent = 5 carbons→ pentane



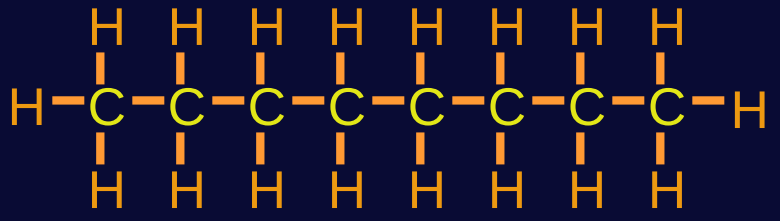
Hex = 6 carbons→ hexane



Hept = 7 carbons→ heptane

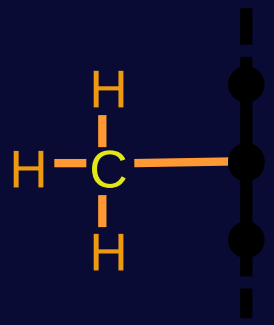


Oct = 8 carbons→ octane



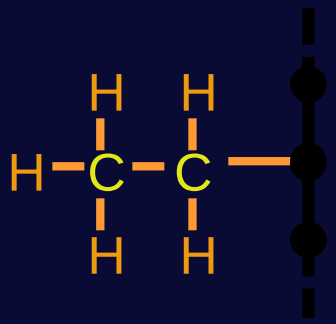
Substituents

Alkyl groups are derived from the alkanes and the name is allocated by substituting the **ane** with an **yl**

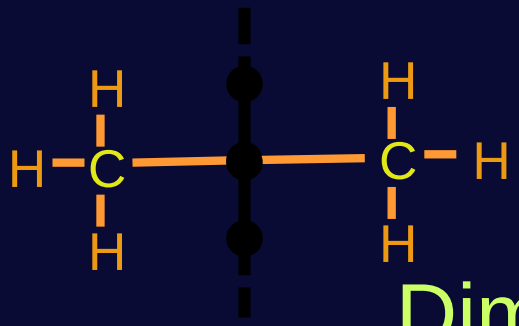


Methyl

Use di or tri to indicate two or three substituents



Ethyl



Dimethyl

Alkanes

IUPAC naming

International Union of Pure and Applied Chemistry

Juffrou Karen

Family of homologous group

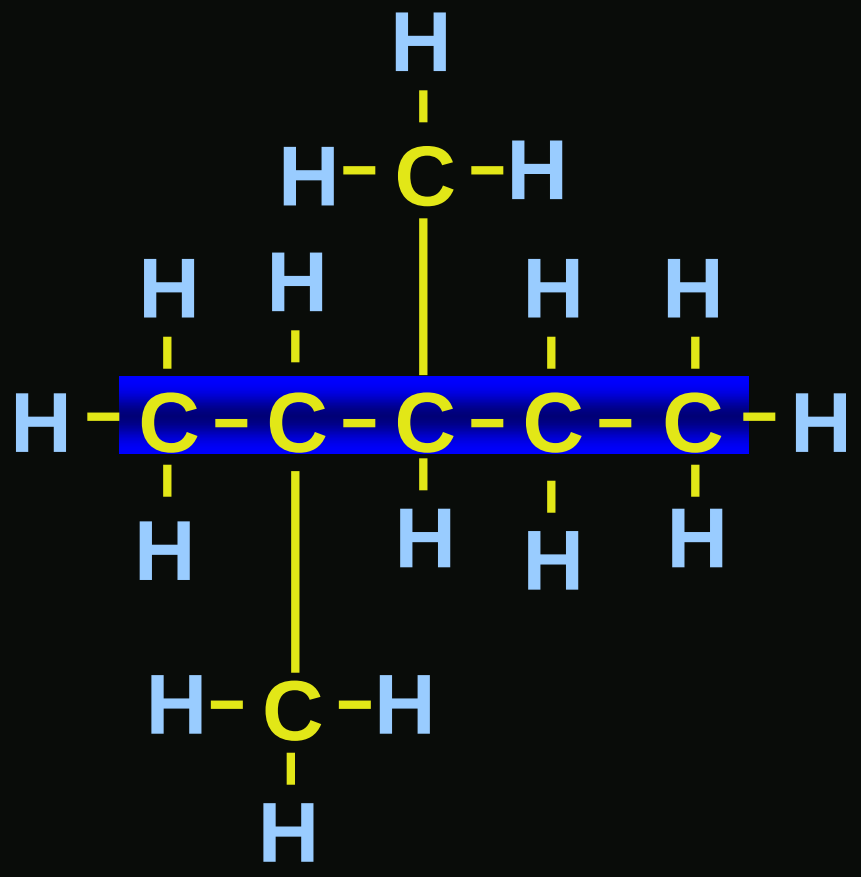
Prefix- Stem- Suffix

Number of C - atoms

Basic rules

Step 1
Find the longest continuous chain of C-atoms

(You may need to go around corners):

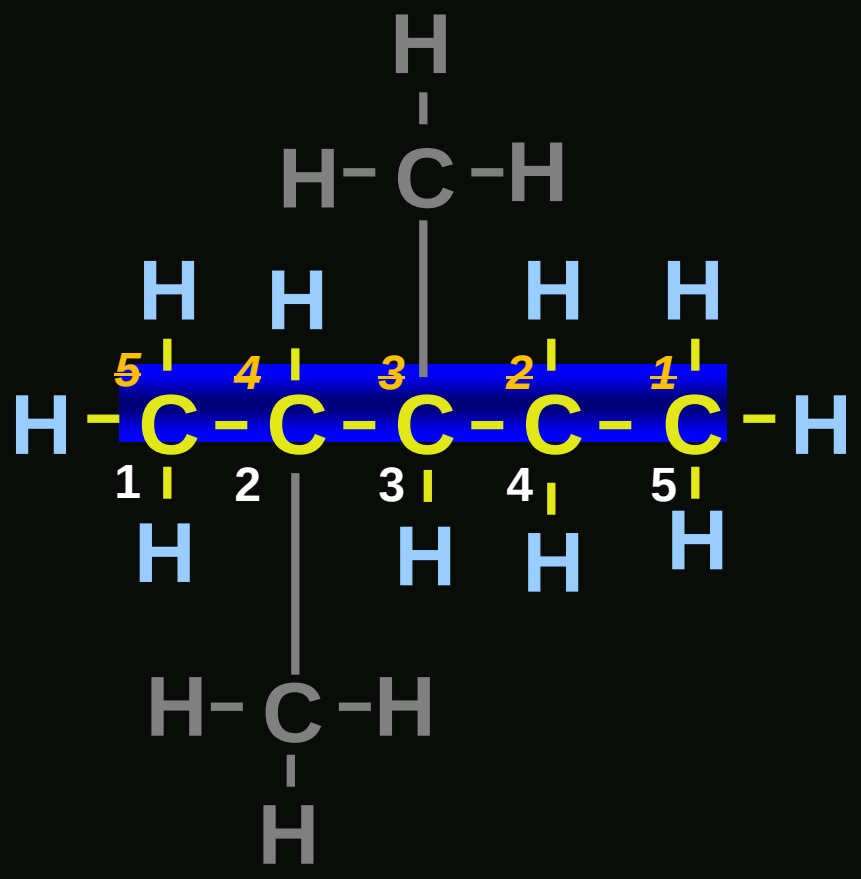


The stem name= pent

Single bonds= **ane**

Basic rules

Step 2
Number the C-atoms in the main chain to give the alkyl group (substituent) the lowest number



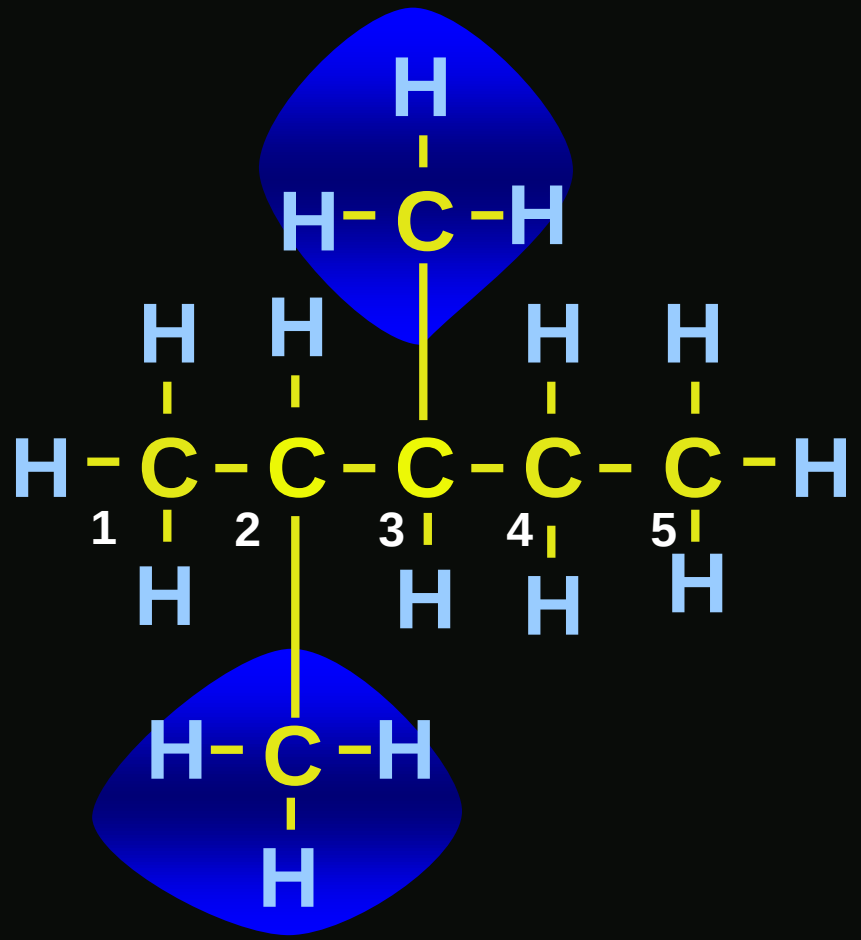
The stem name = pent

Single bonds = ane

First carbon connected to a substituent is 2

Basic rules

Step 3
Identify and number all the substituents:



The stem name = pent

Single bonds = ane

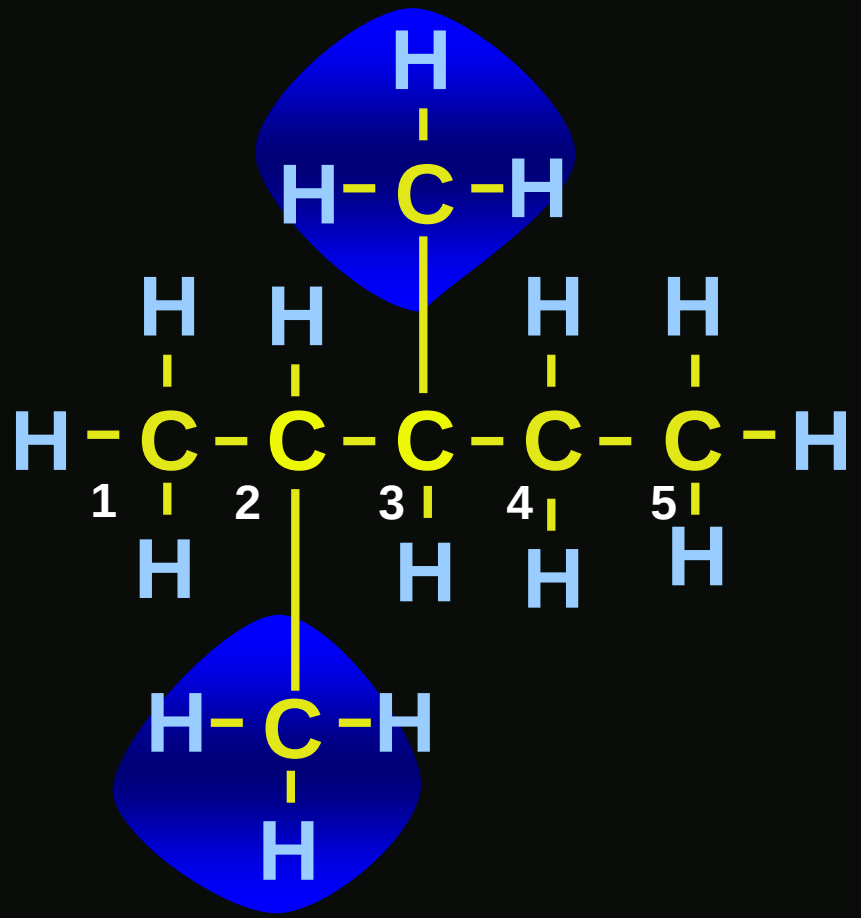
First carbon connected to a substituent is 2

Methyl at 2
Methyl at 3

Basic rules

Step 4

If there is more than one identical substituent the prefix is indicated with the prefixes di-(2), tri-(3) and tetra-(4):



The stem name = pent

Single bonds = ane

First carbon connected to a substituent is 2

Methyl at 2

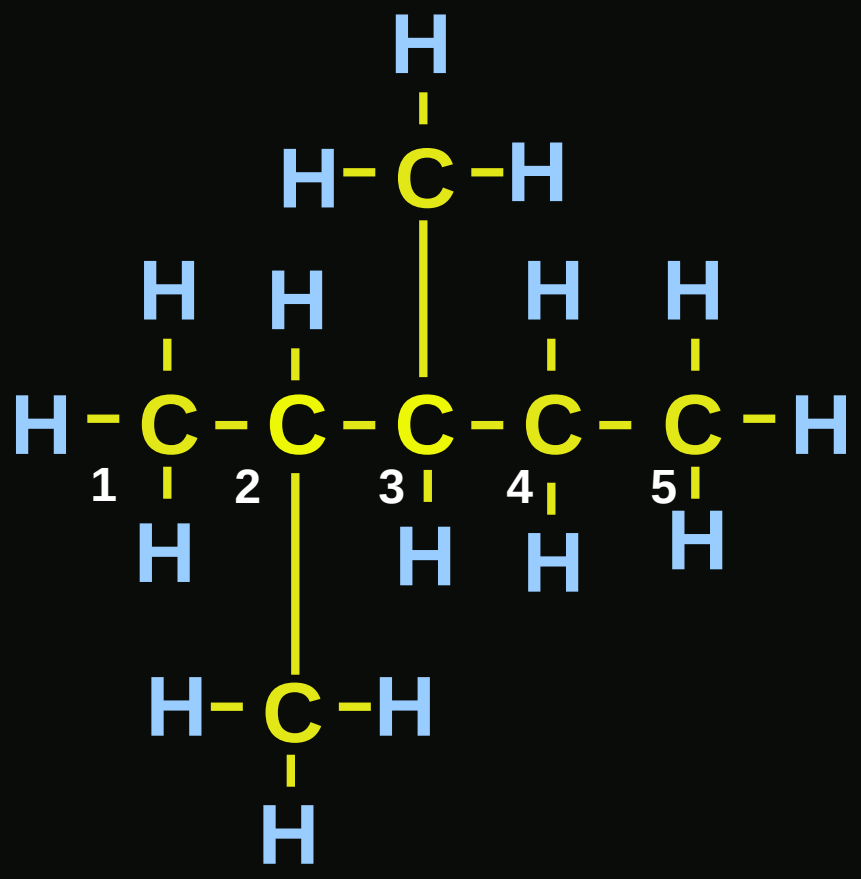
Methyl at 3

Dimethyl at 2,3

Basic rules

The name is:

Dimethyl pent ane



The stem name = pent

Single bonds = ane

First carbon connected to a substituent is 2

Methyl at 2

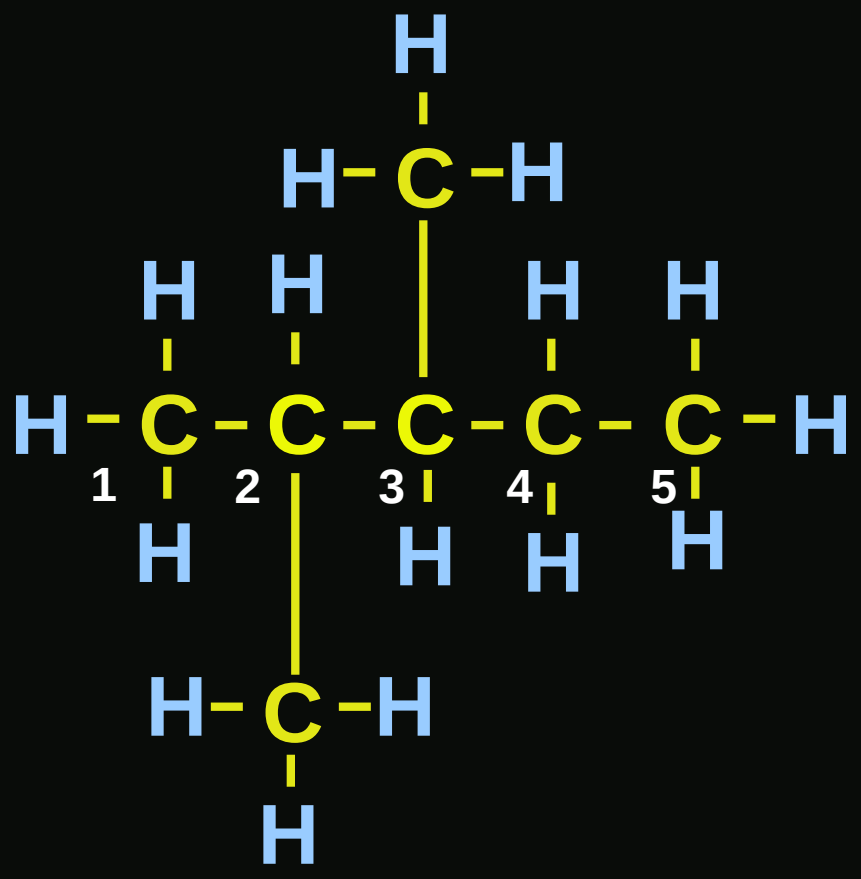
Methyl at 3

Dimethyl at 2,3

Basic rules

The name is:

2,3-Dimethylpentane



The stem name = pent

Single bonds = ane

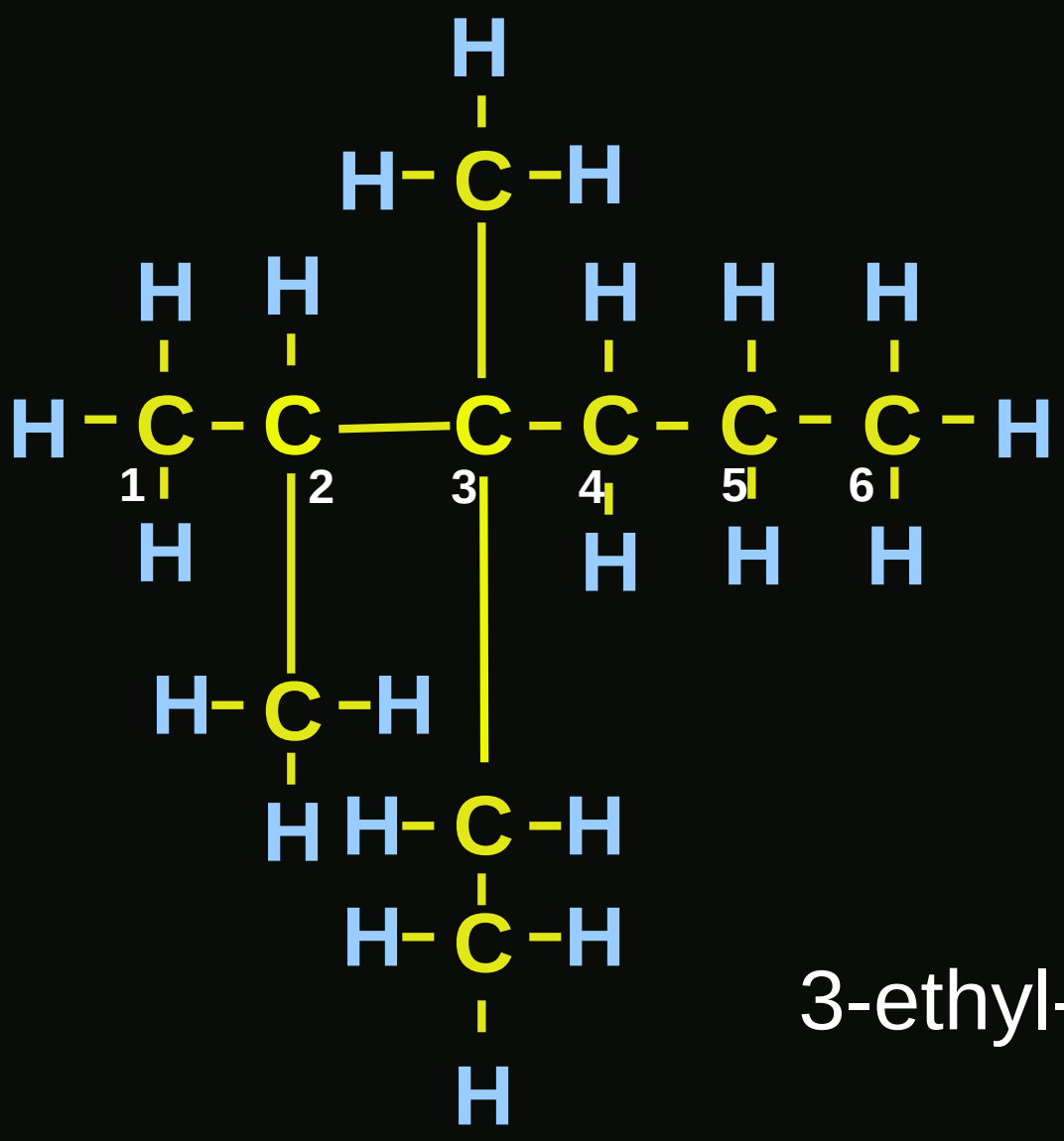
First carbon connected to a substituent is 2

Methyl at 2

Methyl at 3

Dimethyl at 2,3

Basic rules



If 2 different alkyl groups are present, they are written alphabetically (ignore the prefixes di, tri etc. for order but include for name)

3-ethyl-2,3-dimethylhexane

Basic rules

3-ethyl-2,3-dimethylhexane

- hyphens separate numbers from words
- commas separate two numbers
- write the name as a single word with no spaces

Juffrou Karen

Basic rules

These are the basic rules.
We will add to these rules
when we need to.

Juffrou Karen

Give the IUPAC name for the following compound:

The stem is = **But**

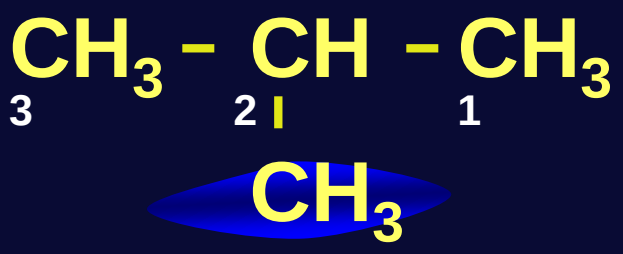
Single bonds = **ane**

No substituents

butane

(Cadac gas = mixture of butane and propane)

Give the IUPAC name for the following compound:



The stem is = **Prop**

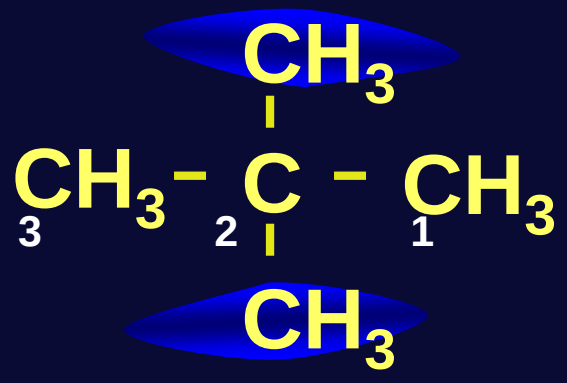
Single bonds = **ane**

Methyl at Carbon 2

2-Methylpropane

Juffrou Karen

Give the IUPAC name for the following compound:



The stem is = **Prop**

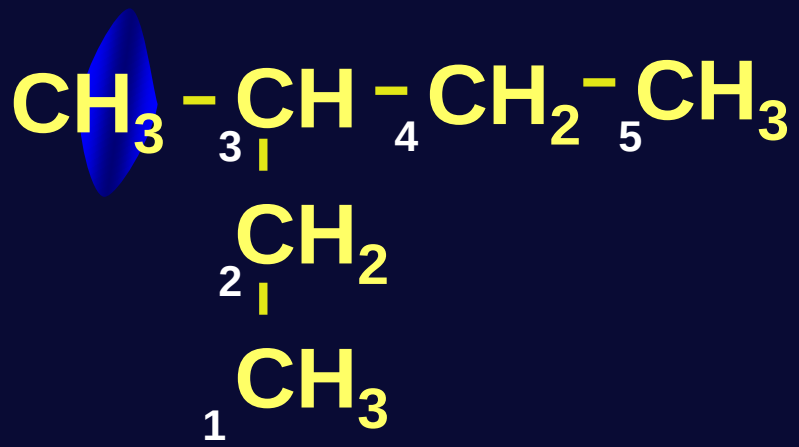
Single bonds = **ane**

2 Methyls at carbons 2 and 2

2,2-Dimethylpropane

Juffrou Karen

Give the IUPAC name for the following compound:



The stem is = pent

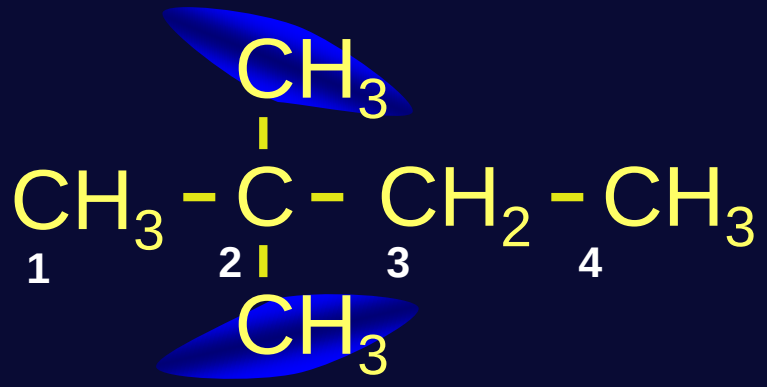
Single bonds = **ane**

1 Methyl at carbon 3

3-Methylpentane

Juffrou Karen

Give the IUPAC name for the following compound:



The stem is = **But**

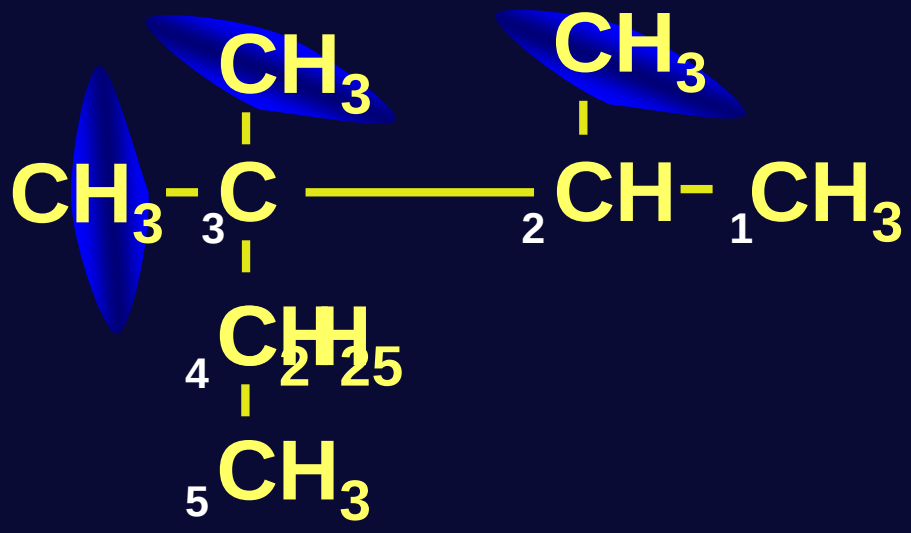
Single bonds = **ane**

2 Methyls at carbons 2 and 2

2,2-Dimethylbutane

Juffrou Karen

Give the IUPAC name for the following compound:



The stem is = **Pent**

Single bonds = **ane**

3 Methyls at carbons 2, 3 and 3

2,3,3-trimethylpentane

Juffrou Karen

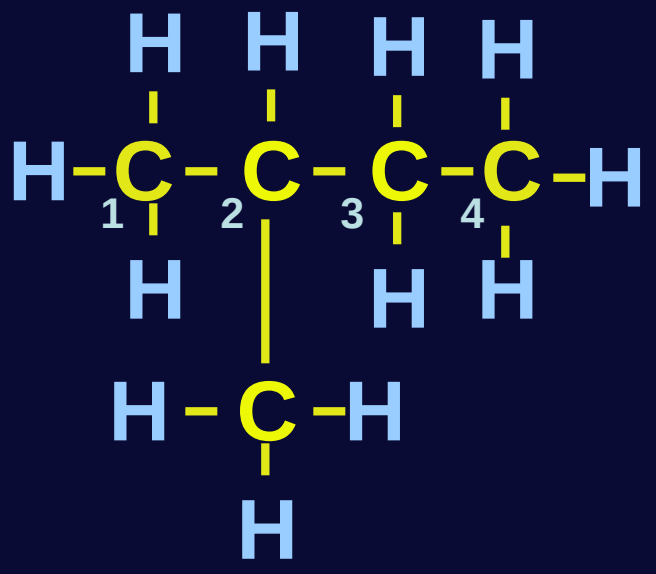
Draw a structural formula for the following compound:

2-Methylbutane

4 carbons

Methyl at carbon 2

Single bonds



Juffrou Karen

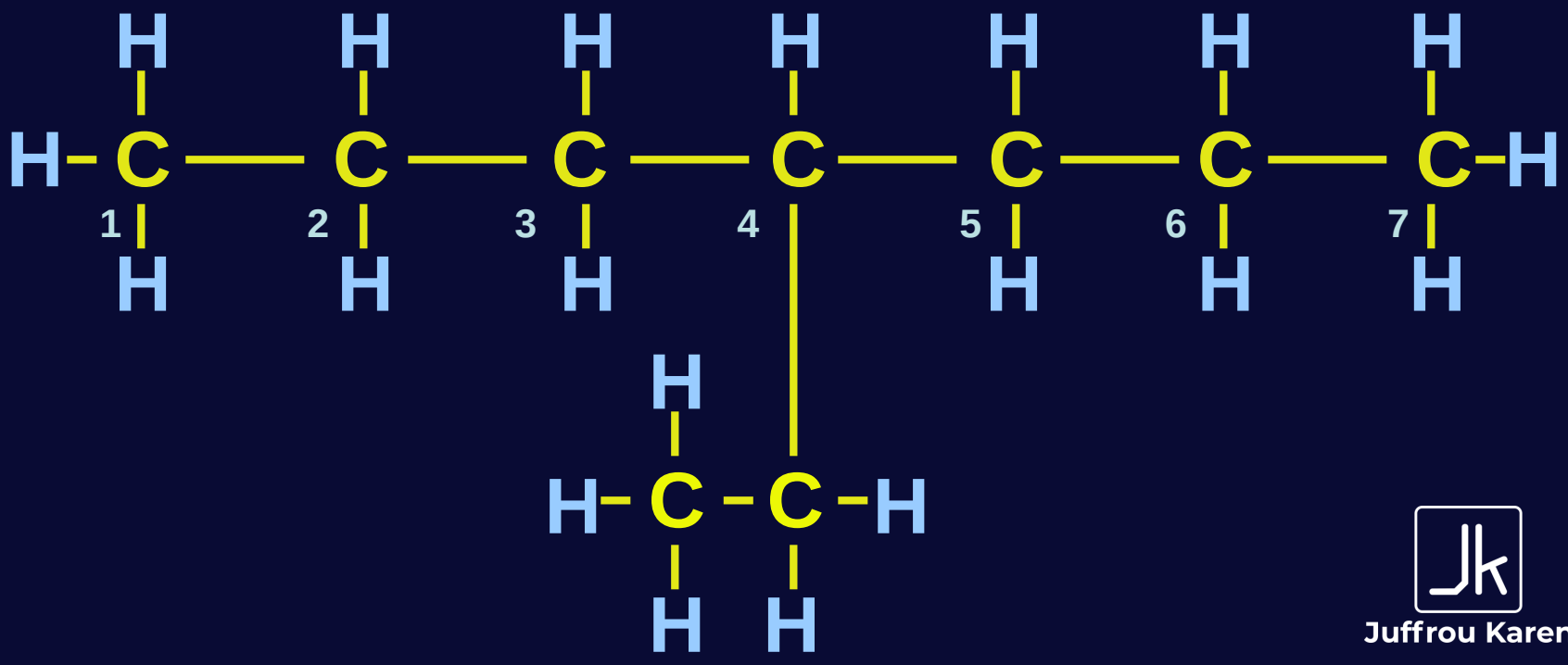
Draw a structural formula for the following compound:

4-Ethylheptane

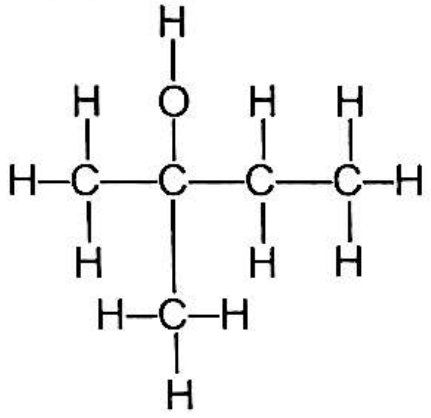
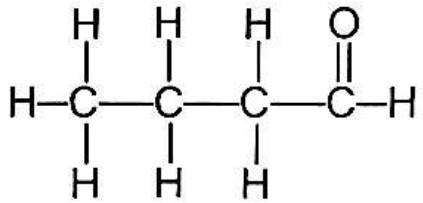
7 carbons

Ethyl at 4

Only single bonds



Juffrou Karen

A		**B**	
C	Butan-1-ol	**D**	Butan-2-one
E