لجان الدُّفعات

PHARMACEUTICAL ORGANIC CHEMISTRY"1"

MORPHINE ACADEMY

Pharmaceutical Organic Chemistry-1

مرحبا بكم في العضوية

Chapter-1: Introduction

Organic Chemistry: Definition

المادة العضوية بالنسبة النا في الكيمياء هي الكائنات الحية التي تحتوي على العنصر الاساسي وهو الكربون

- The word Organic can be a biological or chemical term, in biology it means anything that is living or has lived. The opposite is Non-Organic.
- Organic Chemistry is unique in that it deals with vast numbers of substances, both natural and synthetic.

  The clothes, the petroleum products, the paper, rubber, wood, plastics, paint, cosmetics, insecticides, and drugs

- But, from the chemical makeup of organic compounds, it was recognized that one constituent common to all was *the element carbon*.
- Organic chemistry is defined as *the study of carbon/hydrogen-containing compounds and their derivatives.*

The Uniqueness of Carbon

- What is unique about the element *carbon*?
- Why does it form so many compounds?
  - *The answers lie in*

    يتميز الكربون ؟

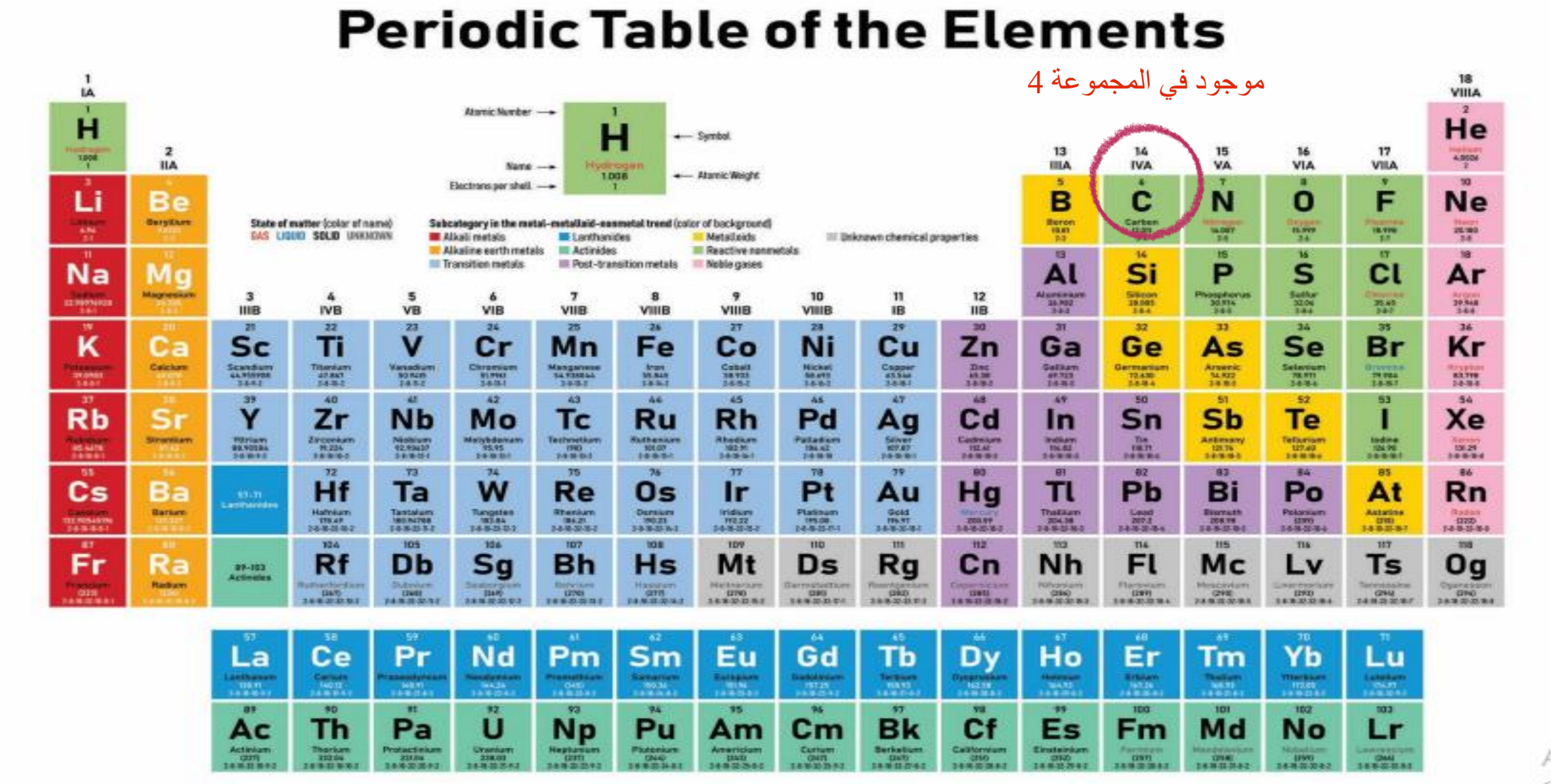
    - The structure of the *carbon* atom.

    الجدول الدوري

    - **The position of *carbon* in the periodic table.**
- These factors enable it to form strong bonds with
  - other carbon atoms

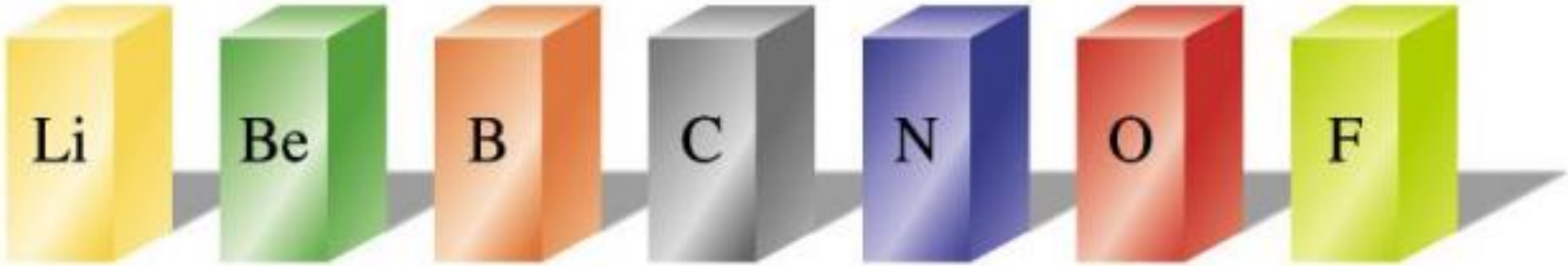
  وصفات الكربون بتتغير بناءً على ارتباطه بالذرات الاخرى

  - and with other elements (hydrogen, oxygen, nitrogen, halogens,...etc).
- Each organic compound has its own characteristic set of physical and chemical properties which depend on the *structure of the molecule*.



موجود في المجموعة 4

- Organic compounds are compounds containing carbon



the second row of the periodic table

المجموعات 1/2/3 يفقدوا الالكترونات وبصير عليهم شحنة موجبة

- Atoms to the left of carbon give up electrons.

المجموعات 5/6/7 يكتسبوا اللكترونات وبصير عليهم شحنة سالبة

- Atoms to the right of carbon accept electrons.
- Carbon shares electrons.

Atomic Structure

- Atoms consist of three main particles: neutrons (have no charge), protons (positively charged) and electrons (negatively charged).
  - Neutrons and protons are found in the nucleus.
  - Electrons are found outside the nucleus.

  Electrons are distributed around the nucleus in successive *shells* (*principal energy levels*).

  بكونوا electrons في levels مختلفة عشان بيناتهم شحنات سالبة ويتنافروا مع بعض

- Atom is electrically neutral.

  i.e. Number of electrons = Number of protons

  والي هو بناءً عليه بنرتب العناصر في الجدول الدوري

- Atomic number of an element is the number of protons.

  Or number of eletrons in neutral atom

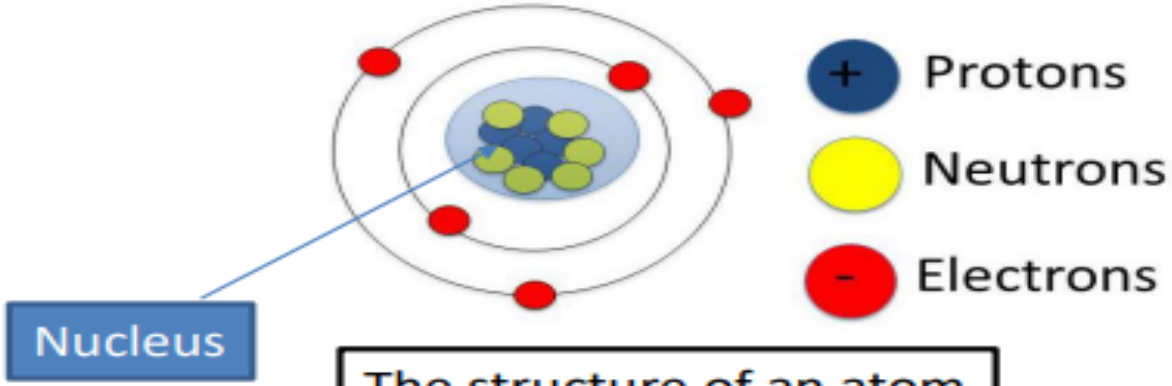
  الذرة المتعادلة

Bonding and Isomerism

1.1 How Electrons Are Arranged in Atoms

- An atom is: the *smallest particle* of an element that retains all of the chemical properties of that element.

•An atom consists of negatively charged electrons, positively charged protons, and neutral neutrons



The structure of an atom

- **Atomic number**: numbers of protons in its nucleus and it's the number of electrons in the neutral atom.

مجموع

- **Mass number**: the sum of the protons and neutrons of an atom.

(Protons and neutrons are ~1837 times the mass of an e^-)

- Isotopes have the same atomic number but different mass numbers (^{12}C and ^{13}C)

النظائر

Atomic Structure

- The energy levels are designated by capital letters (*K, L, M, N, ..*) or whole numbers (*n*).

- The maximum capacity of a shell = $2n^2$ electrons.

  n = number of the energy level.

- For example, the element carbon (atomic number 6)

  6 electrons are distributed about the nucleus as

Shell	K	L	M	N
Number of electrons	2	4	0	0

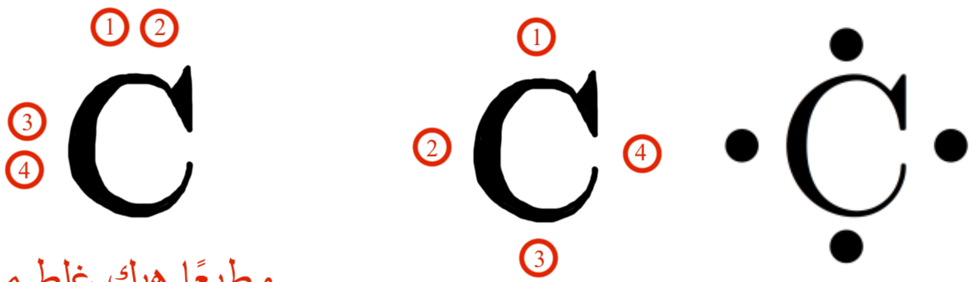
Atomic Structure

الكترونات التكافؤ الموجودة في المدار الاخير

Valance Electrons: Electron-Dot Structures

احنا بنهتم بهذه electrons عشان هي الي
بتتفاعل مع العناصر الثانية

- Valance Electrons are those electrons located in the *outermost energy level* (*the valance shell*).
- Electron-dot structures
  - ➢ The symbol of the element represents the core of the atom.
  - ➢ The valance electrons are shown as dots around the symbol.



وطبعًا هيك غلط ما
بنحط ثنتين الا لما
يخلص كل الجهات

هيك الصح على
الداير

كيف بنعبر عنهم ؟
بنكتب رمز العنصر بالنص
وبعدين عدد eletrons في
المدار الاخير وزعهم زي
كنقاط الي مرسوم هون
على الداير

Chemical Bonding

طبعًا صعب جدًا ان يكون element بالصيغة الحرة ومش مرتبط مع مركبات
عشان المركبات تسعى انها تكون تشبه الغازات النبيلة وتكون مستقرة ويكون المدار الاخير شبعان ما بكسب ولا بفقد

- In 1916 G.N. Lewis pointed out that:

  The noble gases were stable elements and he described their lack of reactivity to their having their valence shells filled with electrons.

  - 2 electrons in case of helium.
  - 8 electrons for the other noble gases.

- According to Lewis,

  in interacting with one another atoms can achieve a greater degree of stability

  by rearrangement of the valence electrons

  to acquire the outer-shell structure of the closest noble gas in the periodic table.

When two atoms combine together

بس مش شرط لنفس element دائمًا

Of the same element they form a molecule of element

Ex:

O + O → O_2

Oxygen atom | Oxygen atom | Oxygen molecule

Of different elements they form a molecule of compound.

Ex:

Na + Cl → NaCl

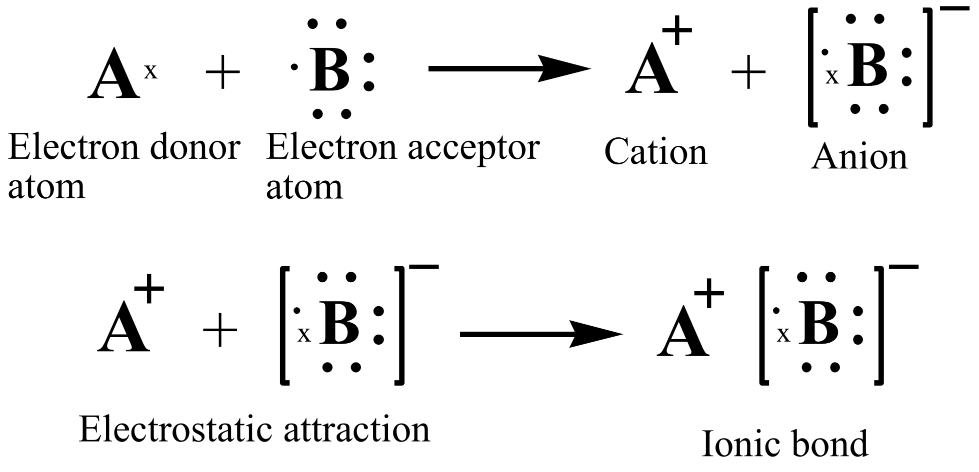
Sodium atom | Chlorine atom | Sodium chloride molecule

Covalent Bonds	*Ionic Bonds*
تعتبر اقوى رابطة ولا يمكن كسرها بسهولة	

A) Ionic Bonds

- Elements at the left of the periodic table give up their valance electrons and become *+ve charged ions* (*cations*).
- Elements at the right of the periodic table gain the electrons and become *-ve charged ions* (*anions*).
- Ionic bond

  The electrostatic force of attraction between oppositely charged ions.



- The majority of ionic compounds are *inorganic substances*.

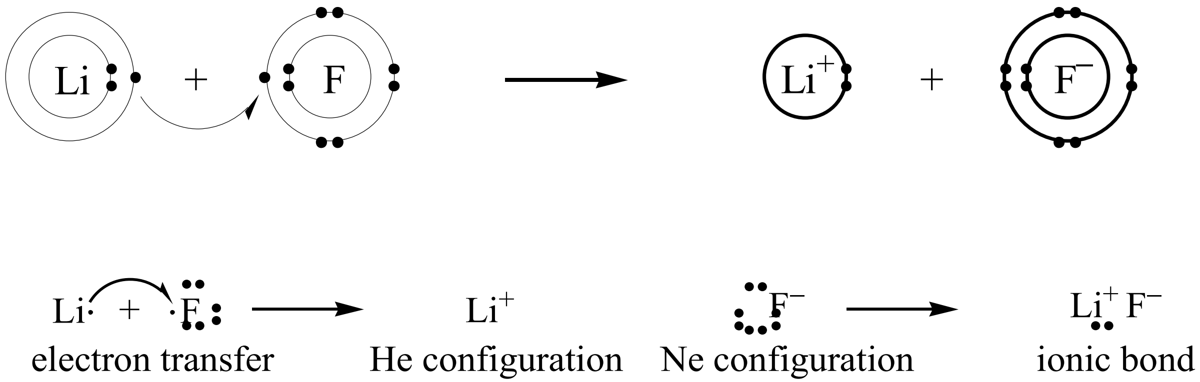
Electronegativity Measures The Ability of An Atom To Attract Electrons

Increasing electronegativity

Decreasing electronegativity

هدول الاسهم بالجدول الدوري

يعتبر الفلور أقوى واحد



B) Covalent Bonds

- Elements that are close to each other in the periodic table attain the stable noble gas configuration *by sharing valence electrons between them.*
- Covalent bond

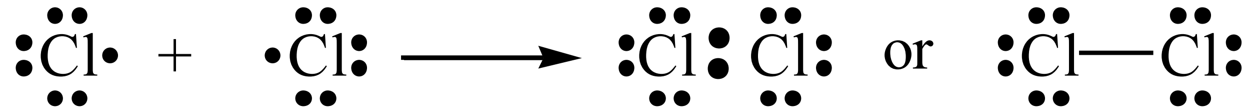
  The chemical bond formed when two atoms share one pair of electrons.
- A shared electron pair between two atoms or single covalent bond, will be represented by a dash (-).

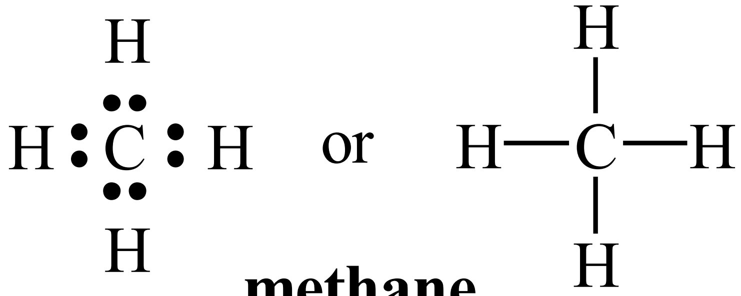
B) Covalent Bonds

Examples

H_2 H• + •H ⟶ H : H or H—H each H shares two electrons (He configuration)

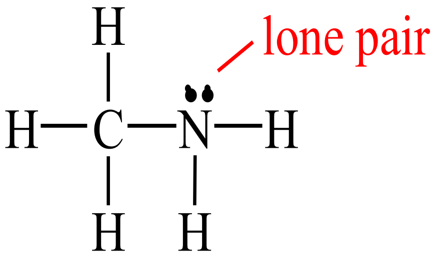
Cl_2



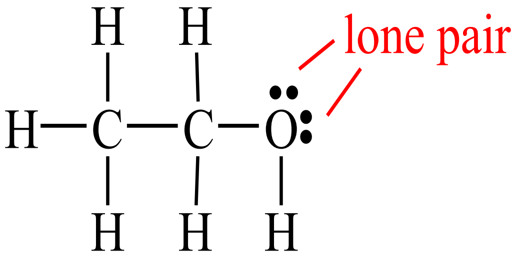


methane

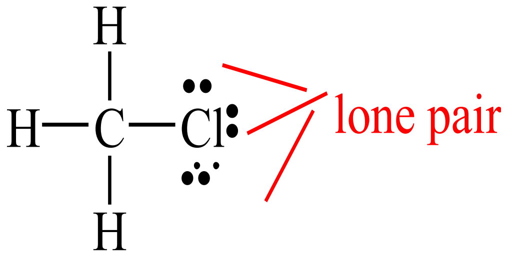
N_2



methyl amime



ethanol



chloromethane

B) Covalent Bonds

- In molecules that consist of two like atoms;

  the bonding electrons are shared equally

  (both atoms have the same electronegativity).

- When two unlike atoms;

  the bonding electrons are no longer shared equally (shared unequally).

A) Polar Covalent Bond

الكربون في المجموعة 4 والاكسجين في المجموعة 6 يعني مين بحب electrons أكثر ؟ هو الأكسجين حسب
الجدول الدوري والي حكينا فوق ، يعني بيكون electronegative اكثر وبسحبهم يعني فترة بقاء electron عند
الاكسجين اكثر بلحظات معينة

A bond, in which an electron pair is shared unequally.

- The more electronegative atom assumes a partial negative charge and the less electronegative atom assumes a partial positive charge.

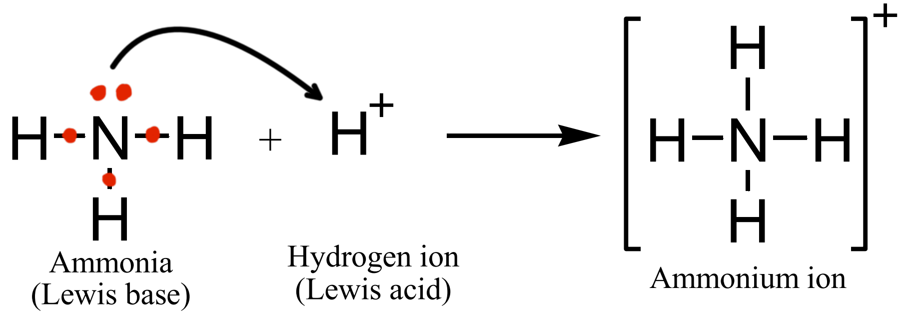
$$C-O \quad \text{or} \quad \overset{\delta+}{C}-\overset{\delta-}{O}$$

التناسقية

B) Coordinate Covalent Bonds

هسا في covelent bond العادية او poler بيكون في تشارك بين الذرات في electrons
اما في coordinate بيكون electrons من ذرة وحدة

- There are molecules in which one atom supplies both electrons to another atom in the formation of a covalent bond.
- For example;



- Lewis base

  The species that furnishes the electron pair to form a coordinate covalent bond.

  ال element الي قدم زوج electrons هو قاعدة lewis

- Lewis acid

  The species that accepts the electron pair to complete its valance shell.

  اما الي استقبل زوج electrons هو حمض lewis

مدارات

- Electrons are located in atomic orbitals (S, P, d, f).

- Orbitals $\boxed{\text{tell us}}$ the energy of the electron and the volume of space around the nucleus where an electron is most likely to be found.

بهمنا كثير الحجم عشان يعني لما نحط المركب في دواء معين
بدنا نعرف كم رح ياخذ مساحة حسب المركبات الاخرى
الموجودة ورح يغيرلنا الكثافة ورح يدخل في المستقبلات او لأ

- Orbitals are grouped in shells .

يعني ما بزبط اعبي في المدار الواحد أكثر من 2 electrons وطبعا بكونوا بدوروا عكس بعض عشان في بينهم تنافر

Each orbital can hold a maximum of $2e^-$ and the two electrons have opposite spin

Table 1.1 Distribution of Electrons in the First Four Shells That Surround the Nucleus

	First shell	Second shell	Third shell	Fourth shell
Atomic orbitals	*s*	*s, p*	*s, p, d*	*s, p, d, f*
Number of atomic orbitals	1	1, 3	1, 3, 5	1, 3, 5, 7
Maximum number of electrons	2	8	18	32

Valence electrons (VE) are located in the outermost shell. They are involved in chemical reactions.

VE = Group number

		VE	Lewis symbol of atom
Examples:	^{1}H: Is^{1}	1	H·
	^{8}O: $IS^{2}\ 2S^{2}\ 2P^{4}$	6	$\ddot{\underset{\cdot\cdot}{O}}$:
	^{6}C: $1S^{2}\ 2S^{2}\ 2P^{2}$		

Table 1.3 Valence Electrons of the First 18 Elements

Group	I	II	III	IV	V	VI	VII	VIII
	H·							He:
	Li·	Be·	·B·	·C·	·N:	·O:	:F:	:Ne:
	Na·	Mg·	·Al·	·Si·	·P:	·S:	:Cl:	:Ar:

How Many Bonds to an Atom? Covalence Number

The number of covalent bonds that an atom can form with other atoms.

i.e. *the covalence number is equal to the number of electrons needed to fill its valance shell.*

Element	Number of valence electrons	Number of electrons in filled valence shell	Covalence number
H	1	2	1
C	4	8	4
N	5	8	3
O	6	8	2
F, Cl, Br, I	7	8	1

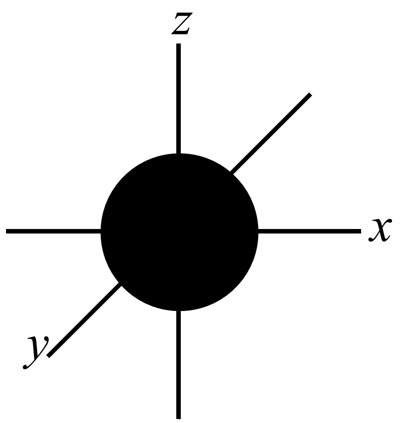
Shapes of Organic Molecules: Orbital Picture of Covalent Bonds

Atomic Orbitals

- An atomic orbital *represents a specific region in space in which an electron is most likely to be found.*
- Atomic orbitals are designated in the order in which they are filled by the letters *s, p, d,* and *f*.
  - Examples: *K shell has only one 1s orbital.*

    L shell has one 2s and three 2p ($2p_x$, $2p_y$ and $2p_z$).

  - An *s* orbital is spherically shaped electron cloud with the atom's nucleus and its center.



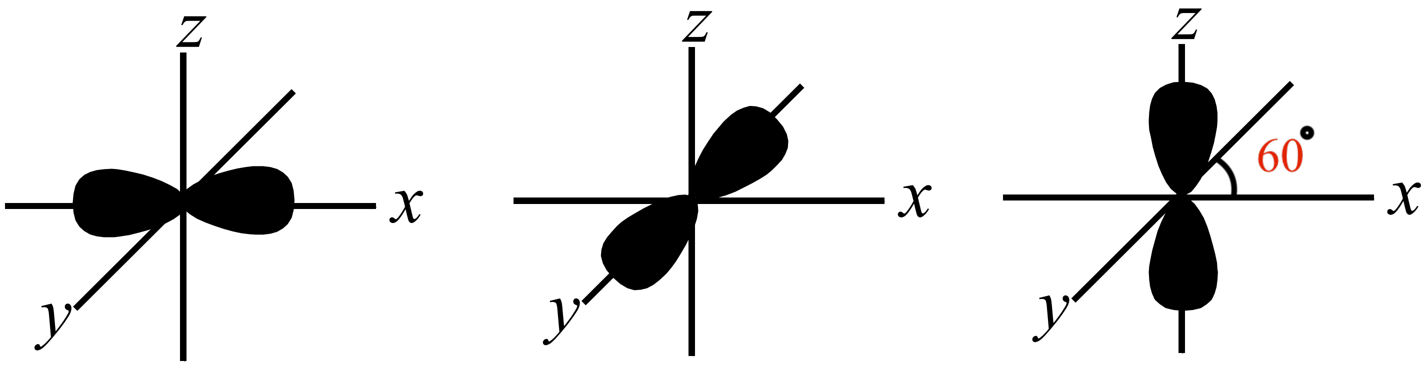
s orbital

Shapes of Organic Molecules: Orbital Picture of Covalent Bonds

Atomic Orbitals

- A *p* orbital is a dumbbell-shaped electron cloud with the nucleus between the two lobes.
  بيكونوا electrons ابعد ما يمكن بحيث يتوزعوا بطريقة يكون بيناتهم زاوية 60 درجة

- Each *p* orbital is oriented along one of three perpendicular coordinate axes (in the *x, y,* or *z* direction).

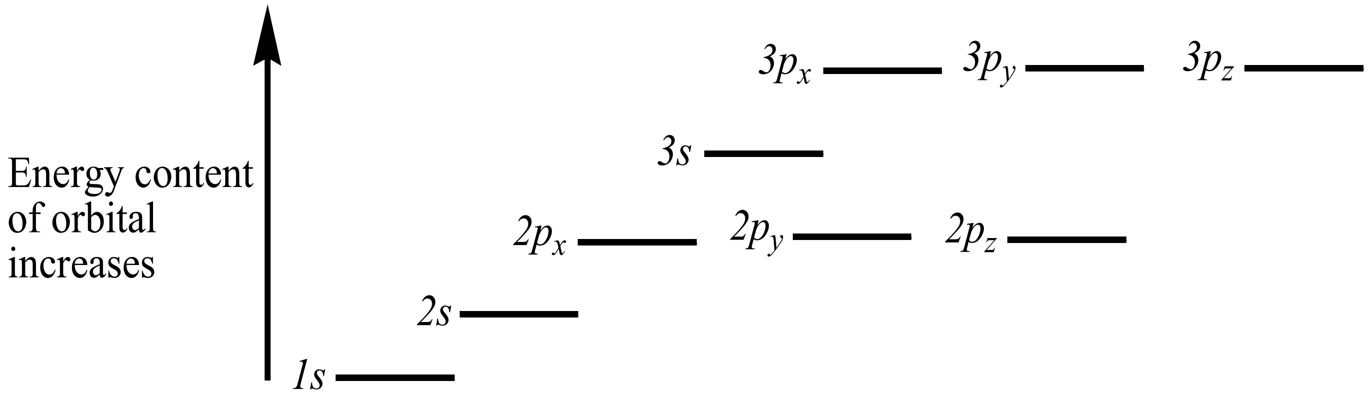


p_x orbital p_y orbital p_z orbital

Shapes of Organic Molecules: Orbital Picture of Covalent Bonds

Atomic Orbitals

- An energy level diagram of atomic orbitals.



- When filling the atomic orbitals, keep in mind that

    (1) An atomic orbital contain no more 2 electrons.

    (2) Electrons fill orbitals of lower energy first.

    (3) No orbital is filled by 2 electrons until all the orbitals of equal energy have at least one electron.

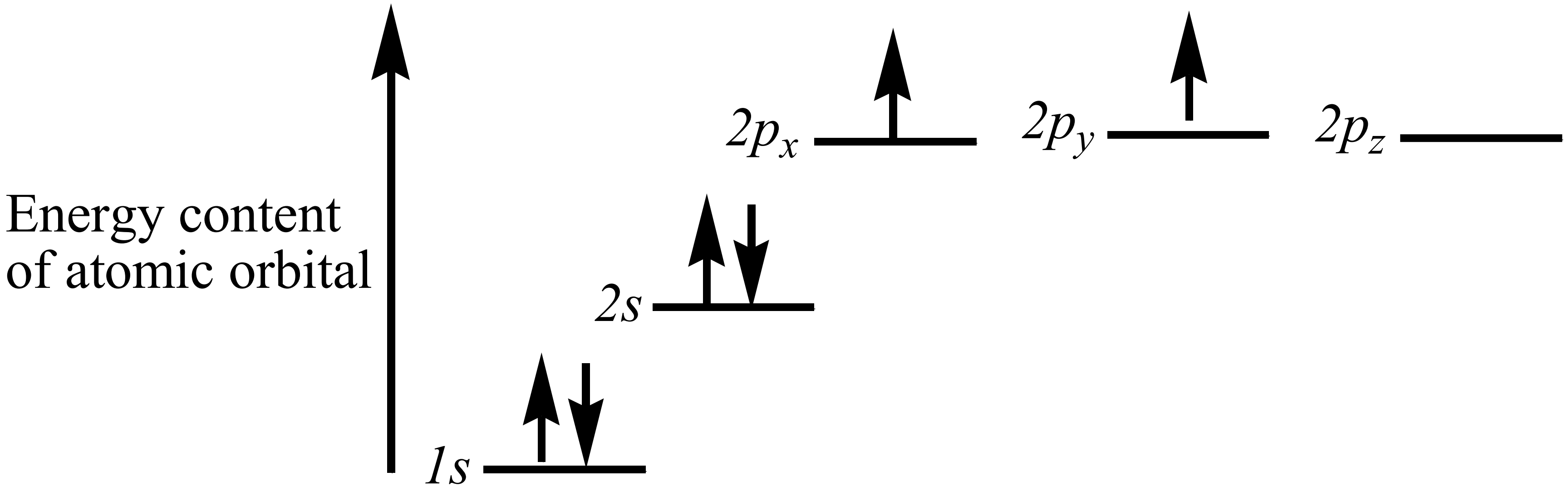
يعني وزع electrons على كل orbital في shell وبعدين بترجع بتعبي من اول وجديد

Shapes of Organic Molecules: Orbital Picture of Covalent Bonds

Atomic Orbitals

- The electronic configuration of carbon (atomic number 6) can be represented as

$1s^22s^2sp^1{}_x2p^1{}_y$ or $1s^22s^22p^2$



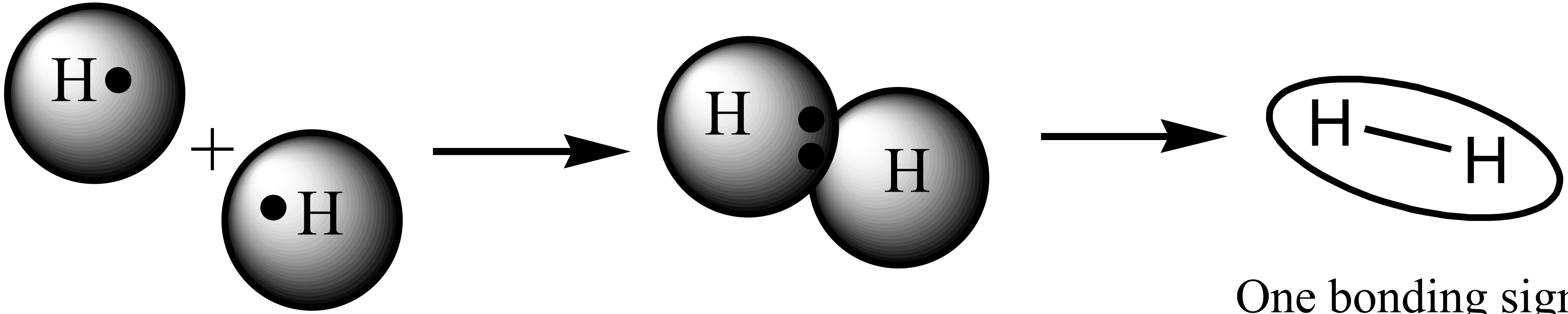
Energy level diagram for carbon.

Shapes of Organic Molecules: Orbital Picture of Covalent Bonds

Molecular Orbitals

- A covalent bond consists of the overlap between two atomic orbitals to form a molecular orbital.
- Example:

Molecular orbital of H_2



Two 1*s* atomic orbitals

Overlap

One bonding sigma molecular orbital

Molecular Orbitals

رابطة احادية

- Sigma bonds (σ bonds) can be formed from
  - The overlap of two *s* atomic orbitals.
  - The end-on overlap of two *p* atomic orbitals.
  - The overlap of two an *s* atomic orbital with a *p* atomic orbital.

رابطة ثنائية

- pi bonds (π bonds) can be formed from the side-side overlap between two *p* atomic orbitals.

Bond Energy and Bond Length

- A molecule is more stable than the isolated constituent atoms.

  This stability is apparent in the release of energy during the formation of the molecular bond.

- Heat of formation (bond energy)

  The amount of energy released when a bond is formed.

- Bond dissociation energy

  The amount of energy that must be absorbed to break a bond.

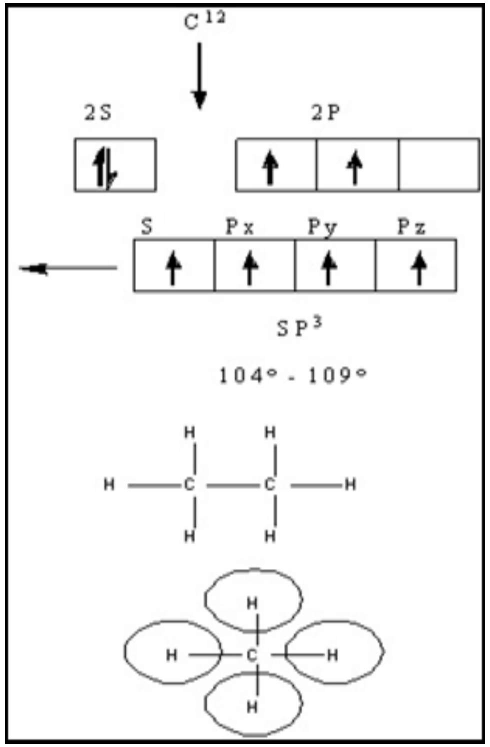
- Bond length

  The distance between nuclei in the molecular structure.

Hybridization (Alkanes sp^3)

$1s + 3p$

- In the case of **alkanes sp^3**, the three *2p* orbitals of the carbon atom are combined with its *2s* orbital to form four new orbitals called "sp^3" hybrid orbitals.
- Four hybrid orbitals were required since there are four atoms attached to the central carbon atom.
- These new orbitals will have an energy slightly above the *2s* orbital and below the *2p* orbitals as shown in the following illustration.
- Notice that no change occurred with the *1s* orbital.



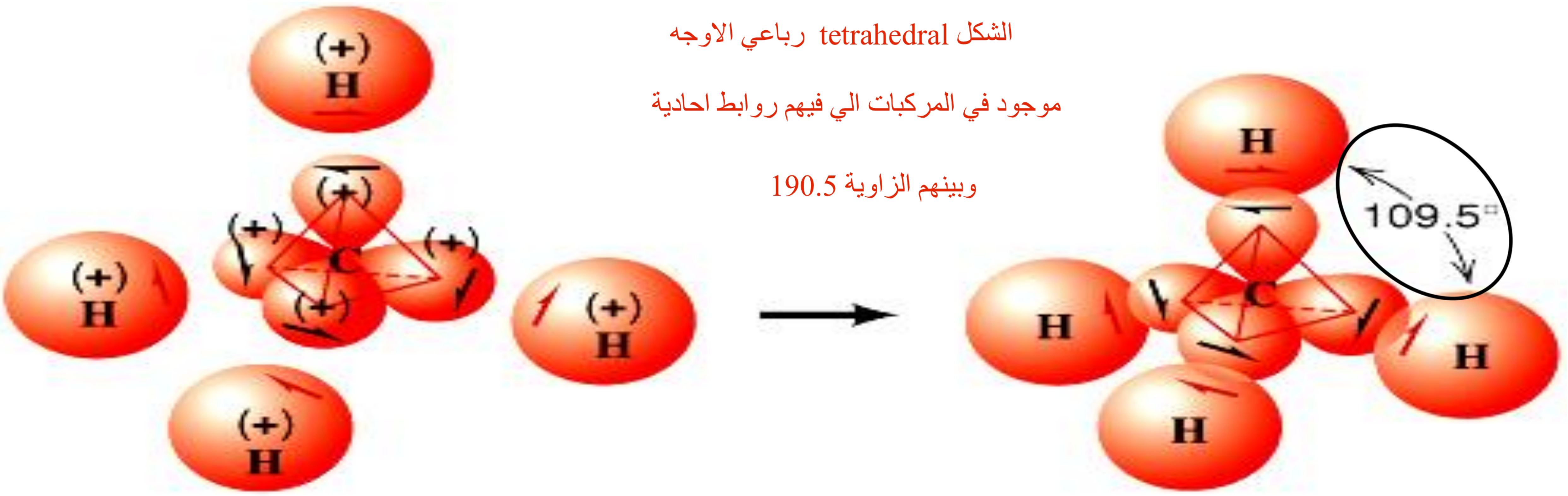
Methane

Hybridization (Alkanes sp^3)

الشكل tetrahedral رباعي الاوجه

موجود في المركبات الي فيهم روابط احادية

وبينهم الزاوية 190.5



Methane, CH_4

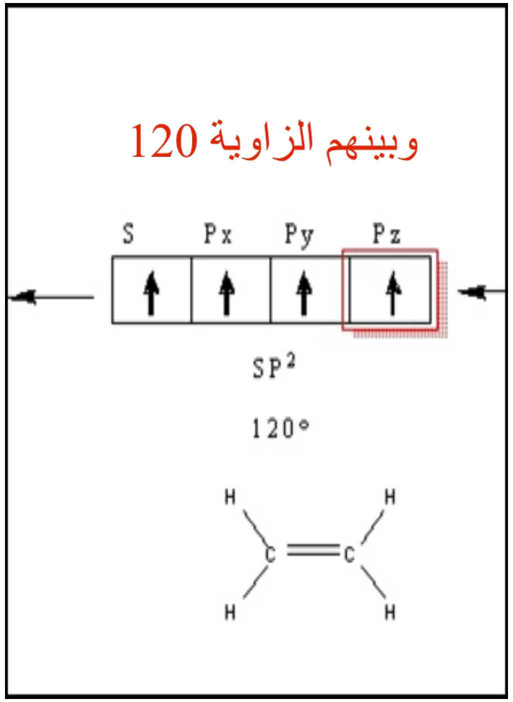
Hybridization (Alkenes sp^2)

1s + 2p

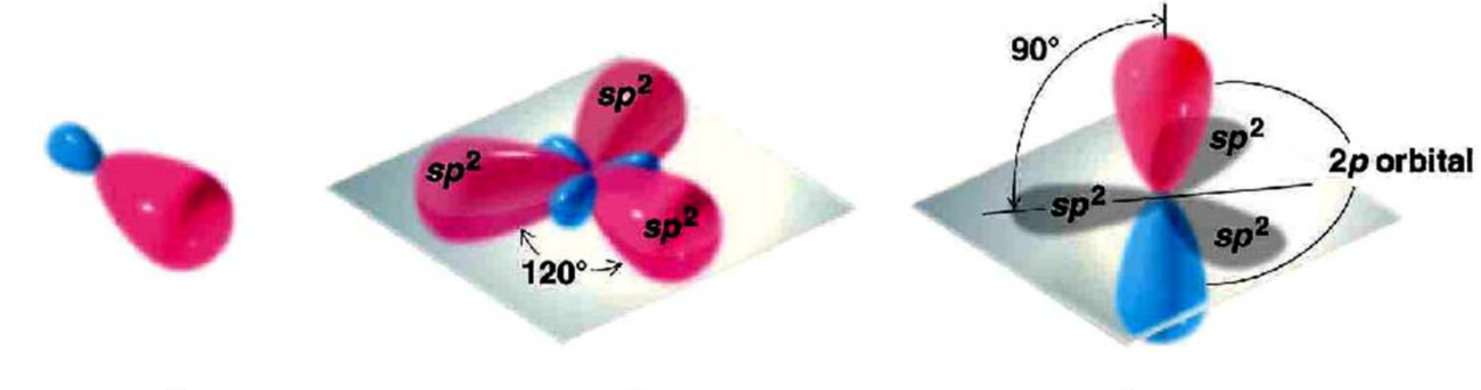
موجود في المركبات الي فيهم روابط ثنائية يعني
sigma bond and pi bond

الشكل trigonal ثلاثي الاوجه

- In the case of **alkenes *sp^2***, the *2s* orbital is combined with only two of the *2p* orbitals (*since we only need three hybrid orbitals for the three groups. thinking of groups as atoms and non-bonding pairs*) forming three hybrid orbitals called *sp^2* hybrid orbitals.
- The other *p*-orbital remains unhybridized and is at right angles to the trigonal planar arrangement of the hybrid orbitals.
- **The trigonal planar** arrangement has **bond angles of 120°.**



Ethene
(Ethylene)



(a) An sp^2 orbital (b) Three sp^2 orbitals (c) Three sp^2 orbitals and an unhybridized $2p$ orbital

Hybridization (Alkynes *sp*)

1s +1p

موجود في المركبات الي فيهم روابط ثلاثية

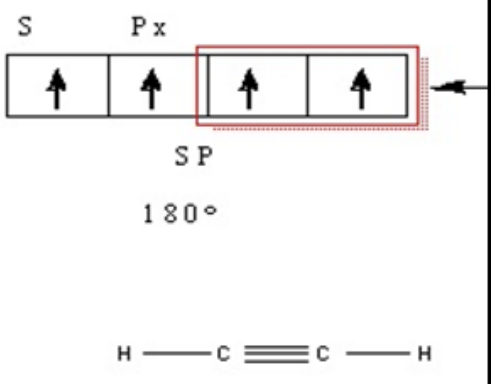
الشكل linear ثنائي الاوجه

- In the case of **alkynes *sp***, the *2s* orbital is combined with only one of the *2p* orbitals to yield two *sp* hybrid orbitals.

- The two hybrid orbitals will be arranged as far apart as possible from each other with the result being a linear arrangement.

- The two unhybridized *p*-orbitals stay in their respective positions (at right angles to each other) and perpendicular to the **linear** molecule **(180°).**

وبينهم الزاوية 180



Ethyne

(Acetylene)

Formal Charge

Formal Charge: is the net charge on each atoms of the molecule or ion. (which contain a covalent bond only)

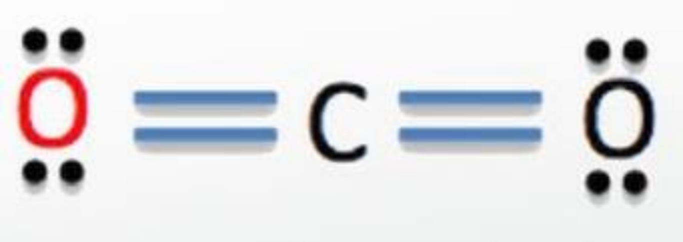
How to calculate the Formal Charge (FC):

$$FC = \begin{matrix}\text{Valence } e^- \\ \text{in Free Atom}\end{matrix} - \left(\begin{matrix}\text{Total} \\ \text{Nonbonding } e^-\end{matrix} + \frac{\text{Total Bonding } e^-}{2} \right)$$

Example: calculate the formal charge of CO2

FC for O= 6-(4+4/2)=0

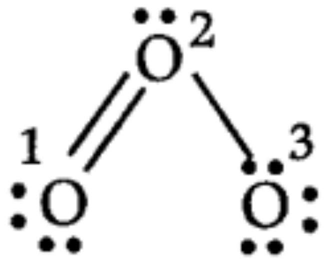
FC for C= 4-(0 + 8/2)= 0



Example:

Formal Charge

Lewis structure of O_3 is

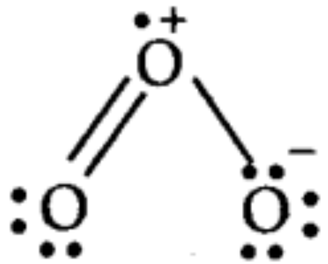


Formal charge on O(1) $= 6 - \left(4 + \frac{4}{2}\right) = 0$

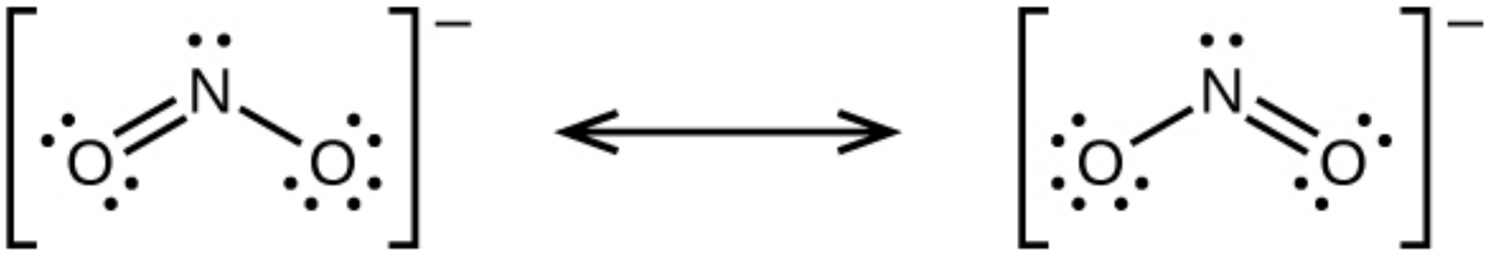
Formal charge on O(2) $= 6 - \left(2 + \frac{6}{2}\right) = +1$

Formal charge on O(3) $= 6 - \left(6 + \frac{2}{2}\right) = -1$

Hence we represent O_3 along with formal charges as follows.



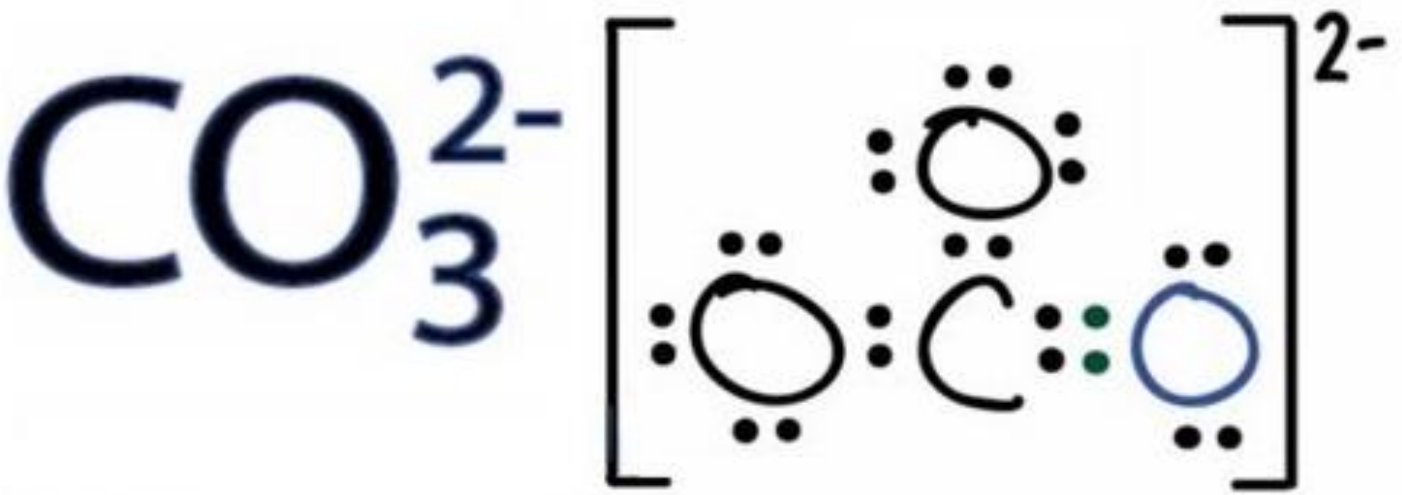
Example:



Formal charge: 0 0 –1   –1 0 0

6-(4 + 4/2) 5-(2+6/2) 6-(6+2/2)

Example:



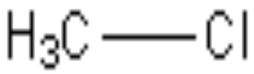
Formal Charge	=	Valence Electrons	-	NonBonding Val Electrons	-	$\frac{\text{Bonding Electrons}}{2}$		
C	=	4	-	0	-	8/2	=	0
O	=	6	-	6	-	2/2	=	-1
O	=	6	-	4	-	4/2	=	0

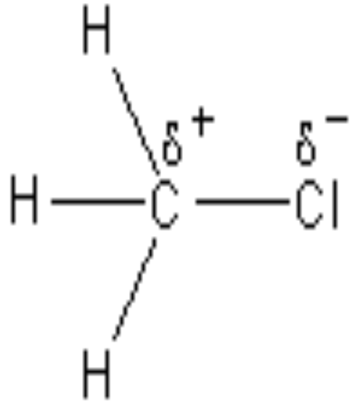
Inductive Effect

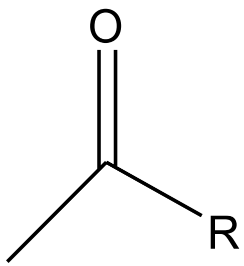
- Inductive effect can be defined as *the permanent displacement of electrons forming a covalent bond (sigma σ bonds) towards the more electronegative element or group*
- . بأنه الإزاحة الدائمة للإلكترونات التي تشكل رابطة تساهمية نحو العنصر أو المجموعة الأكثر كهرسلبية.
- The inductive effect is represented by the symbol, the arrow pointing towards the more electronegative element or group of elements.

(+ I) effect if the substituent electron-donating

(- I) effect if





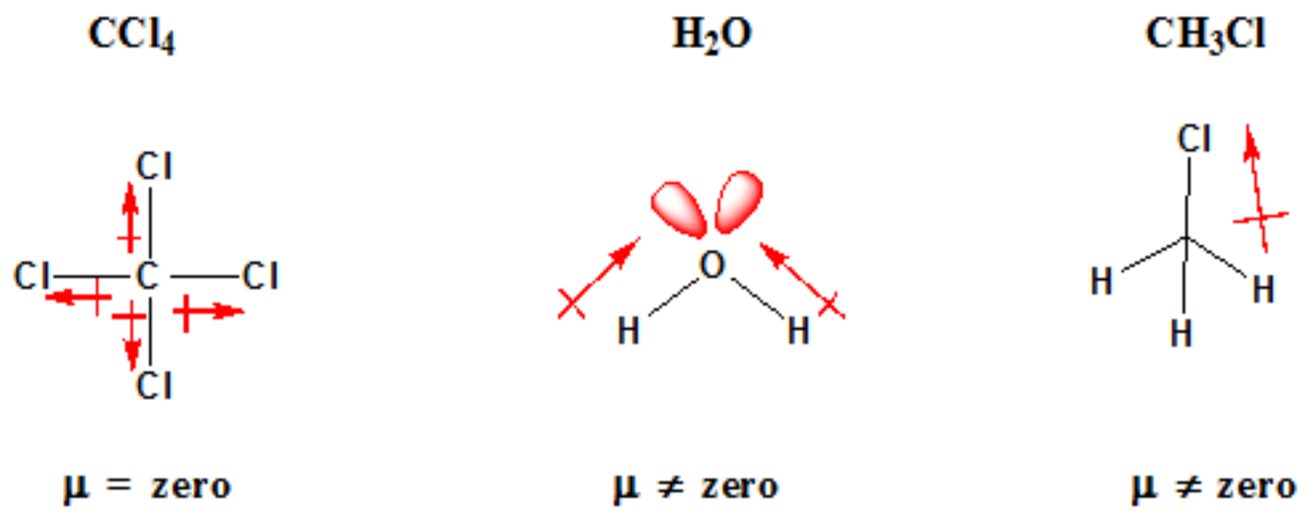


Electron-donating substituents (+I): $-CH_3$, $-C_2H_5$,….

Electron-withdrawing substituents (-I): $-NO_2$, -CN, $-SO_3H$, COOH, COOR, NH_2, OH, OCH_3

Bond Polarity and Dipole Moment (μ)

- **Dipole moment** (depends on the inductive effect).
- A bond with the electrons shared equally between two atoms is called a **nonpolar bond** like in Cl-Cl and C-C bond in ethane.
- A bond with the electrons shared unequally between two different elements is called a **polar bond** like in H-Cl and H-O bond.
- The **bond polarity** is measured by its dipole moment (μ).
- **Dipole moment (μ)** defined to be the amount of charge separation (+δ and –δ) multiplied by the bond length.

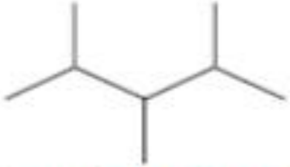


1.17: Classification According to Molecular Framework

- The three main classes of molecular frameworks for organic structures are **acyclic**, **carbocyclic**, and **heterocyclic** compounds.

1.17.a Acyclic Compounds (*not cyclic*): contain chains that may be **unbranched** or **branched**.

unbranched chain of eight carbon atoms



branched chain of eight carbon atoms

geraniol
(oil of roses)
bp 229–230°C

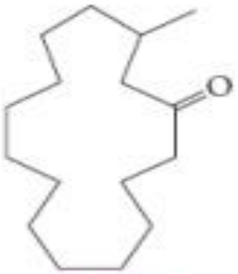
$CH_3(CH_2)_5CH_3$

heptane
(petroleum)
bp 98.4°C

$CH_3\overset{\overset{O}{\|}}{C}(CH_2)_4CH_3$

2-heptanone
(oil of cloves)
bp 151.5°C

1.17b: Carbocyclic Compounds: contain rings of carbon atoms



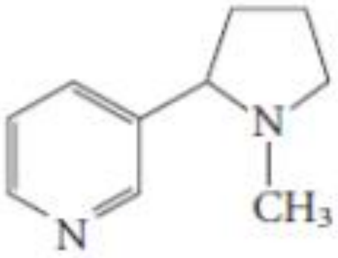
muscone
(musk deer)
bp 327–330°C

limonene
(citrus fruit oils)
bp 178°C

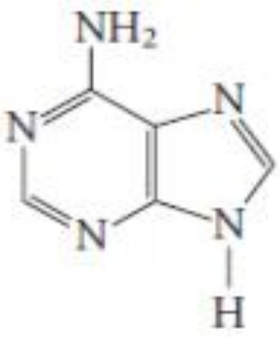
benzene
(petroleum)
mp 5.5°C, bp 80.1°C

اطمنوا الاشكال مش حفظ
#منقول من الدكتورة

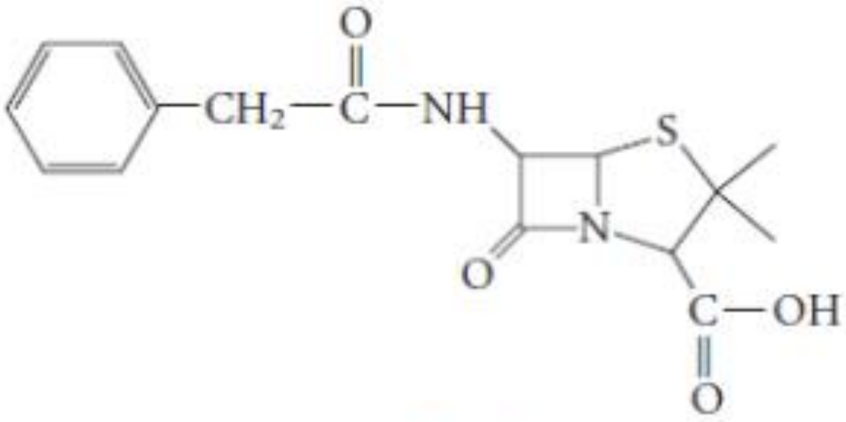
1.17.c Heterocyclic Compounds (In heterocyclic compounds, at least one atom in the ring must be a heteroatom, an atom that is *not* carbon: *eg*. N, O,S...)



nicotine
bp 246°C



adenine
mp 360–365°C
(decomposes)



penicillin-G
(amorphous solid)

لازم يكون عندك فكرة عن كل مجموعة

Classification According to Functional Group

A functional group is an arrangement of atoms with distinctive **physical** and **chemical** properties.

Table 1.6 The Main Functional Groups

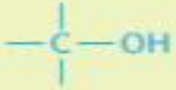
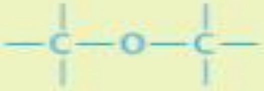
	Structure	Class of compound	Specific example	Common name of the specific example
A. Functional groups that are a part of the molecular framework		alkane	$CH_3—CH_3$	ethane, a component of natural gas
		alkene	$CH_2{=}CH_2$	ethylene, used to make polyethylene
	$—C{\equiv}C—$	alkyne	$HC{\equiv}CH$	acetylene, used in welding
		arene		benzene, raw material for polystyrene and phenol
B. Functional groups containing oxygen				
1. With carbon–oxygen single bonds		alcohol	CH_3CH_2OH	ethyl alcohol, found in beer, wines, and liquors
		ether	$CH_3CH_2OCH_2CH_3$	diethyl ether, once a common anesthetic

Table 1.6 continued

	Structure	Class of compound	Specific example	Common name of the specific example
*2. With carbon–oxygen double bonds**	$-\overset{O}{\overset{\|}{C}}-H$	aldehyde	$CH_2{=}O$	formaldehyde, used to preserve biological specimens
	$-\underset{\|}{\overset{\|}{C}}-\overset{O}{\overset{\|}{C}}-\underset{\|}{\overset{\|}{C}}-$	ketone	$CH_3\overset{O}{\overset{\|}{C}}CH_3$	acetone, a solvent for varnish and rubber cement
3. With single and double carbon–oxygen bonds	$-\overset{O}{\overset{\|}{C}}-OH$	carboxylic acid	$CH_3\overset{O}{\overset{\|}{C}}-OH$	acetic acid, a component of vinegar
	$-\overset{O}{\overset{\|}{C}}-O-\underset{\|}{\overset{\|}{C}}-$	ester	$CH_3\overset{O}{\overset{\|}{C}}-OCH_2CH_3$	ethyl acetate, a solvent for nail polish and model airplane glue
*C. Functional groups containing nitrogen***	$-\underset{\|}{\overset{\|}{C}}-NH_2$	primary amine	$CH_3CH_2NH_2$	ethylamine, smells like ammonia
	$-C{\equiv}N$	nitrile	$CH_2{=}CH-C{\equiv}N$	acrylonitrile, raw material for making Orlon
D. Functional group with oxygen and nitrogen	$-\overset{O}{\overset{\|}{C}}-NH_2$	primary amide	$H-\overset{O}{\overset{\|}{C}}-NH_2$	formamide, a softener for paper
E. Functional group with halogen	$-X$	alkyl or aryl halide	CH_3Cl	methyl chloride, refrigerant and local anesthetic
F. Functional groups containing sulfur[†]	$-\underset{\|}{\overset{\|}{C}}-SH$	thiol (also called mercaptan)	CH_3SH	methanethiol, has the odor of rotten cabbage
	$-\underset{\|}{\overset{\|}{C}}-S-\underset{\|}{\overset{\|}{C}}-$	thioether (also called sulfide)	$(CH_2{=}CHCH_2)_2S$	diallyl sulfide, has the odor of garlic

Functional Groups

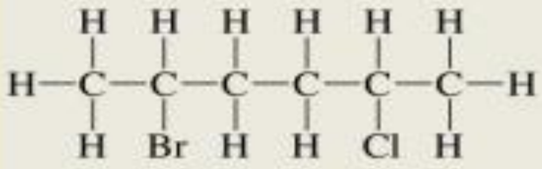
Functional Group is a reactive portion of an organic molecule, an atom, or a group of atoms that confers on the whole molecule its characteristic properties.

Class	General formula	Functional group	Specific
Alkane	RH	C – C (single bond)	$H_3C - CH_3$
Alkene	$R - CH = CH_2$	C = C (double bond)	$H_2C = CH_2$
Alkyne	$R-C\equiv CH$	$C\equiv C$ (triple bond)	$HC\equiv CH$
Alkyl halide	RX	-X (X = F, Cl, Br, I)	H_3C - Cl
Alcohol	R – OH	-OH	H_3C - OH
Ether	R – O –R'	- C- O – C -	$H_3C - O - CH_3$
Aldehyde	$R-\overset{O}{\overset{\|}{C}}-H$	$-\overset{O}{\overset{\|}{C}}-H$	$H-\overset{O}{\overset{\|}{C}}-H$, $H_3C-\overset{O}{\overset{\|}{C}}-H$
Ketone	$R-\overset{O}{\overset{\|}{C}}-R$	$-\overset{\|}{\underset{\|}{C}}-\overset{O}{\overset{\|}{C}}-\overset{\|}{\underset{\|}{C}}-$	$H_3C-\overset{O}{\overset{\|}{C}}-CH_3$
Carboxylic acid	$R-\overset{O}{\overset{\|}{C}}-OH$	$-\overset{O}{\overset{\|}{C}}-OH$	$H-\overset{O}{\overset{\|}{C}}-OH$, $H_3C-\overset{O}{\overset{\|}{C}}-OH$
Ester	$R-\overset{O}{\overset{\|}{C}}-OR$	$-\overset{O}{\overset{\|}{C}}-OR$	$H-\overset{O}{\overset{\|}{C}}-OCH_3$ $H_3C-\overset{O}{\overset{\|}{C}}-OCH_3$
Amine	$R - NH_2$	$-\overset{\|}{\underset{\|}{C}}-NH_2$	$H_3C - NH_2$

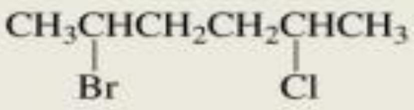
Dash formula

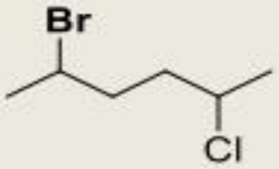
Kekul structur e	Condensed structures	Bond line formula

Atoms bonded to a carbon are shown to the right of the carbon. Atoms other than H can be shown hanging from the carbon.

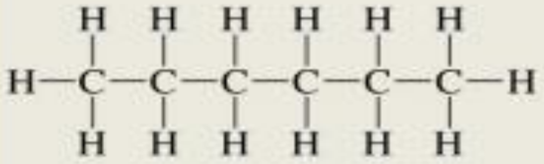


$CH_3CHBrCH_2CH_2CHClCH_3$ or



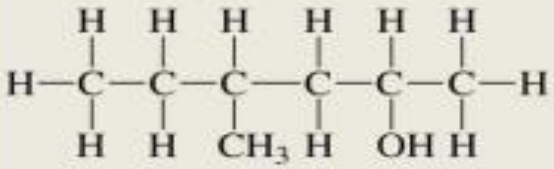


Repeating CH_2 groups can be shown in parentheses.

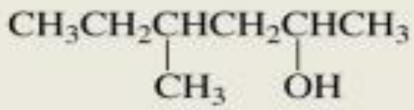


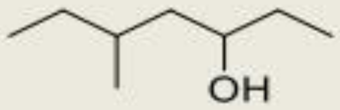
$CH_3CH_2CH_2CH_2CH_2CH_3$ or $CH_3(CH_2)_4CH_3$

Groups bonded to a carbon can be shown (in parentheses) to the right of the carbon, or hanging from the carbon.

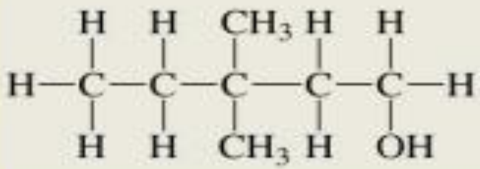


$CH_3CH_2CH(CH_3)CH_2CH(OH)CH_3$ or





Groups bonded to the far-right carbon are not put in parentheses.



$CH_3CH_2C(CH_3)_2CH_2CH_2OH$ or