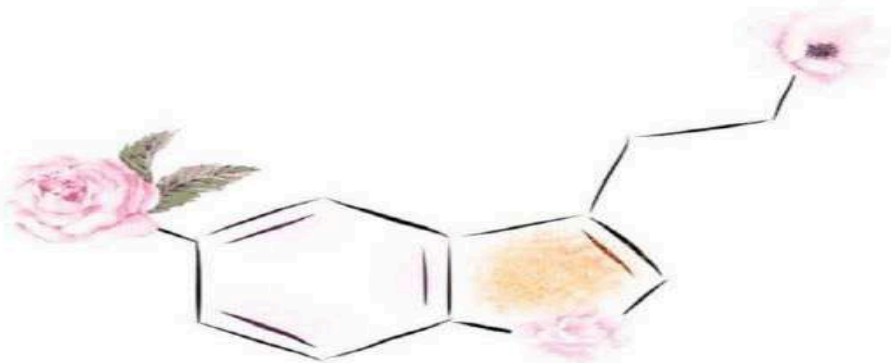
Date: 27/10/2023

لجان الدُّفعات

Soul Academy



تفريغ عضويه 1

موضوع المحاضرة: Chapter (1)

رقم المحاضرة : (3 + 4)

إعداد الصيدلانيه : Gufran Khaseeb

Saturated Hydrocarbons
1. Alkanes

Nomenclature

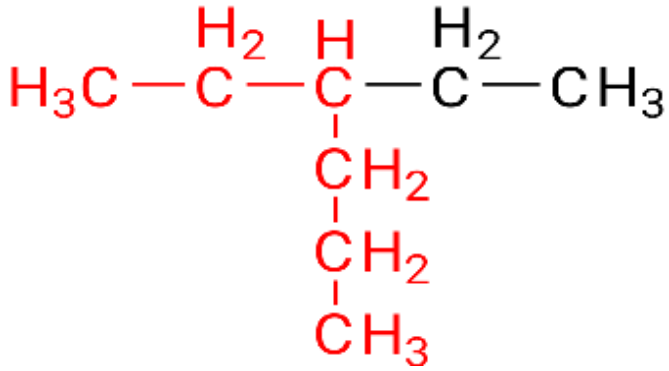
- Most organic compounds are known by two or more names:
  - The older unsystematic names, (*Common* شائعة *names*).
  - The IUPAC names. (Before)

International Union of Pure & Applied Chemistry

Nomenclature

The IUPAC Rules

1. Select the **parent structure** = ***the longest continuous chain***

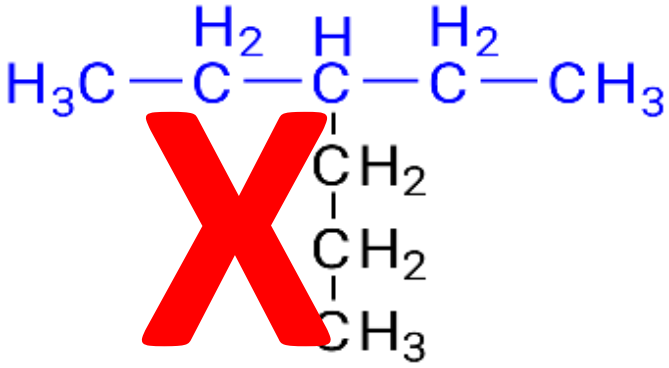


Ethyl hexane

2 — 6

ضايفينوا عليه(منكتبه قبله)

not



Propyl pentane

The **longest continuous** chain is **not** necessarily **straight**. (مستقيمة)

reason: the bond used (single) (sigma) have free rotation

ممكن يكون المركب مايل و هو straight

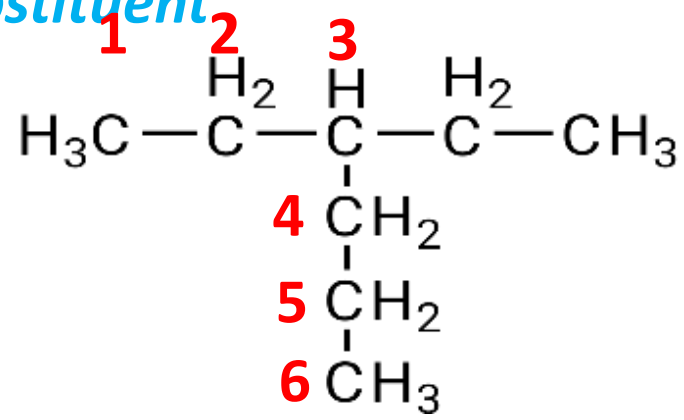
Nomenclature

The IUPAC Rules

2 Number the carbons in the parent chain

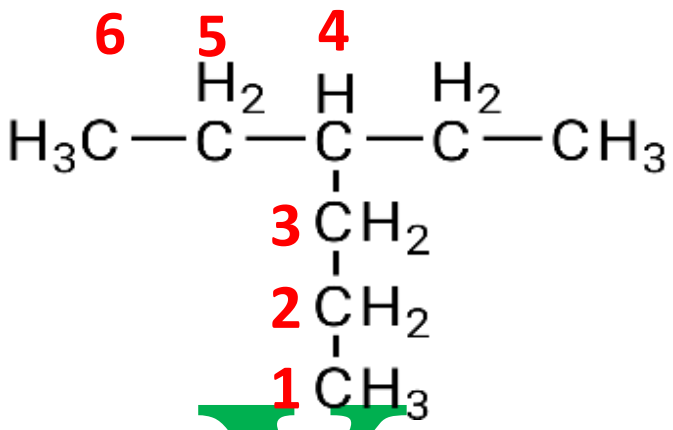
starting from the end which gives the lowest number for the substituent

بديل



3-Ethyl hexane

not

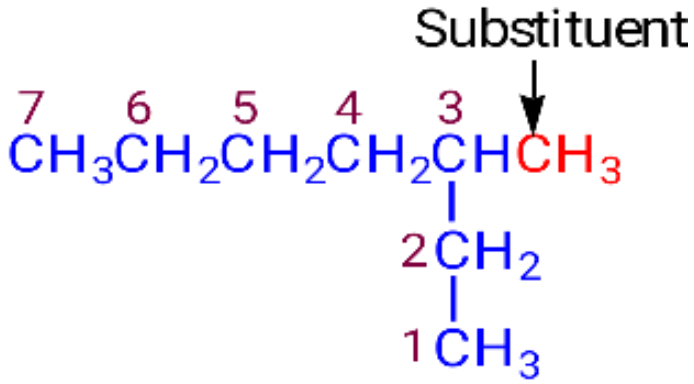


4-Eth hexane

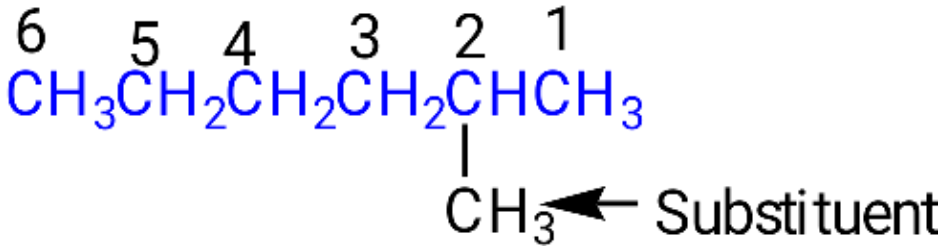
Nomenclature

The IUPAC Rules

2) **Number the carbons in the parent chain**



3-Methylheptane



2-Methylhexane

Nomenclature

The IUPAC Rules

To name the compound;

1) The position of the substituent on the parent carbon chain by a number.

2) The number is followed by a hyphen (-).

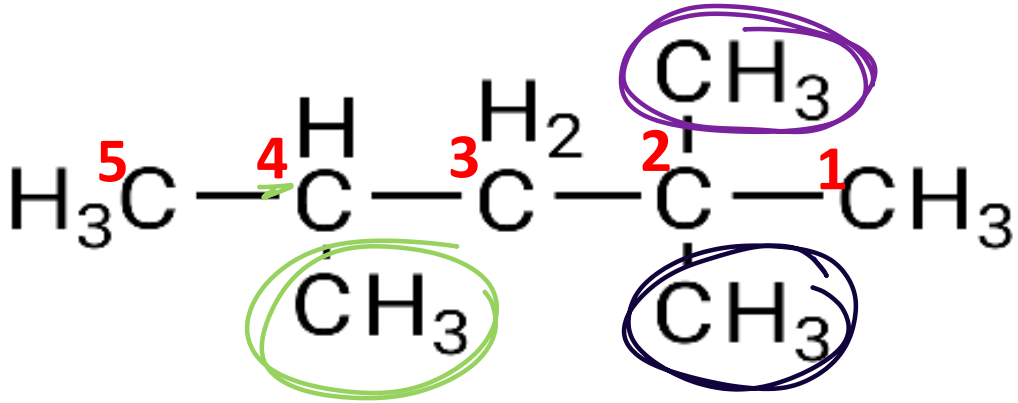
3) The combined name of the substituent (ethyl).

4) The parent carbon chain (hexane)

Nomenclature

The IUPAC Rules

3) If the same alkyl substituent occurs more than once on the parent carbon chain, the prefixes (2) di-, (3) tri-, (4) tetra-, (5) penta-, and so on are used to indicate two, three, four, five, and so on.

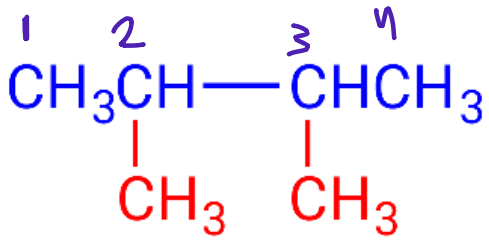


2,2,4- Tri methyl pentane

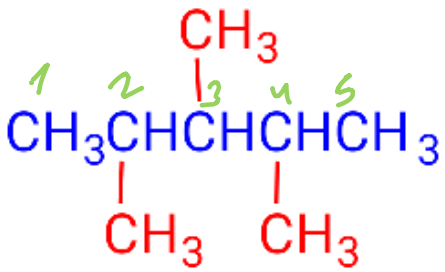
Saturated Hydrocarbons
1. Alkanes

Nomenclature

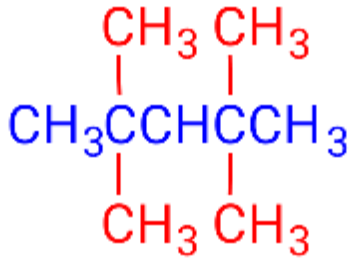
The IUPAC Rules



2,3-Dimethylbutane



2,3,4-Trimethylpentane

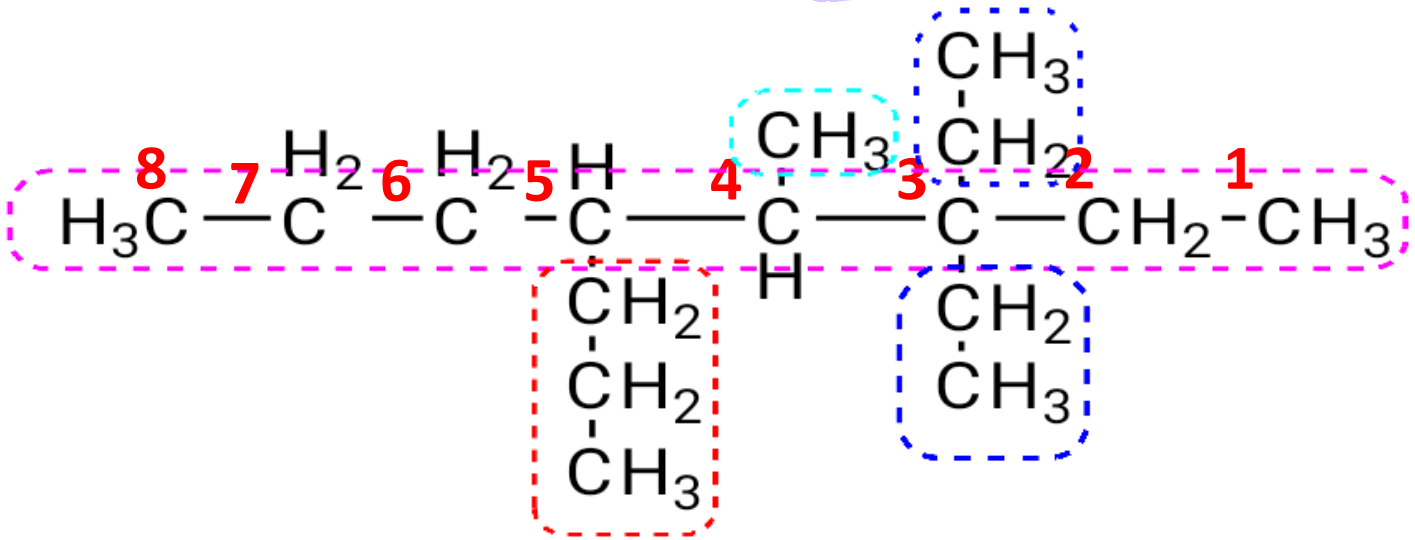


2,2,4,4-Tetramethylpentane

Nomenclature

The IUPAC Rules

4) If different alkyl substituents are attached on the parent carbon chain, they are named in order of alphabetical order.



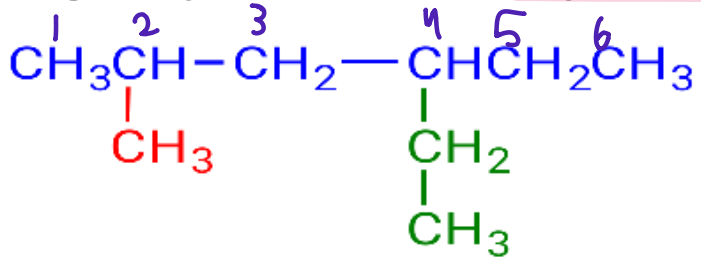
3,3- di ethyl
4- methyl
5- propyl

3,3-Diethyl -4-methyl-5-propyl octane

Nomenclature

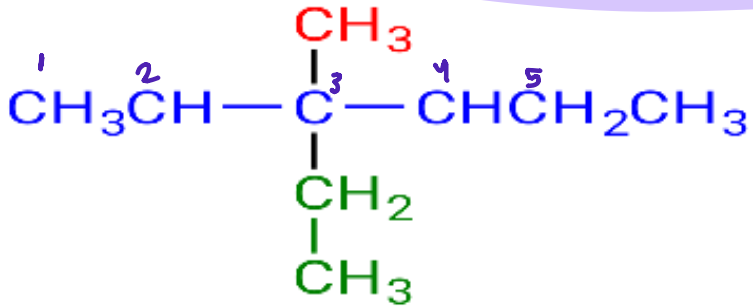
The IUPAC Rules

Note that each substituent is given a number corresponding to its location on the longest chain. The substituent groups are listed alphabetically.



4-Ethyl-2-methylhexane

5) When two substituent are present on the same carbon, use the number twice.

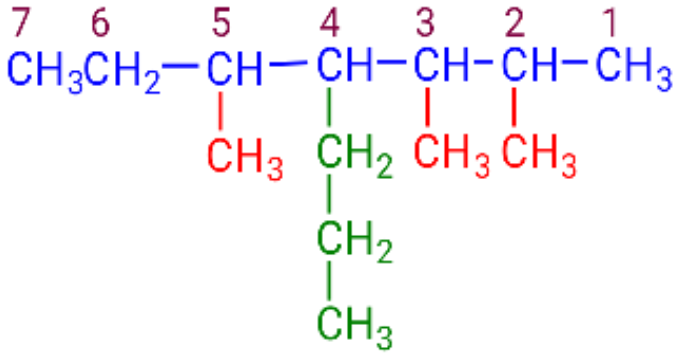


3-Ethyl-3-methylhexane

Nomenclature

The IUPAC Rules

6) When two chains of equal length compete for selection as the parent chain, choose the chain with the greater number of substituents.



2,3,5-Trimethyl-4-*n*-propylheptane

Nomenclature

The IUPAC Rules

7) If substituents other than alky groups are also presents on the parent carbon chain; all substituents are named alphabetically.

ألاولوية إلهم

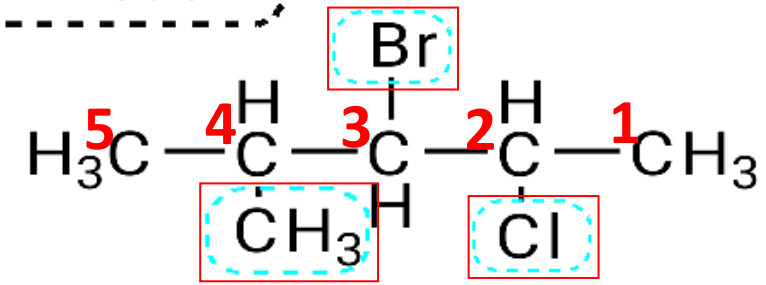
-F fluoro

-Cl chloro

-Br bromo

-I iodo

$-NO_2$ nitro



2-chloro
3-bromo
4- methyl

3-bromo -2-chloro -4-methylpentane

Saturated Hydrocarbons
1. Alkanes

Sources of Alkanes

- The two principal sources of alkanes are petroleum and natural gas.

  Petroleum and natural gas constitute the chief sources of رئيسية

  - Alkanes up to 40 Carbons
  - Aromatic (Gasoline and its derivatives)
  - Alicyclic (Cyclic aliphatic hydrocarbons) يعدل (Alicyclic) [saturated]
  - Heterocyclic Unsaturated (x atoms (N,O,S)

Saturated Hydrocarbons
1. Alkanes

Sources of Alkanes

Petroleum Refining

Some components of refined petroleum

Fraction	Boiling range (°C)	Caron content
Gas quickly evaporates	Below 20	C1 – C4
Petroleum ether	20 – 60	C5 – C6
Naphtha	60 – 100	C6 – C7
Gasoline	40 – 200	C5 – C10
Kerosine	175 – 325	C11 – C18
Gas oil	300 – 500	C15 – C40
Lubricating oil, asphalt, petroleum coke and paraffins	Above 400	C15 – C40

↑ number of carbon : ↓ Boiling Point

gas → liqued → solid

greasy compounds

Saturated Hydrocarbons
1. Alkanes

Physical Properties

Physical Properties of Alkanes, Alkenes and Alkynes

Those properties that can be observed without the compound undergoing a chemical reaction

A. Physical States

C1 (C2) to C4 are gases,
C5 to C17 are liquids,
C18 and larger alkanes are wax –(semi)like solids.

2 layers
dissolved (2 layer disappeared)
not dissolved 2 layers (didn't disappear)

B. Solubility

- Alkanes, Alkenes and Alkynes are nonpolar compounds. (composed of H, O)
- Their solubility " Like dissolve like"
- Alkanes, Alkenes and Alkynes are soluble in the nonpolar solvents;
  carbon tetrachloride, CCl_4 and benzene,
- Alkanes, Alkenes and Alkynes are insoluble in polar solvents like water.

Intermolecular Forces and Liquids and Solids

Intermolecular Forces (To know the nature of the material)

1. ***Intermolecular forces*** are attractive forces **between** (different) molecules.
2. ***Intramolecular forces*** hold atoms together in a molecule.

Intermolecular vs Intramolecular

- 41 kJ to vaporize 1 mole of water (**inter**) (weaker)
- 930 kJ to break all O-H bonds in 1 mole of water (**intra**) (stronger)

multiple choice question

"Measure" of intermolecular force

boiling point

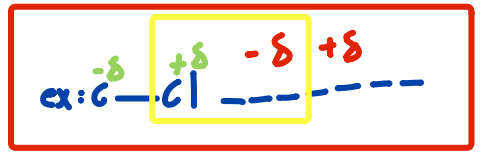
melting point

Generally, **inter**molecular forces are much weaker than **intra**molecular forces.

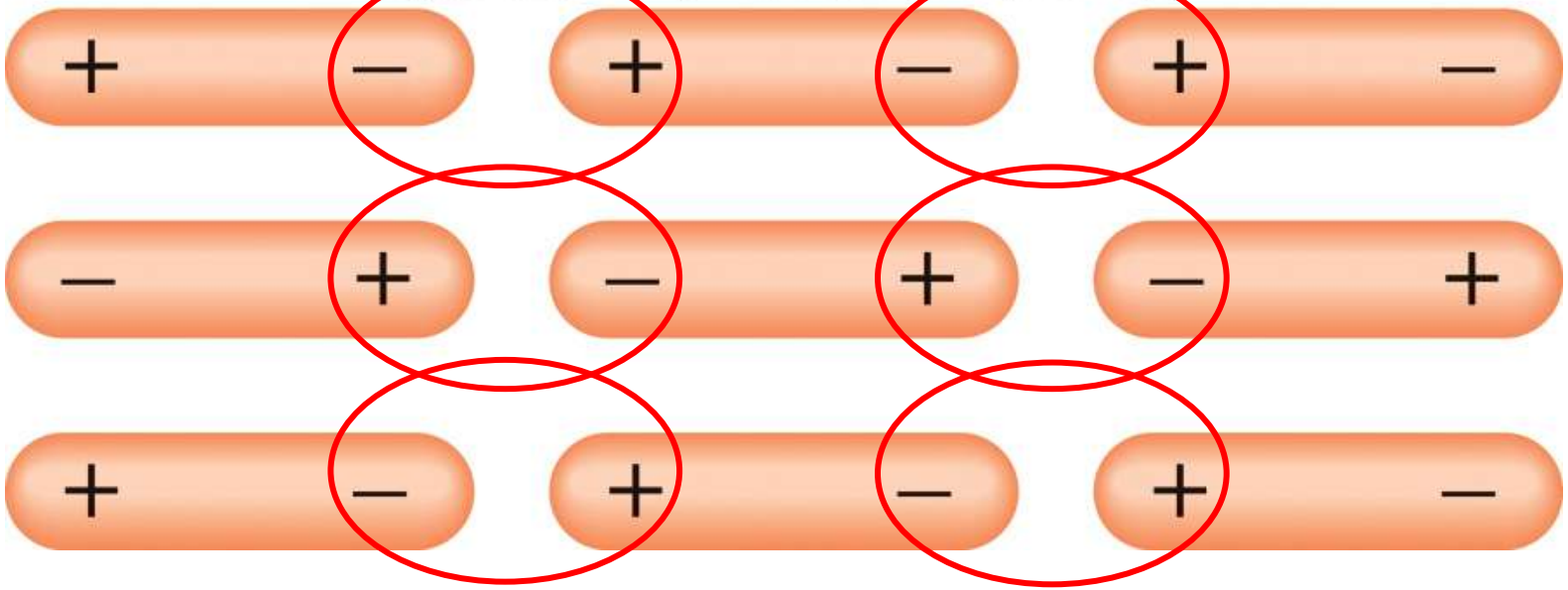
Intermolecular Forces

Dipole-Dipole Forces

Attractive forces between **polar molecules**



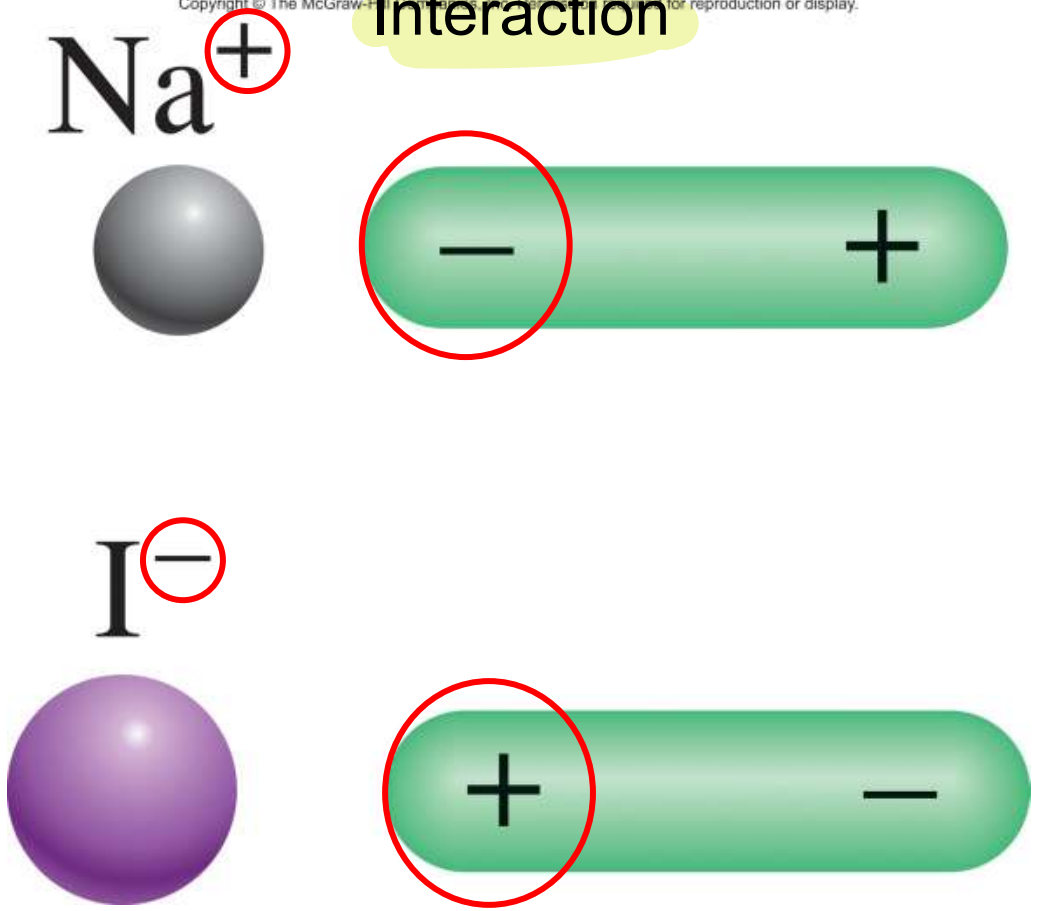
Orientation of Polar Molecules in a Solid



Intermolecular Forces

Attractive forces between an **ion** and a **polar molecule**

Ion-Dipole Interaction



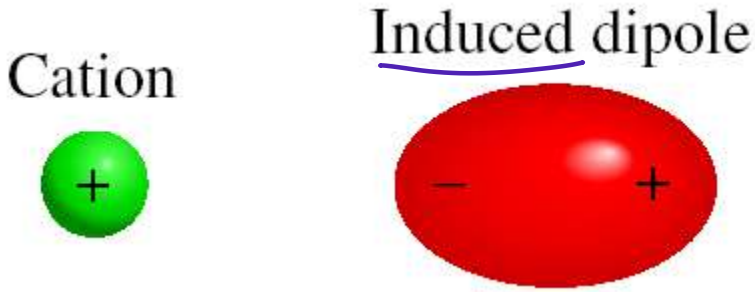
London forces (dipole-induced dipole attraction)

- Non-polar molecules do not have dipoles like polar molecules. How, then, can non-polar compounds form solids or liquids?
- London forces (also called van der Waal forces) are due to small dipoles that exist in non-polar molecules
- Because electrons are moving around in atoms there will be instants when the charge around an atom is not symmetrical
- The resulting tiny dipoles cause attractions between atoms/molecules **(the greater the mass, the greater the London forces)**

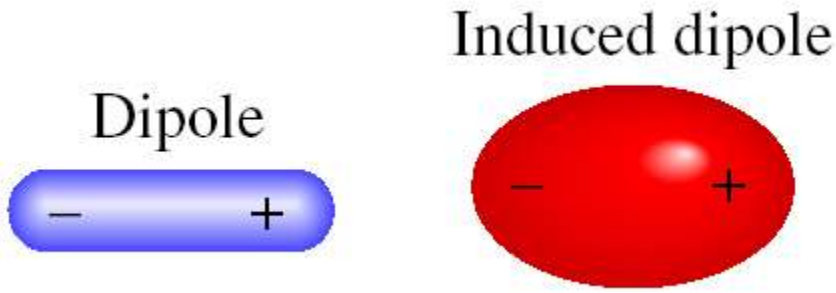
Intermolecular Forces

Dispersion Forces

Attractive forces that arise as a result of **temporary dipoles induced** in atoms or molecules

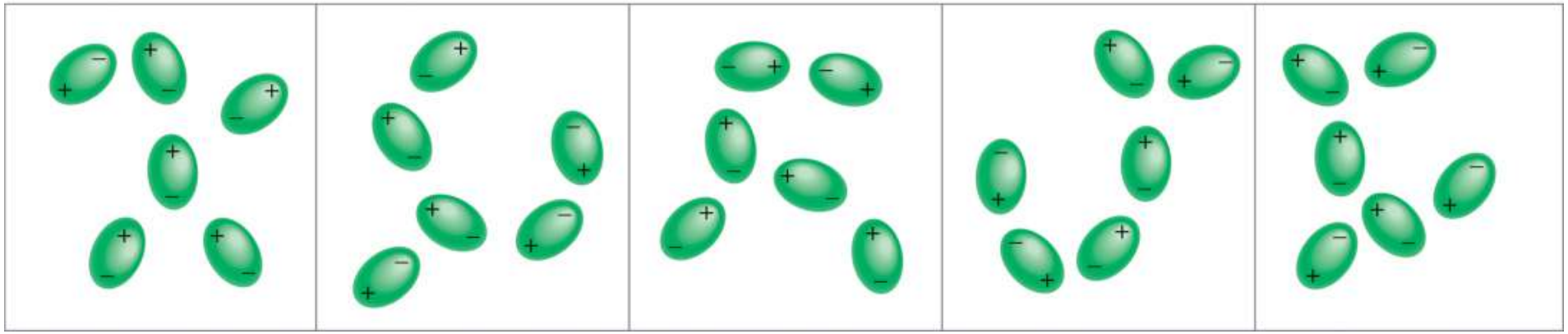


ion-induced dipole interaction



dipole-induced dipole interaction

Induced Dipoles Interacting With Each Other



Intermolecular Forces

Hydrogen Bond

Is very important for soluble in solvents or not

Polar

The ***hydrogen bond*** is a special dipole-dipole interaction between the hydrogen atom in a polar N-H, O-H, or F-H bond and an electronegative O, N, or F atom.

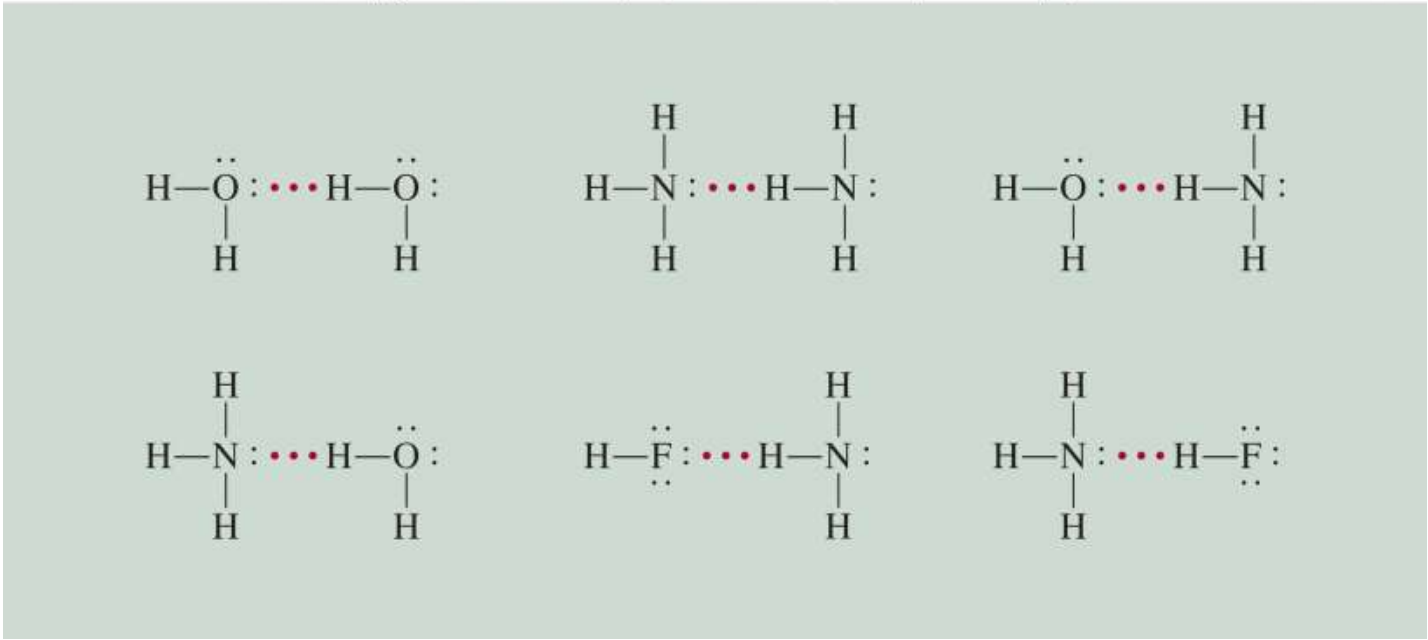
most of the line

6 group 5 group

Cl (group 7)

$$A — H \cdots B \quad \text{or} \quad A — H \cdots A$$

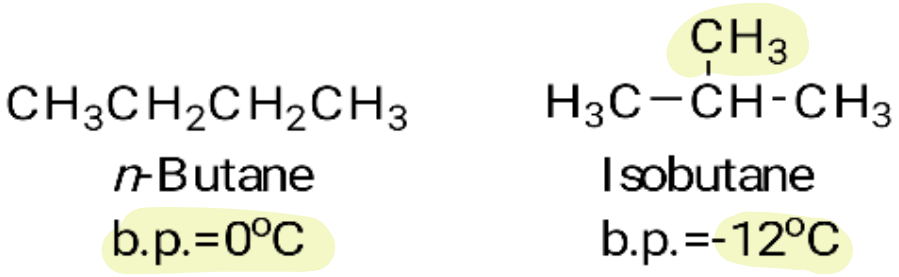
A & B are N, O, or F

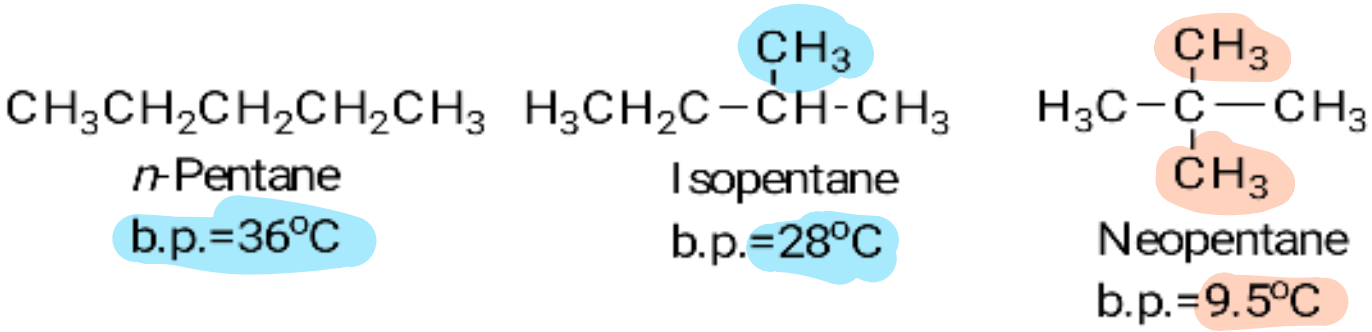


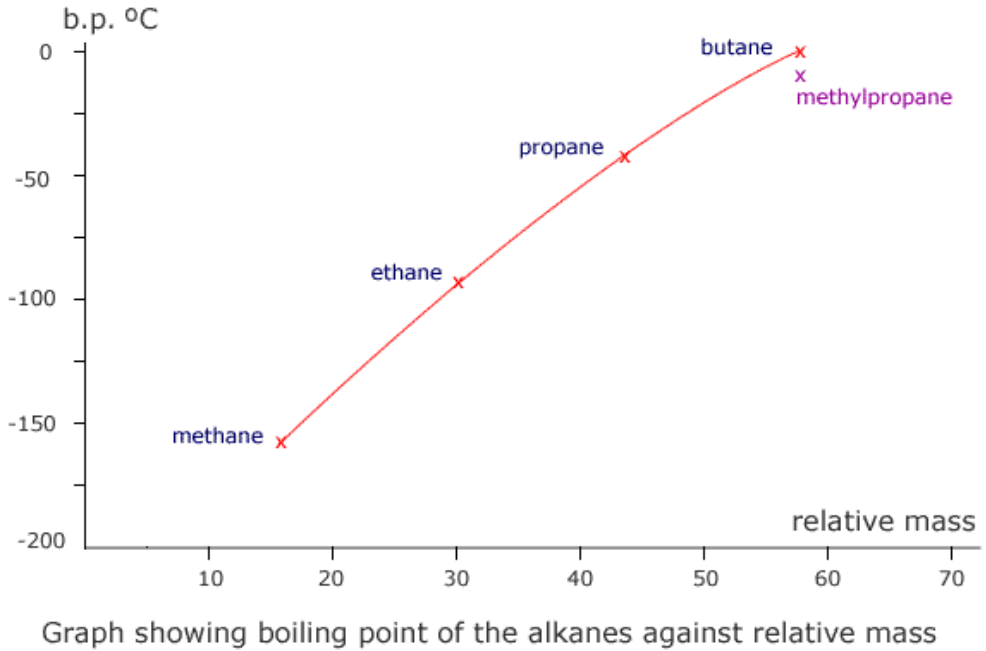
Saturated Hydrocarbons
1. Alkanes

Physical Properties

C. Boiling Points





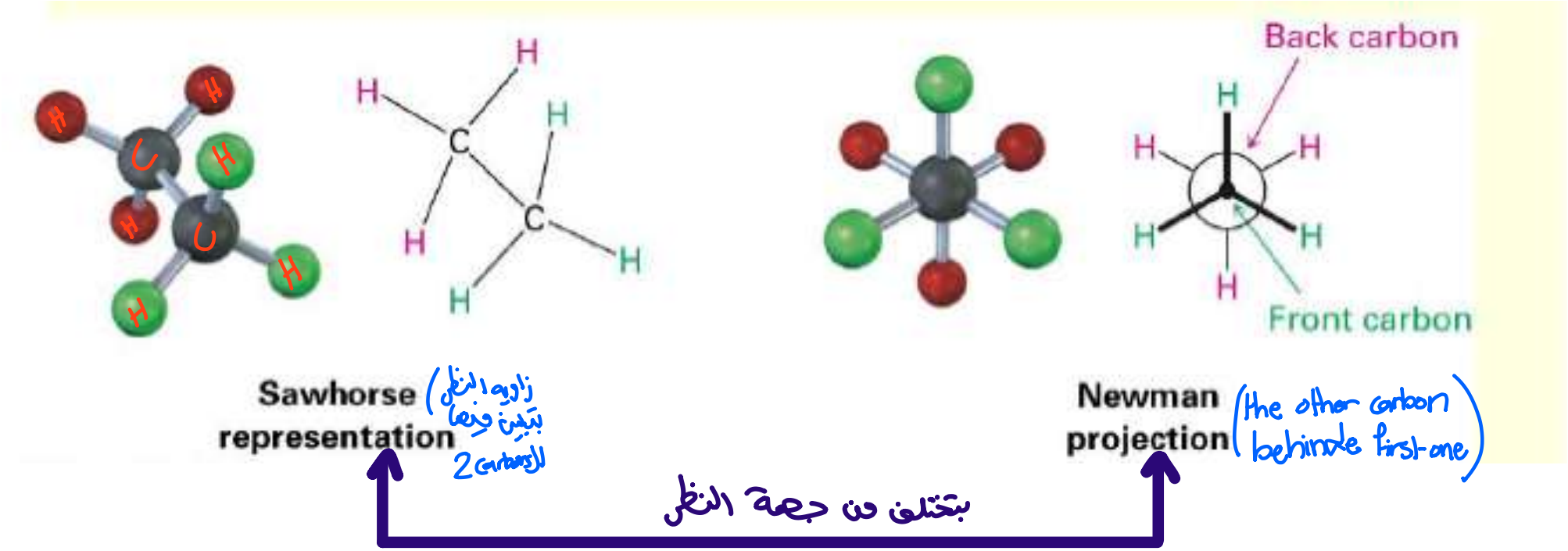


Graph showing boiling point of the alkanes against relative mass

- Boiling point decreases with increasing branches
- Boiling point increases with increasing molecular weight.

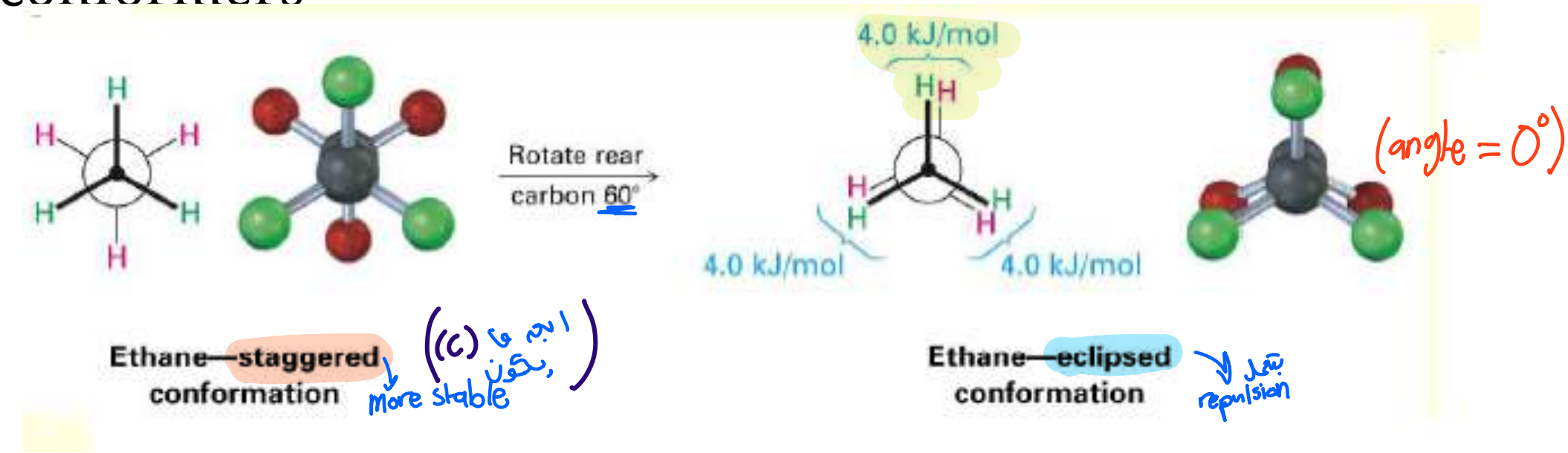
Conformational Isomers of Alkanes

Isomers that differ as a result of sigma bond
Isomers that differ as a result of sigma bond rotation of C-C bond in alkanes



Bond Rotation and Newman Projections

As carbon-carbon bond rotates, interconvert carbon bond rotates, interconvert between staggered and eclipsed conformers



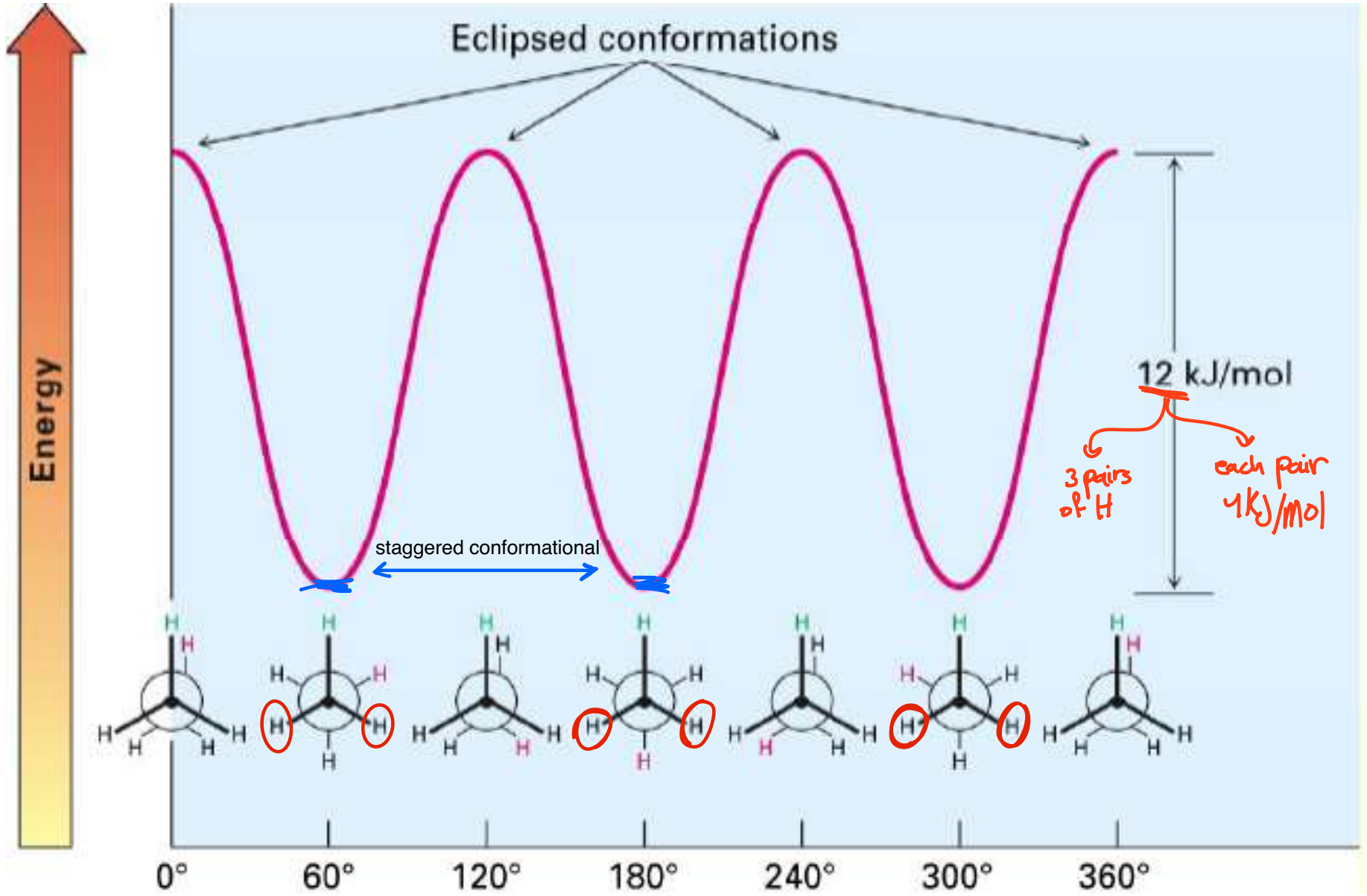
Eclipsed conformer is 12.0 kJ/mol higher in energy ('free' rotation at room temperature)

Repulsion يؤدي الى → **Torsional Strain Energy** طاقة الاجهاد الالتوائي

Force that opposes (يعارض) rotation due to the repulsion Force that opposes rotation due to the repulsion of bonding electrons

- We do not observe perfectly free rotation
- There is a barrier (حاجز) to rotation, and some conformers (المطابقين) are more stable than others
- Small energy barrier easily overcome at RT
- Each eclipsed H-H costs 4 kJ/mol of Torsional Energy

- in staggered
  - ↓
  - (H) البعد مايكون عن بعض
  - ↓
  - less energy
  - in stable situation
  - (60°, 180°, 300°)



Strain Energy in Alkanes

Torsional Strain

Steric strain- repulsive interaction occurring between atoms that are forced closer together than their at far from each other.

Table 3.5 | Energy Costs for Interactions in Alkane Conformers

Interaction	Cause	Energy cost (kJ/mol)	Energy cost (kcal/mol)
H⟷H eclipsed	Torsional strain	4.0	1.0
H⟷CH_3 eclipsed	Mostly torsional strain	6.0	1.4
CH_3⟷CH_3 eclipsed	Torsional and steric strain	11	2.6
CH_3⟷CH_3 gauche	Steric strain	3.8	0.9

قريبات من بعض
بس مش ورا بعض

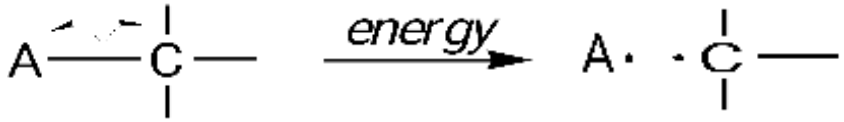
Notations for bond breaking and bond making

- the homolytic need high energy than heterolytic

- A covalent bond can be broken in either two ways,

Homolytic cleavage.

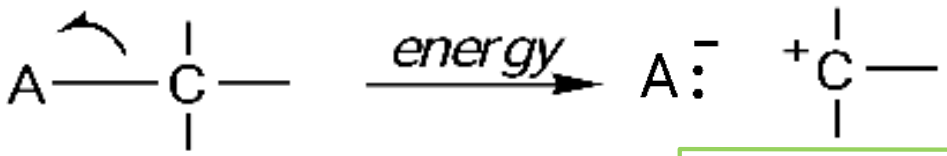
كل واحد يأخذ الإلكترون تبعو



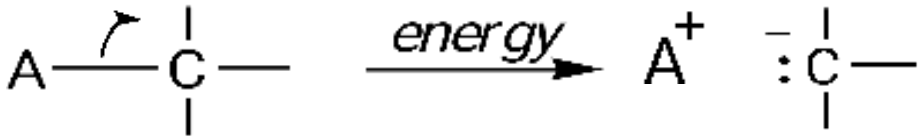
Free radicals (not stable)

Heterolytic cleavage.

one of the molecules → take charge the another one → Positivly chargred



Carbocation → when the carbon take a charge



Carboanion

Preparation of Alkanes

1) Hydrogenation of Alkenes and Alkynes

(adding a H to a compound)

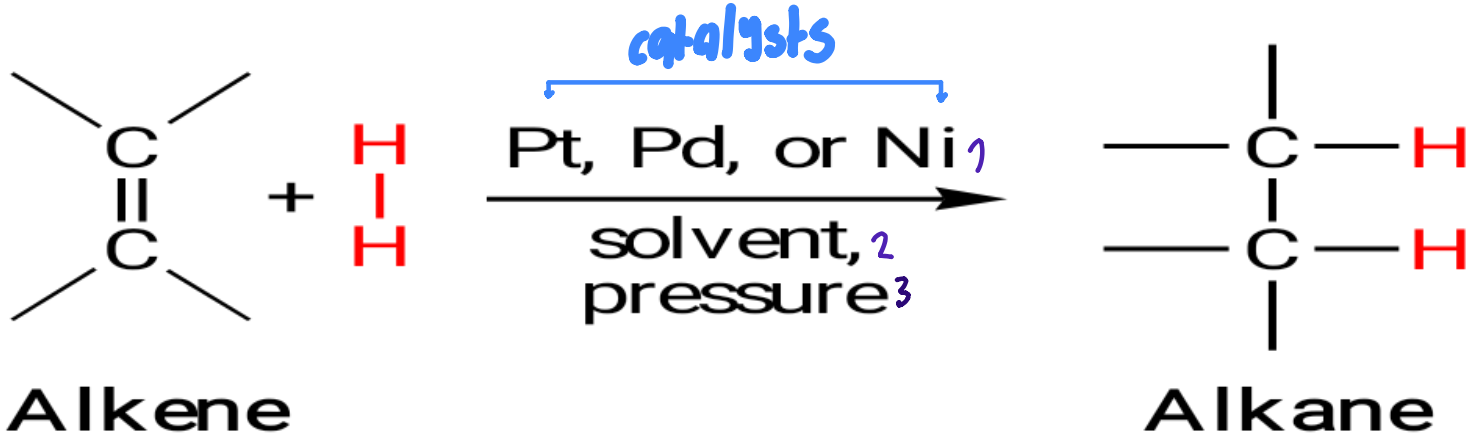
A great number of alkanes can be obtained by fractional distillation of crude petroleum and subsequent reactions as follows:

the mean source (natural)

1. Catalytic hydrogenation: in the lab

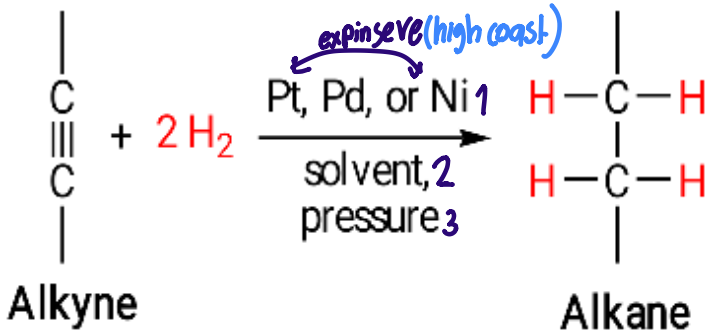
Alkenes and alkynes react with hydrogen in the presence of metal catalysts such as nickel, palladium, and platinum to produce alkanes.

General Reaction

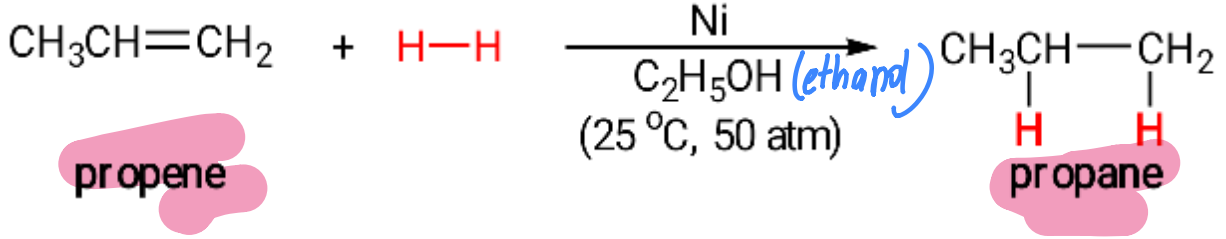


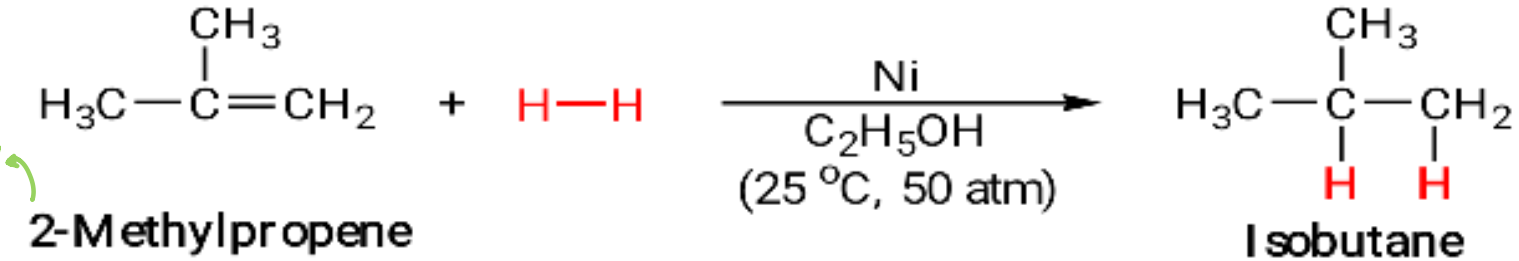
Preparation of Alkanes

1) Hydrogenation of Alkenes and Alkynes



- ***Specific Examples***





هو مطلوب تسميات alkenes

Saturated Hydrocarbons
1. Alkanes

Preparation of Alkanes

2) Hydrolysis of Grignard Reagent

$$R{-}X + Mg \xrightarrow{\text{solvent: dry ether}} R{-}MgX \quad (\text{Alkyl magnesium halide, Grignard reagent})$$

$$R{-}MgX + HOH \longrightarrow RH + MgX(OH)$$

- *Grignard reagents* react readily with any source of protons to give hydrocarbons.

$$CH_3CH_2Br + Mg \xrightarrow{\text{Dry Ether}} CH_3CH_2MgBr$$

Ethyl bromide → Ethyl magnesium bromide (Grignard reagent)

$$CH_3CH_2MgBr + HOH \longrightarrow CH_3CH_3 + MgBr(OH)$$

ethene + grignard reagent → Ethane

3) By coupling of alkyl halides with dialkyl cuprate (all kinds of alkanes)

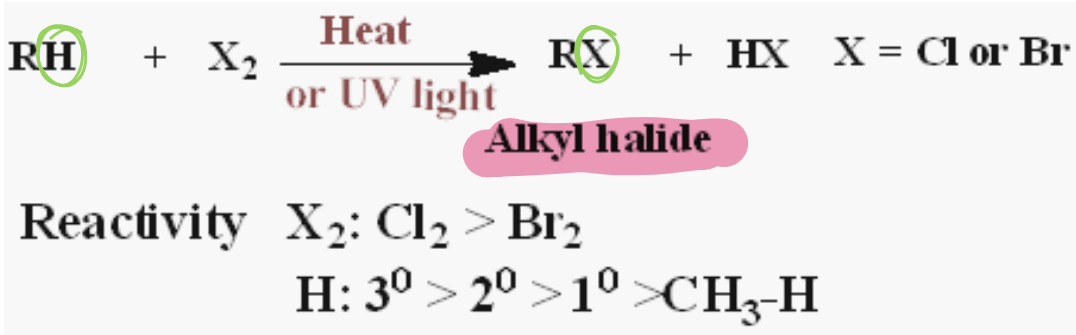
$$(CH_3CH_2)_2CuLi \xrightarrow{CH_3Br} CH_3CH_2CH_3$$

Reactions of Alkanes

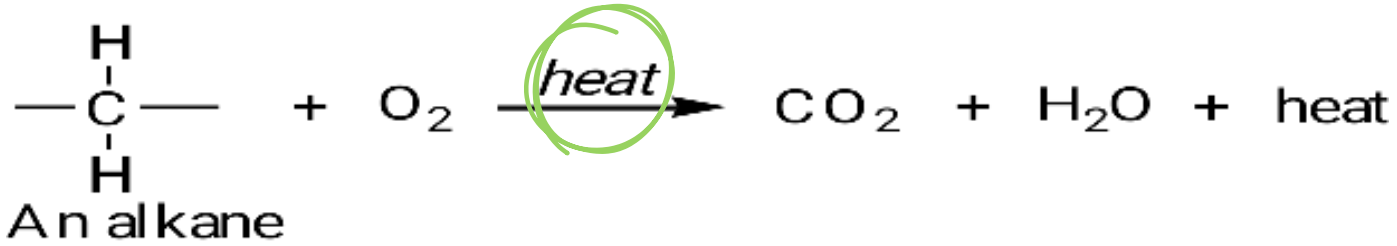
Saturated hydrocarbons undergo very few reactions, so they are called Paraffinic hydrocarbons. (Latin *parum*, little; *affinis*, affinity)

Halogenation

The halogenation of an alkane appears to be a simple free radical substitution in which a C-H bond is broken and a new C-X bond is formed



Combustion



Reactions of Alkanes

A. Halogenation

- Substitution reaction of alkanes,
  (استبدال)
  i.e. replacement of hydrogen by halogen,
  usually chlorine or bromine, giving alkyl chloride or alkyl bromide.

- Flourine reacts explosively with alkanes
  It is unsuitable reagent for the preparation of the alkyl flourides. (highly reactive) (the most electronegative)

- Iodine is too unreactive
  It is not used in the halogentaion of alkanes.

- Halogenation of alkanes take place at
  high temperatures or under the influence of ultraviolet light

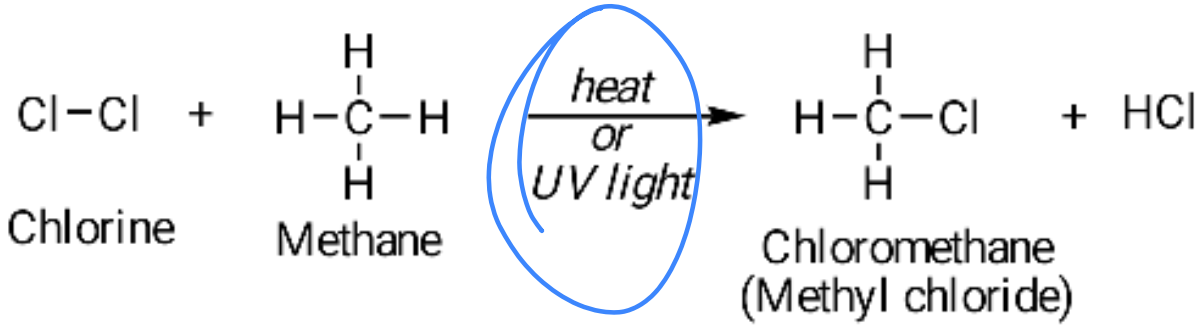
Reactions of Alkanes

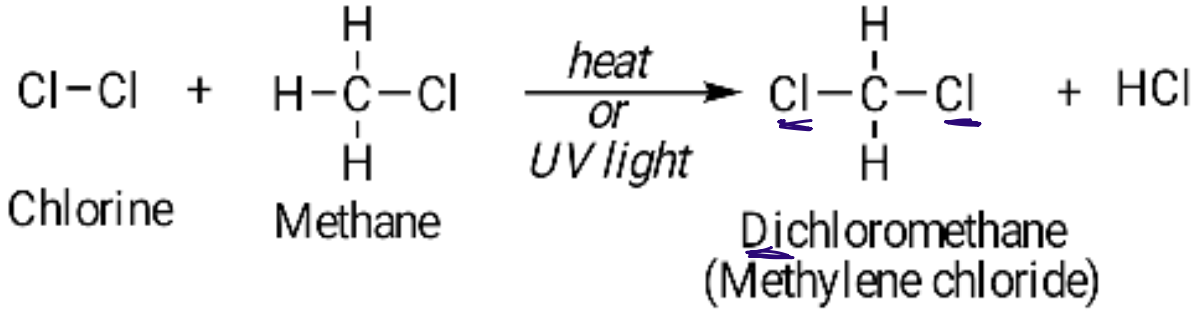
A. Halogenation

- Chlorination of an alkane usually gives a mixture of products

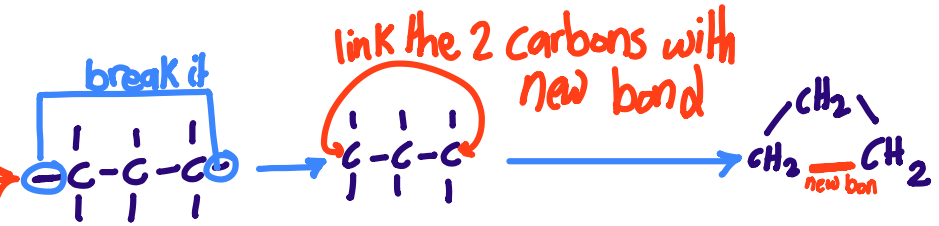
at any reaction

price → sheep
multibule product
isolation → it costs mony and time





2-Alicyclic Alkanes

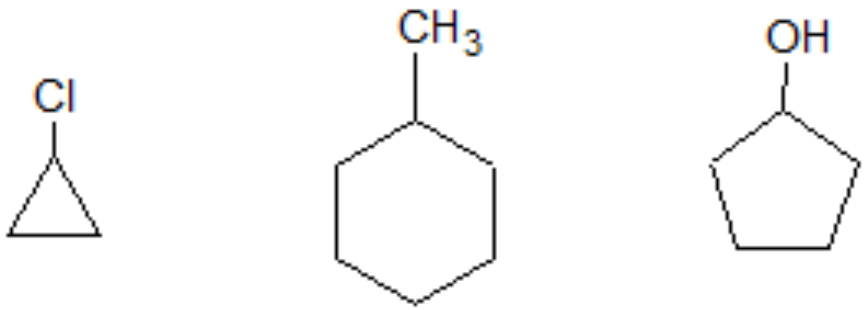


Cycloalkanes: C_nH_{2n} (*contain carbon-carbon single bond in a single ring*)

without (+2) reason

minimum (3 carbons) → cyclopropane

(sigma bond) (109.5°) تعبر الزاوية اقل

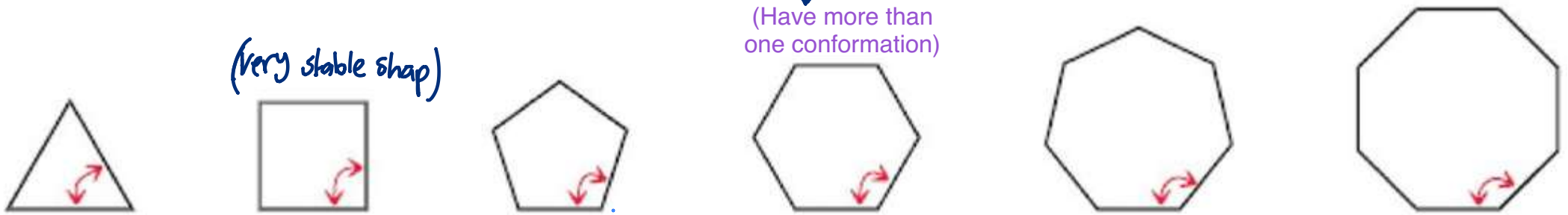


Saturated Hydrocarbons
2. Alicyclic Alkanes

Cyclic Alkanes

- Carbon atoms in alkanes are sp^3 hybridized

Have bigger size
The movement easier
(Have more than one conformation)

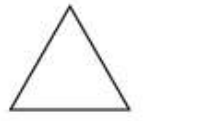


- To optimize the bond angles, most cycloalkanes are NOT flat in their most stable conformation

Nomenclature

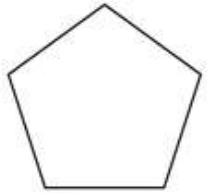
Cycloalkanes

- Alkanes with closed ring(s) of C atoms
- General formula: C_nH_{2n} (C_3H_6, C_4H_8, C_5H_{10}, etc.)
- Naming: use cyclo- prefix before alkane name

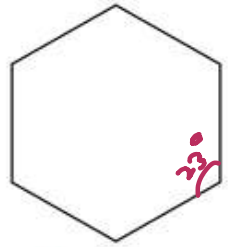


cyclopropane
n = 3
C_3H_6

cyclobutane
n = 4
C_4H_8



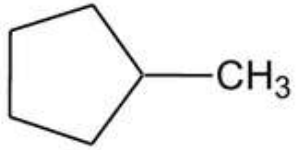
cyclopentane
n = 5
C_5H_{10}



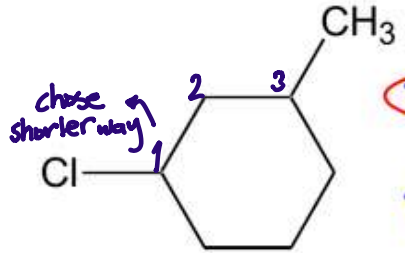
cyclohexane
n = 6
C_6H_{12}

Naming substituted cycloalkanes:

- 1 substituent: no numbering necessary
- 2 or more substituents: highest alpha priority on C #1



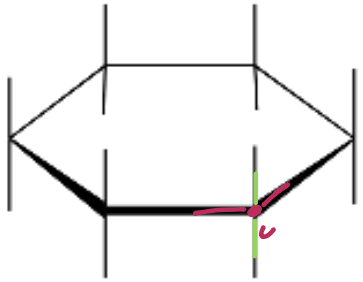
methylcyclopentane



1-chloro-5-methylcyclohexane

1-chloro-3-methylcyclohexane

Conformations of Cyclohexane

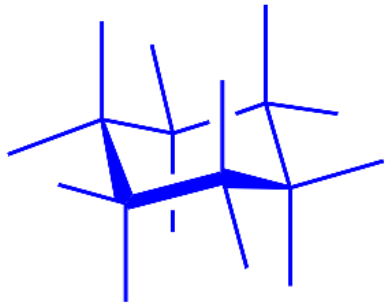


Cyclohexane does not have any angle strain! It isn't a flat molecule. By rotating about the carbon-carbon bonds, it can achieve 109.5° bond angles.

the substituents (in the C) → axial (up) (down)
→ equatorial

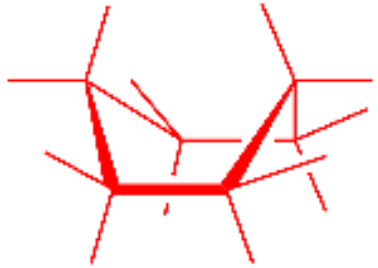
(the form is unless diverse)

conformations of cyclohexane



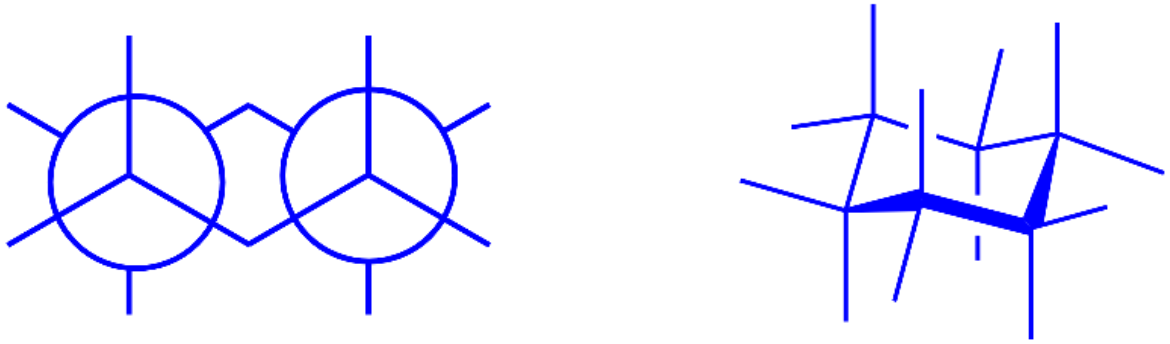
chair

twist boat



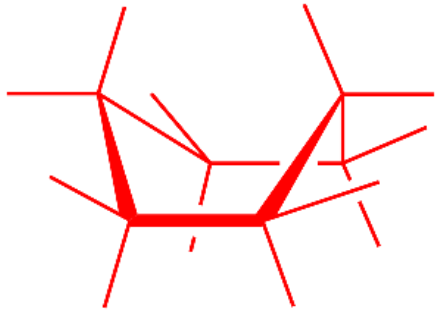
boat

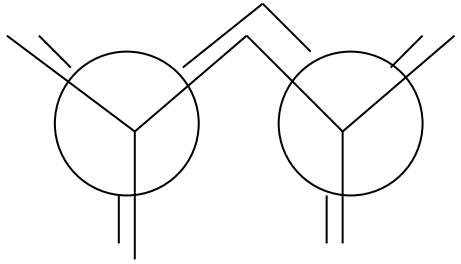
conformations of cyclohexane



The **chair** conformation of cyclohexane is free of both angle strain and torsional strain (deviation from staggered). This is the **most** stable conformation. → the substituents ليش ما يكون + the carbons

conformations of cyclohexane



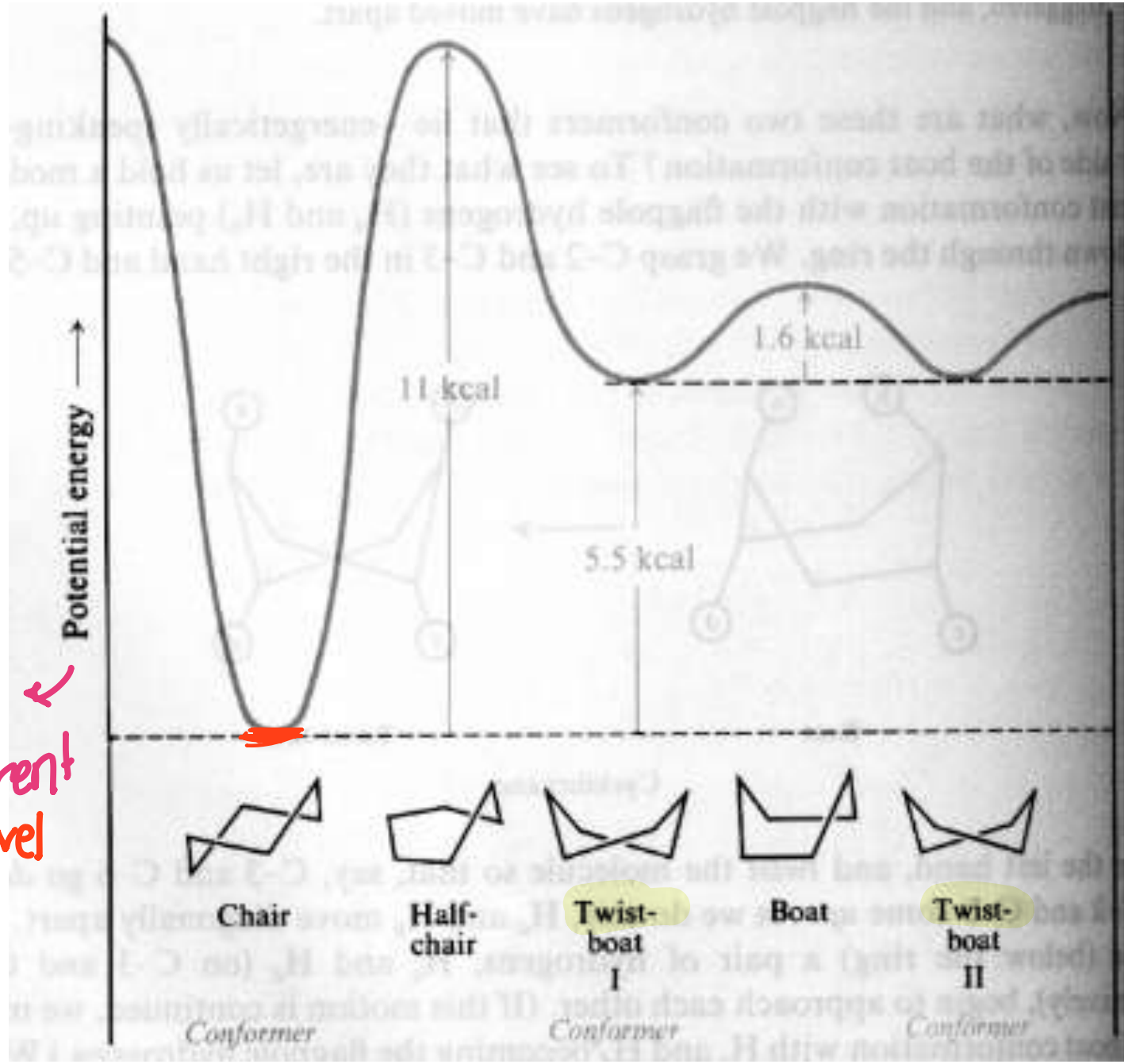


The boat conformation is free of angle strain, but has a great deal of torsional strain (eclipsed). To relieve the strain, it twists slightly to form the twist boat:

the carbons قريبة من بعض
the substituents

unstable because need energy
rebullion تنافر

conformations of cyclohexane



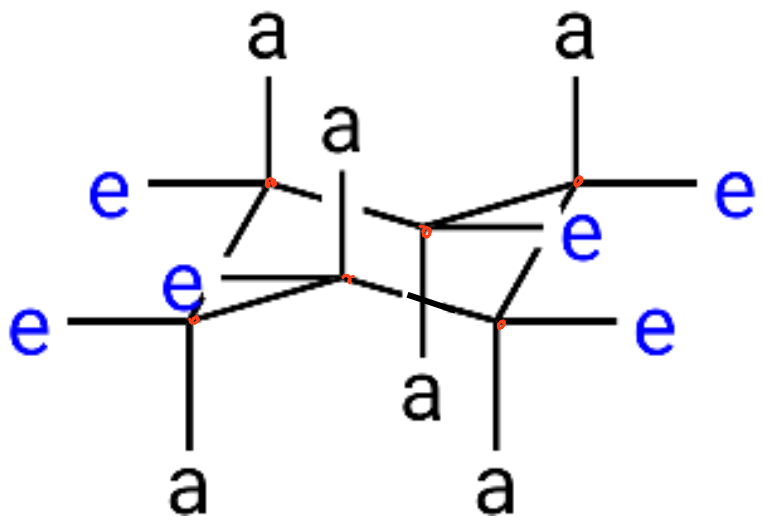
every one have different energy level

#360° الكرسي في الشكل chair & boat بين

most popular shapes ← cyclohexane, cyclopentane

The most stable
The least energy

conformations of cyclohexane

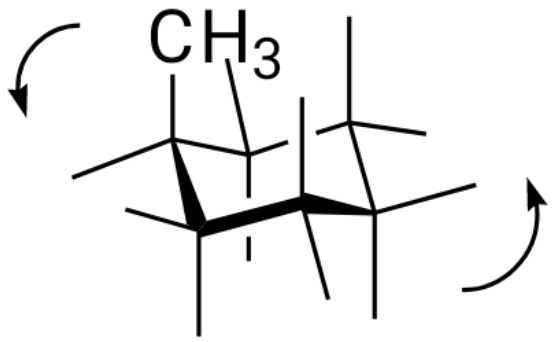


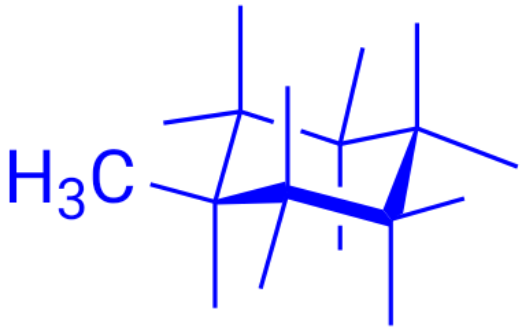
6 carbons (12 substituents)

a = axial (عامودية) positions in the chair conformation

e = equatorial (افقية) positions

conformations of cyclohexane

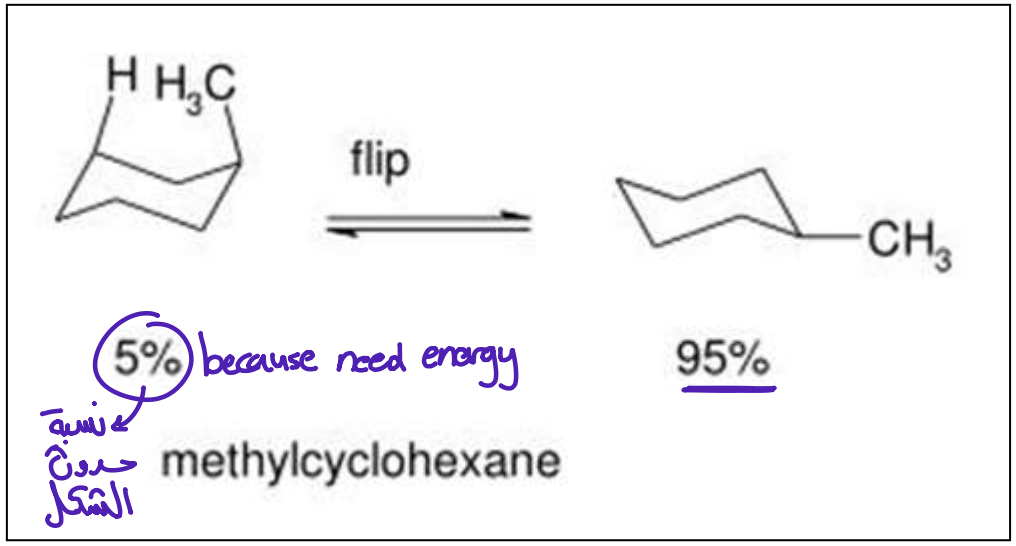


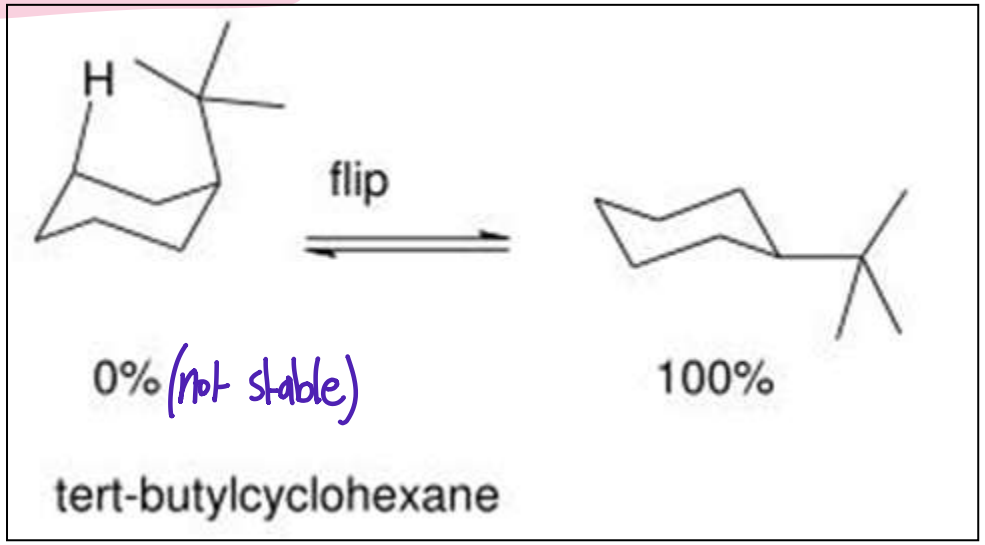


CH_3 in axial position

CH_3 in equatorial position

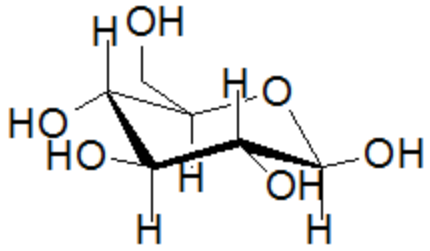
is more stable

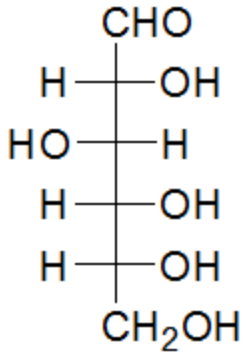


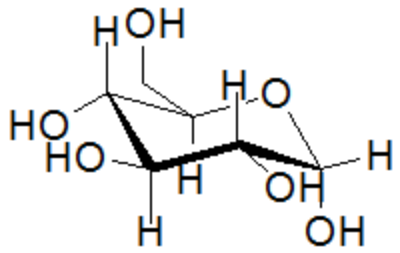


conformations of cyclohexane

Glucose molecule







beta-D-glucose

all OH groups equatorial

more stable

alpha-D-glucose

one group forced to be axial

(equatorial الباقي)

ex: cyclopentane

(it can move)

name: half chair

half boat

(fabric) envelope