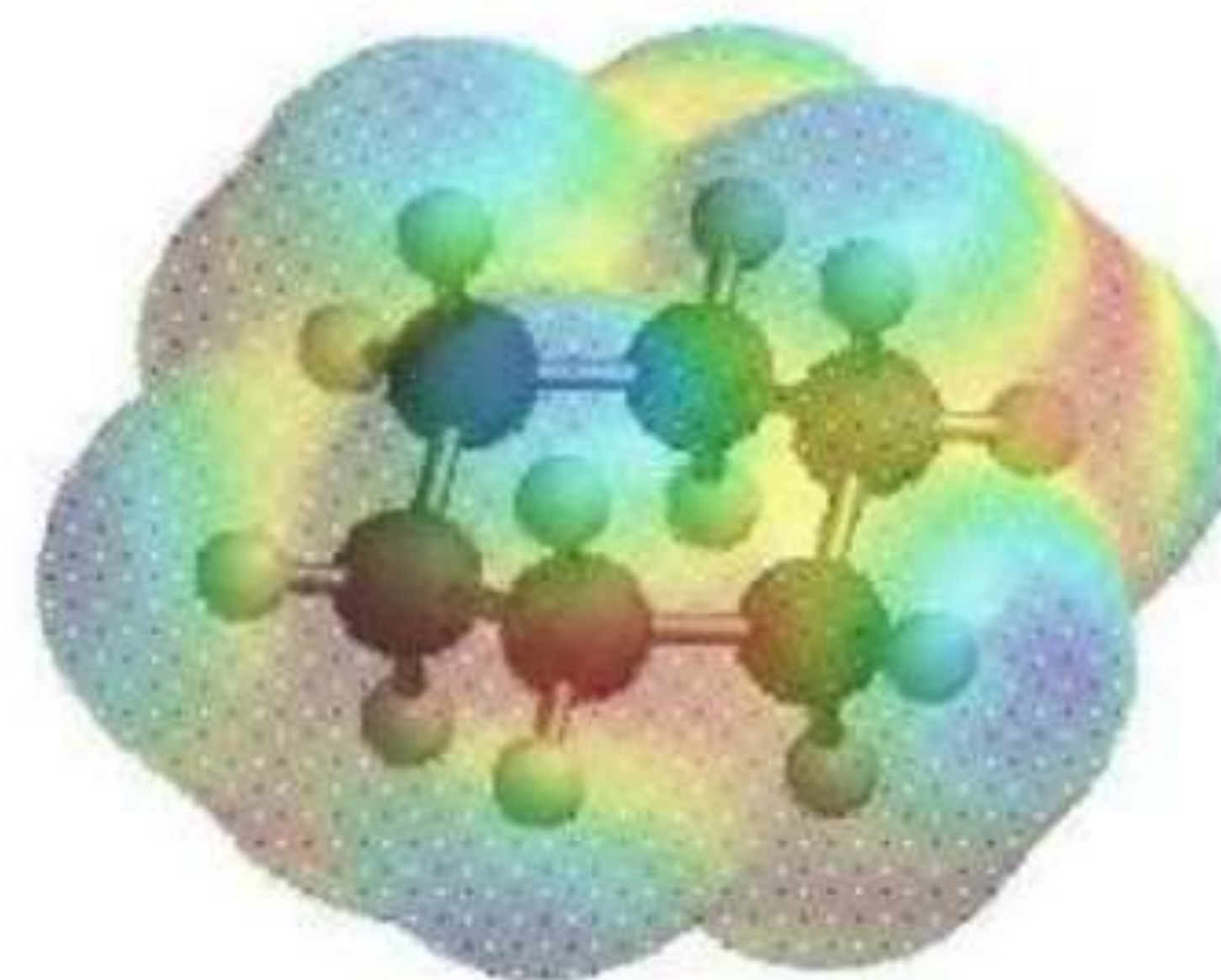
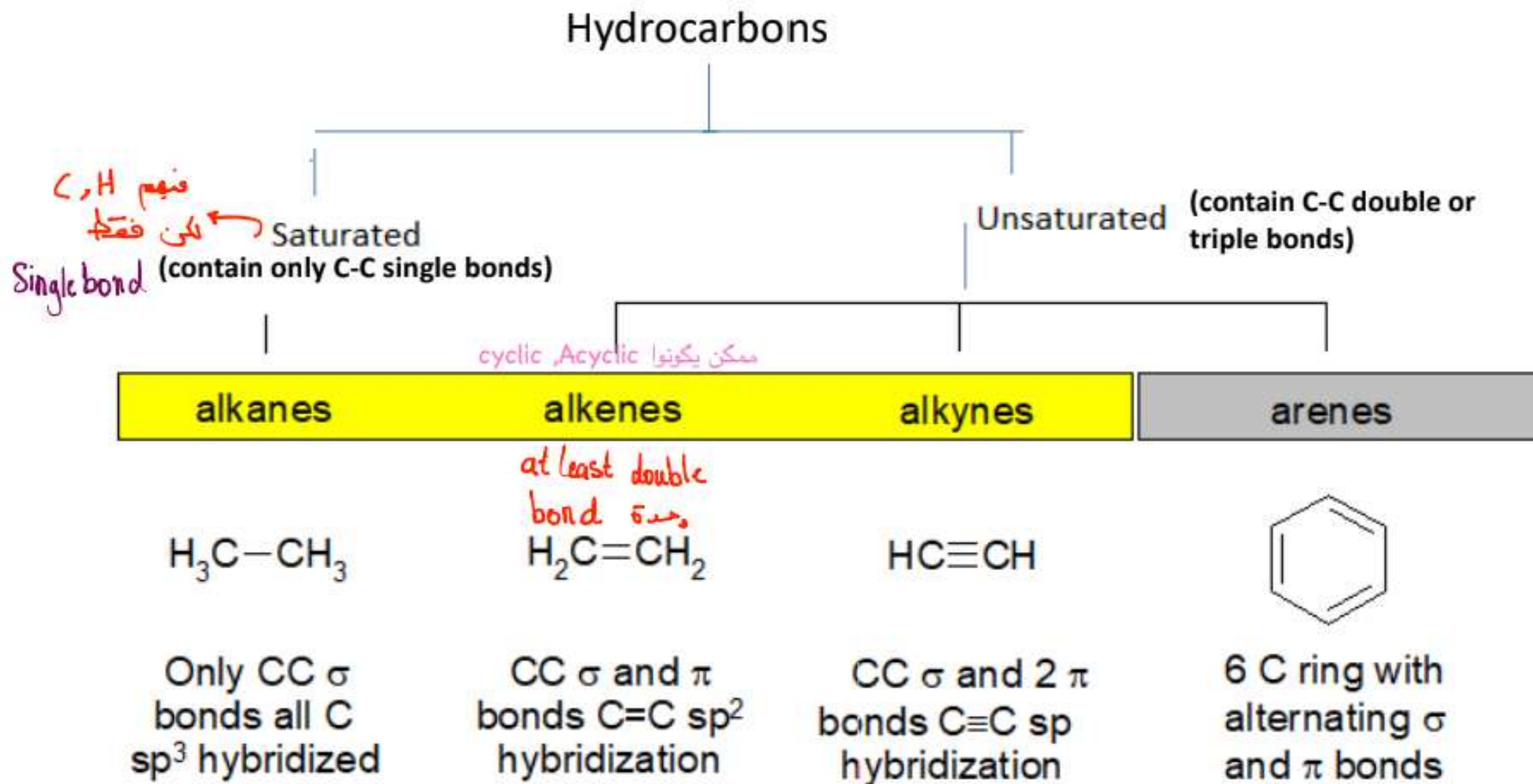


Chapter 2: Alkanes and Cycloalkanes: Conformational and Geometric Isomers



Types of Hydrocarbons بتتكون من H, C

Hydrocarbons are compounds that only contain C and H atoms.



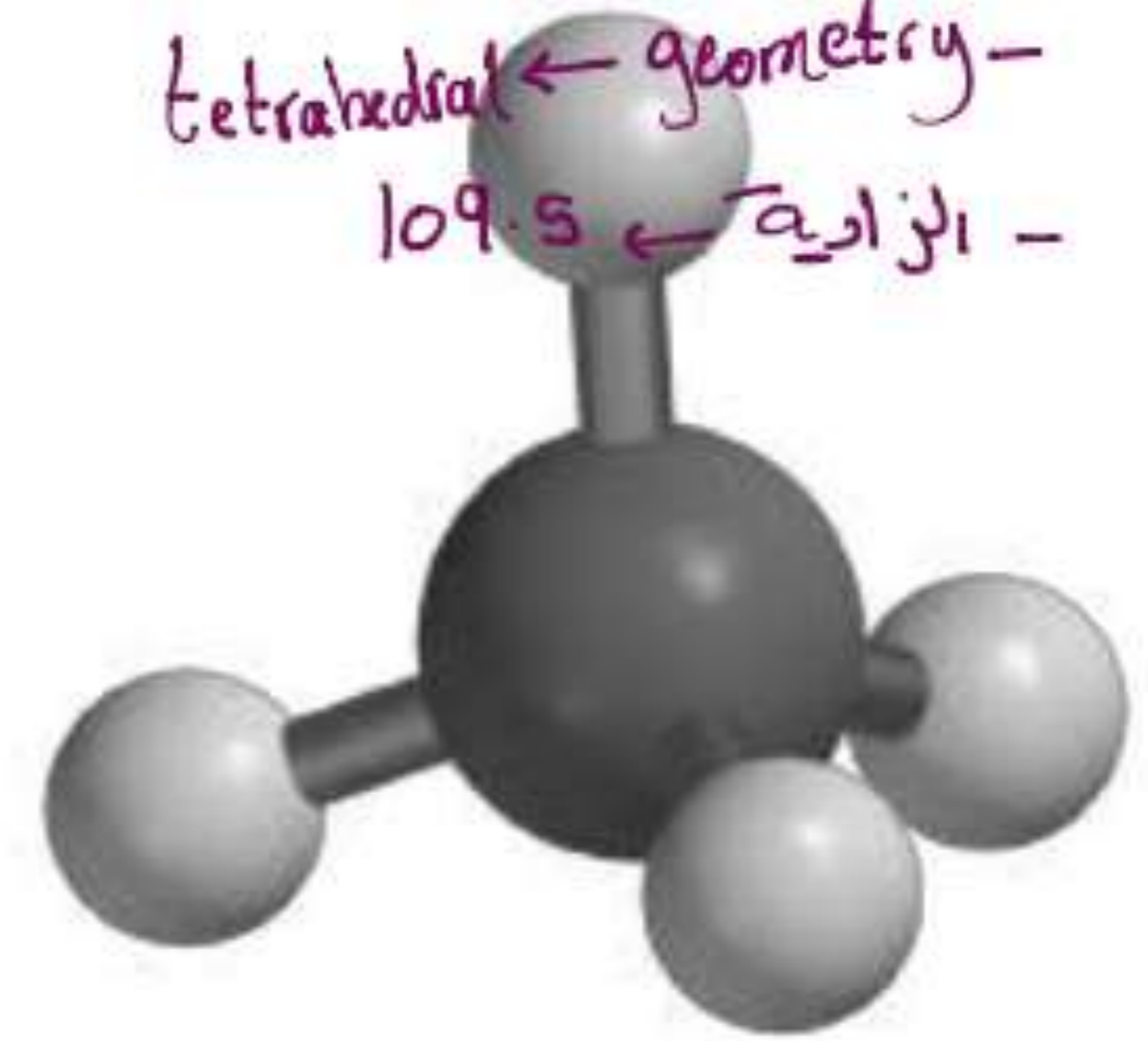
هسه بالنسبه لحلقة البنزين الروابط الثنائية الي فيها بتضلها تتحرك بسبب resonance وال resonance يعطي هاي المركبات stability عالية كثير اعلى من باقي مركبات الالكين عشان هيك

Structure of Alkanes

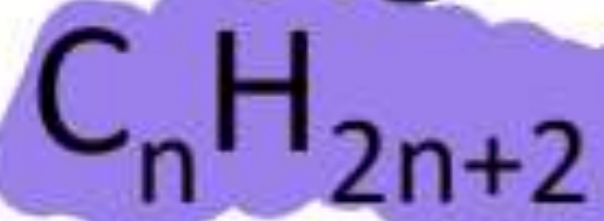
تعيين للرابطة
لا C هي sp^3

tetrahedral ← geometry -
الزاوية ← 109.5

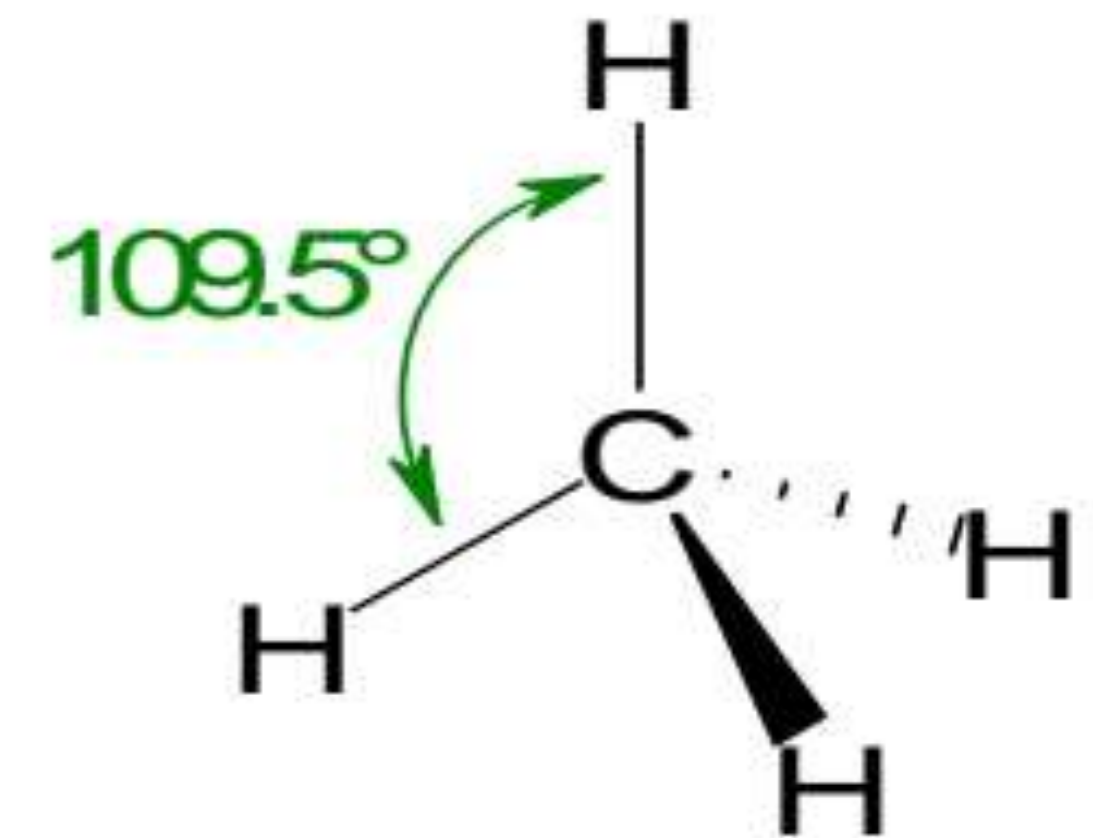
Alkanes are saturated hydrocarbons, that is they contain the maximum number of H atoms possible for the number of C atoms present.



The generic formula for an alkane is:

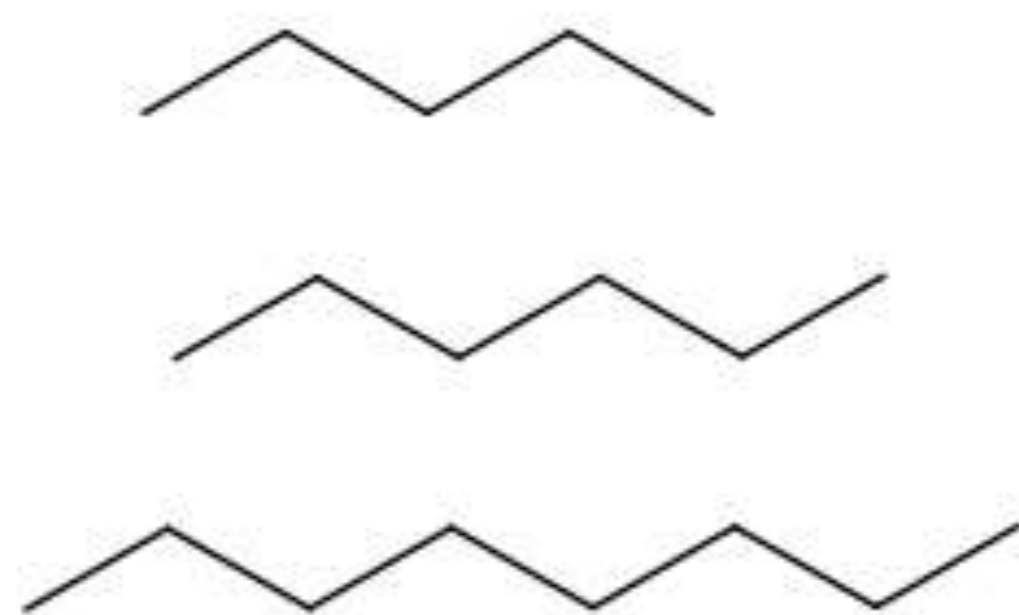


This means every C atom is sp^3 hybridized with bond angles of $\sim 109.5^\circ$



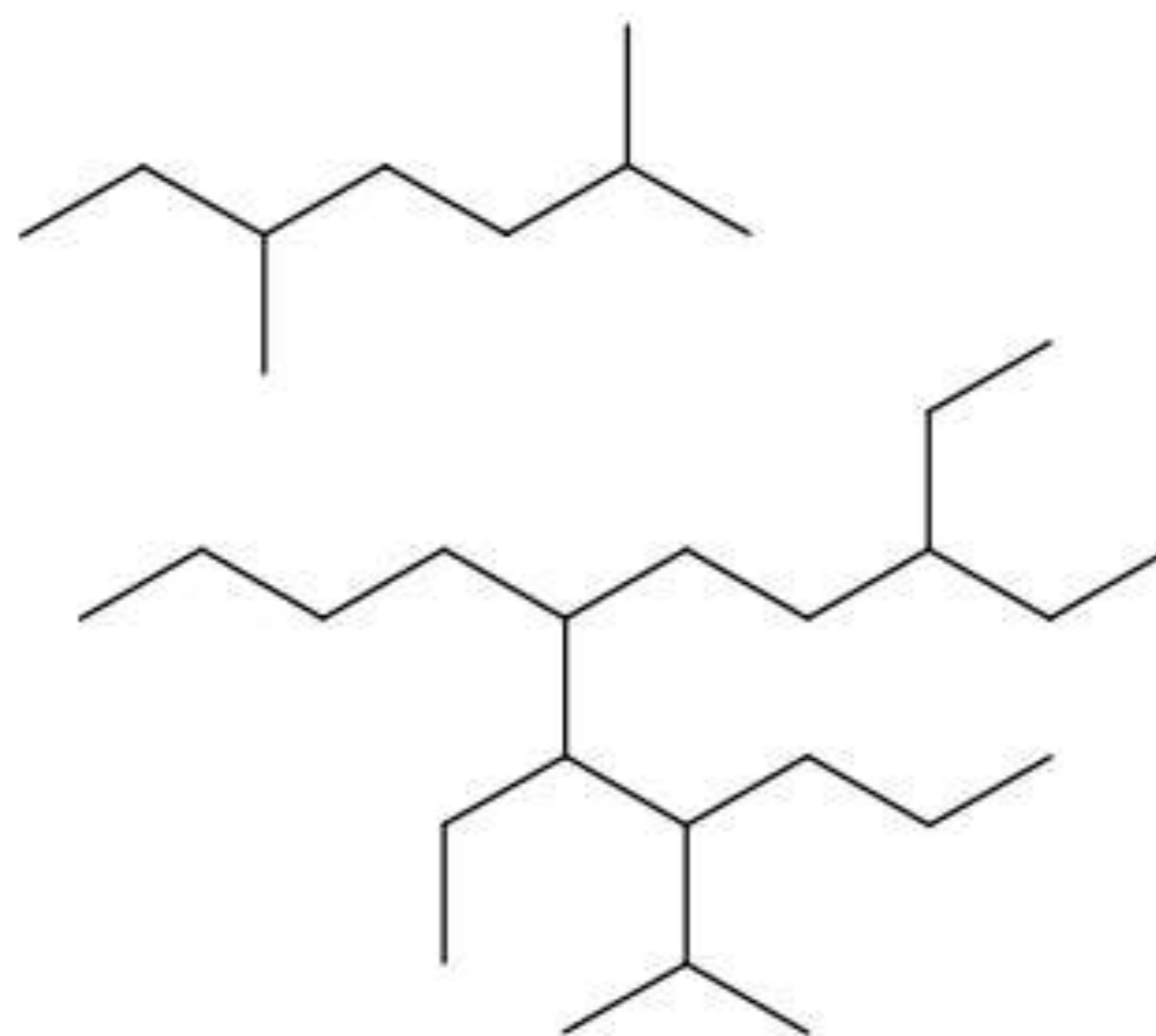
Structure of Alkanes (cont'd)

Alkanes can come in two forms, normal (or linear) and branched. Branched alkanes can have branched branches. Therefore the number of isomers possible grows quickly



Normal, unbranched (or linear)

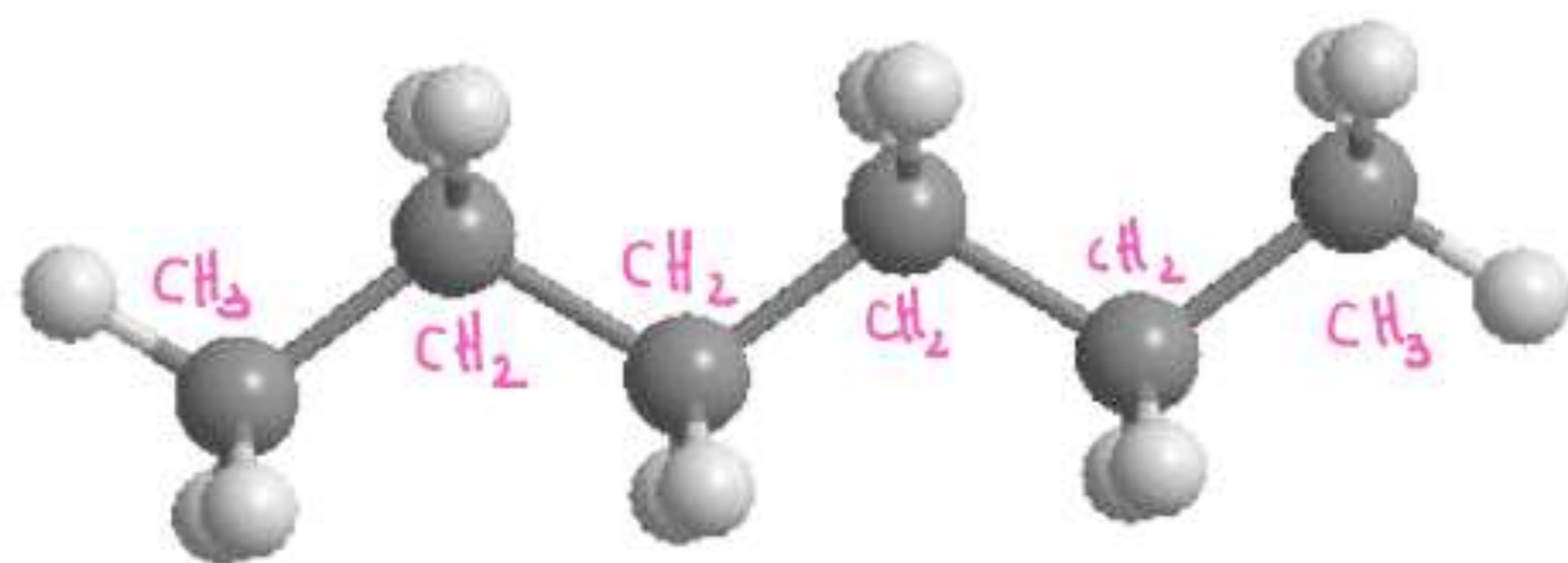
سلسلة لكن ما في أي تفرع



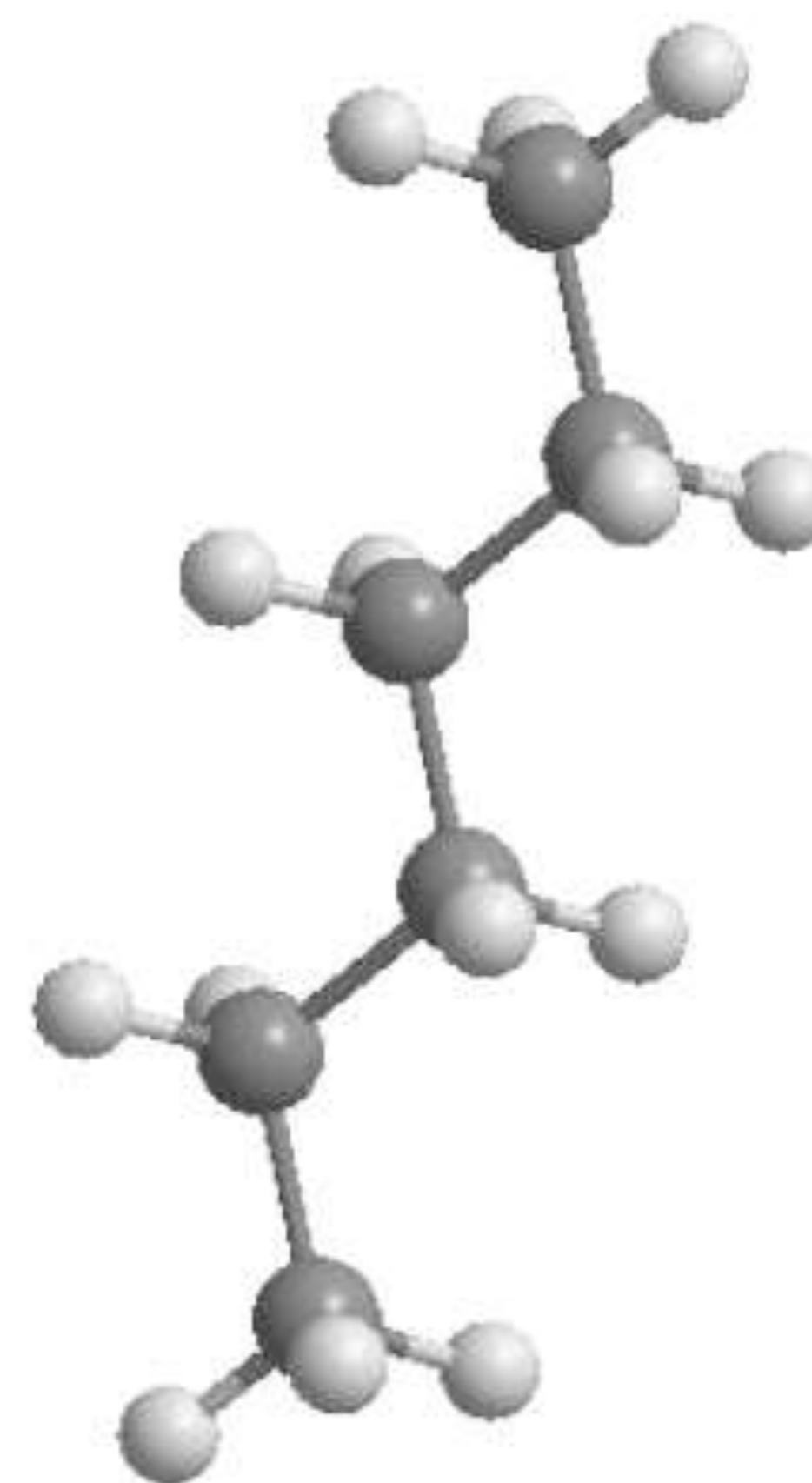
branched

تفرع أو أكثر

Structure of Alkanes (cont'd)



6c -
tetrahedral pairs -



Nomenclature of Organic Compounds

← الطريقة عنوائية .
← محالو اليسوهم حسب رماد /
أبت منها وهيلك .

A. Common names: In the early days of organic chemistry, each new compound was given a name that was usually based on its source or use.

B. IUPAC : → **بنمشی على rules**

The IUPAC name of any compound contains **3 parts** :

IUPAC name = Prefix + parent + suffix

(أسم + رقم) القزيمات

Prefix : What and where substituents.

→ الأسماء التي يتكون بها السلسلة الرئيسية .

① **Parent (Root)** : longest chain → هي التي تعمل الاسم الأساسي .

Suffix : functional group.

(هالكين / الكاين)

Table 2.1 Names and Formulas of the First Ten Unbranched Alkanes

Name	Number of carbons	Molecular formula	Structural formula	Number of structural isomers
methane	1	CH ₄	CH ₄	1
ethane	2	C ₂ H ₆	CH ₃ CH ₃	1
propane	3	C ₃ H ₈	CH ₃ CH ₂ CH ₃	1
butane	4	C ₄ H ₁₀	CH ₃ CH ₂ CH ₂ CH ₃	2
pentane	5	C ₅ H ₁₂	CH ₃ (CH ₂) ₃ CH ₃	3
hexane	6	C ₆ H ₁₄	CH ₃ (CH ₂) ₄ CH ₃	5
heptane	7	C ₇ H ₁₆	CH ₃ (CH ₂) ₅ CH ₃	9
octane	8	C ₈ H ₁₈	CH ₃ (CH ₂) ₆ CH ₃	18
nonane	9	C ₉ H ₂₀	CH ₃ (CH ₂) ₇ CH ₃	35
decane	10	C ₁₀ H ₂₂	CH ₃ (CH ₂) ₈ CH ₃	75

Note: The repeating group is (-CH₂-) is Methylene group

IUPAC Rules for Naming Alkanes

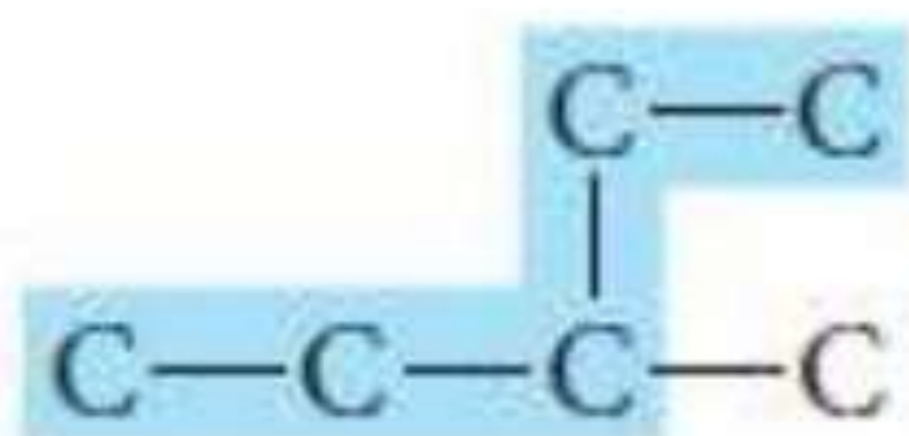
1. First identify the longest continuous chain (parent name) → longest chain

* أطول سلسلة

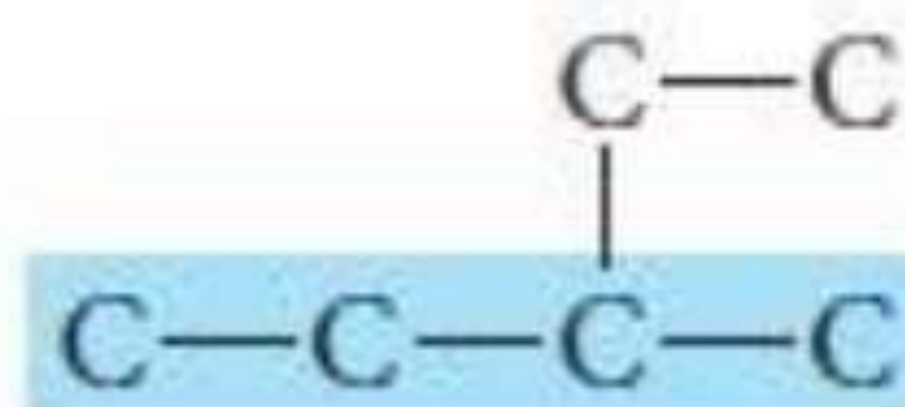
هي التي يكون فيها

أجود عدد C متوالي

فمن بينهم فواجل



not



① اختيار longest chain

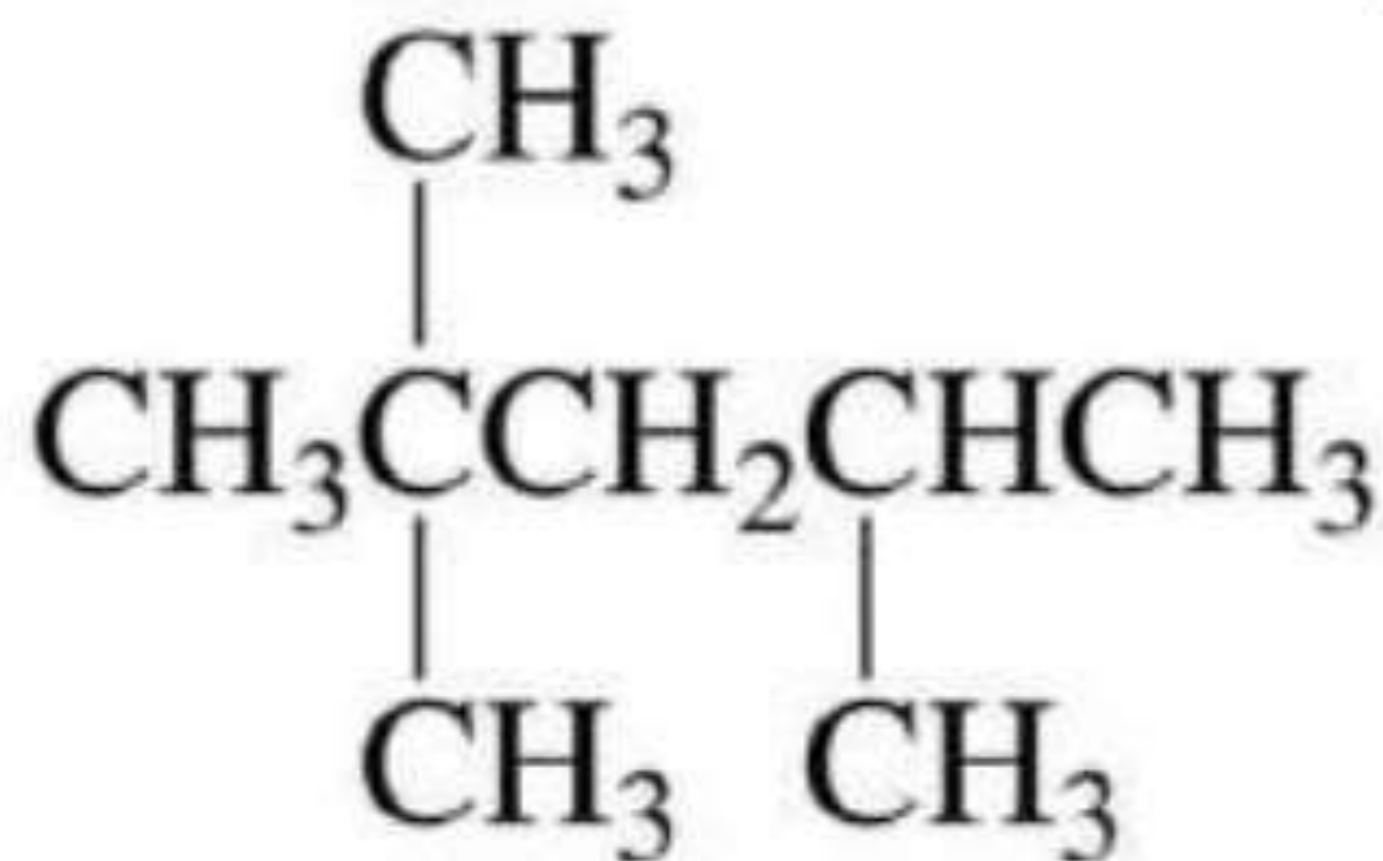
② اعدد substituent

لأنهم اعلى

numbering

لأنهم

الي بعد انه ابشئ يمينا يسار ولا العكس هو انه ارقم بحيث اعطي substituent اقل رقم (الرقم الأقرب إلى التقعر)

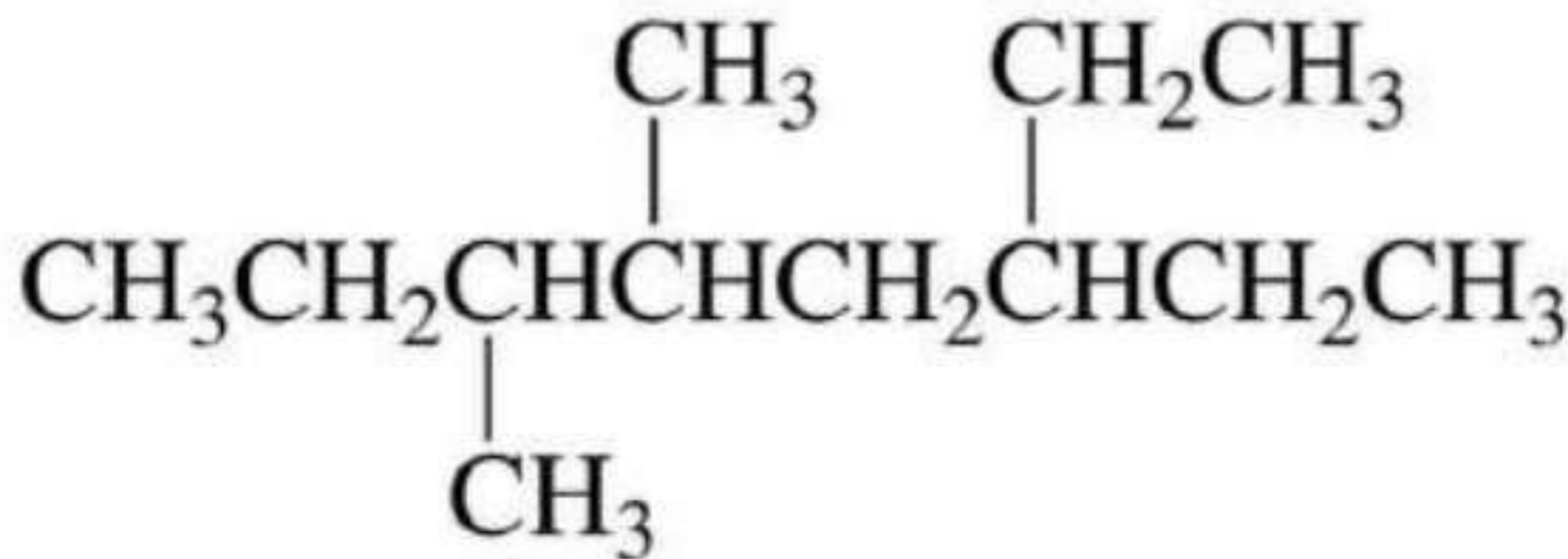


2,2,4-trimethylpentane

not

2,4,4-trimethylpentane

because $2 < 4$



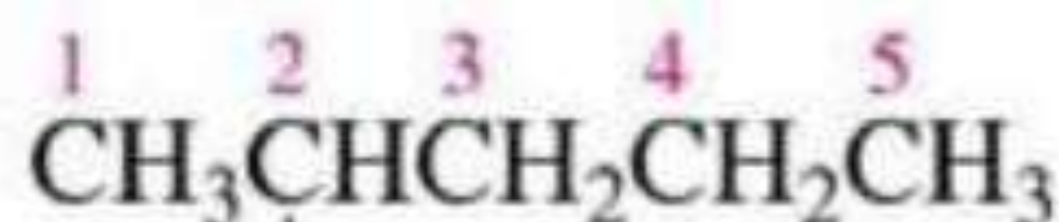
6-ethyl-3,4-dimethyloctane

not

3-ethyl-5,6-dimethyloctane

because $4 < 5$

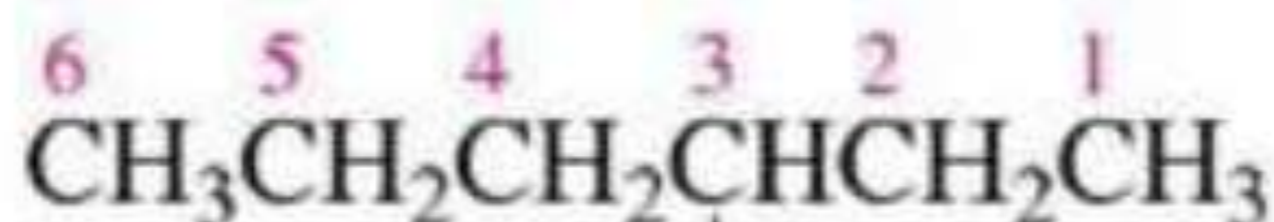
2. Number the chain in the direction that gives the substituent as low a number as possible



2-methylpentane

not

4-methylpentane



3-ethylhexane

not

4-ethylhexane

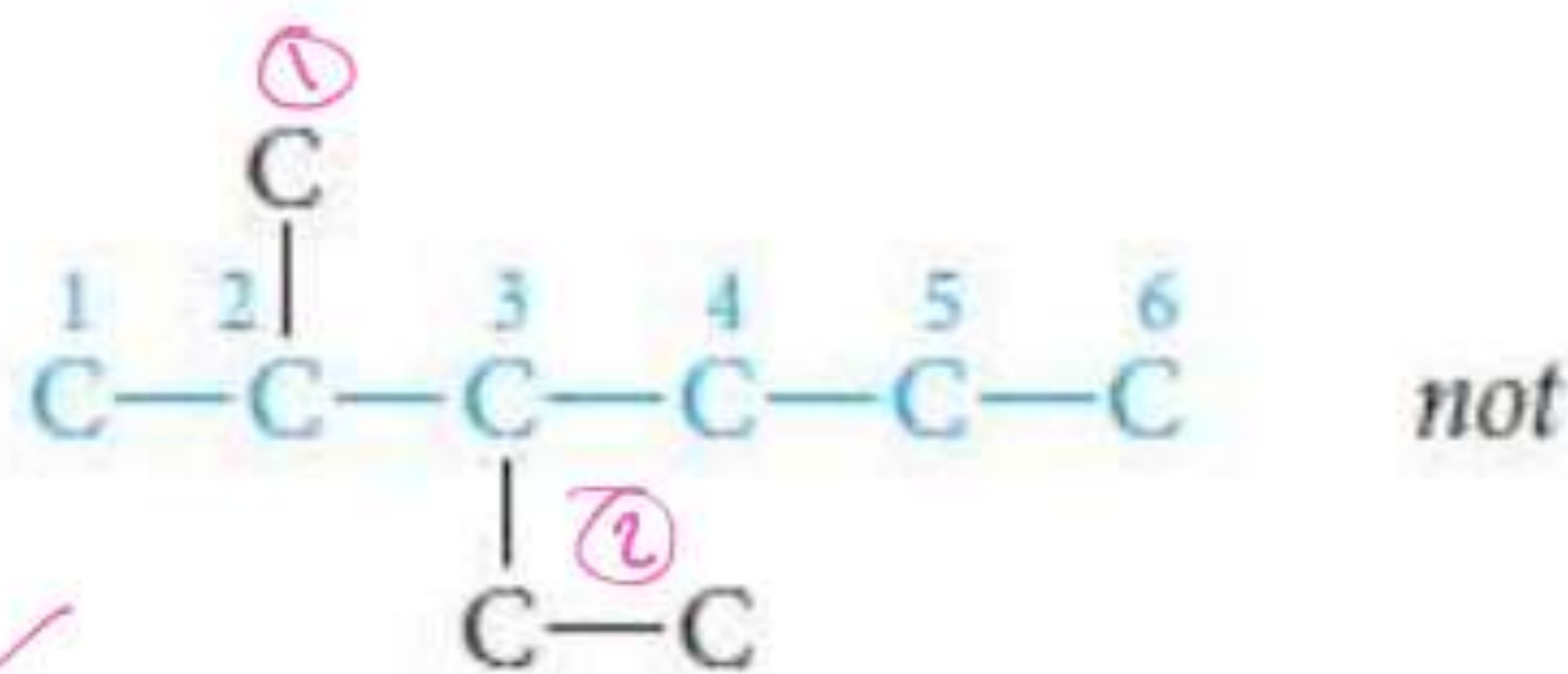


4-propyloctane

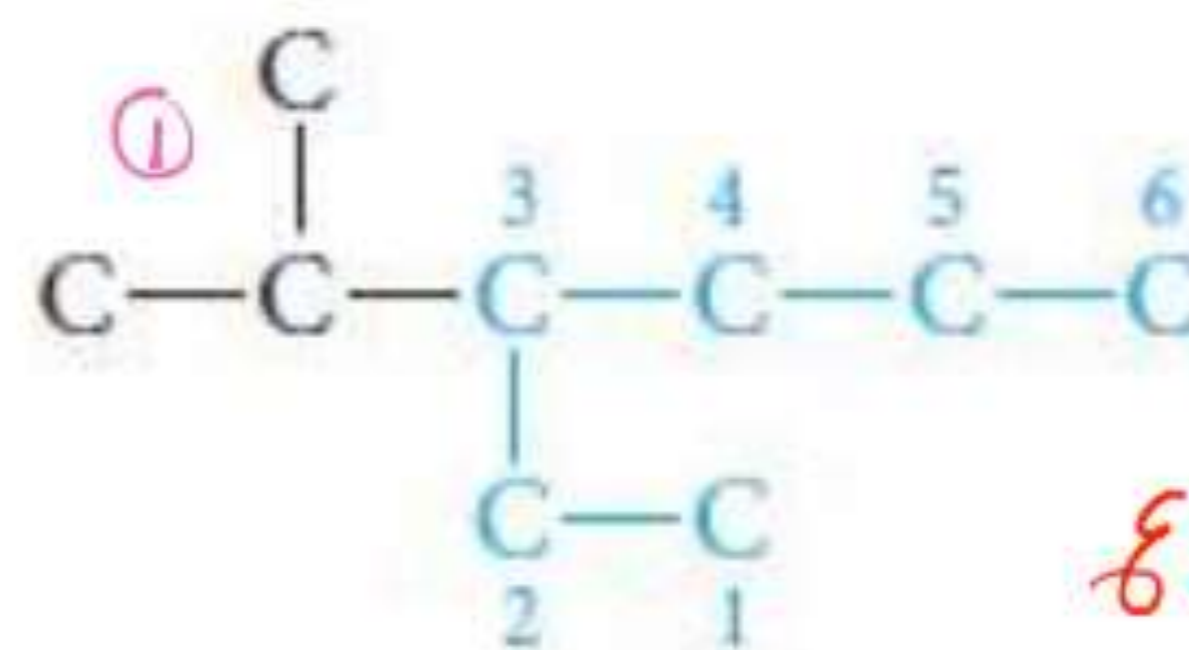
not

5-propyloctane

Note: If there are two equally long continuous chains, select the one with the most branches. For example:



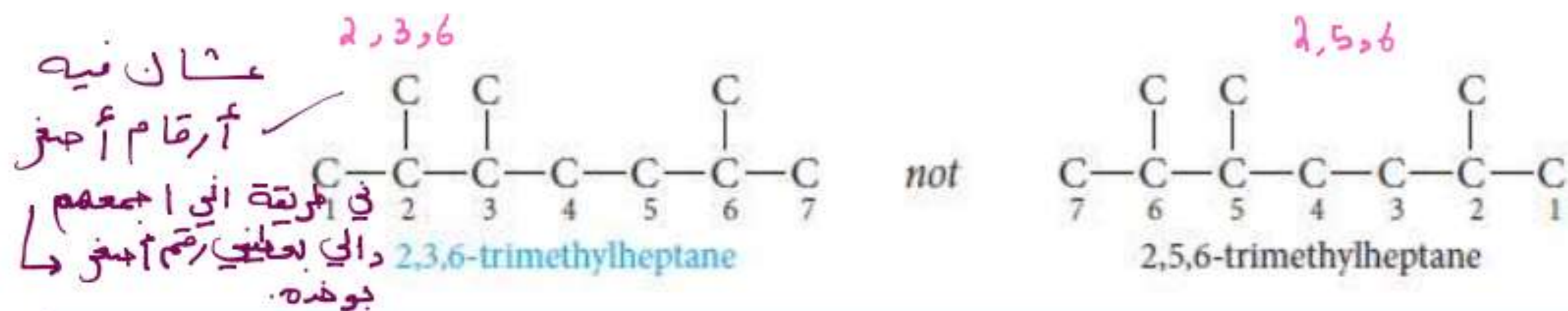
two branches



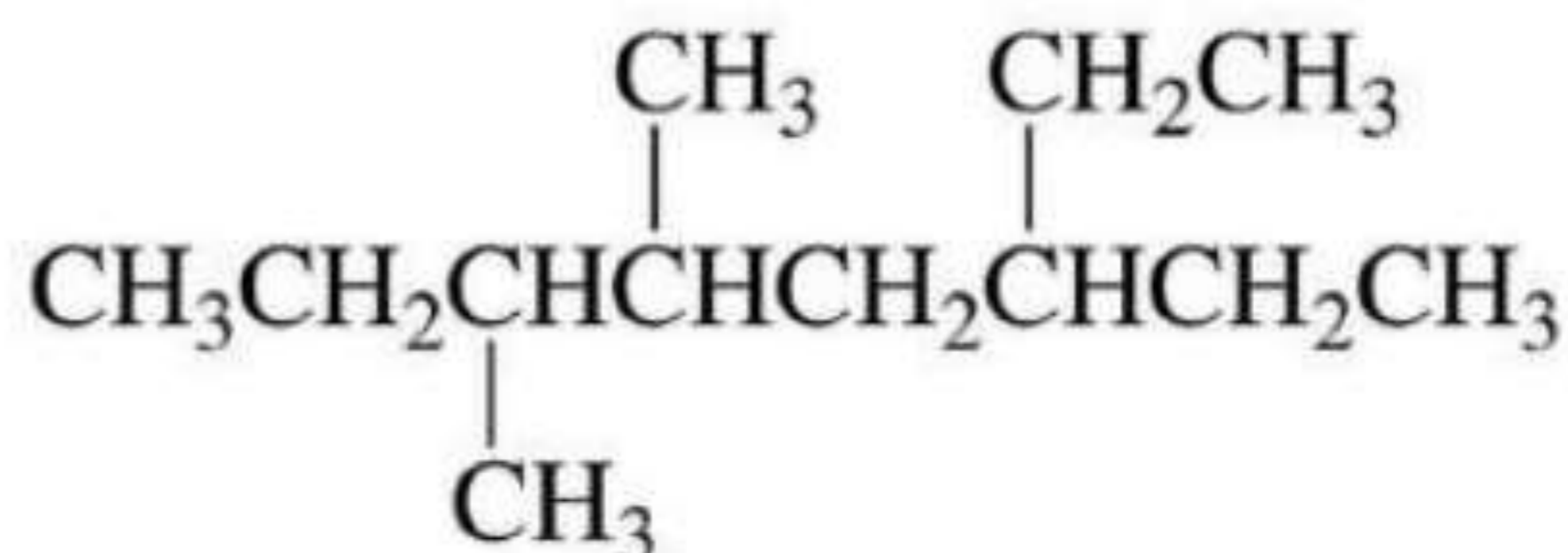
one branch

— ہون گایکونوا
 الاٹین
 longest chain
 برو خدالی بیعطینی تفریح
 اکثر

If there is a branch equidistant from each end of the longest chain, begin numbering nearest to a third branch



- How to name a substituent?
- It can be a branch in the chain
- A branch (alkyl substituent): is (Alkane – H)



Replace "ane" of alkane with "yl."

للتفرع

CH₃—
methyl group

CH₃CH₂—
ethyl group

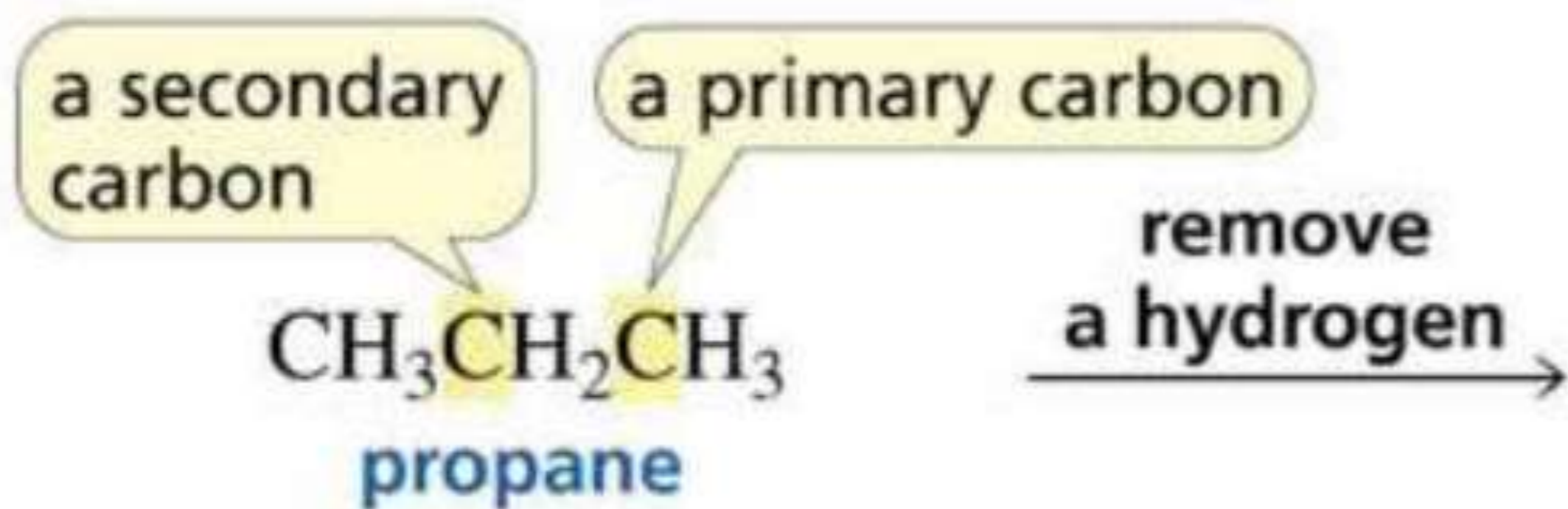
CH₃CH₂CH₂—
propyl group

CH₃CH₂CH₂CH₂—
butyl group

CH₃CH₂CH₂CH₂CH₂—
pentyl group

R—
any alkyl group

-There are two propyl Groups



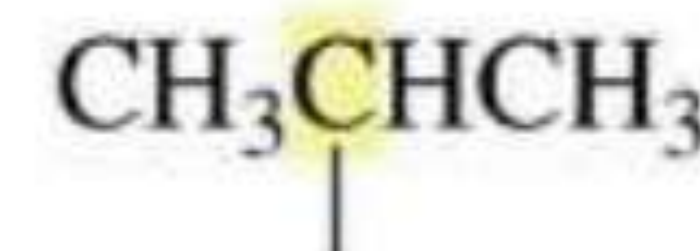
remove
a hydrogen →



propyl group

-Pr

← تسبكت في الكربون



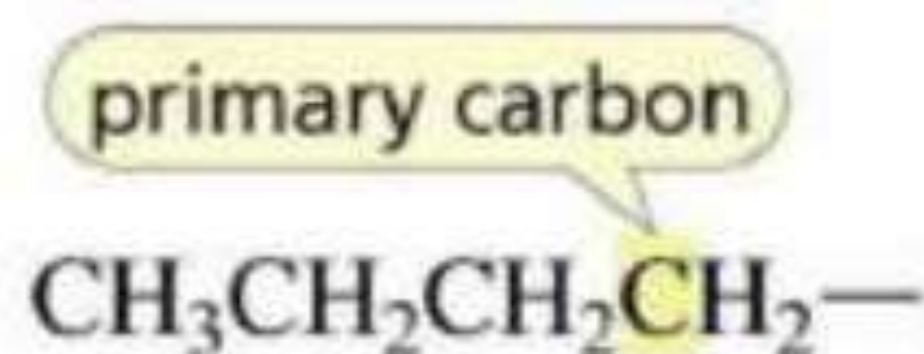
isopropyl group

i-Pr-

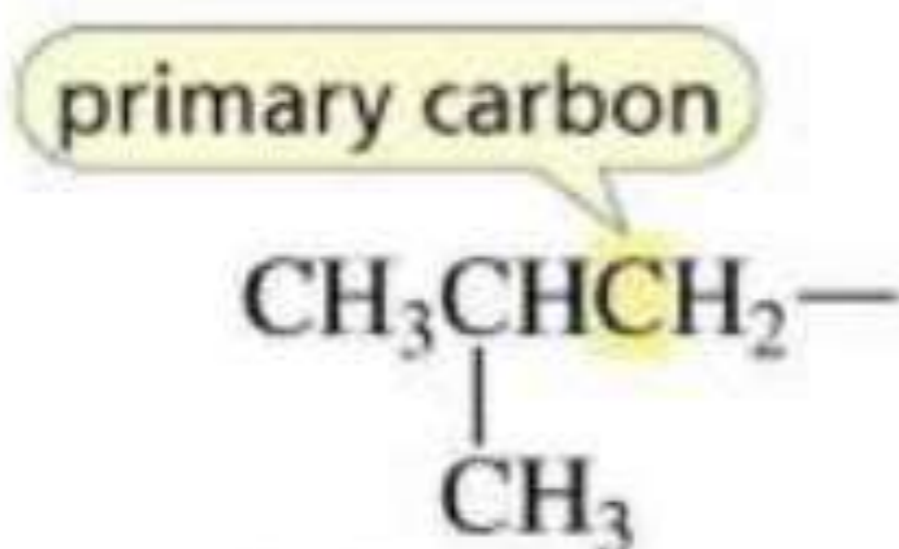
← تسبكت في النصف

ما يفرقوا عن بعض $\begin{matrix} \text{CH}_3 & \text{CH}_2 \\ \text{CH}_2 & \text{CH}_3 \end{matrix}$
 هون بفرق من أي مكان
 اتزعج لا يعني من النصف
 عن الطرف رجاء من
 بتعمل 3C ↑

-There are Four Butyl Groups

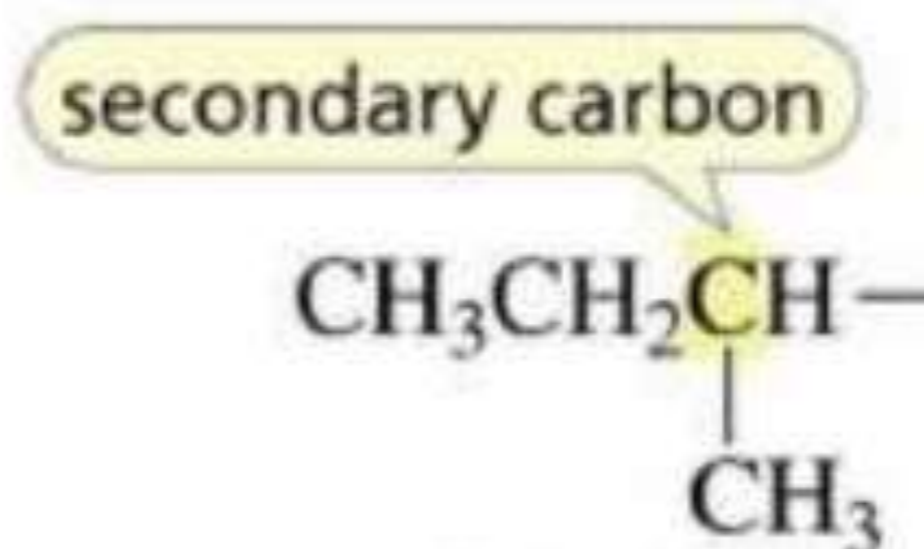


butyl group



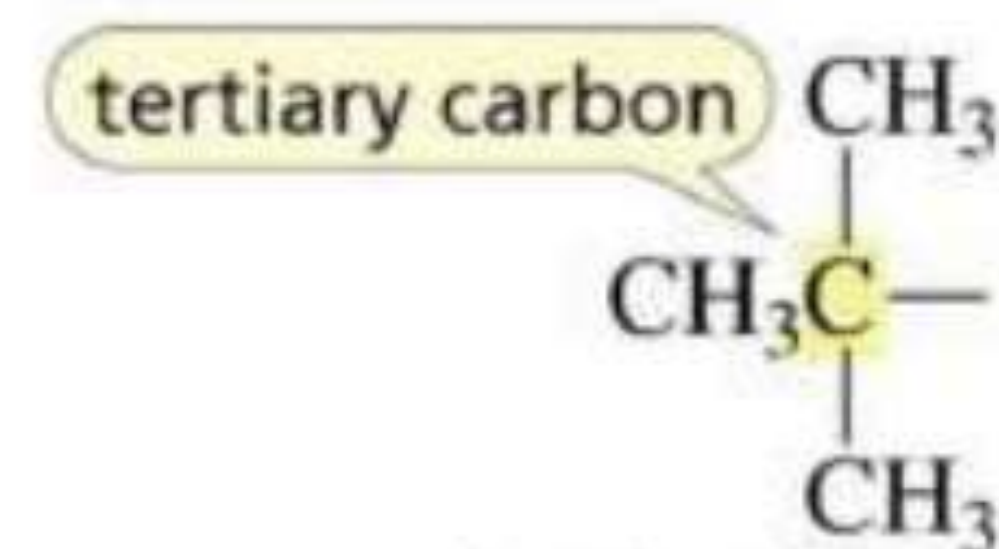
isobutyl group

من النصف ومربوط
معها 1C



sec-butyl group

من النصف ومربوط معها
2C



tert-butyl group

من النصف ومربوط معها
3C

Note: These names for the alkyl groups with up to four carbon atoms are very commonly used, so you should memorize them.

Examples:

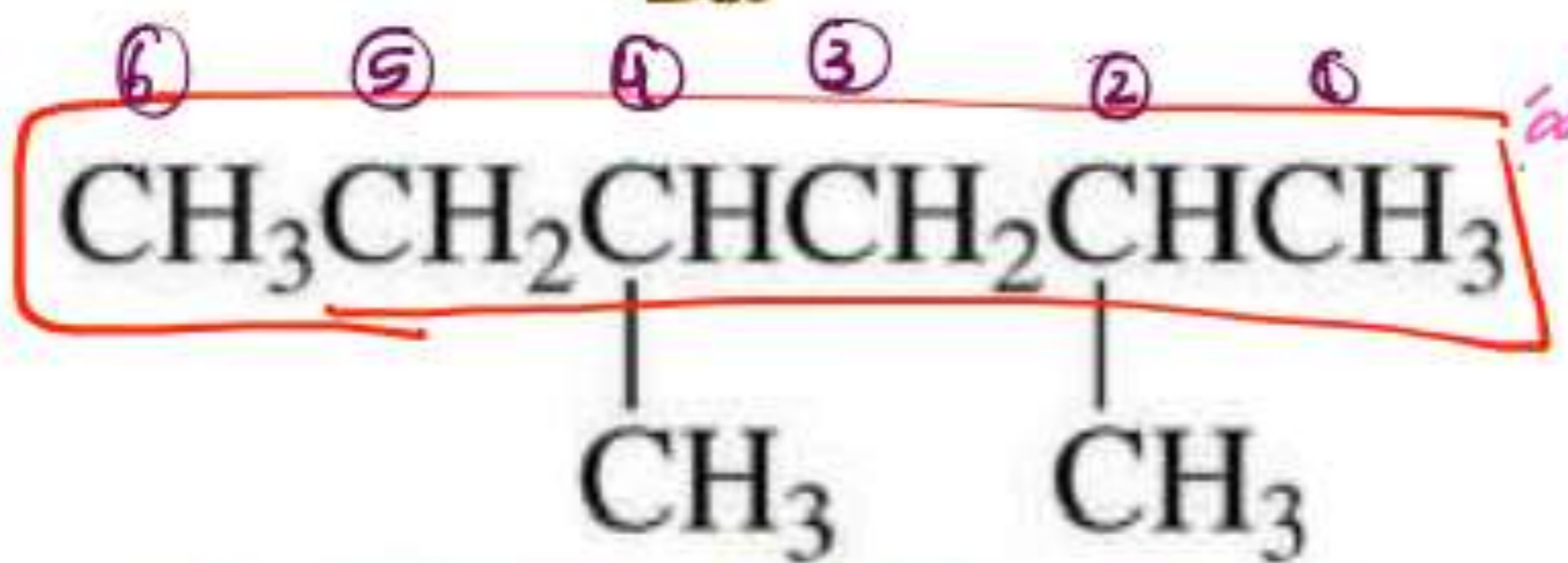
بِس اَجِي بَدِي اَجِي
بَرْتَب التَّفْرَعَات اِجْدِيَاً

Note 1: di-, tri-, and tetra- are used for the same **Multiple** Substituents

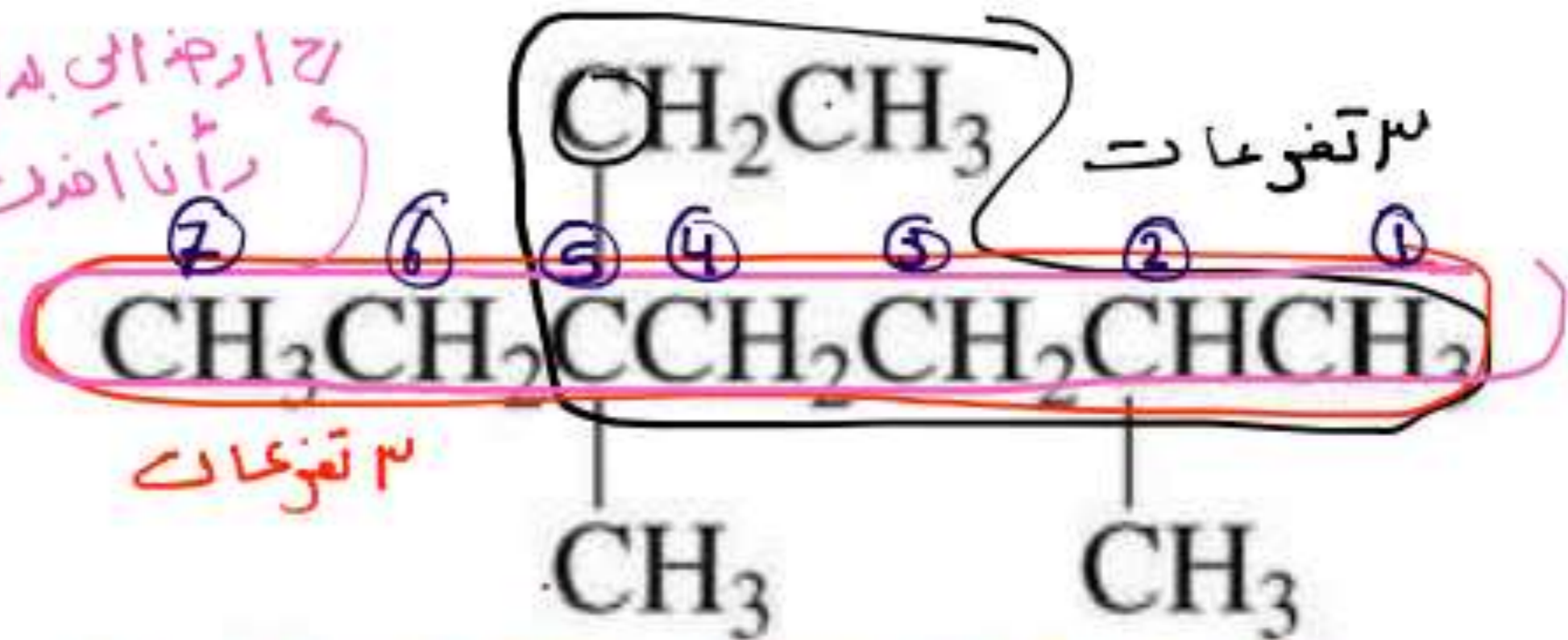
Note 2: Substituents are listed in **alphabetical order**.
(di, tri, tetra, sec, tert are not alphabetized)

مثلاً Ethyl / Methyl
لَمْ يَلِمْ لَمْ يَلِمْ هَاهِي
لَمْ يَلِمْ لَمْ يَلِمْ هَاهِي

2+4=6 ← يعني همدون فقط
3+5=8 → الترتيب فقط حالة رقم
إلي يدخلوا فيها وهي
Iso



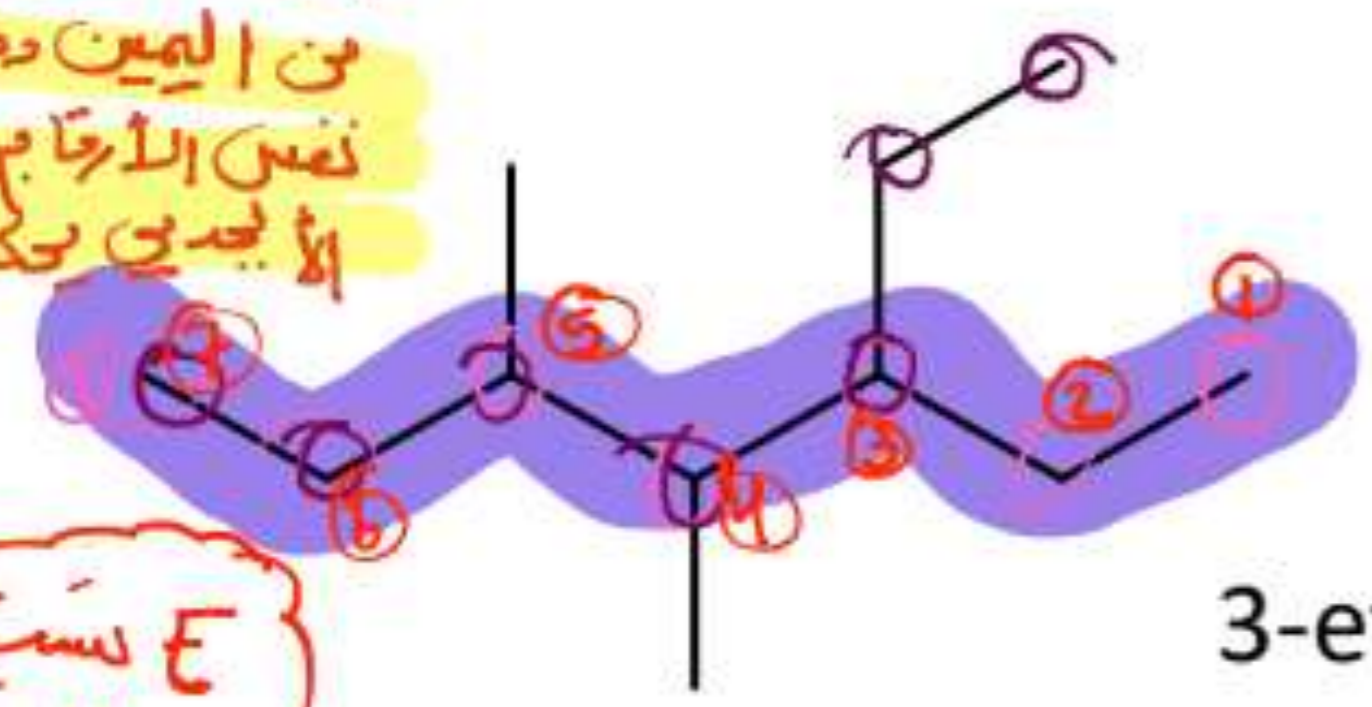
2,4-dimethylhexane



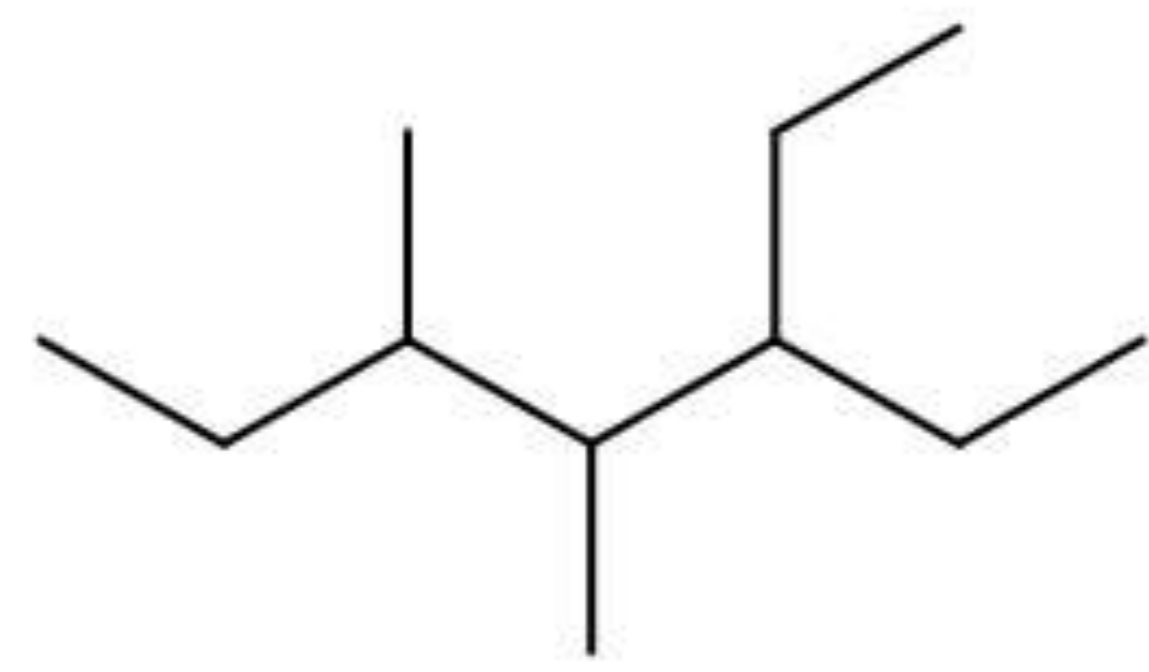
5-ethyl-2,5-dimethylheptane

numbers are separated by a comma;
a number and a word are separated by a hyphen

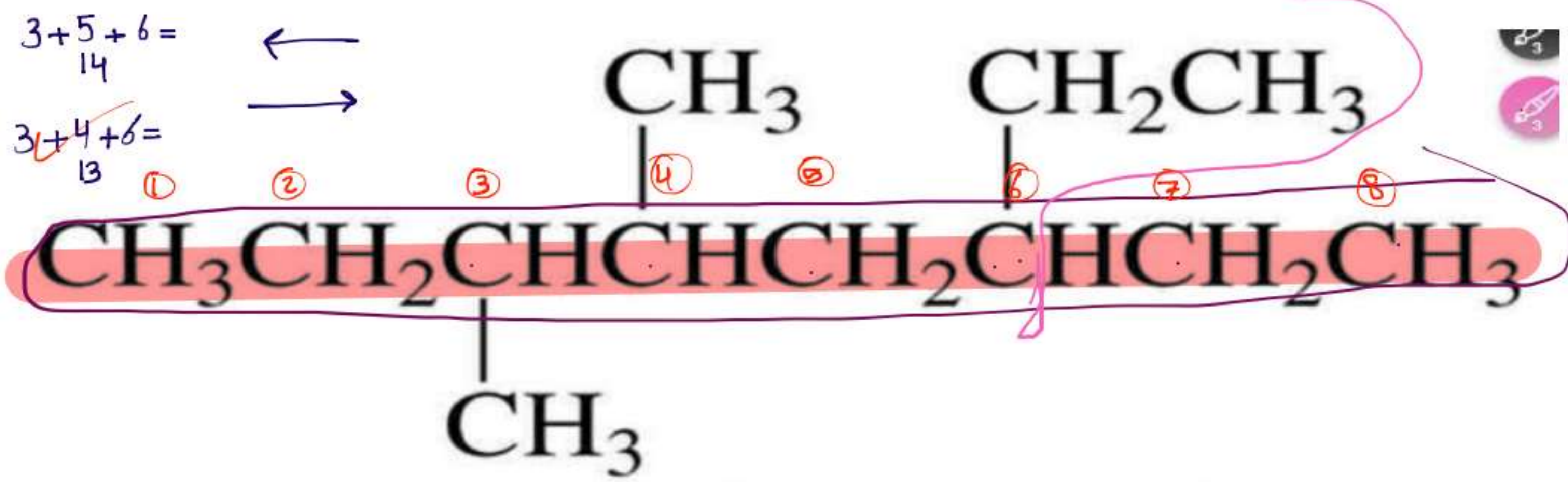
إذا كان عندني
من اليمين ومن اليسار
نفس الأرقام فخذي
الأجدي بحكم



3-ethyl-4,5-dimethylheptane



E سبق
M



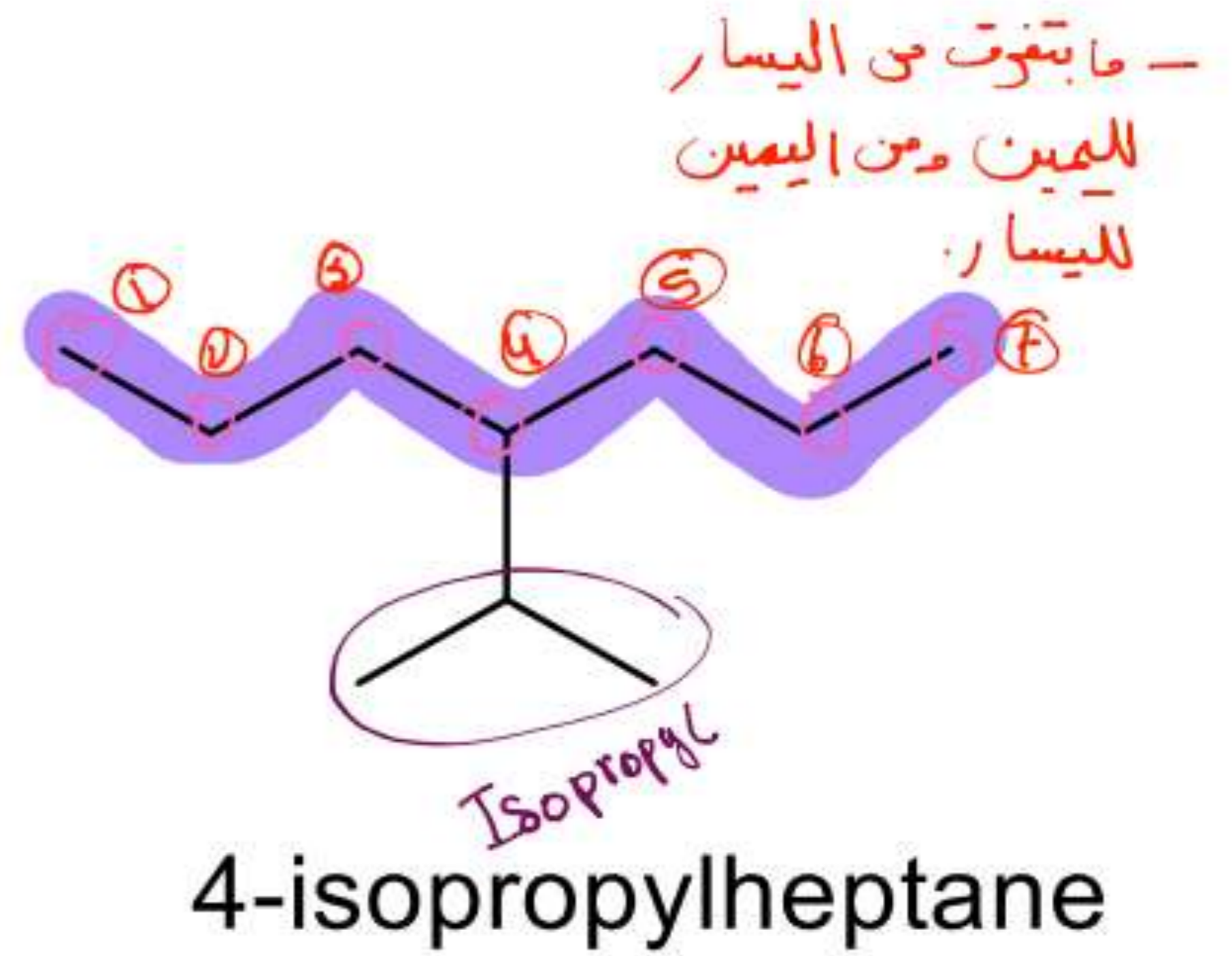
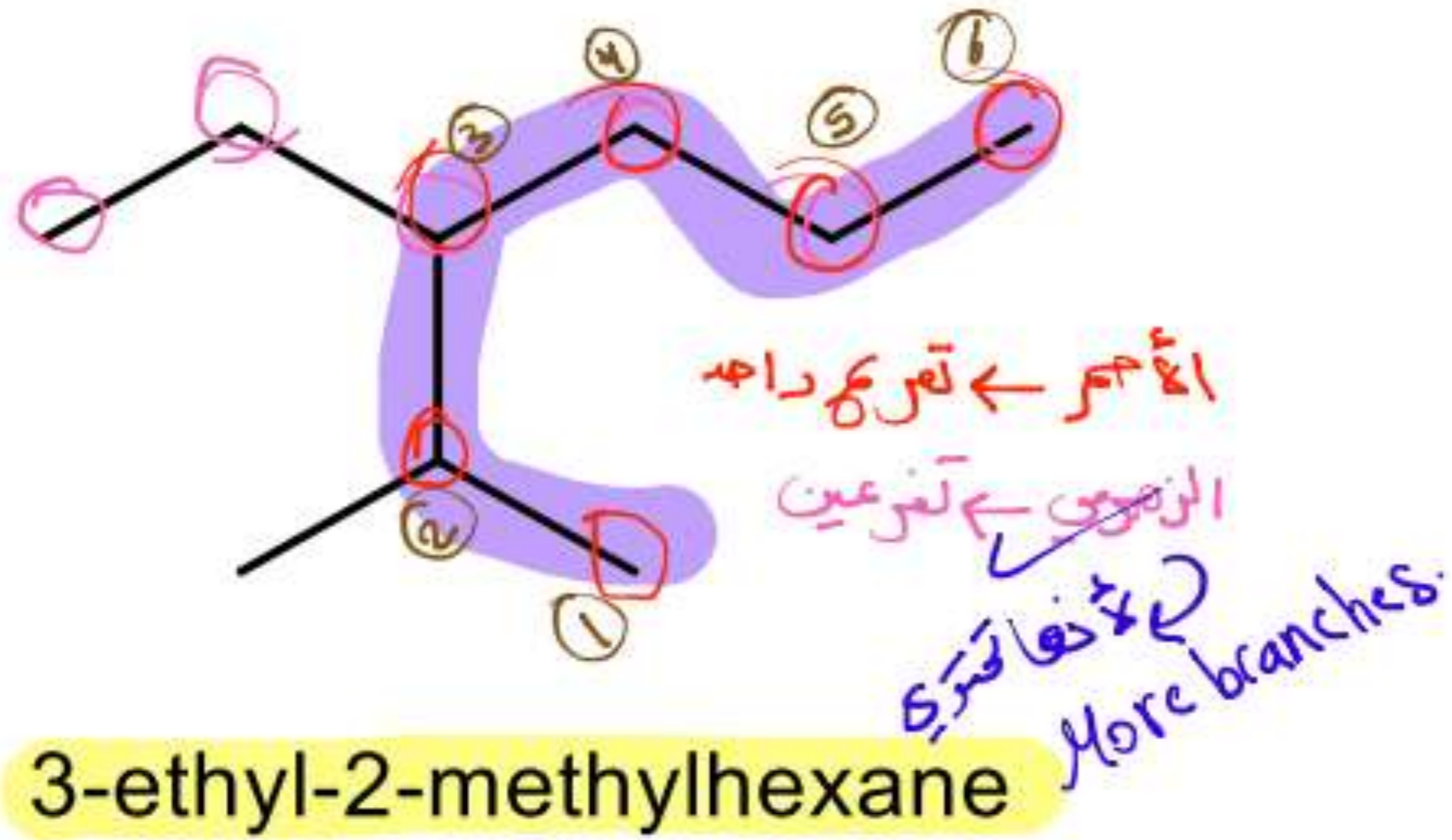
6-ethyl-3,4-dimethyloctane

not

3-ethyl-5,6-dimethyloctane

because $4 < 5$

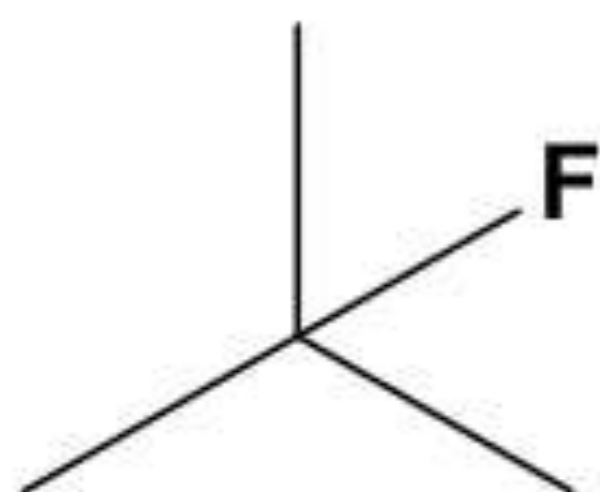
Examples



2.4: Alkyl and Halogen Substituents (R-X)

Common name : Alkyl halide
eg. $\text{CH}_3\text{CH}_2\text{Br}$ Ethyl bromide

اذا شلت H حطيت بدالها X (هالوجين). رح
يصير اسمها Alkyl halide



Common name:
tert-butyl fluoride

IUPAC:

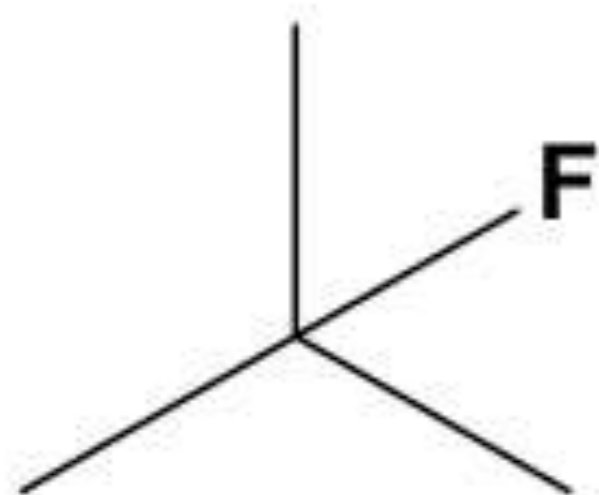
Halogen substituents are named by changing the *-ine* ending of the element to *-o*.

F: fluoro

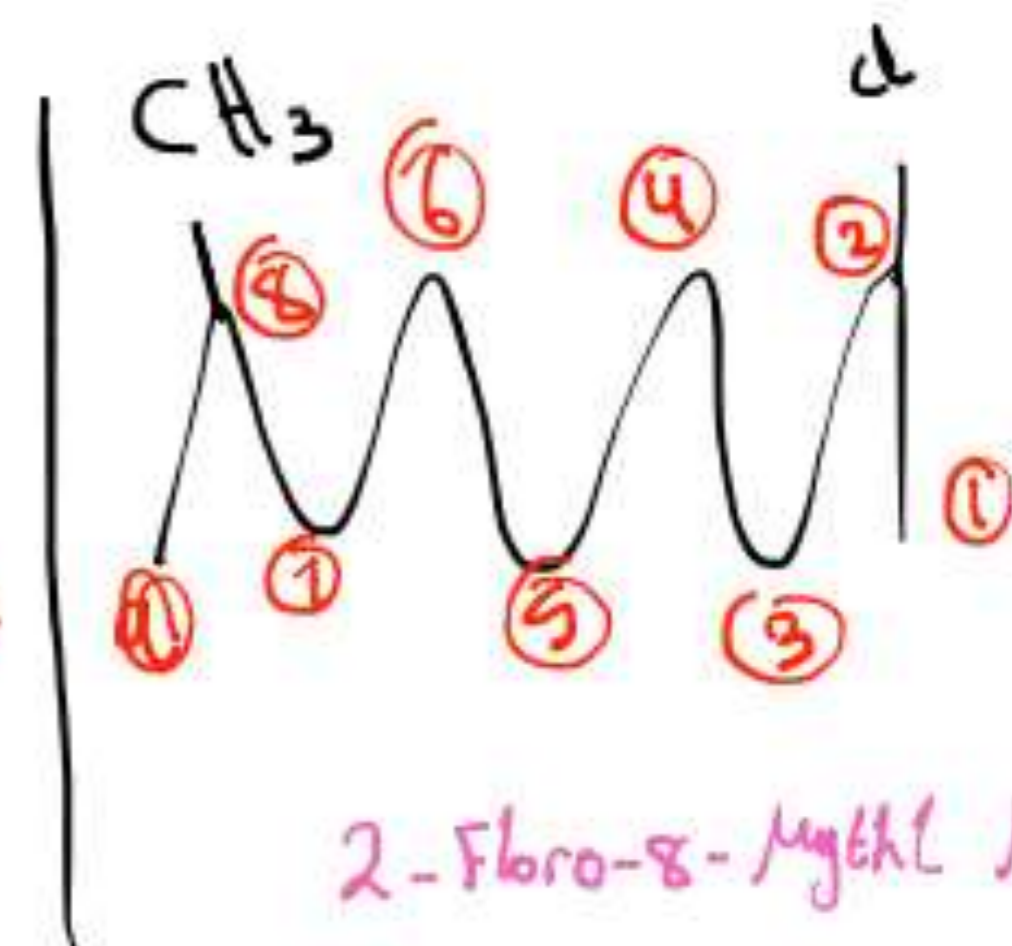
Cl: chloro

Br: bromo

I: iodo-



ايوبان
2-fluoro-2-methylpropane



Sources of Hydrocarbons

Hydrocarbons are found in crude oil and natural gas. Both are mixtures of different hydrocarbons and they are separated by “fractional distillation” a process where the different compounds are separated in a long distilling column based on their boiling points. Heavy fractions can be “cracked” into small lighter, hydrocarbons using heat and/or catalysts.

2.7: Physical Properties of Alkanes and Nonbonding Intermolecular Interactions

A physical property is any property of matter or energy that can be measured.

When it changes, the chemical composition of the object does not change

* التغيير الفيزيائي ما بأتري على Chemical Composition
 يرجع لجدتين كأمثلة
 رعدة من الخصائص الفيزيائية

Alkanes are insoluble in water. This is because **water molecules are polar**, whereas **alkanes are nonpolar** (Like dissolves like: Polar/ionic solvents **dissolve** polar/ionic solutes and non-polar solvents **dissolve** non-polar solutes)

Polar يذوبه polar

nonpolar يذوبه nonpolar

الدرجة التي عندها المادة يتحول لغاز = External pressure = Vapor pressure

Alkanes have lower boiling points for a given molecular weight than most other organic compounds. This is because they are nonpolar molecules.

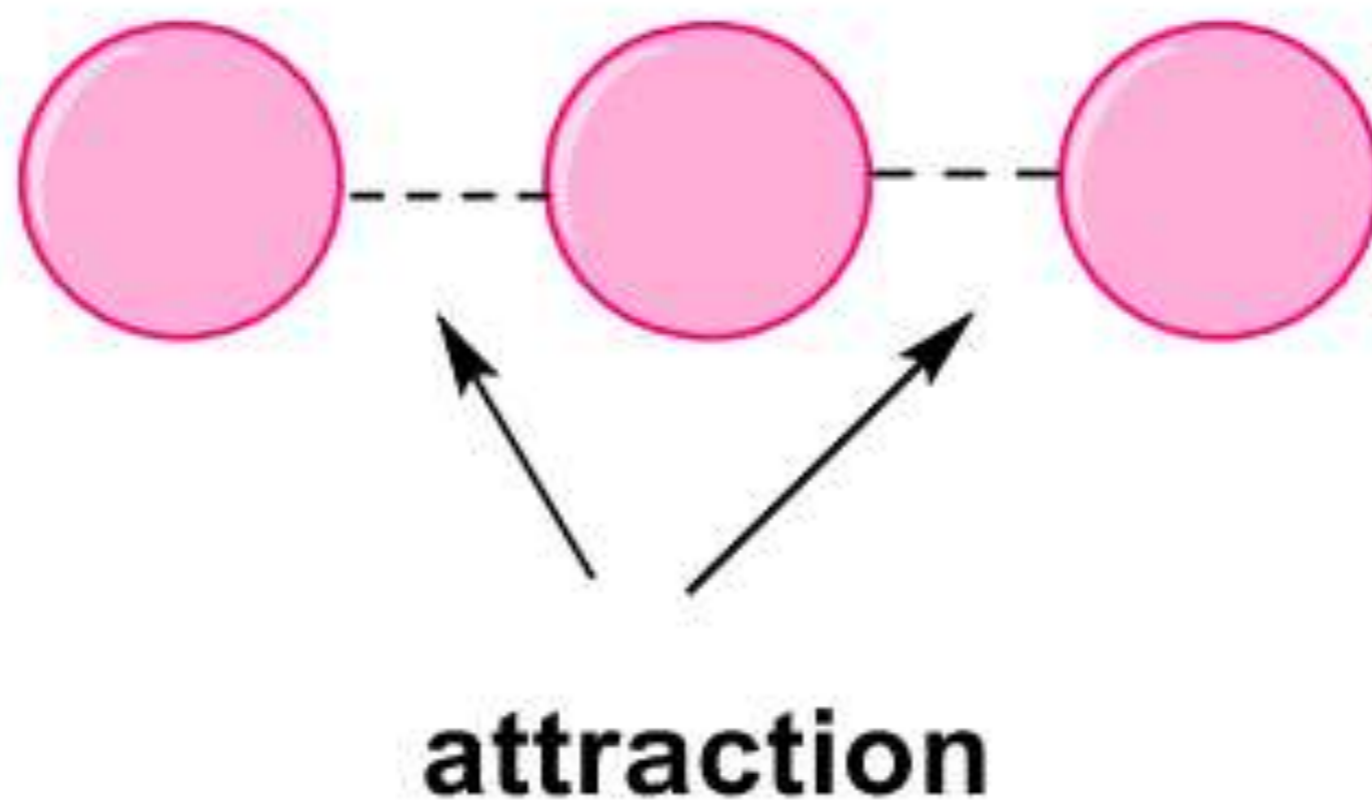
The physical properties of molecules are in part dependent on the type's of intermolecular forces (IMF) present.

- في عندي liquidide بدي امره ل gas

في ال liquide يتكون هدول ال molecule متقاربة
 يس مش منتظمة وهاض الفرق بينها وبين المادة
 الصلبة التي يتكون الجزيئات فيها متقاربة ومنتظمة
 فلو بدي احولها لغاز بخلي الجزيئات بعيدة عن
 بعض (مش متقاربة)

اللي بخلي هدول molecule متقاربة نوع من ال
 forces او attraction التي بنطلق عليه
 intermolecular forces (روابط بين
 الجزيئات) ويس بدي ابعدهم عن بعض بكسر هاي
 ال intermolecular forces

كل ما كانت هاي القوة اكبر يتكون boiling point اكبر



في الالكانات

Van der Waals هي

دهي، مسؤره من
bolling point

Intermolecular Forces

The physical properties of molecules are in part dependent on the type's of intermolecular forces (IMF) present.

Boiling points (BP) are also dependent on the **mass of the molecule**.

Solubility, the ability to dissolve into a solvent is dependent on IMFs.

The strength of the interaction between molecules is also dependent on the **overall shape** of the molecule.

Intermolecular Forces

There are 3 types of IMFs, by decreasing strength they are:

- 1) Hydrogen bonding
- 2) Dipole-dipole
- 3) Van der Waals or London Dispersion

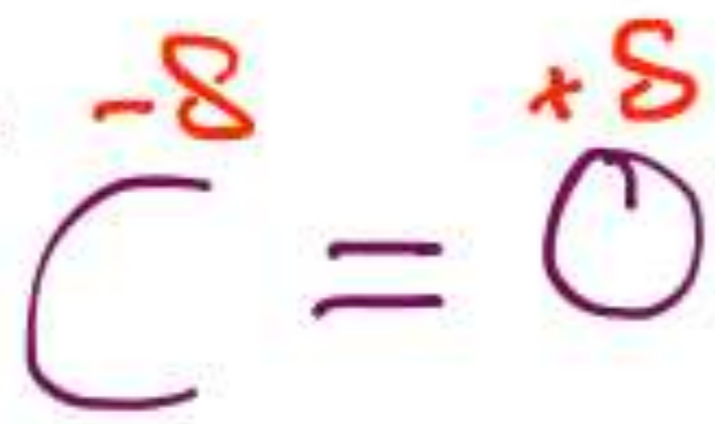
Dipole-dipole

Dipole-dipole forces arise from the attraction of oppositely charged atoms (other than H) in molecules. These molecules may have a **permanent** dipole moment. Generally in organic molecules they result from the presence of C-X bonds where X is more electronegative than C.

These are generally weaker than H-bonding, ranging from about 5-10 kJ/mol.

$\leftarrow e'$

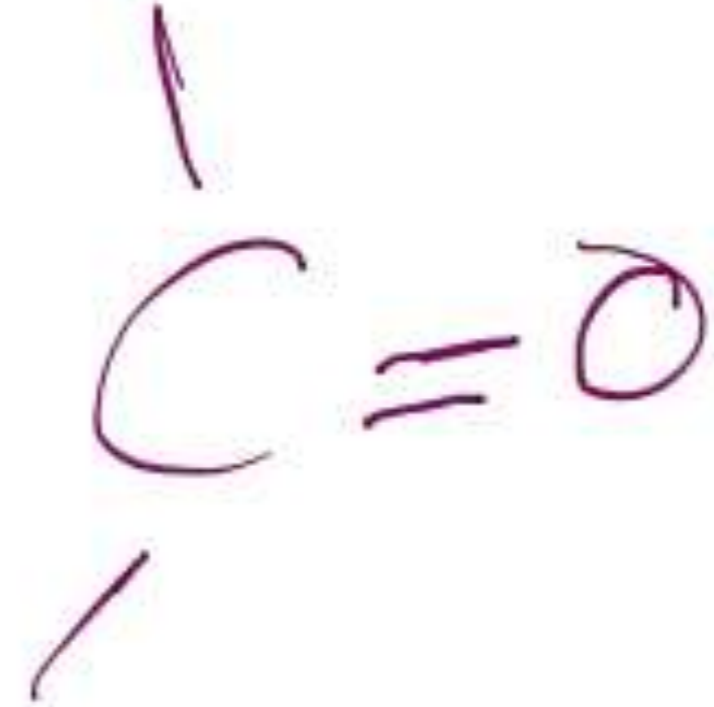
هدون مستأيل
تنتج
لاشارات
فبتكون
permanent



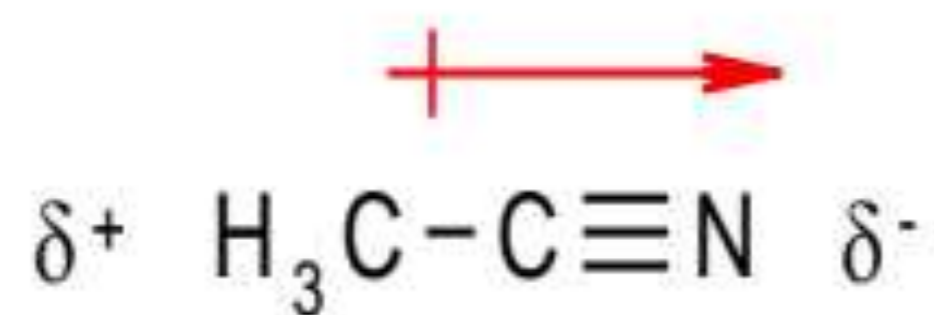
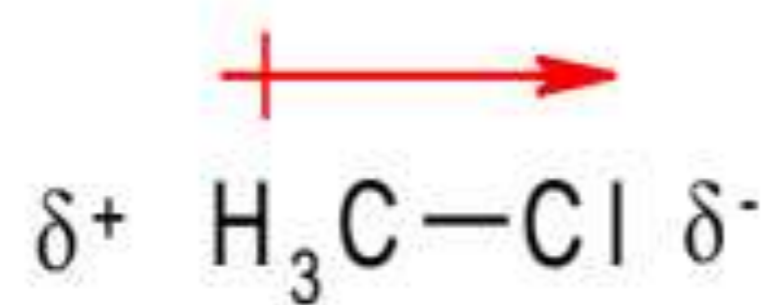
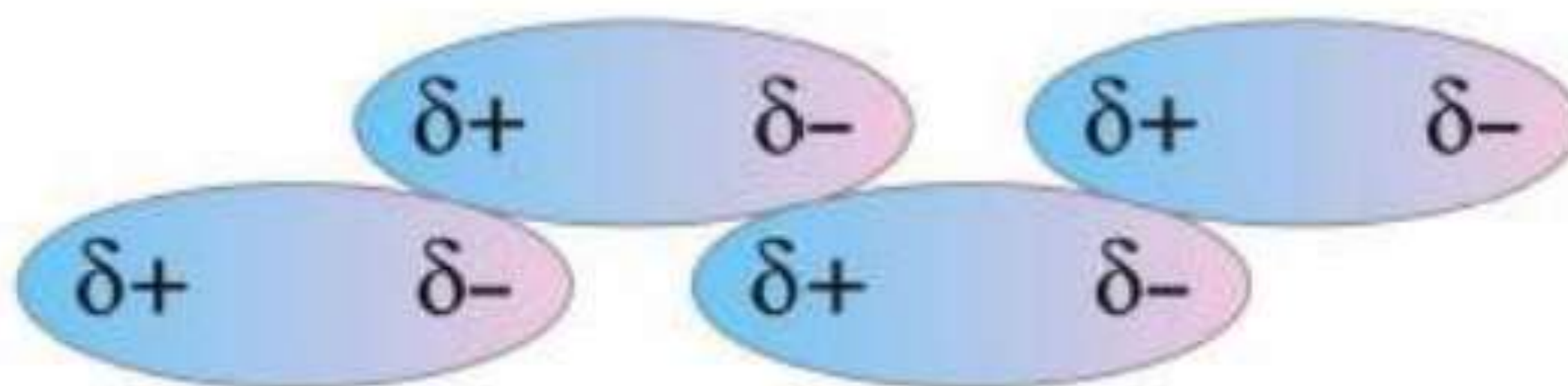
polar

الواصلة الي
لنوم هي

dipole-dipole.



Dipole-dipole



دپول-دپول سے نوع جانا ہے

Hydrogen Bonding

هو ارتباط N,O,F مع
سکتا ہے / احفظها
من اسم نون

تکون اقوی و
منها

Hydrogen bonding is a complex interaction that includes dipole-dipole, as well as orbital interactions and the transfer of electron density between molecules.

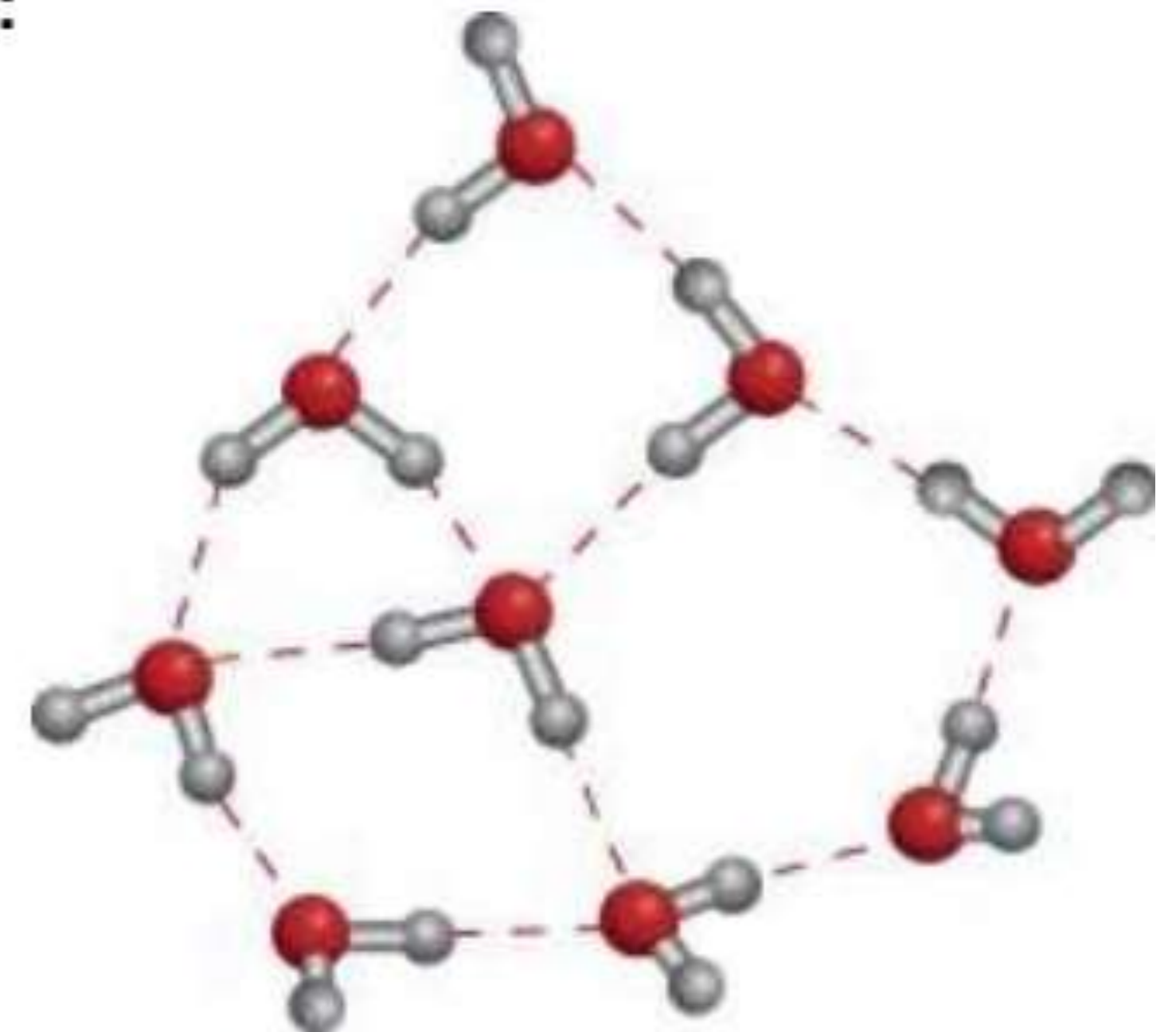
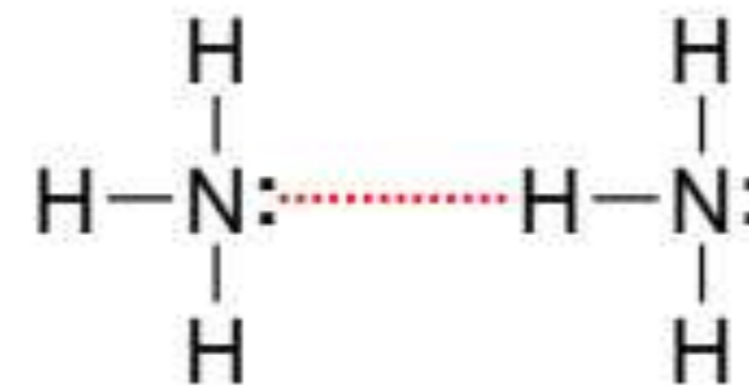
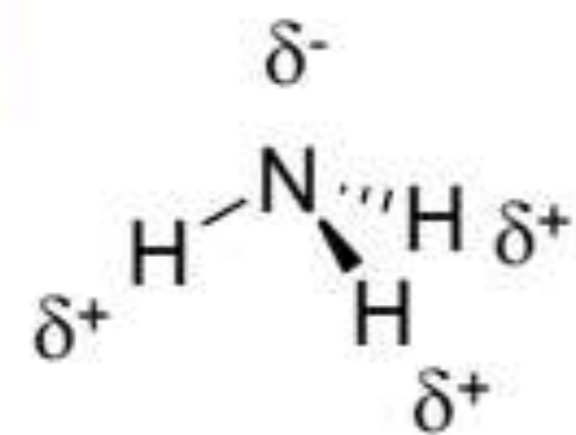
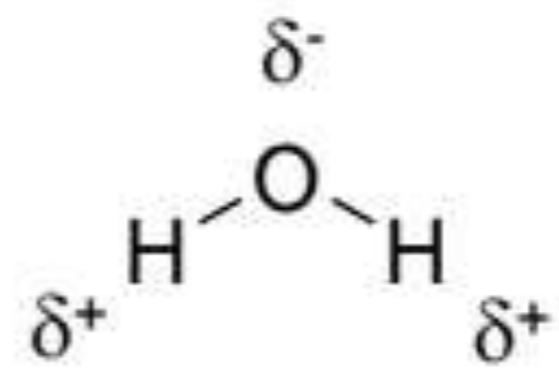
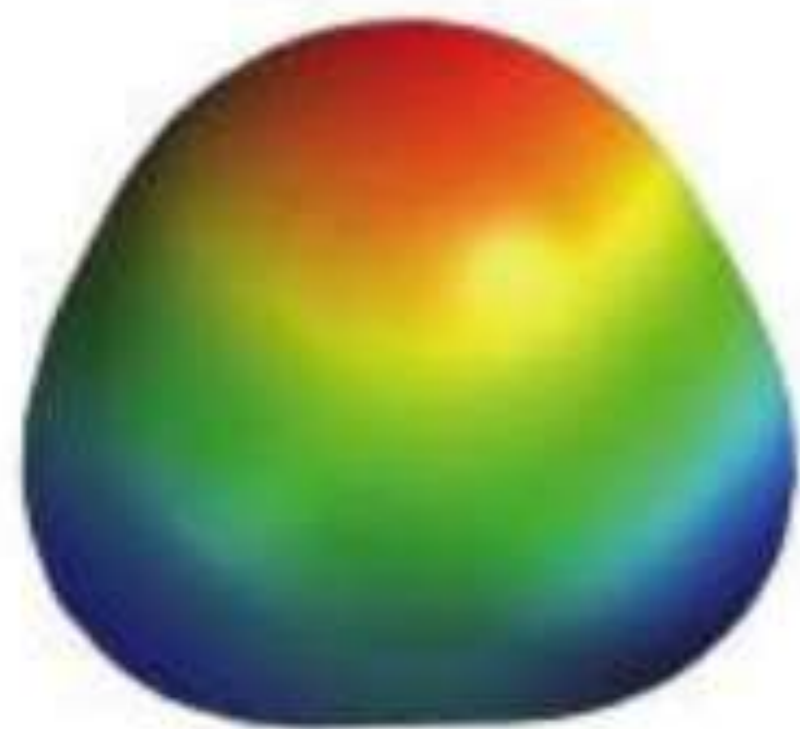
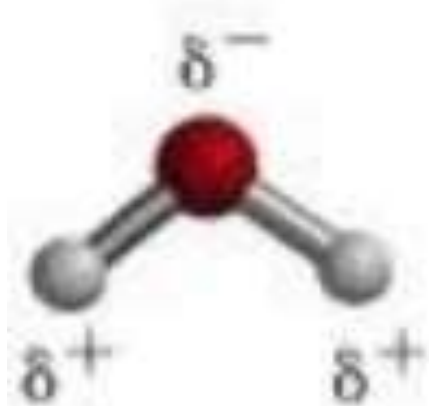
لأنه N,O,F تتكون السالبة تبعثهم عالية

These are the strongest of the IMFs and range from 5 – 25 kJ/mol

Hydrogen Bonding

Occur primarily between OH, NH and FH. The more EN the atom the stronger the interaction. (The atom H is attached to usually has a lone pair of e⁻)

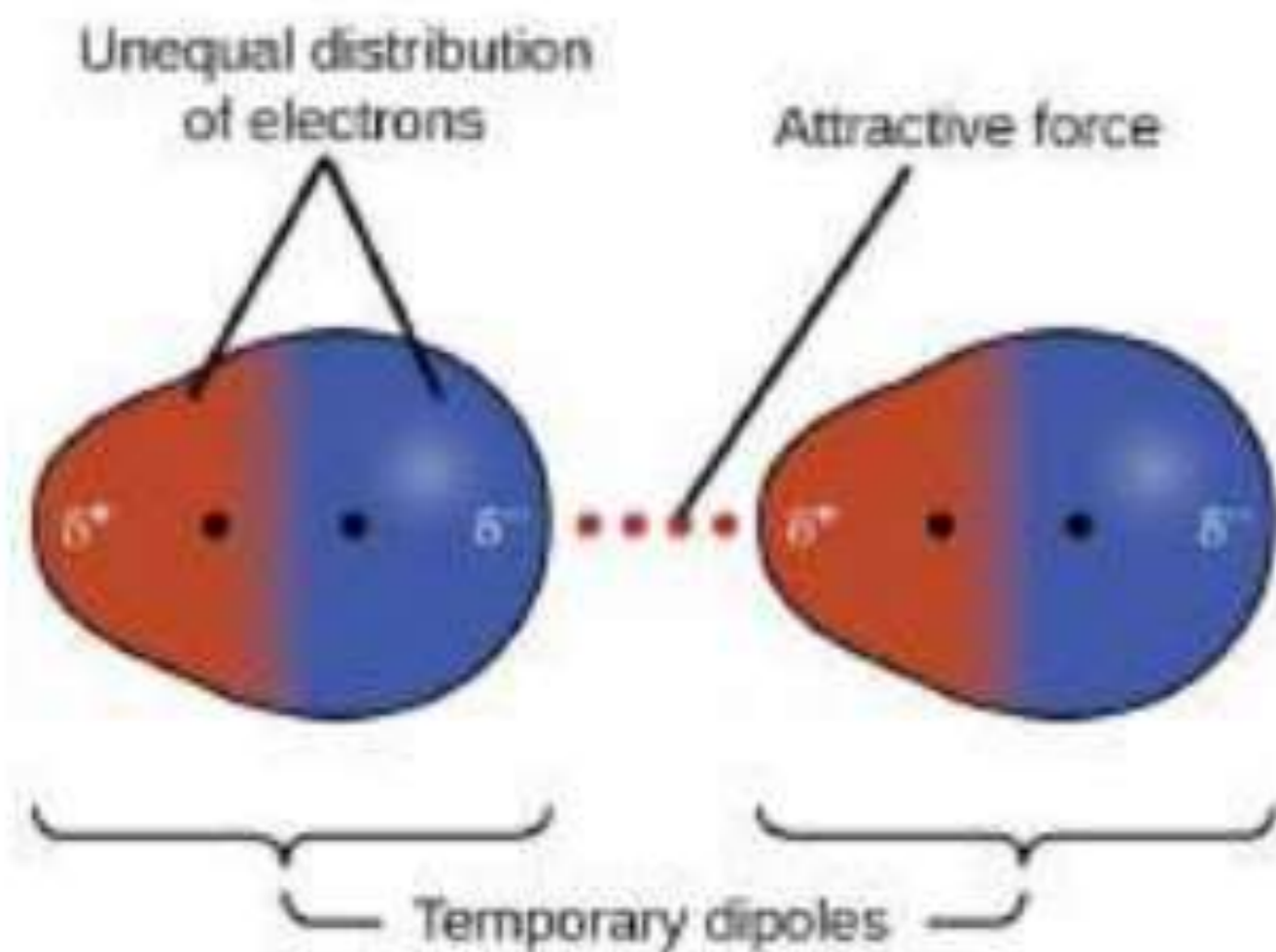
Geometry: $X-H \cdots :X-$



nonpolar ← تكون الجزيئات
Weak ← تكون

Van der Waals or (London) **dispersion** forces arise from the movement of electrons within a molecule. This natural motion can produce an uneven distribution of the electrons (polarization of the distribution) resulting in a **temporary dipole moment** in the molecule. This will induce the movement of electrons in adjacent molecules producing a dipole moment in them. These "induced" dipole moments are very brief as they disappear when the electrons move to new locations within the molecule, so they forces are very brief and weak, only 2-5 kJ/mol.

ليس فيه
إزاحة للتي مجموعة أكثر
من المجموعة الأخرى
لأنه نقل
فزيح
لعمل مثل
جانب
لجيت انه
ال
opposite
charges
تكون جنب بعض

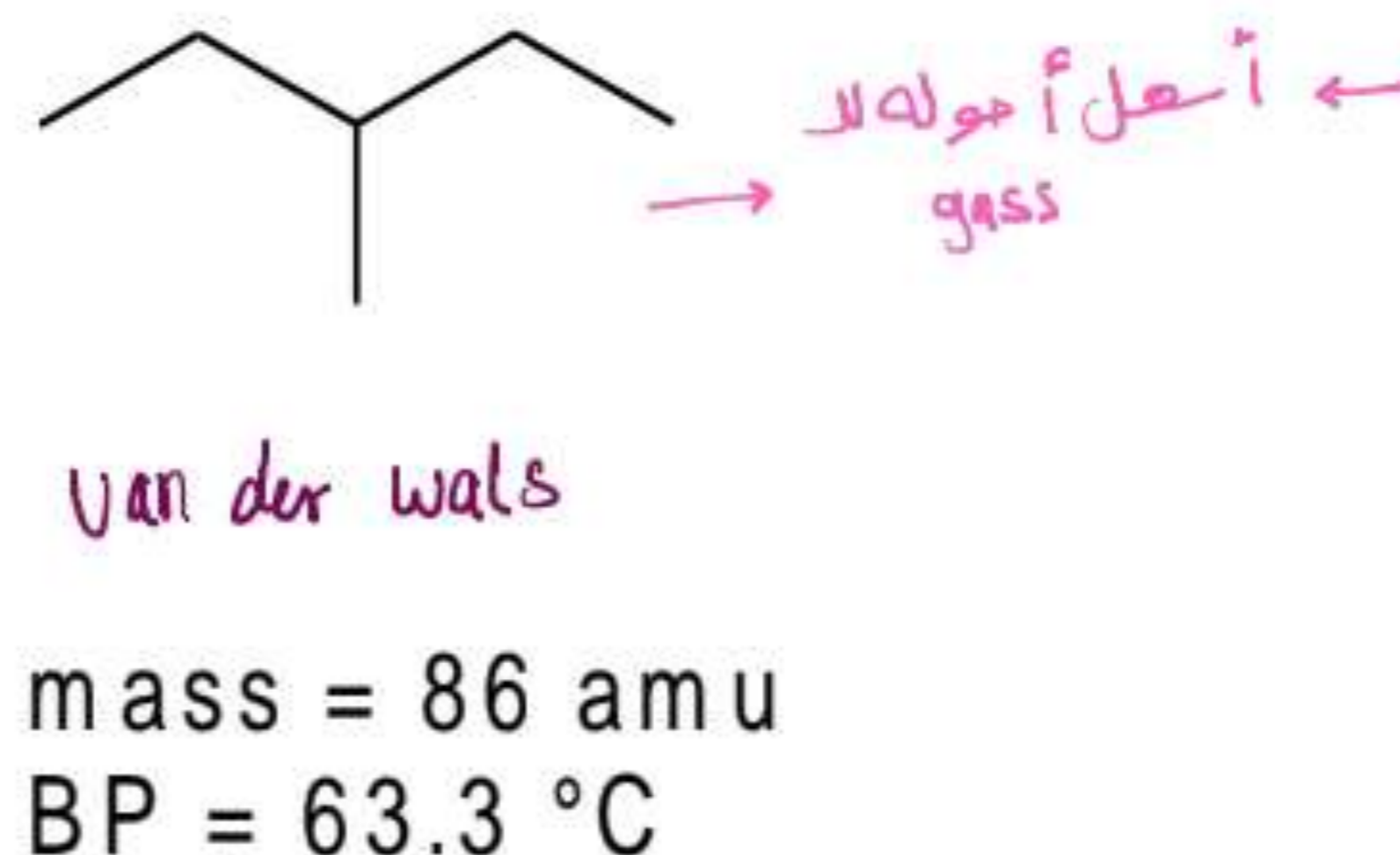
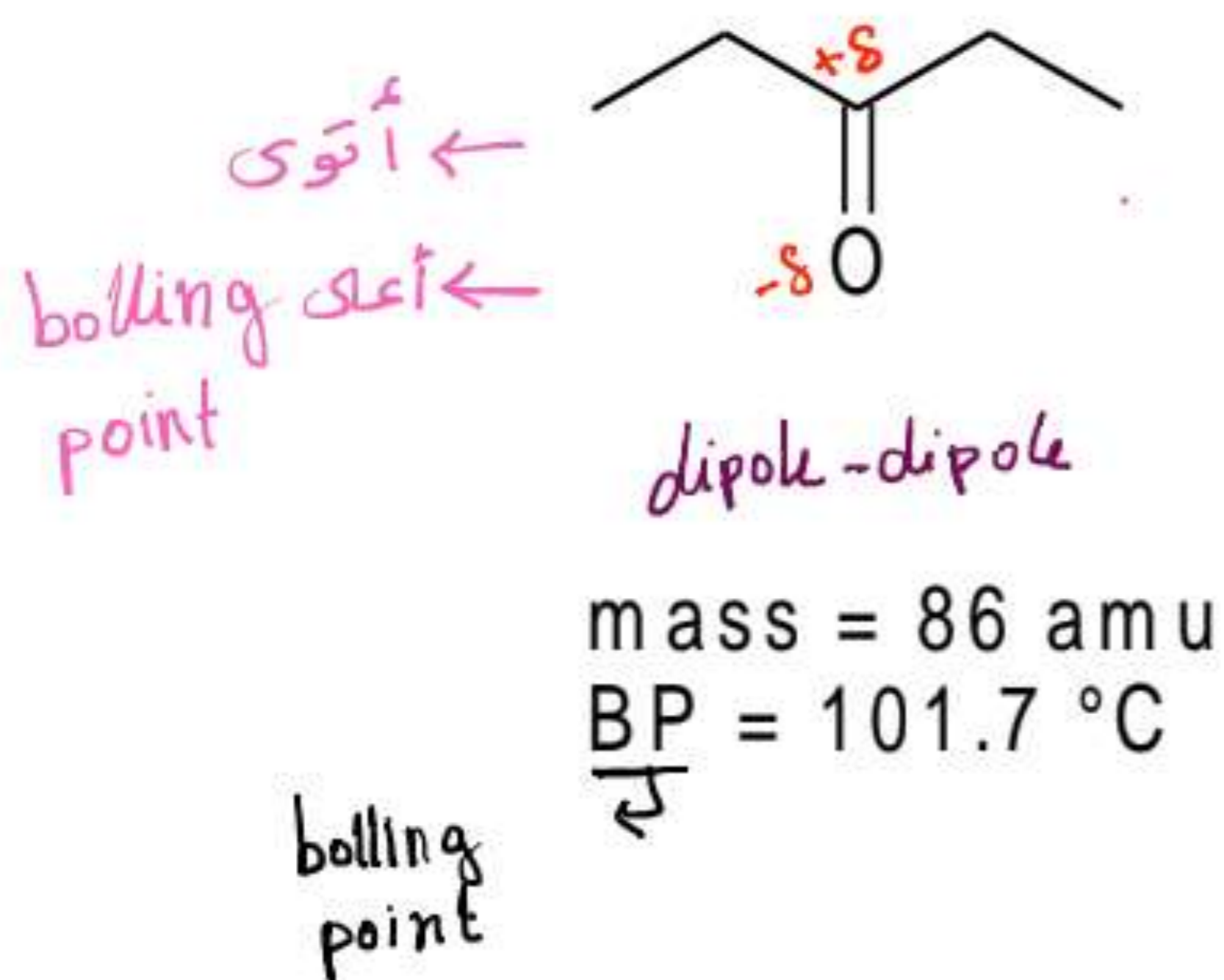


Very Weak attraction

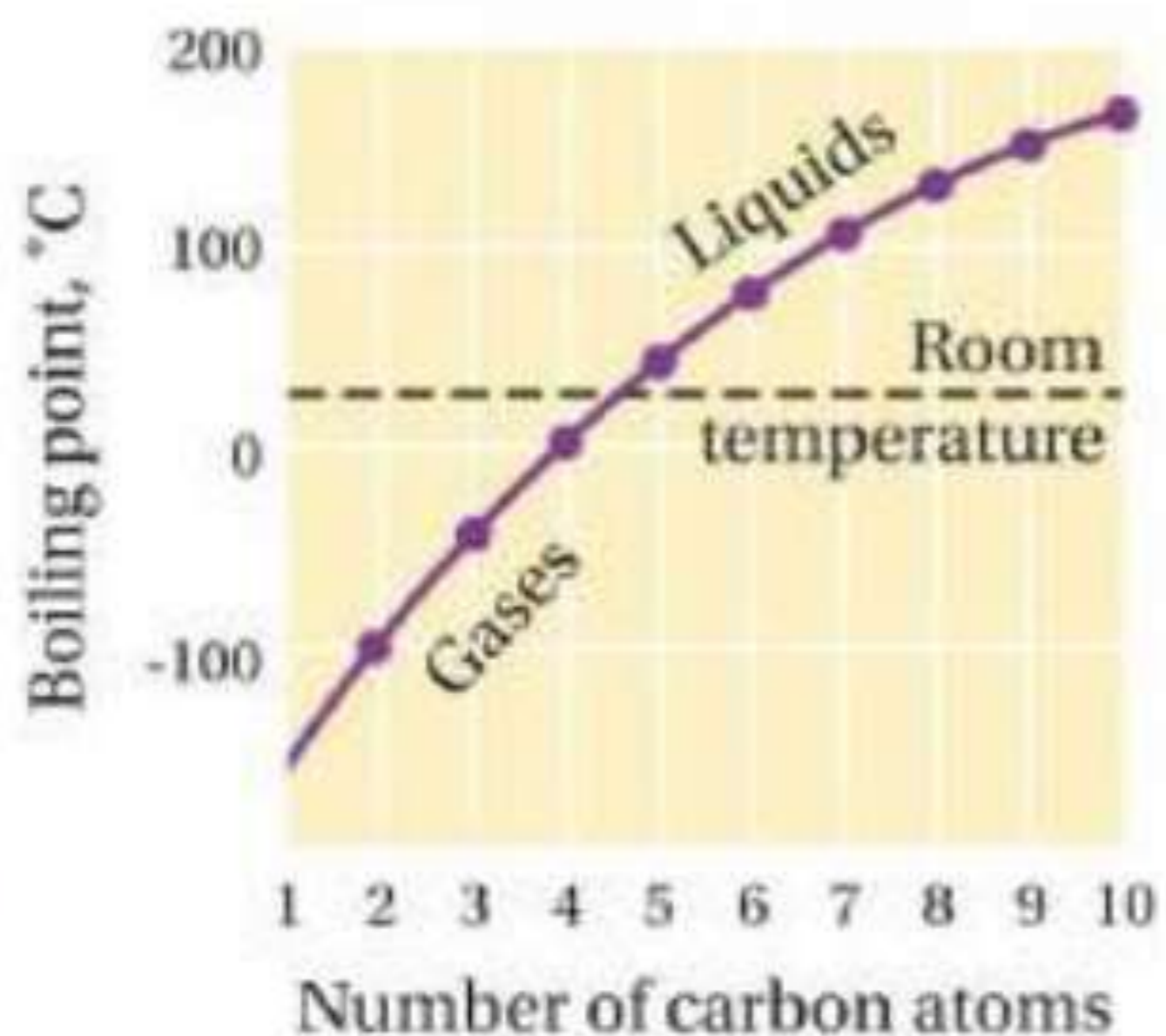
London dispersion, < dipole-dipole, < Hydrogen bonding

Effects on Physical Properties (cont'd)

Dipole forces: much stronger IMFs so the BP is higher when dipole-dipole interactions are present, i.e.



Alkanes: no H-bonding or dipole moment (C & H have nearly the same EN ∴ not polar).



Name	Formula	Boiling point, °C
pentane	$\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_3$	36
2-methylbutane (isopentane)	$\begin{array}{c} \text{CH}_3\text{CHCH}_2\text{CH}_3 \\ \\ \text{CH}_3 \end{array}$	28
2,2-dimethylpropane (neopentane)	$\begin{array}{c} \text{CH}_3 \\ \\ \text{CH}_3 - \text{C} - \text{CH}_3 \\ \\ \text{CH}_3 \end{array}$	10

هسه عندي كل مركب الة boiling point مختلفة يس لو انا اجبت ثبتت ال boiling point وبلشت ازيد بعدد e رح الاقي انه ال boiling point صارت تزايد

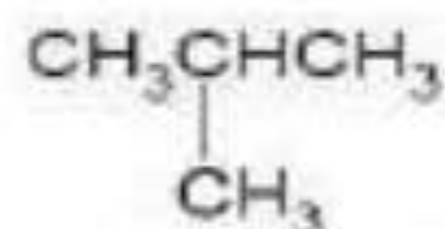
عدد C = Mass = حجم

- Boiling point for alkanes increases with increasing size (mass)
- Boiling point for alkanes decreases with increasing branching

Example:



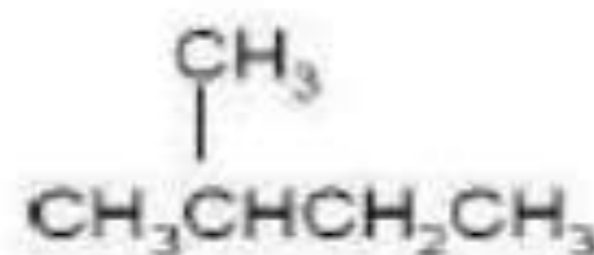
n-butane, 0°C



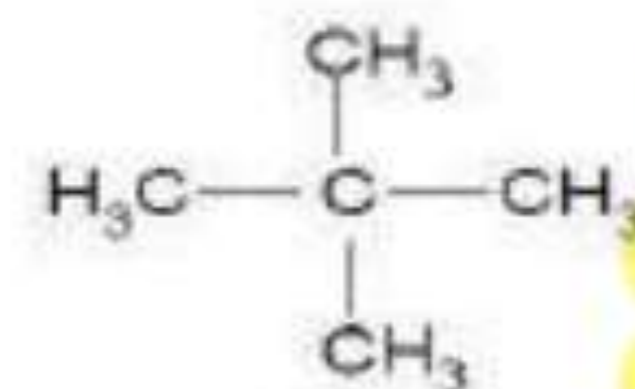
Isobutane, -12°C



n-pentane, 36°C



Isopentane, 28°C



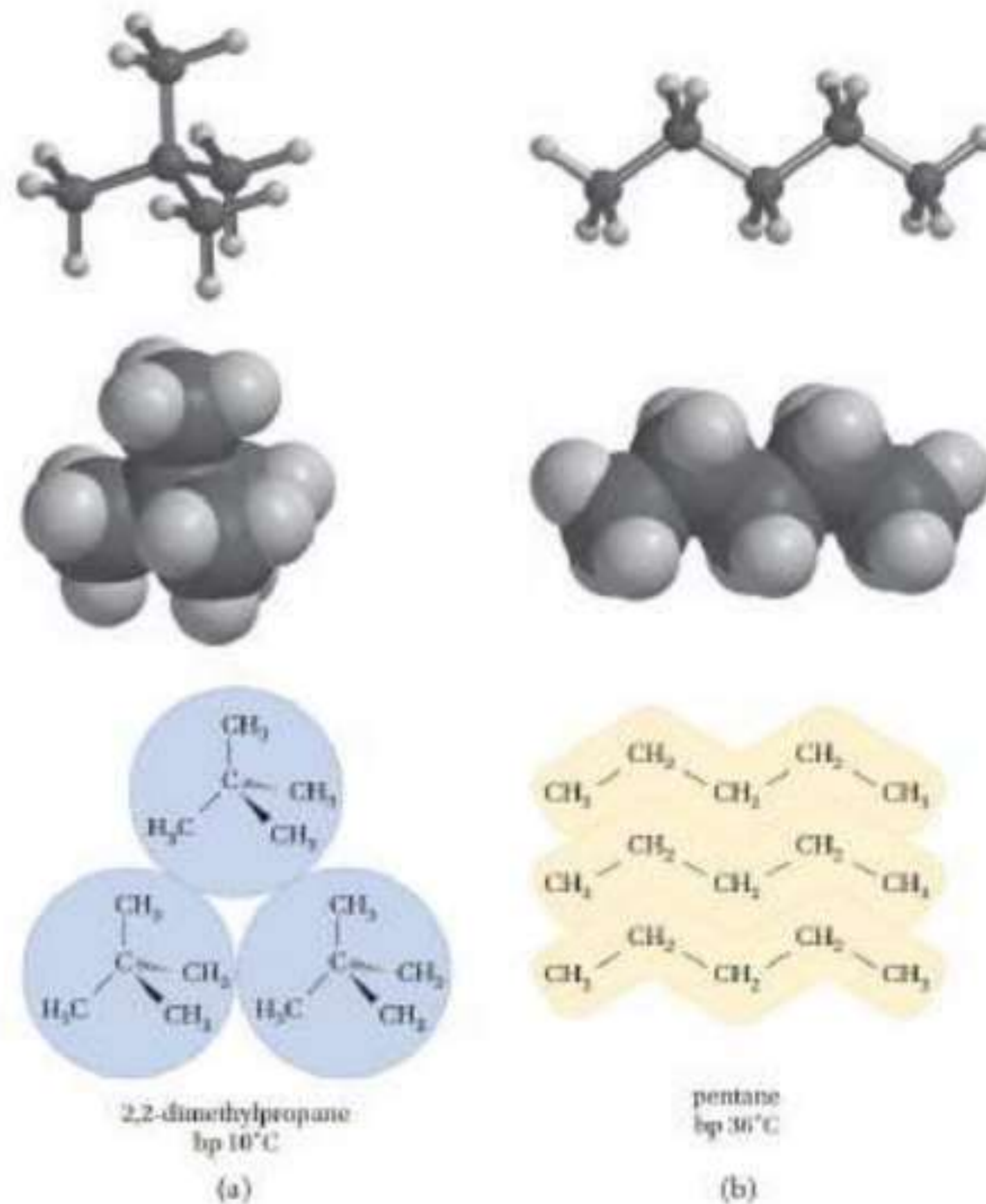
Neopentane, 9.5°C

هسة هون عنان
حل هابي الا سئلة اول
اخي يشوف عدد C كده حتى
مع التفرع اذا اتساوى
بجاء للتفرع.

هدول كلهم فيهم نفس العدد من C,H يس الاختلاف في ال structure تبعهم يعني انا مثبت عدد ال C ومثبت ال intermolecular forces يس غيرت في ال shape فيلاحظ انه كل مازاد التفرع مع تثبت عدد الكربون والهيدروجين بتقل boiling point والسبب انه زيادة التفرع بتقل ال surface area بصير فيها

Structural Effects on IMFs

The strength of the IMFs depend on the amount of contact between the molecules, especially for dispersion forces. Hence the shape of the molecule can affect the **surface area of contact**, long thin molecules have more surface in contact than spherical molecules.

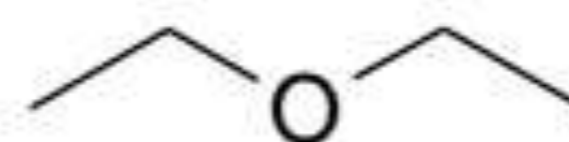


Effects on Physical Properties (cont'd)

Hydrogen bonding:
strongest
intermolecular
forces so BP are
very high for
equivalent MW
compounds, i.e.



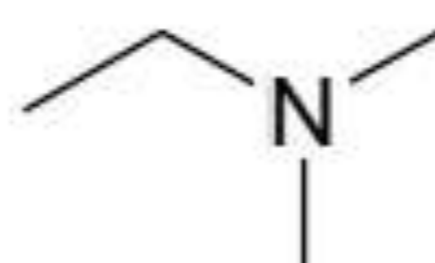
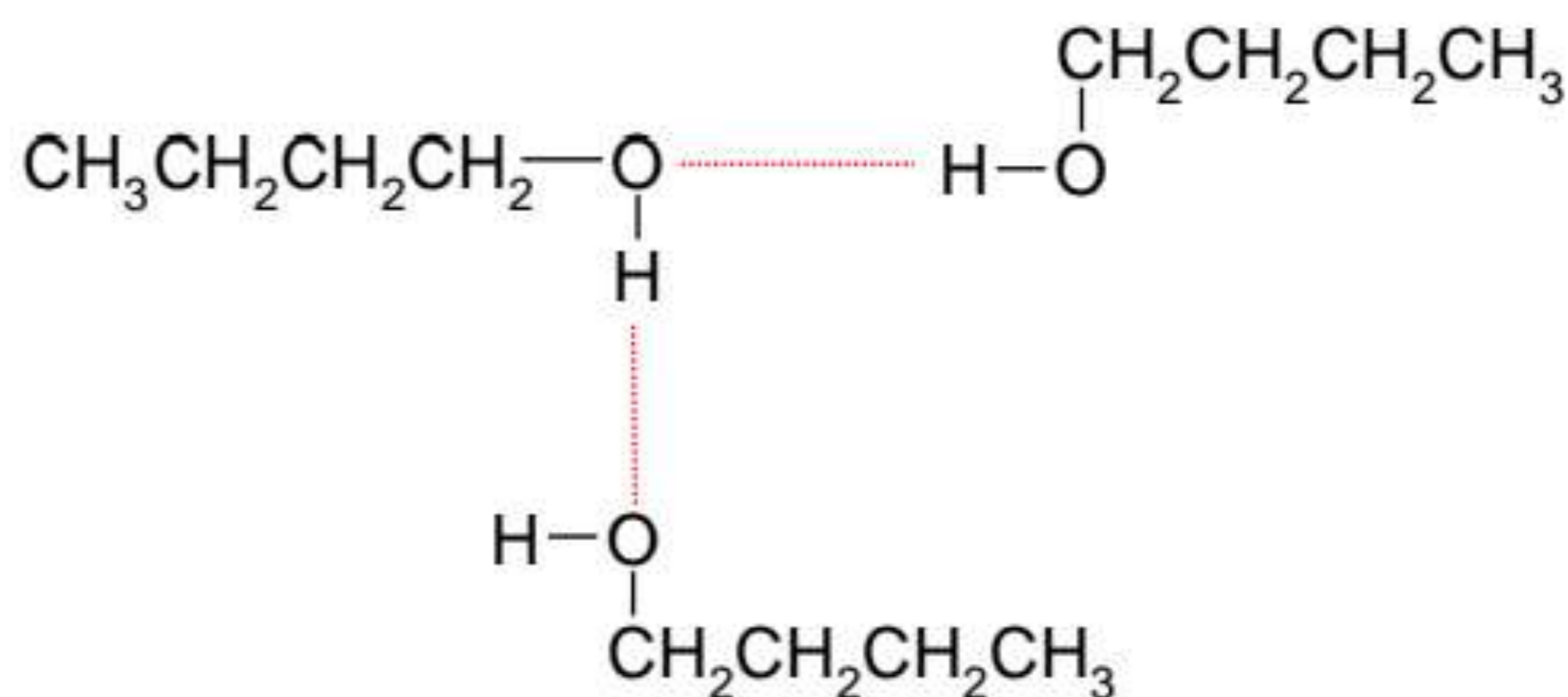
mass = 72 amu
BP = 36.1 °C



mass = 74 amu
BP = 35 °C



mass = 74 amu
BP = 117 °C



mass = 73 amu
BP = 36 °C



mass = 73 amu
BP = 78 °C

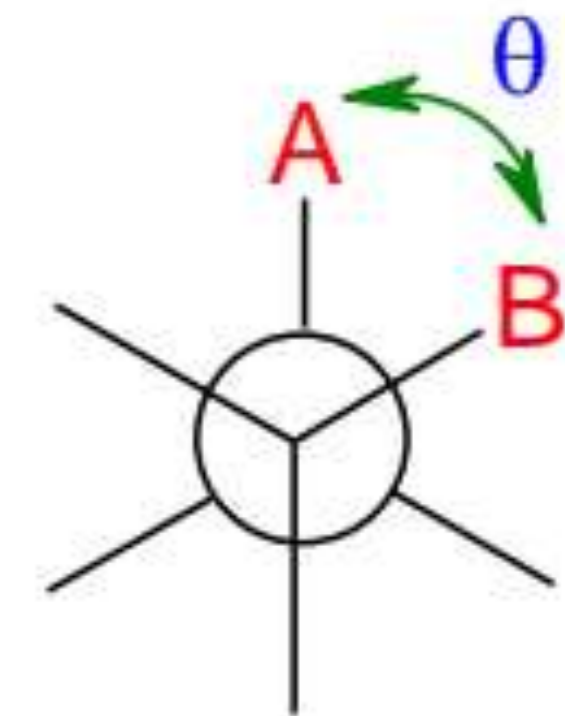
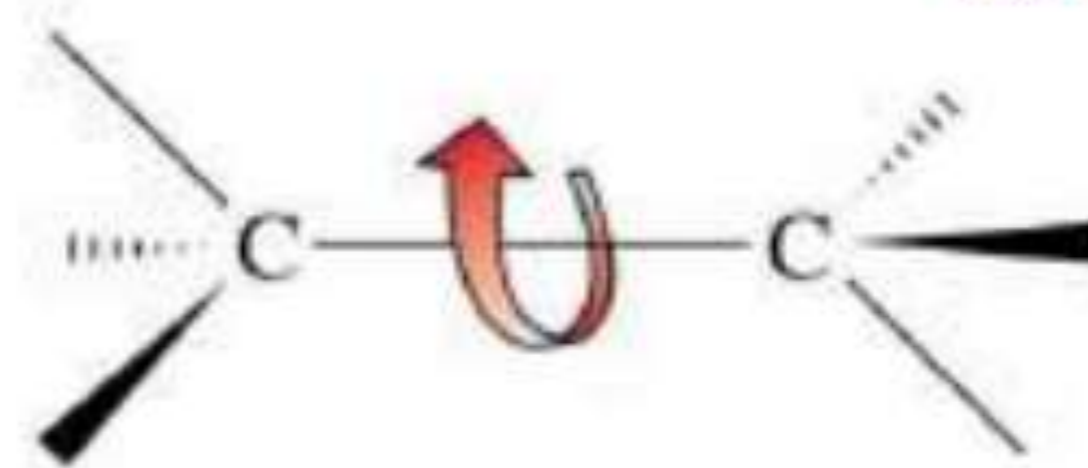
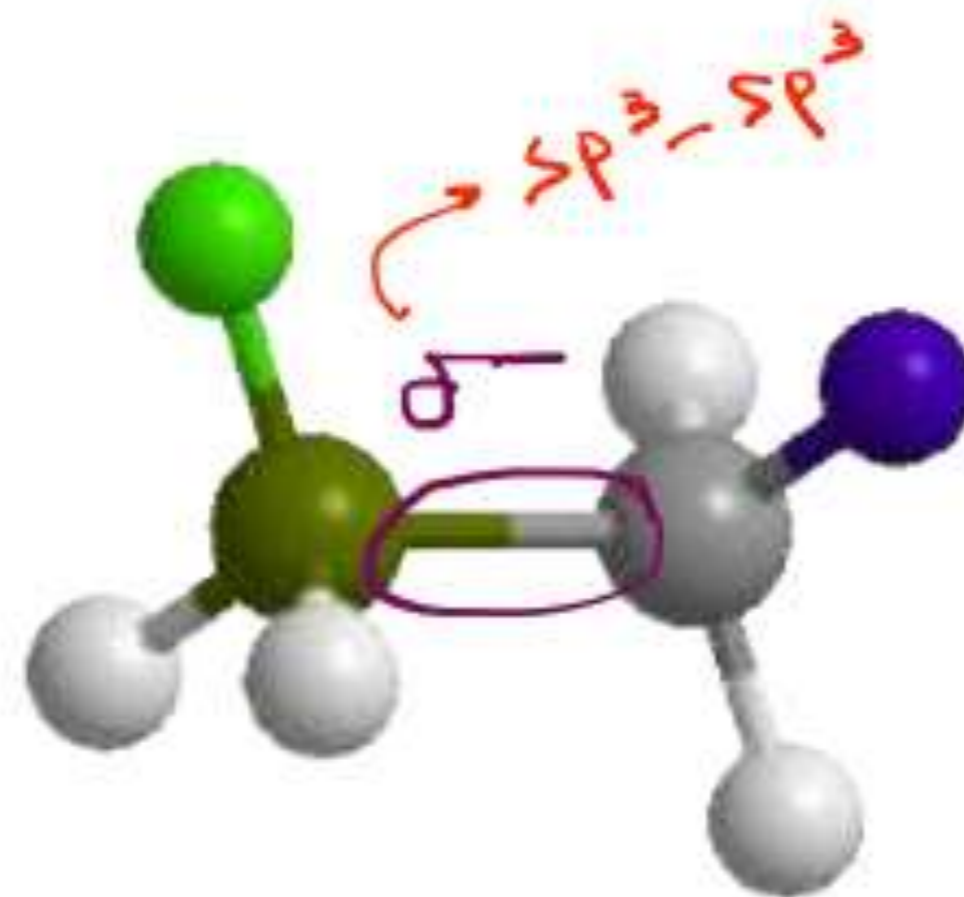
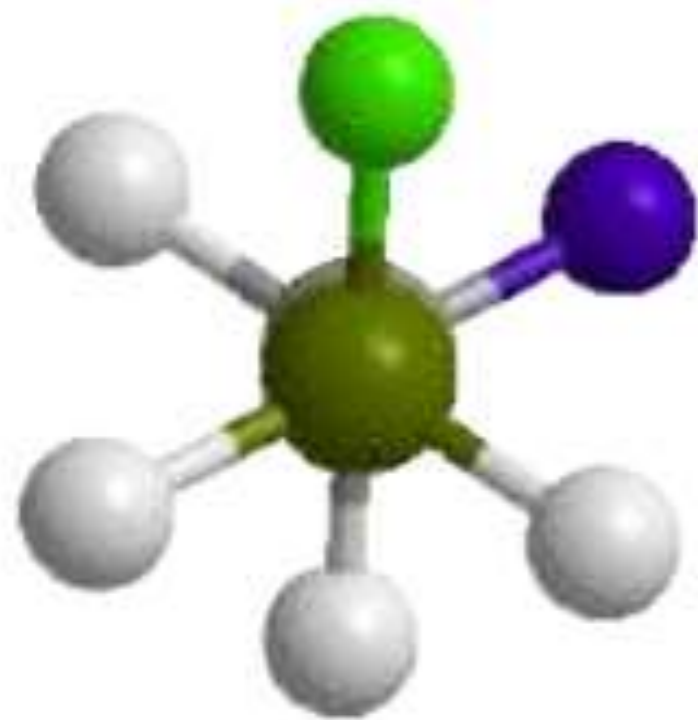
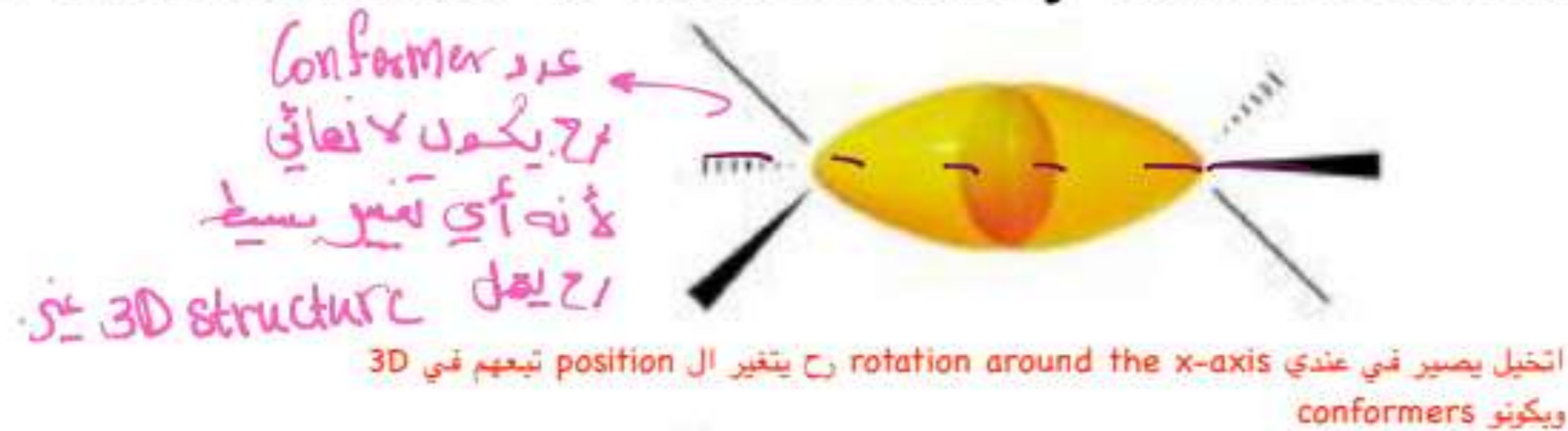
Conformational Isomers

بنتجو عن طريق ال rotation around

Conformational isomers (rotamers or conformers) are compounds with the same constitution (atoms are bonded in the same order) but the atoms are located in different places in space.

This is achieved by rotating about C-C single (s) bonds or the dihedral (or torsion) angle (θ).

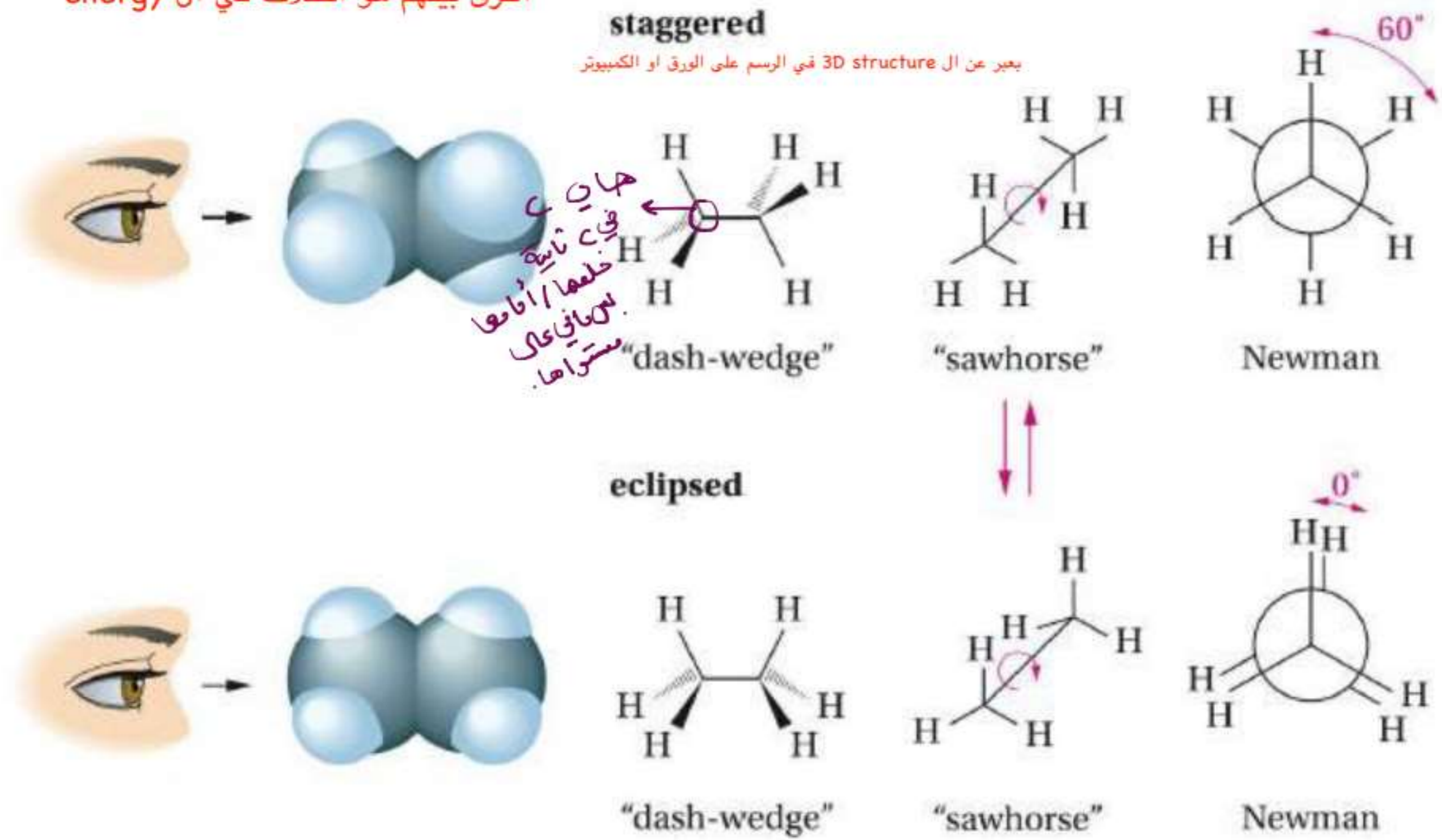
Rotation about a **single bond** occurs easily because the amount of overlap of the sp^3 orbitals on the two carbon atoms is unaffected by rotation about the sigma bond



Conformational Isomers (cont'd)

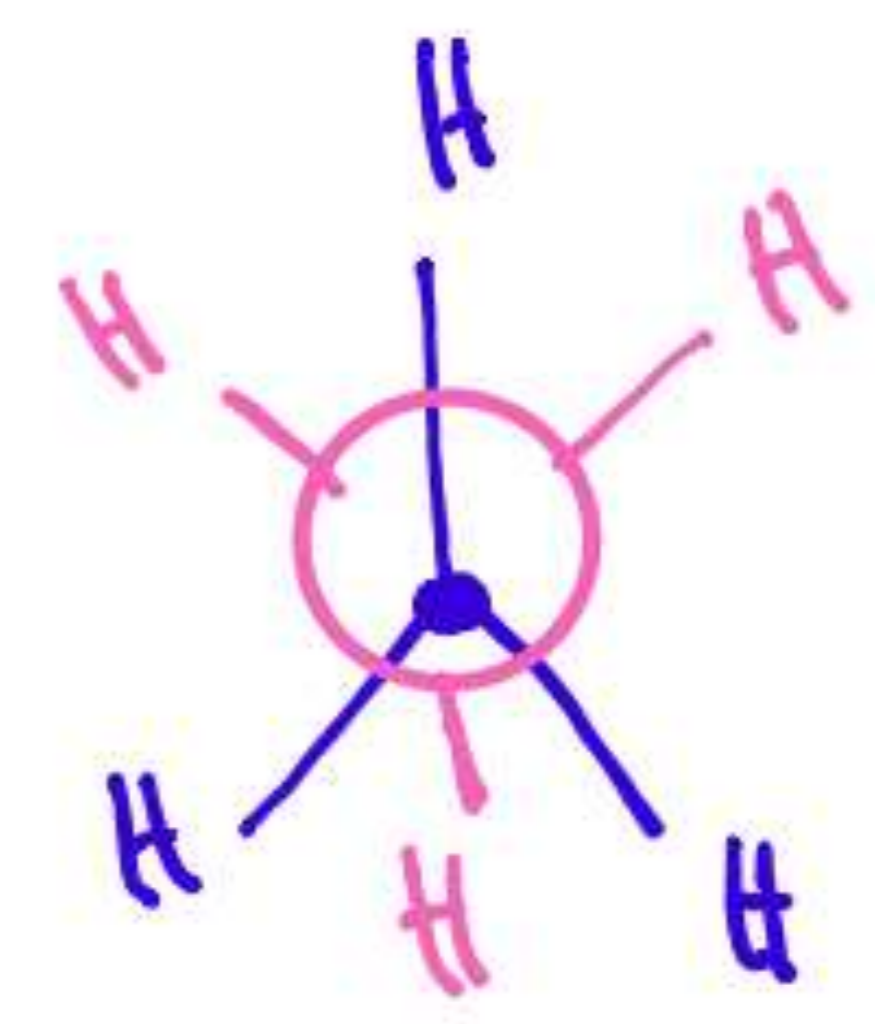
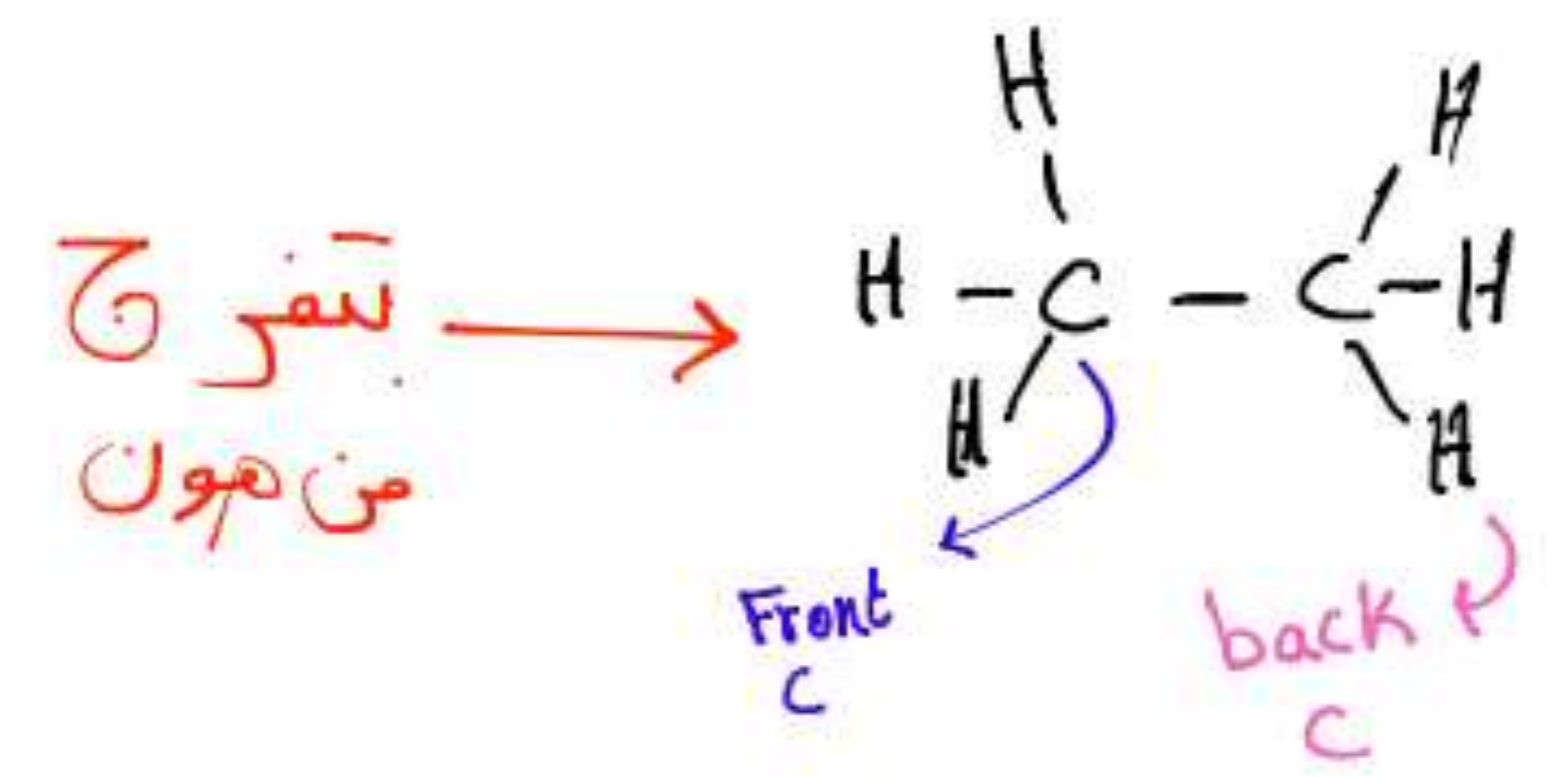
Two extremes exist for ethane: staggered & eclipsed

الفرق بينهم هو اختلاف في ال energy

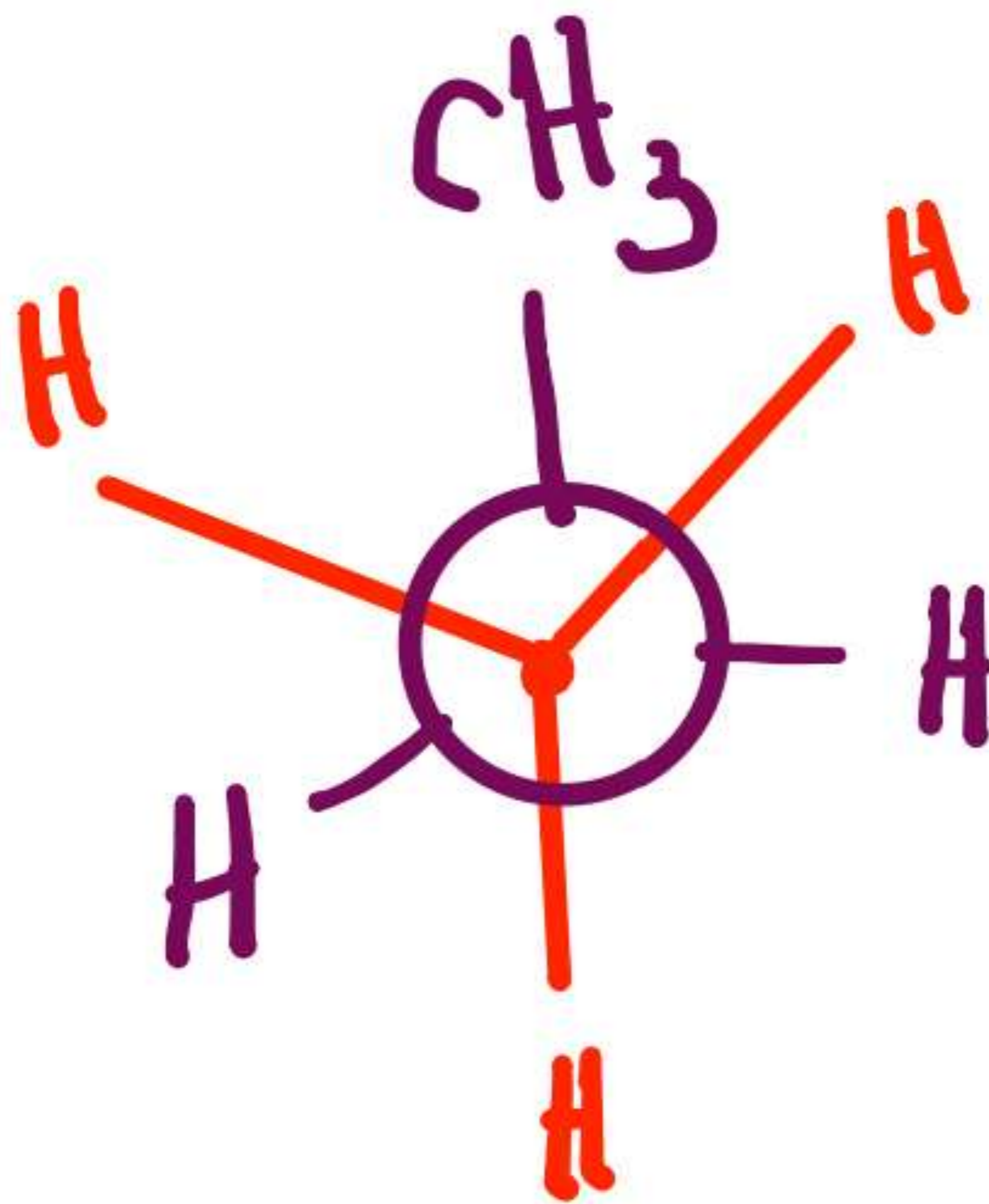
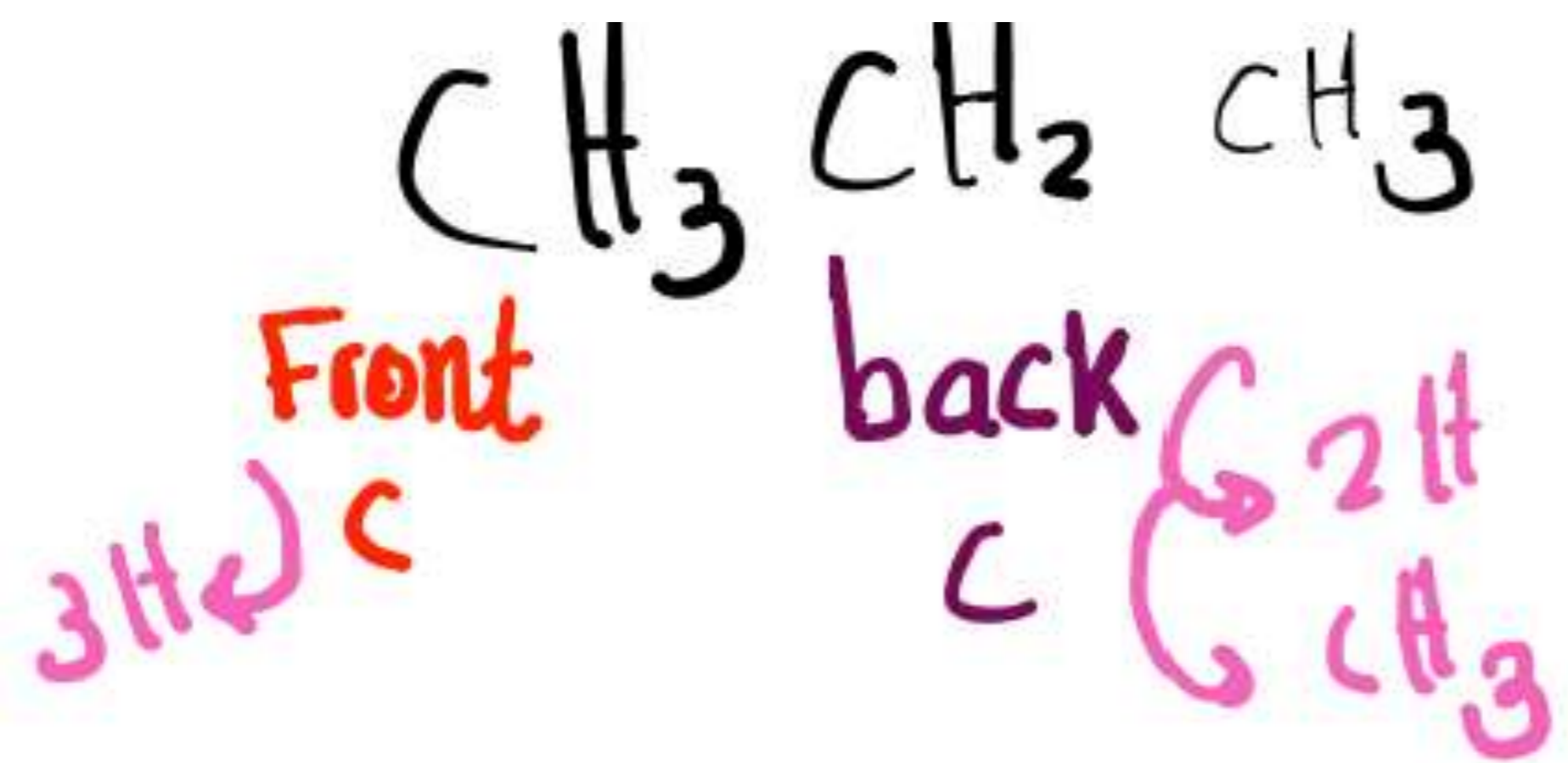


طريقة Newman :-

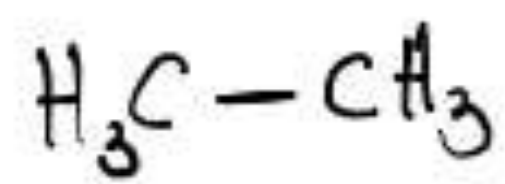
العلاقة بين الطاقة (potential energy) وال stability علاقة عكسية



الزاوية بتكون بين ال 0 و 60



* هسة هون ما لغزت دین خط
 ال CH_3 الی بتكون مرتبطة
 بال C لأنه C تعطيني نفس
 الطاعة لعم بالبو تال
 و طالع . + ما لهم مين C
 تكون ال front
 . back



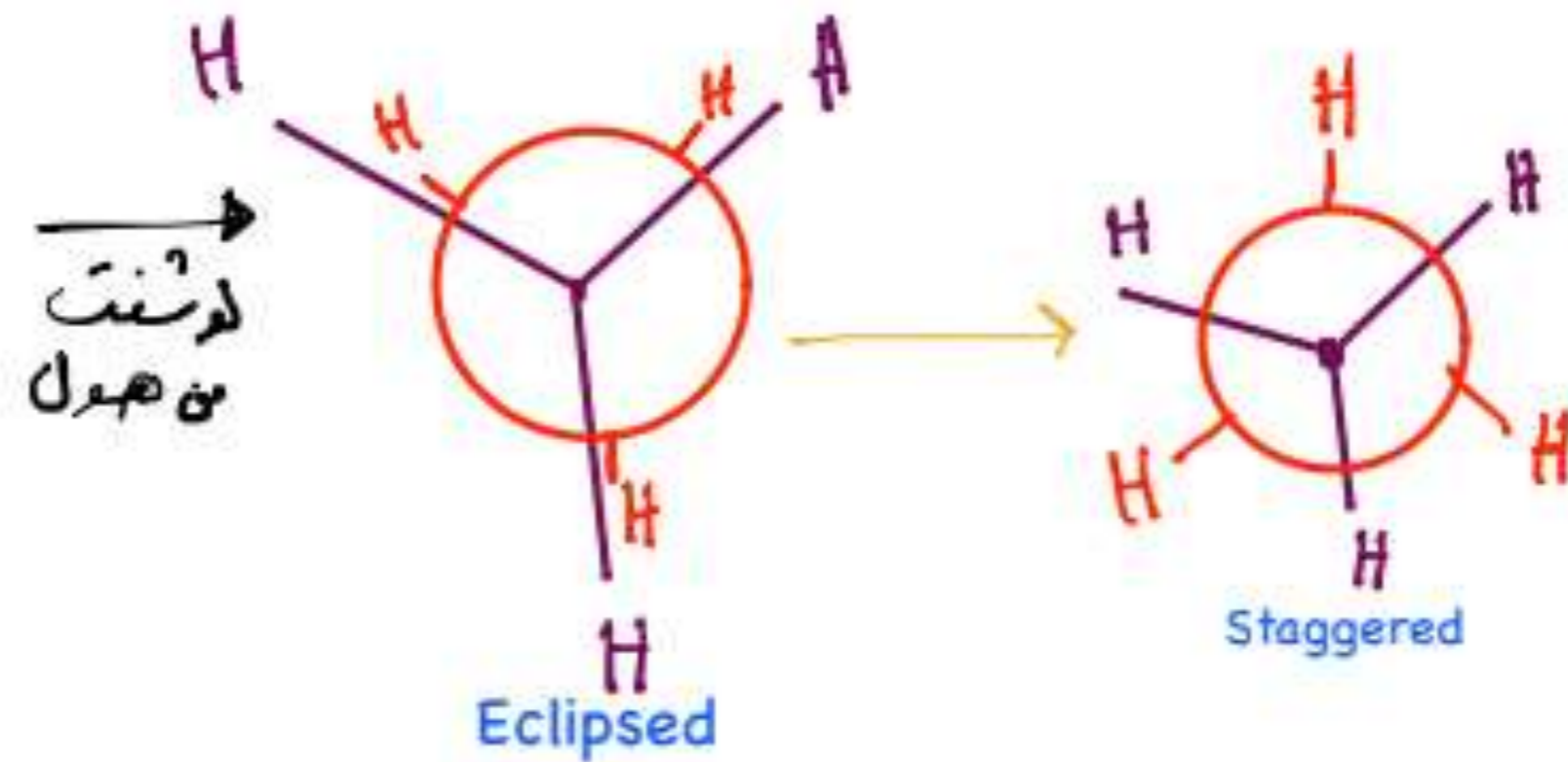
Eclipsed
High energy

Staggered
Low energy
high stability

الزاوية = zero

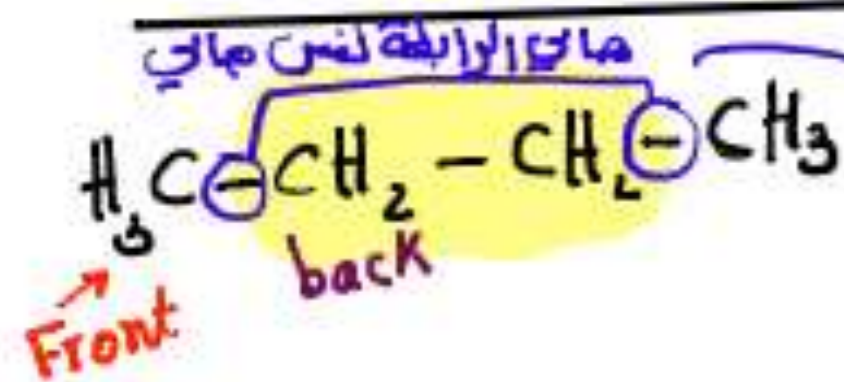
الزاوية = 60°

عشان الف لازم انعكس واحد والثبت واحد
له معنى انه rotation
ليس بين لد C front
back بتقبل
ناتبة.



Eclipsed

Staggered



بس ابي بالنص
تغيرت منهم
شك هبلاء
ح بدلنا ابي
رابطة تختار

وهاض ح يكون أكثر استقراراً
من Eclips

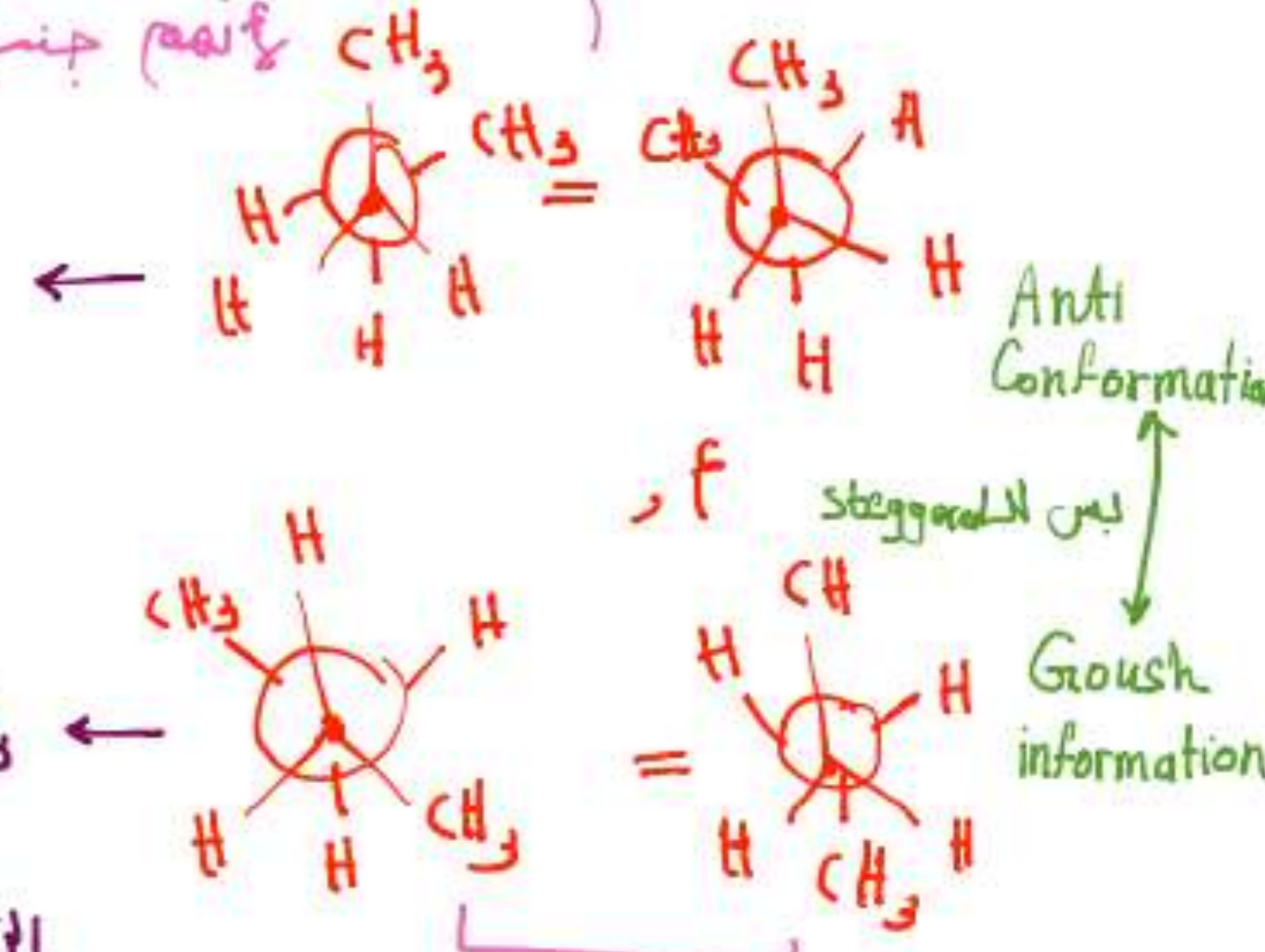
هسة عنال غير
A بين هاض , eclips
انه همدل يكون فيه زاوية = 60°
بينهم

Rotation →

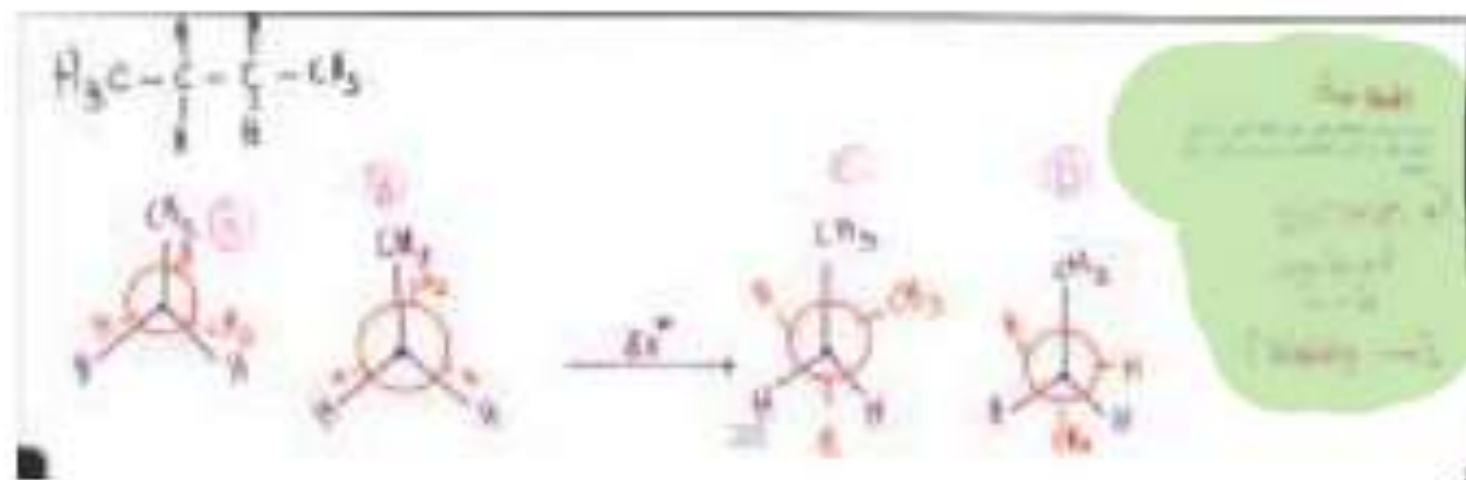
أكثر طاقته وأقل استقراراً
بسبب قوة التنافر بين التفرعات
لأنهم جنب بعض.

CH₃ جنب
بعض
الزاوية بينهم
[60°]

CH₃ قبال
بعض
الزاوية بينهم
[180°]



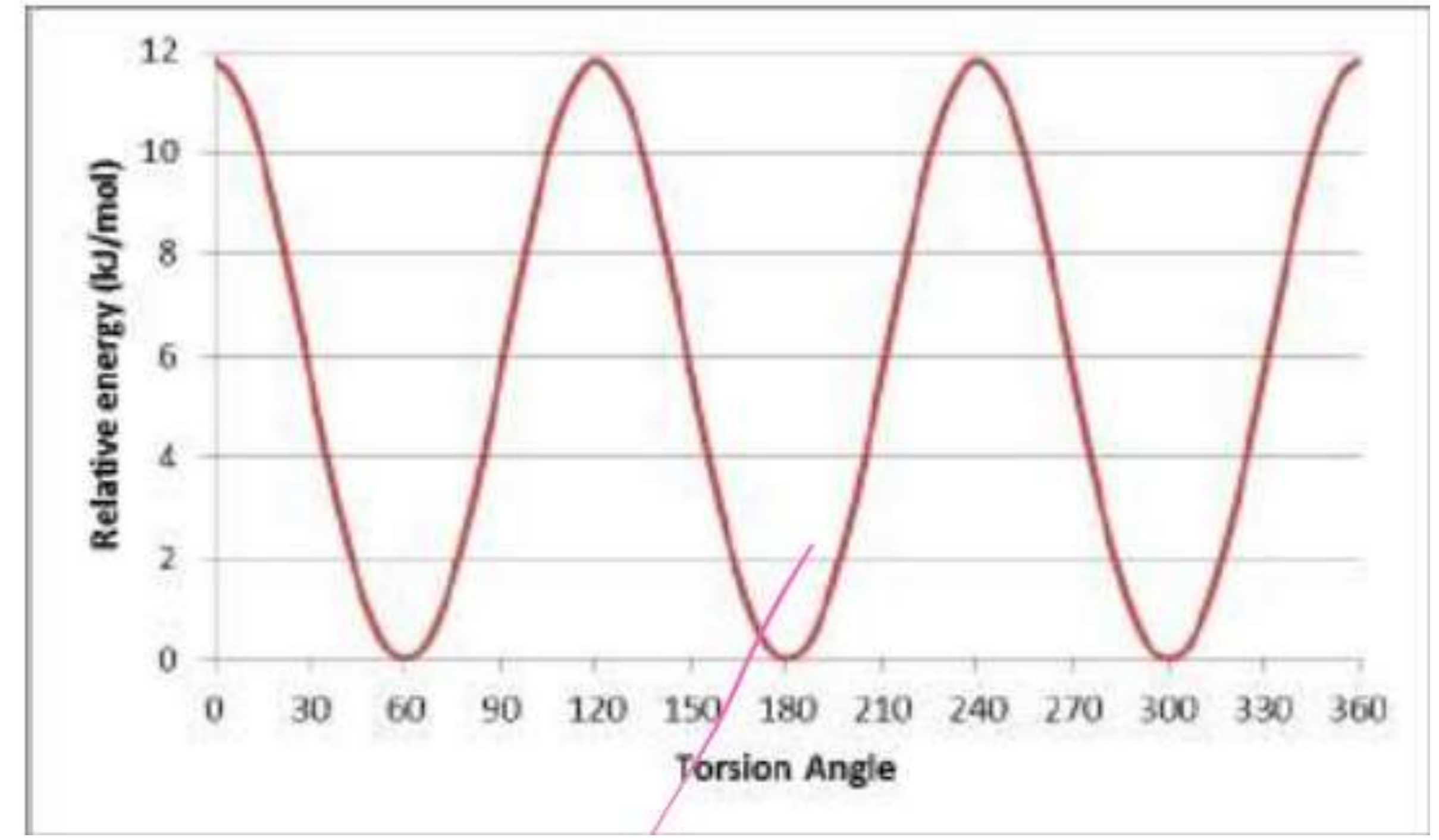
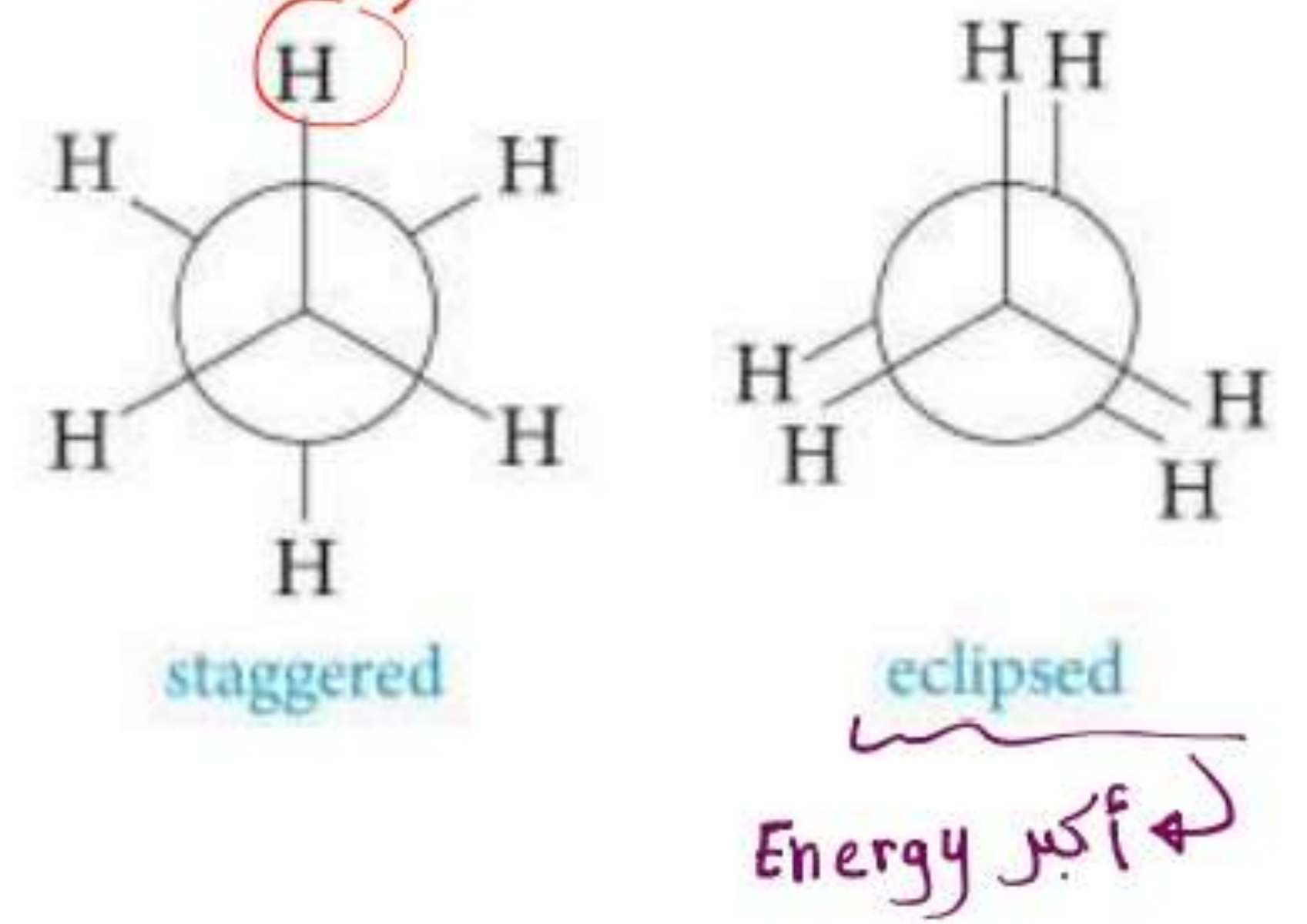
أكثر استقراراً



Conformational Isomers (cont'd)

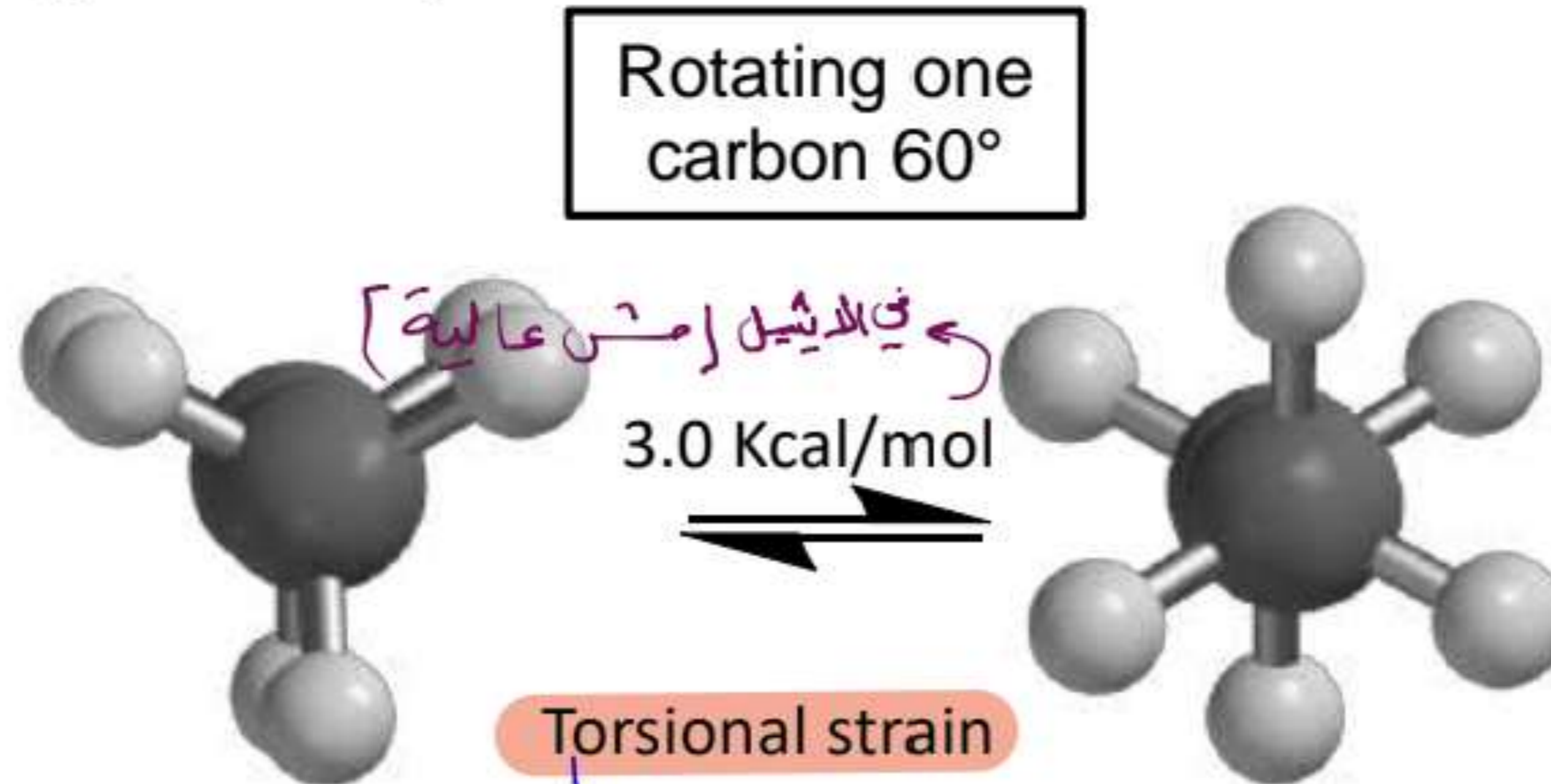
دائريون قبالا شي بيكونوا راحة بين 2 H .

These two extremes represent high and low energy "conformations" of ethane. The "high" E is the eclipsed and low E the staggered.



Conformational Isomers (cont'd)

The difference in energy is caused by “steric” interactions between the H atoms. Steric interactions are repulsions caused when two atoms are too close together in space and their valence shell electrons repel each other.



إذا كان H-H، ارتفاعات حيث يكون ليس يساوي

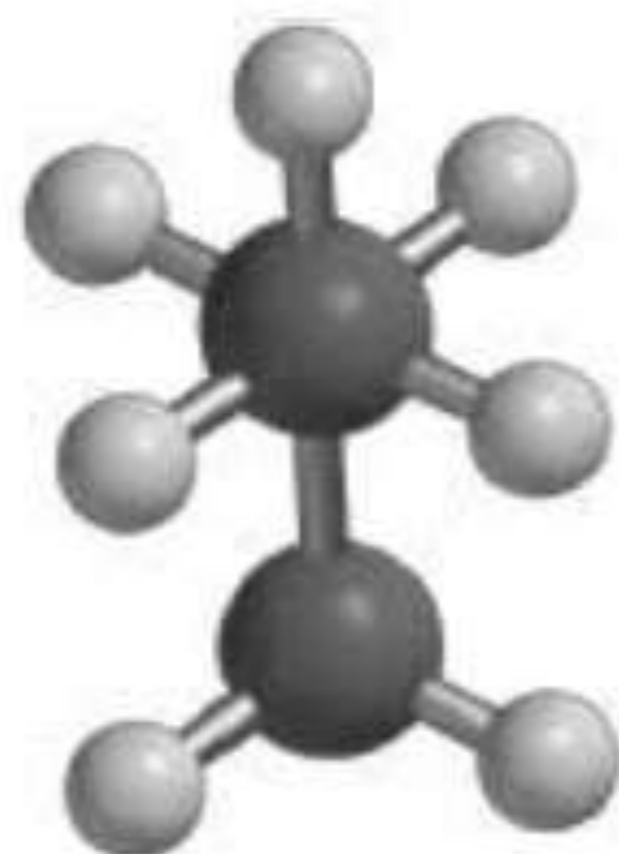
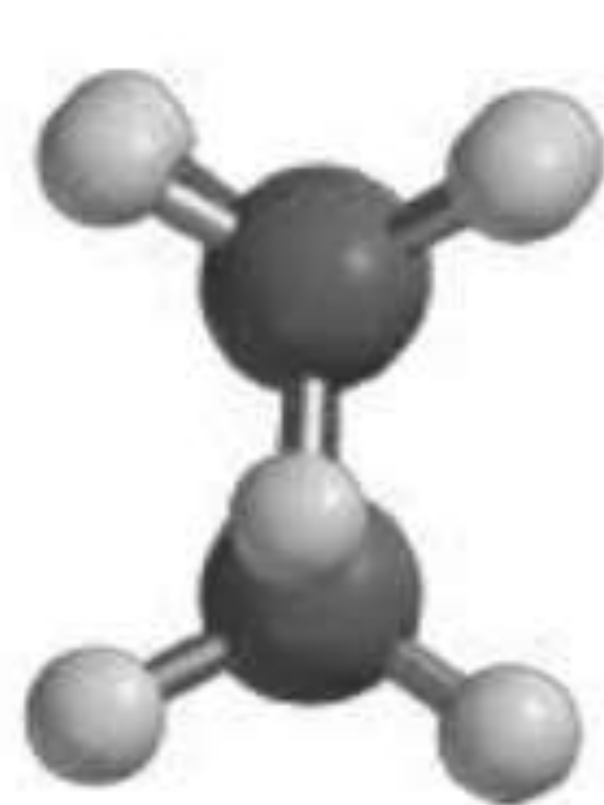
The H – H distance in the eclipsed is 2.36 Å and 2.54 Å in the staggered.

[النماذج]

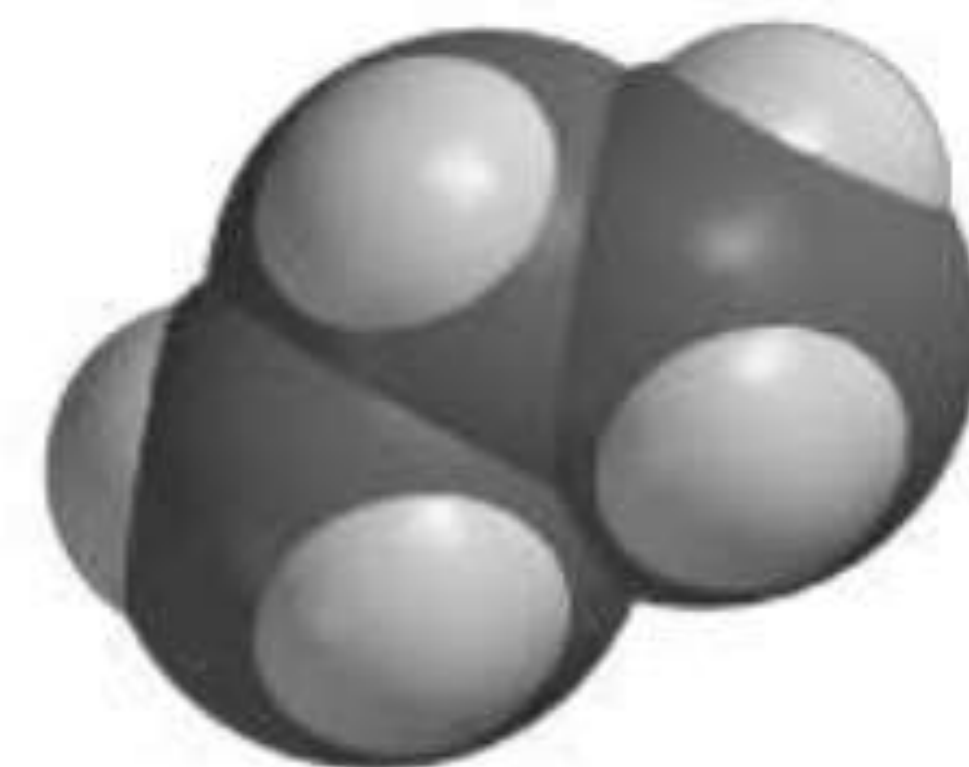
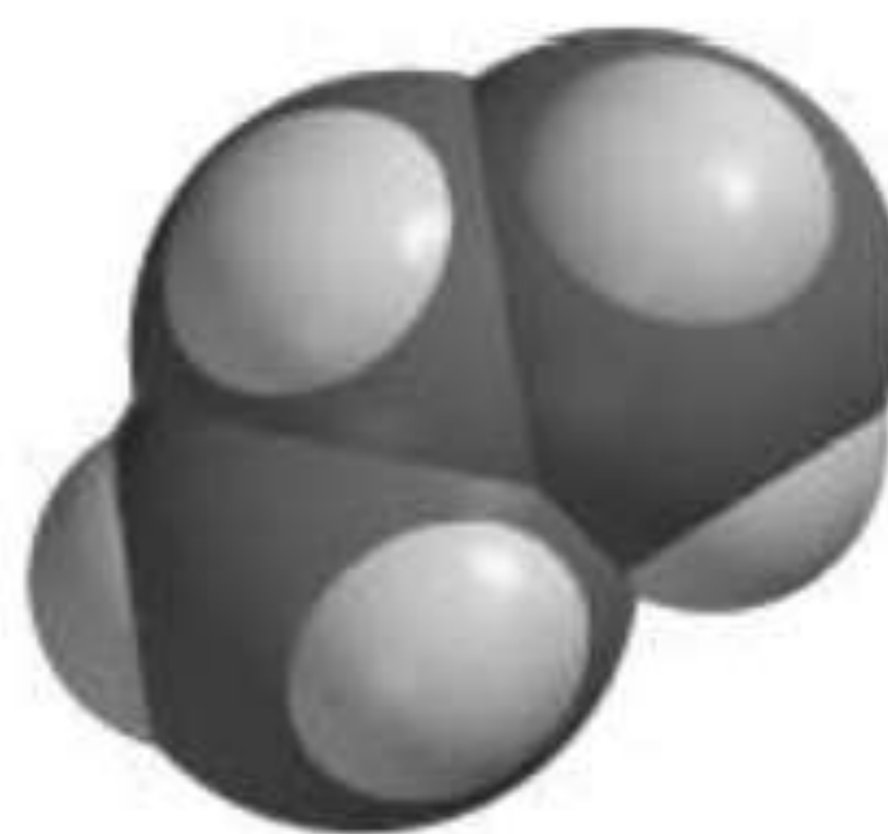
وهي بتكون غالبا عن طريق التصادمات بين ال
molecules بتتفقد و بتكتسب عشان هيك انا بتخيل انه في
اي لحظة عندي eclipsed وفي اي لحظة عندي

Conformational Isomers (cont'd)

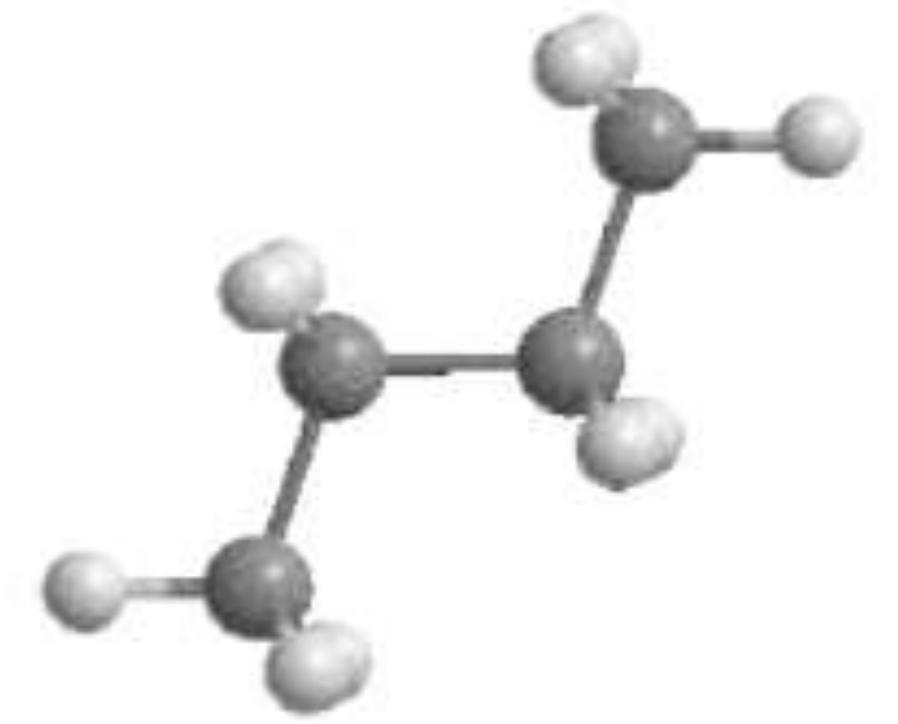
The problem is worse in propane as a methyl group is larger than a H atom. The eclipsed is on the left in both sets of images.



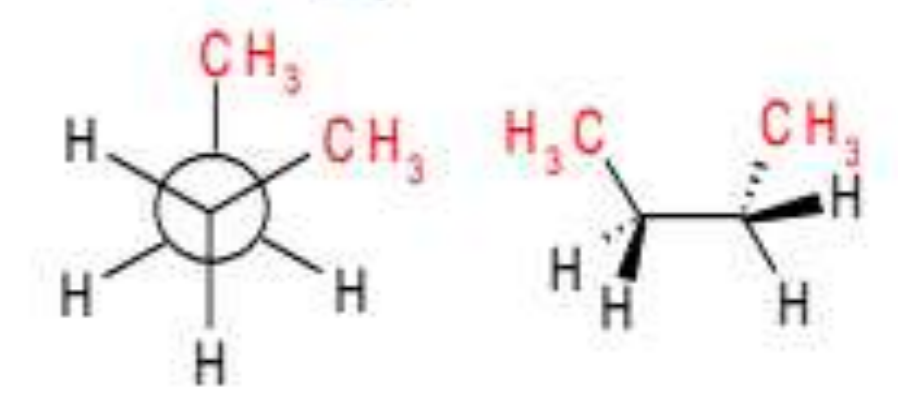
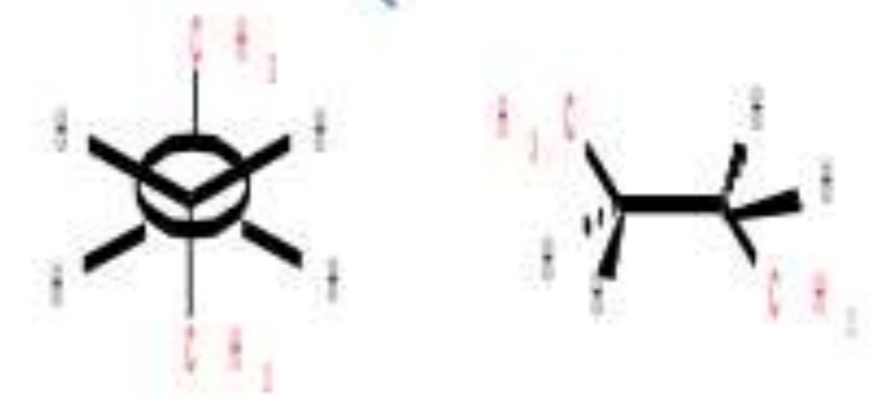
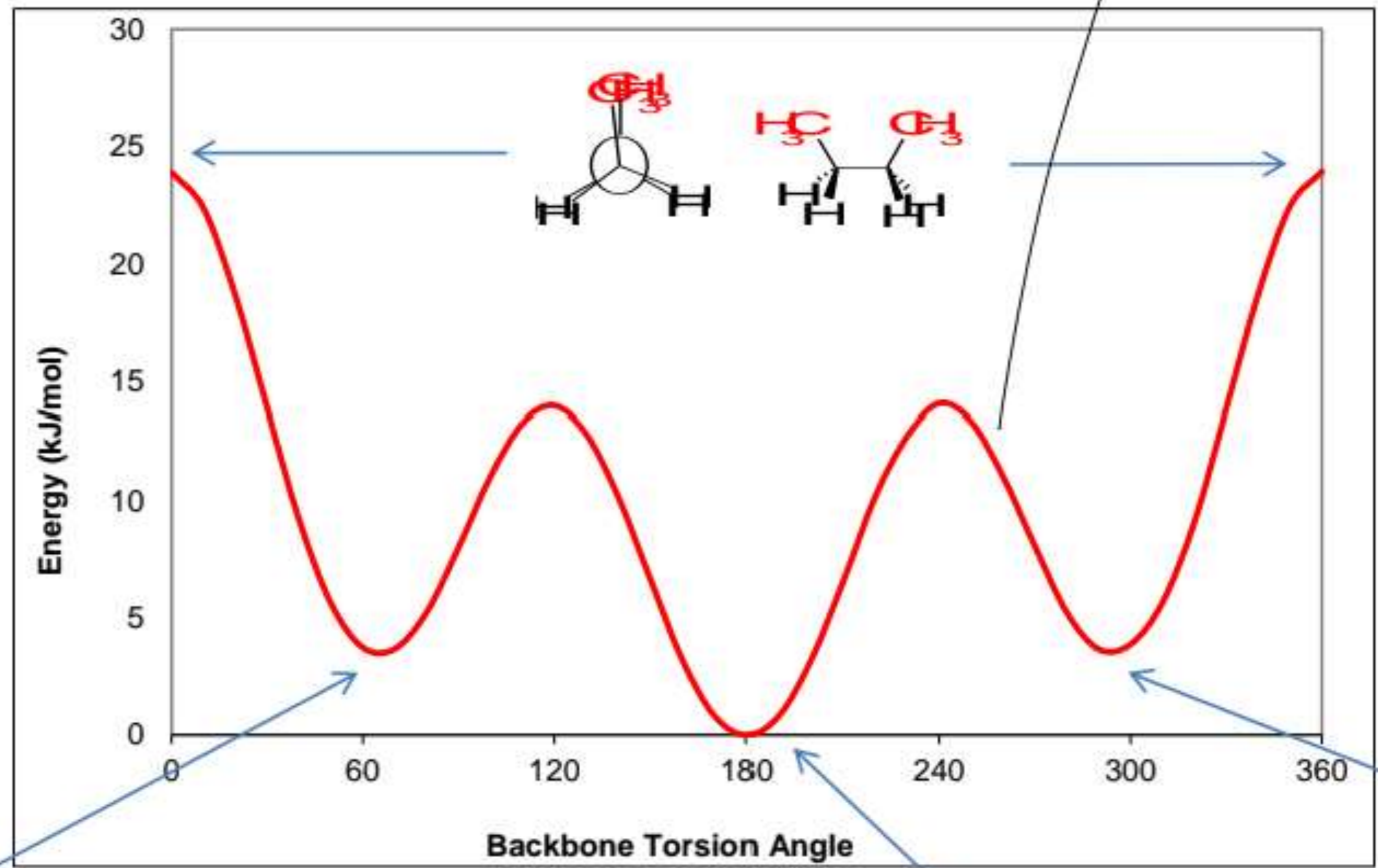
ball & stick



space filling



Steric effects reach their maximum in butane:



2.9 Cycloalkane Nomenclature and Conformation

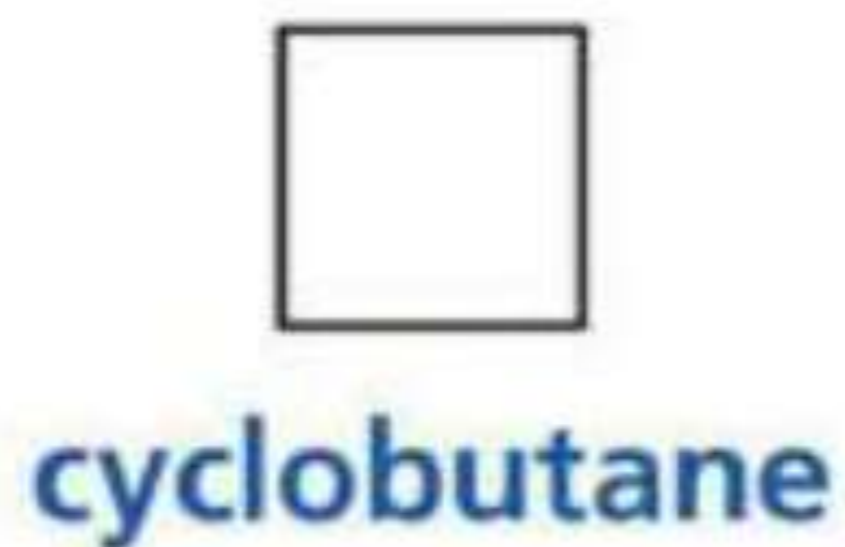
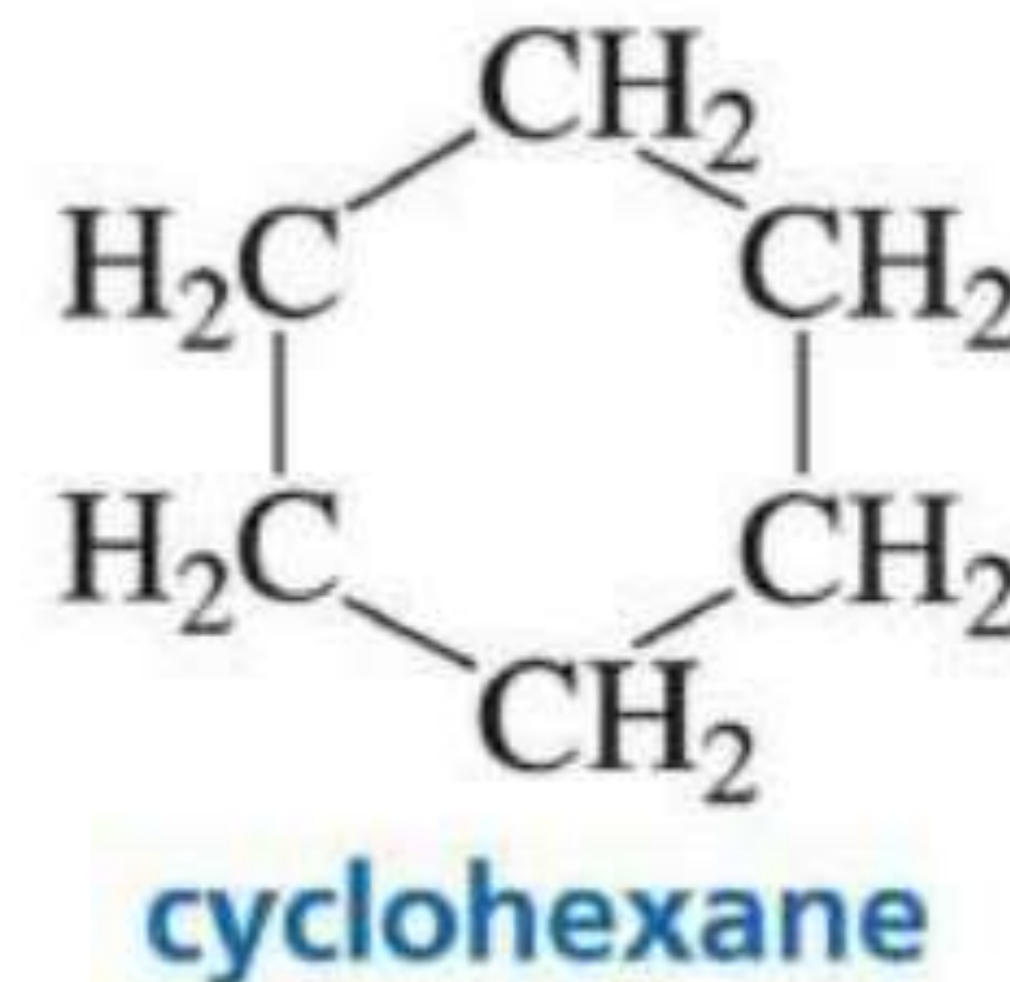
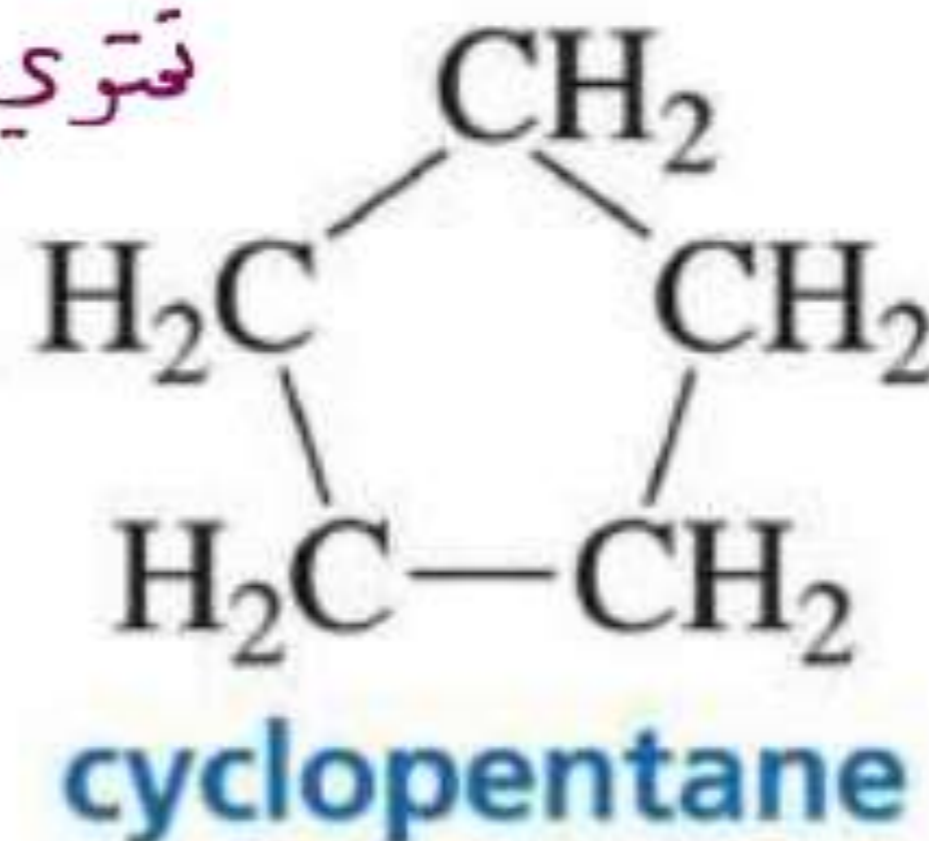
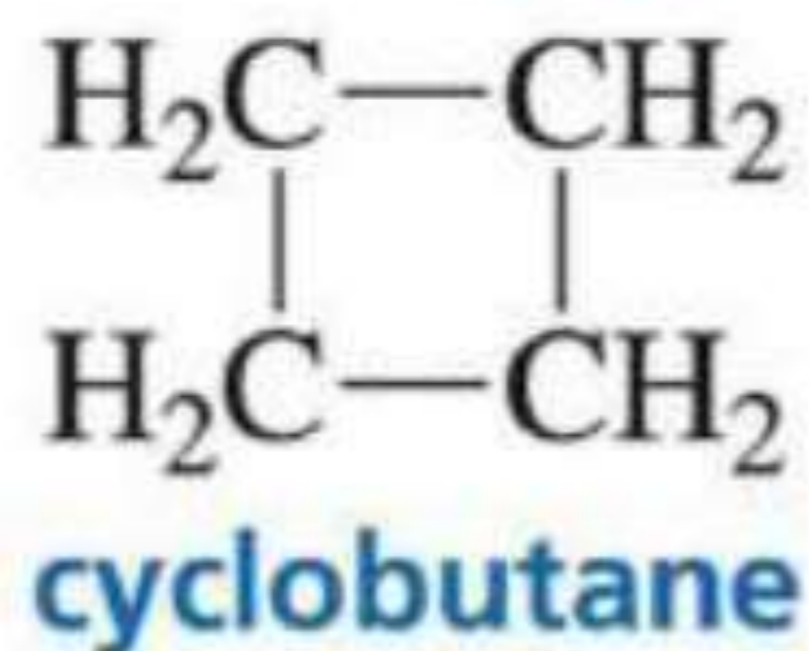
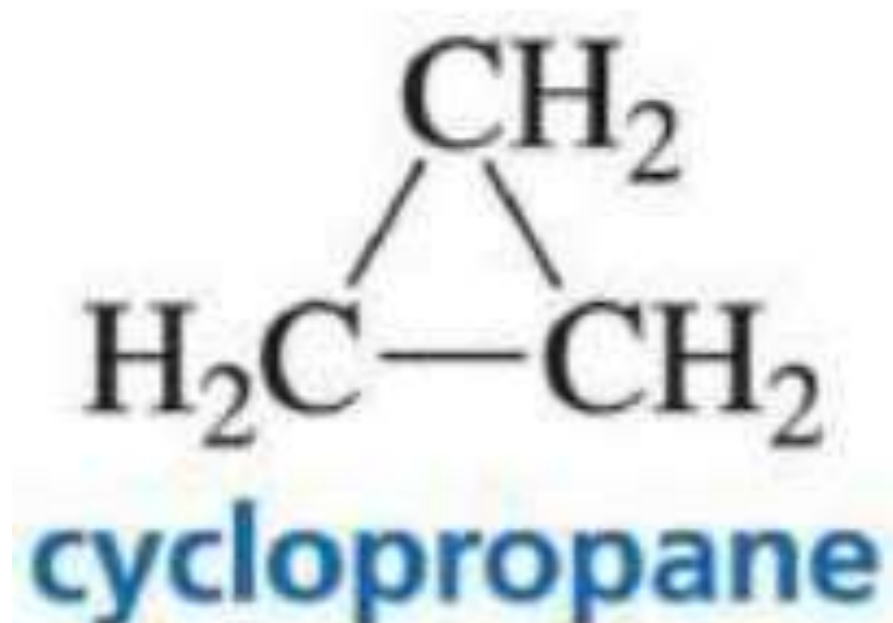
Cycloalkanes are saturated hydrocarbons that have at least one ring of carbon atoms. The general formula is C_nH_{2n} . + saturated.

عشان نسميه بس بدنا نضيف للمركب بالاول كلمة

• bond Angle $\rightarrow 109.5$

• cyclo • بمأمن \rightarrow Cyclopropane

• تحتوي 2H \rightarrow C كل



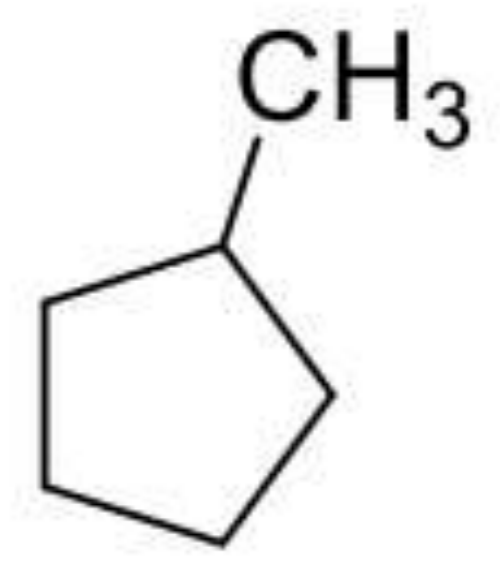
Cycloalkane Nomenclature

إذا كان فيه حلقتين متصلاات
يعني نخالي وحدة parent ووحدة تفرع

Monosubstituted

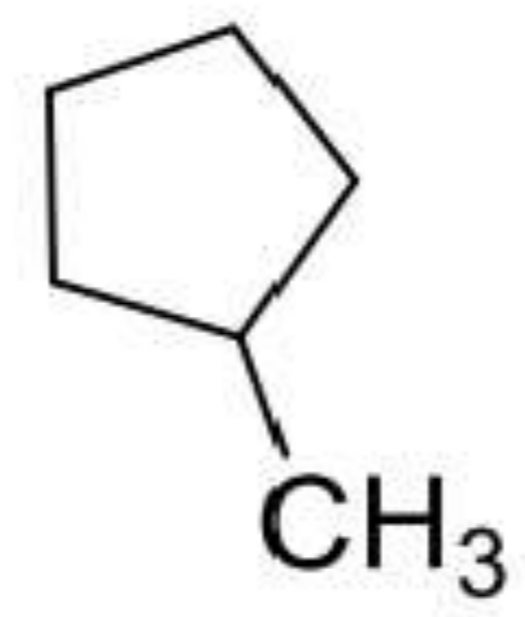
ببعضها بدل ane ← yl

- **One substituent** is always located at ring carbon number 1. A number is **not** needed.



methylcyclopentane

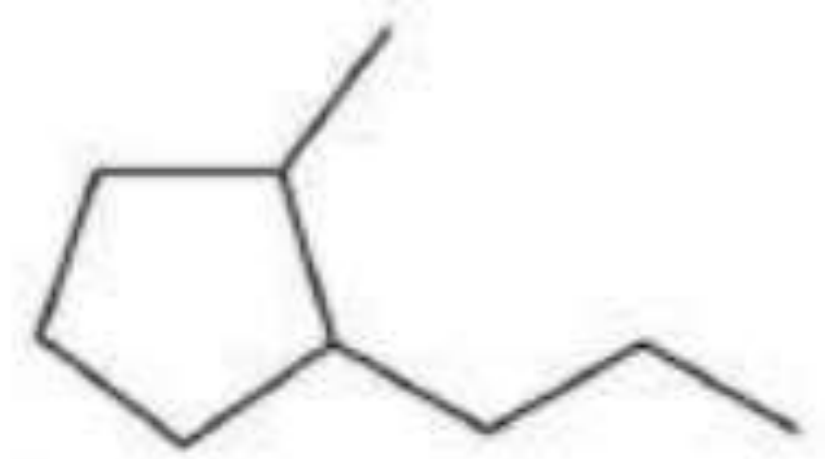
=



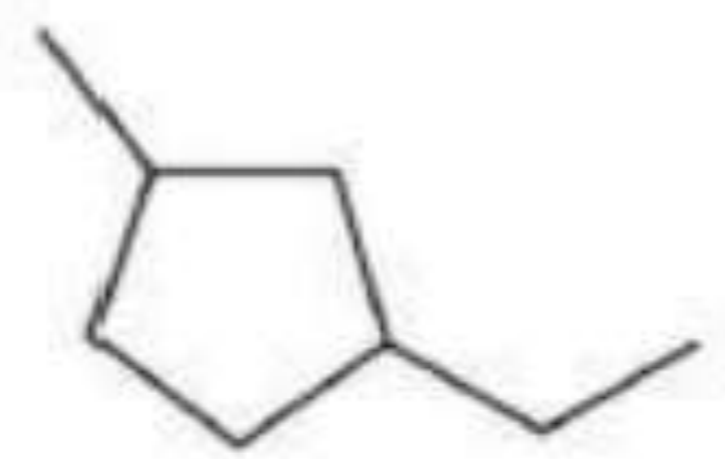
methylcyclopentane

إذا كان عليه تفرع بالاول
بسمي التفرع بعدين بحط اسم
الحلقة واذا كان بس تفرع واحد
مافي داعي ارقم او احط ١
[Alkyl Cycloalkane]

Two substituents : Substituents are stated in alphabetical order. #1 goes to the first-listed substituent

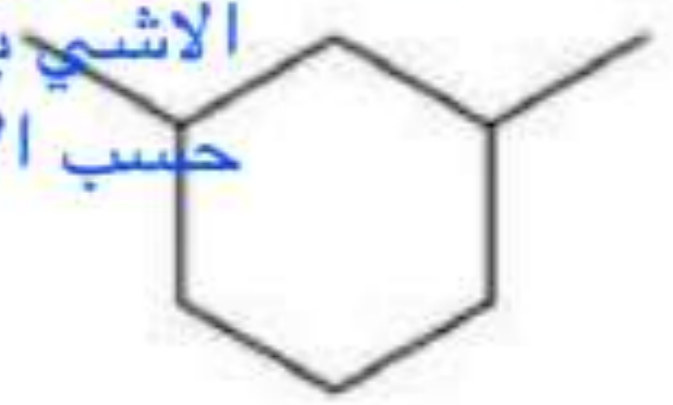


1-methyl-2-propylcyclopentane

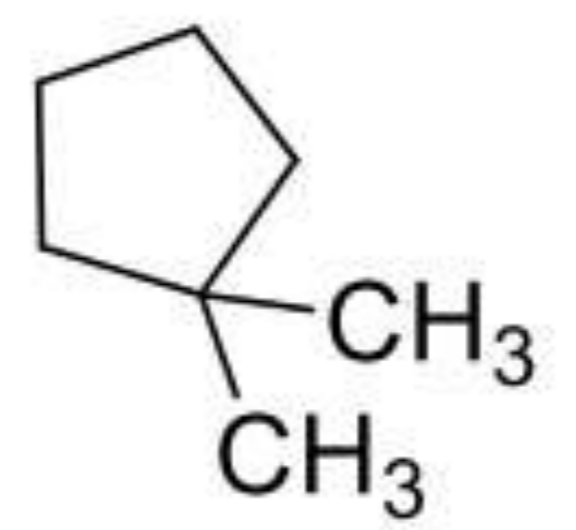


1-ethyl-3-methylcyclopentane

هون برقم واذا
كان الترقين نفس
الاشي برقم
حسب الابجدي



1,3-dimethylcyclohexane





Angle strain + torsional strain \rightarrow Ring Strain

Infor about Cyclopropane:-


- ① أطول + أضعف لكل الرابطة \Rightarrow الروابط الأحادية إلى ضيق
- ② the only cycloalkane that is planar.

Infor about cyclobutane:-

- ① non-planar shape \Rightarrow 

ليس زوايا بين عقد
لي جانب في الارتفاع


Infor about Cyclopentane:-

- ① non-planar shape \rightarrow 

Cyclohexane:-

- ① Angle strain = zero

- ② non-planar shape \rightarrow  chair conformation

* \downarrow Angle Strain \rightarrow Energy \downarrow \rightarrow stability \uparrow
 \downarrow Reactivity \leftarrow

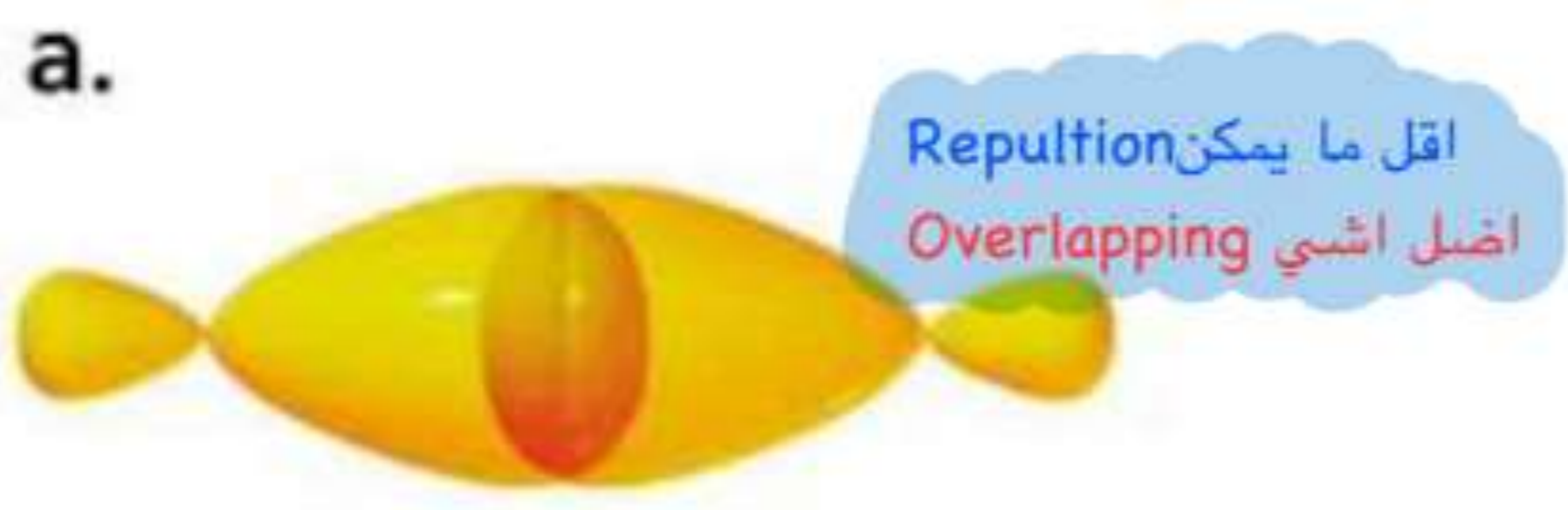
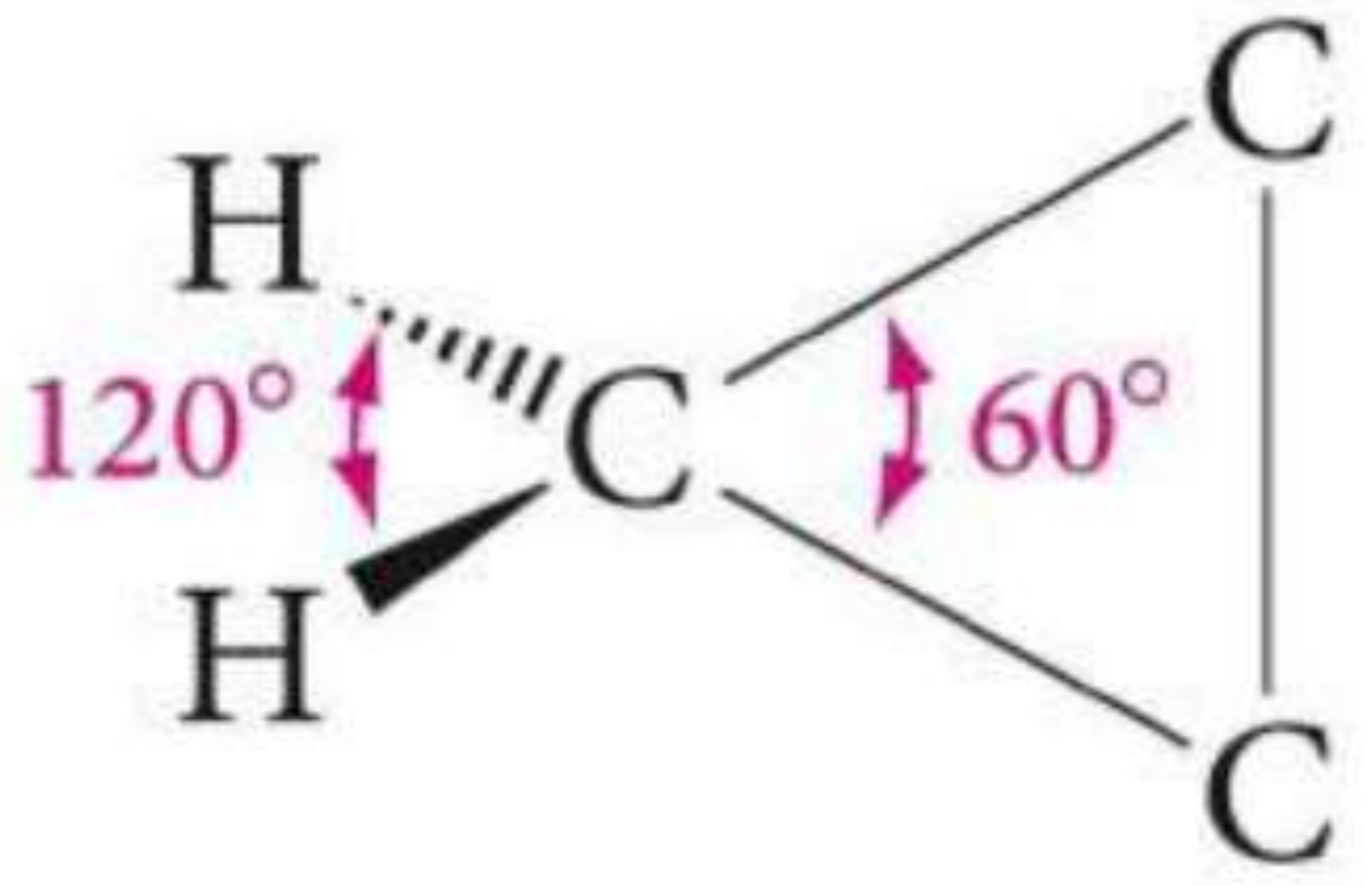
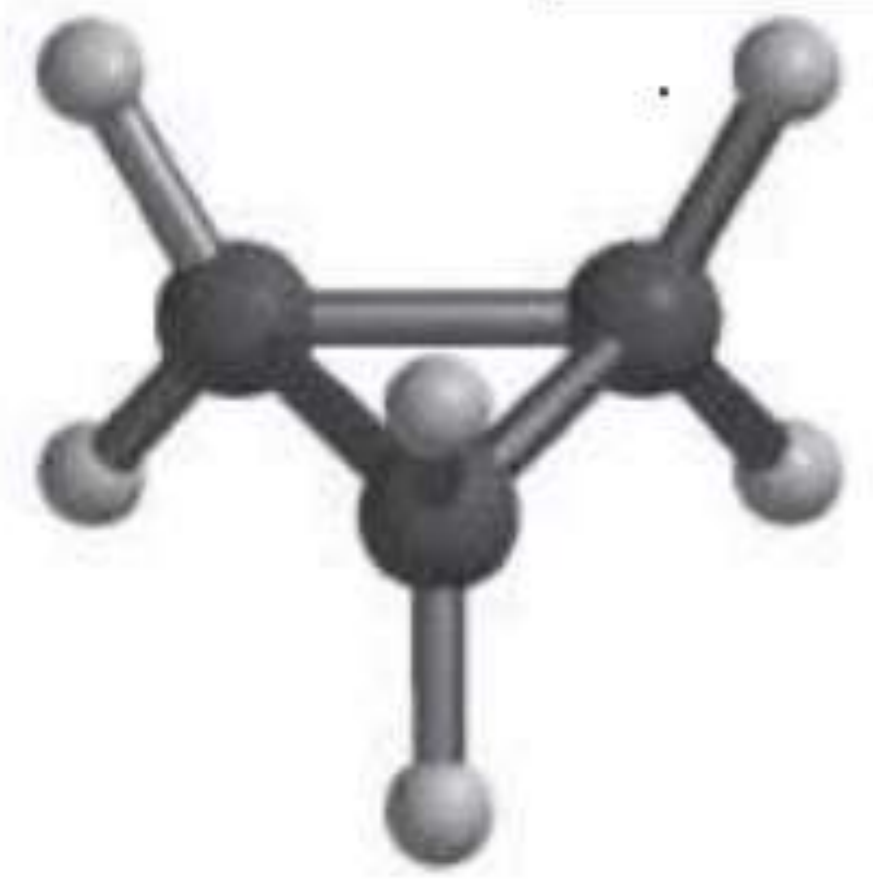
* Angle أكبر Strain \rightarrow Cyclopropane

Angle أقل Strain \rightarrow Cyclohexane

Cycloalkanes: cyclopropane – is the smallest ring structure possible.

- It is rigid and very highly **strained** as the bond angles (60°) are distorted from ideals (109.5°)
- It is more reactive than a linear alkane as the strained C-C bonds are easier to break

Eclipsed Hydrogens



good overlap
strong bond

poor overlap
weak bond

tetrahedral bond angle = 109.5°

bond angle $< 109.5^\circ$

← قد يتسبب أنت أقل من 109°

لذلك أكثر متوتراً
لازم اهتمام فيه
bond angle هي الـ

Angle strain results from poor orbital-orbital overlap because bonds have to deviate from the ideal (109.5°) bond angle

Angle strain = $109.5 - [\text{Angle of Cycloalkane}]$

Angle strain ↑ E ↑ Stability ↓

Cyclobutane ← أحسن من Cyclopropane

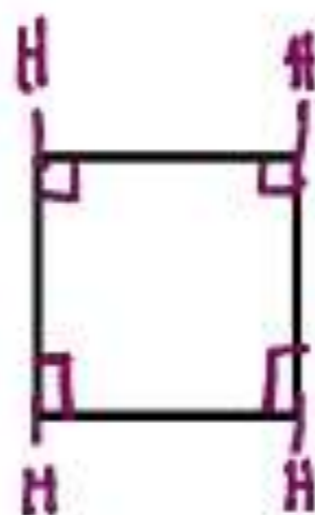
Cycloalkanes: cyclobutane – “puckered” conformation

- It is more flexible than cyclopropane and is not flat although it is commonly drawn that way.
- It is more reactive than a linear alkane as the strained C-C bonds are easier to break, bond angle $\sim 90^\circ$

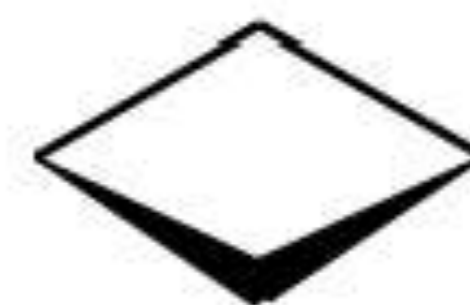


لو اجبت ونزلت هاي ال C شوي في المستوى رح
بيطلو ال CH بنفس مستوى بعض فيجعل minimize
لل eclipsing interaction والزاوية رح تصغر شوي
وتصير ٨٠ بس مش رح تاثر كثير

لـ بعيدة عن ١٥٩



common



better

Molecules twist out of a planar arrangement to minimize **angle strain** and the number of **eclipsed hydrogens**

Energy
تأثير قليل

cyclopentane

بأنه شكله زوي
المختلف

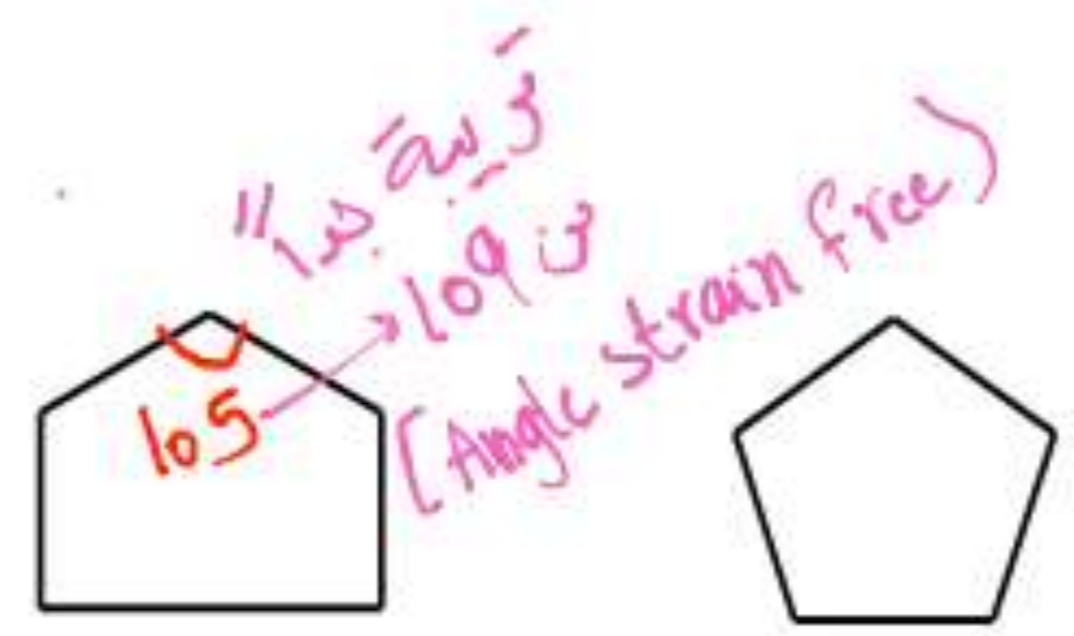
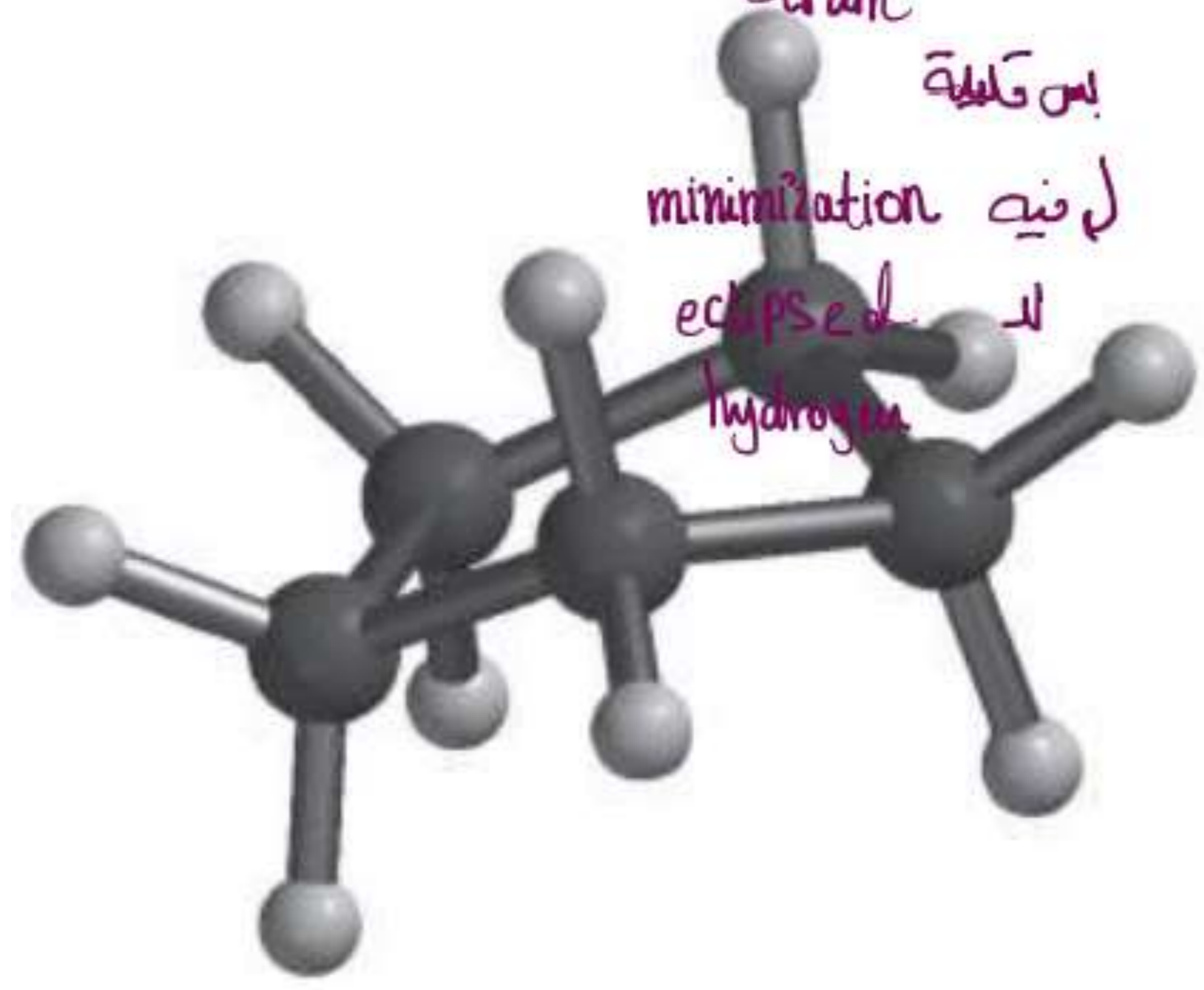
Cycloalkanes: cyclopentane – “envelope” conformation

- It is more flexible than cyclobutane and bond angles are $\sim 105^\circ$, and less strained

torsional strain
تأثير قليل

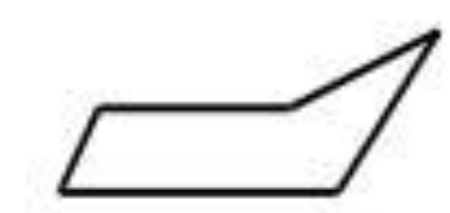
minimization
تأثير قليل

eclipsed hydrogen
تأثير قليل



poor

better



good



best

Molecules twist out of a planar Arrangement to minimize **angle strain** and the number of **eclipsed hydrogens**.

the most stable ← cyclohexane Conformer

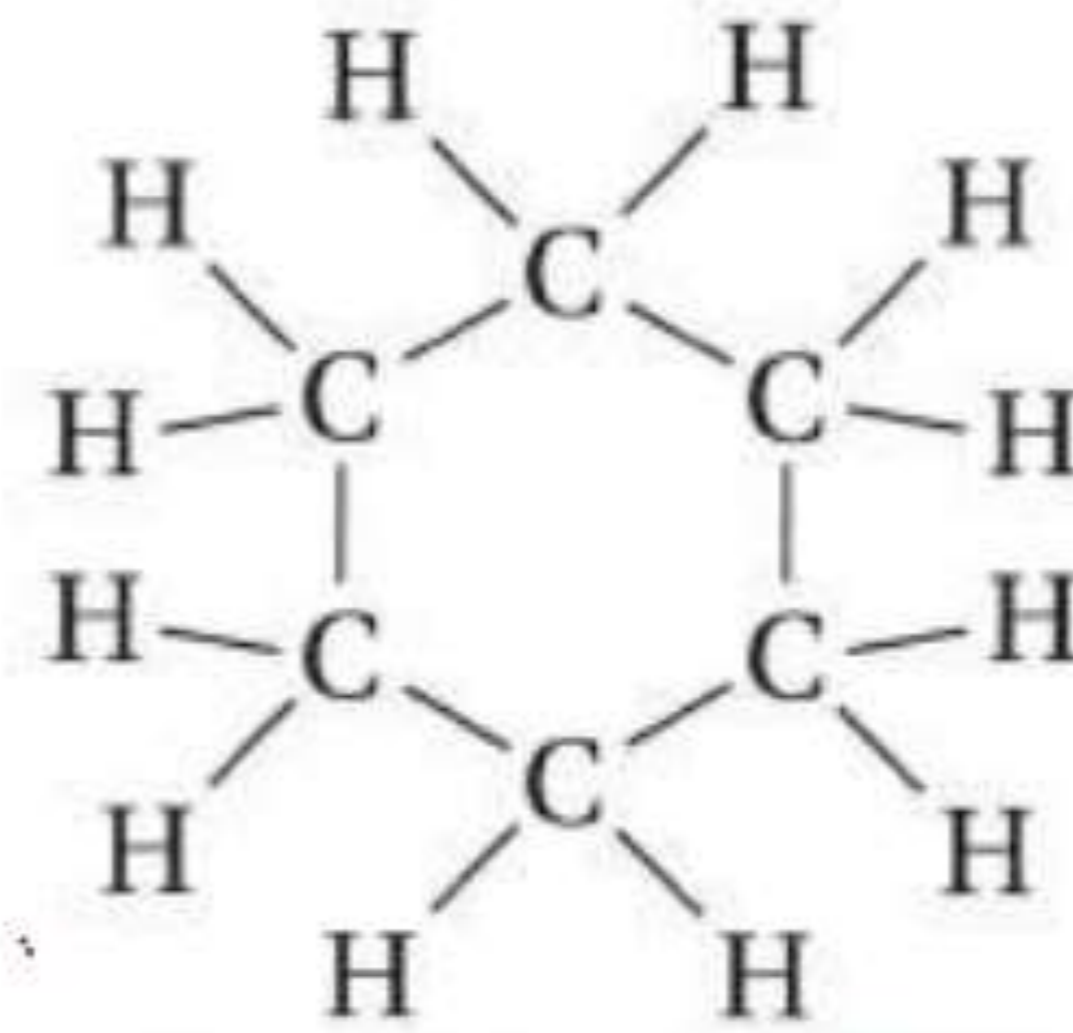
الزاوية المثالية لياض المركب tetrahedral هو قديش يتعدد هاي الزاوية عن Angle strain
 المسايقة الفراغية بينهم هل هم قراب عن بعض او بعدد عن بعض وهيك: Torsional strain

كل ما كانو بعدد بين بعض يكونو مرتاحين اكثر وال potentiel energy اقل وال stability اكثر

Cycloalkanes: cyclohexane – “chair”

- It is highly flexible and can adopt a **strain free** non-planar conformation with bond angle of 109.5°
- It is very common in nature so understanding its conformations is important.

Although commonly drawn as a hexagon, implying a flat six-membered ring this is not the common conformation seen.



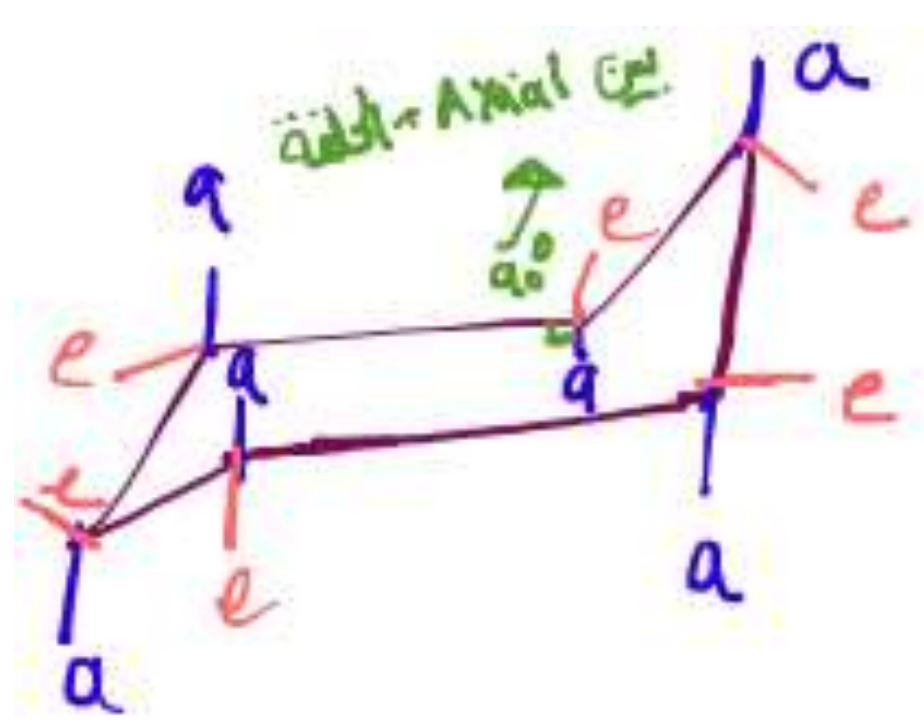
① الزاوية 109
 ② مافي eclipsing hydrogen
 Ring Strain (4/7) يعبر
 Free + or torsional strain free.
 Most stable.

Structural and abbreviated structural formulas for cyclohexane

Type your text

السبب الي بخليه more stable هو انه مافي angle strain
 لانه الزاوية 109 ولانه ترتيب ذرات الكربون يكون وحدة فوق والثانية تحتها ومارح يكون في عندي
 torsional angle ورح يكون التركيب steggerd



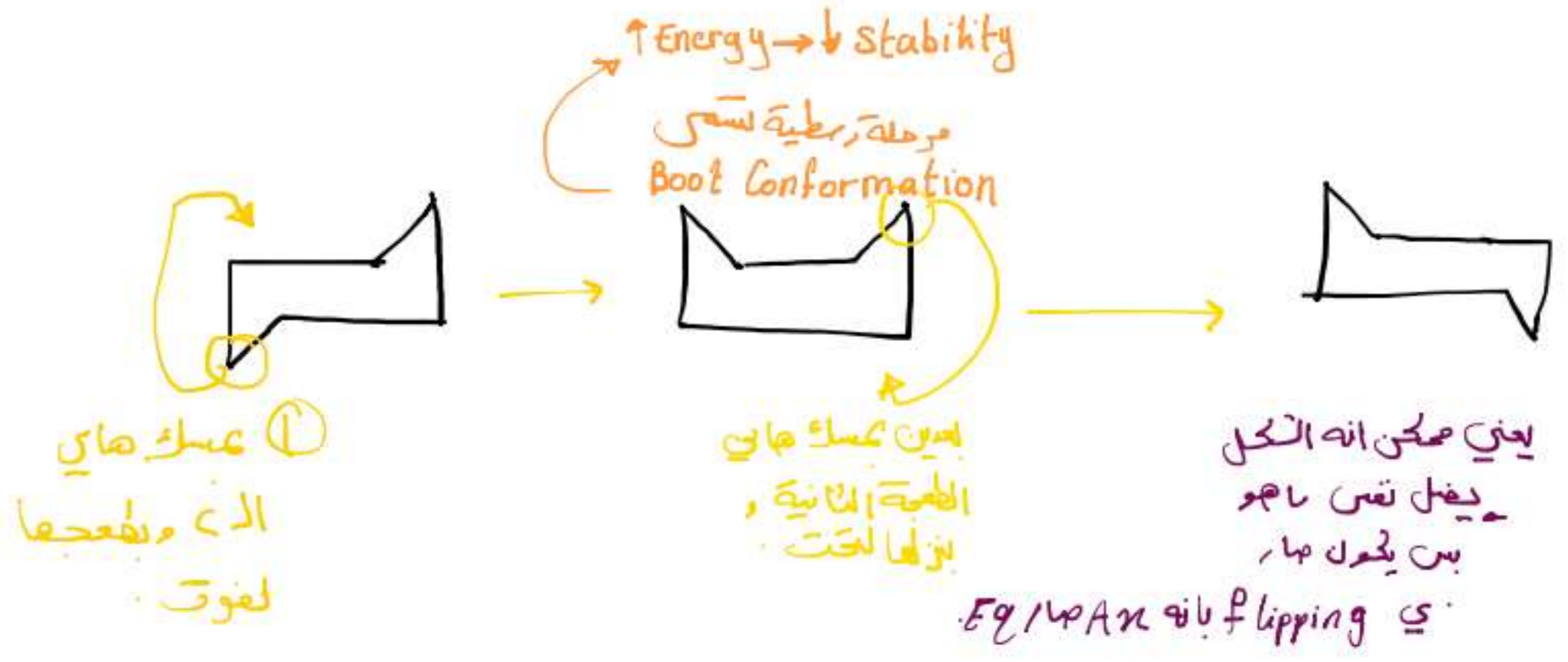


* كل C من كربونات الـ Cyclohexane عليها رابطتين
 له في الوضع الطبيعي يوجد (H) عال هذه الروابط لأنه (Cyclohexane)

رابطه محورية (محور) [Axial]
 استوائية [equatorial]

* لازم نحدد اتجاه الروابط على الكربونات

Ring Flipping ← Cyclohexane (RF)
 هي العملية التي تحول فيها
 + كل روابط Ax بتغير Eq والعكس.



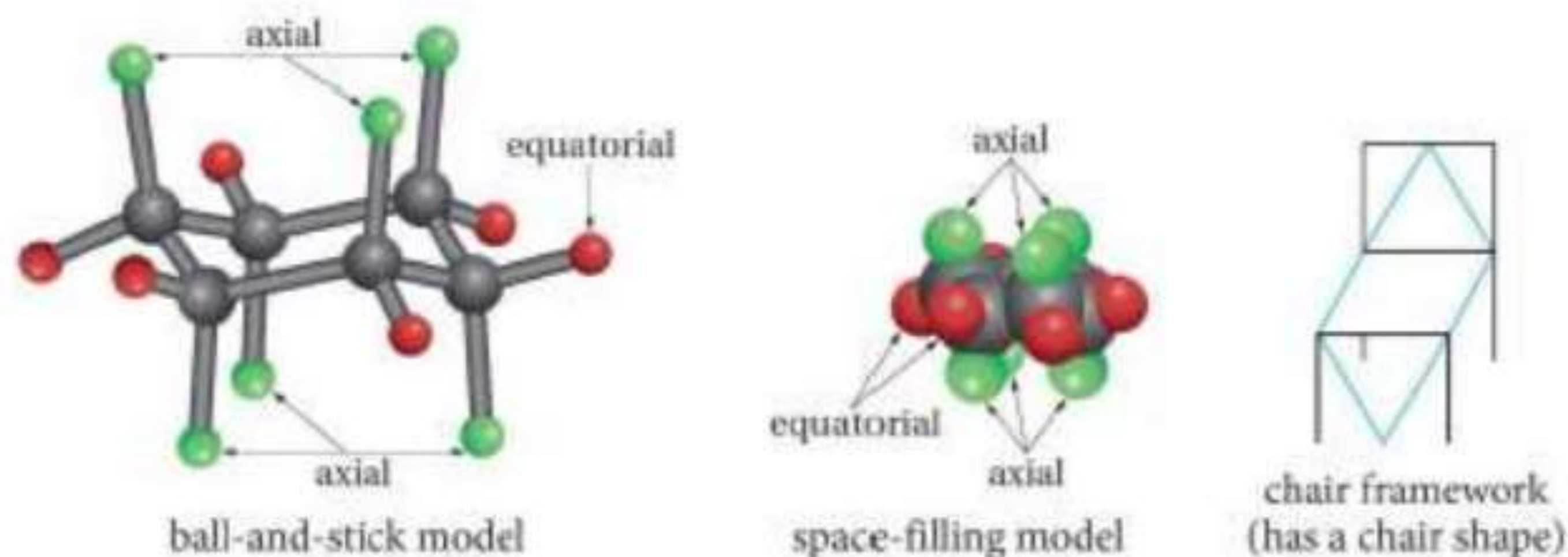
* هذه الترتيب الأساسي عنان أقول انه ما رينه flipping انه الروابط هاي تفتكس من انه التخل يعني

يعني flipping باق Ax Eq

Conformational Isomers (cont'd)

Cyclohexane cont'd:

The most common conformation of cyclohexane is the “chair” conformation. In this geometry the C bonds are all $\sim 109.5^\circ$ as opposed to the 120° in a planar structure.



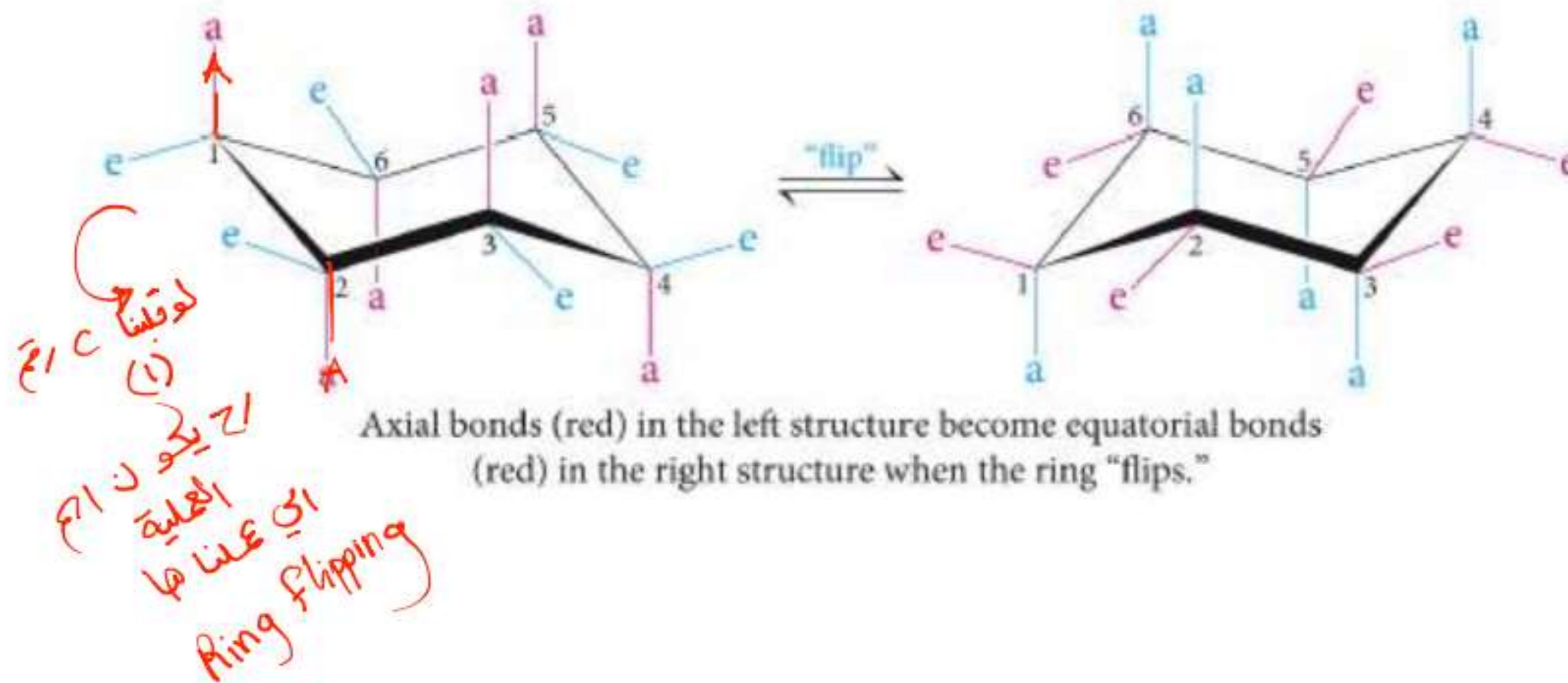
This structure creates two subsets of hydrogen atoms, those lying in the same plane as the C atoms, the equatorial H and those lying above and below that plane, the axial H atoms

Cyclohexane **interconverts** between two **chair conformers**.

Type your text

Cyclohexane cont'd:

Since the C-C bonds are all single (σ) bonds, it is possible to rotate about these bonds. This process is known as a **ring inversion** or a "chair-chair" **flip**. In the process of the inversion **all equatorial H become axial and axial become equatorial.**



Chair Conformation Naming :-

Chair Conformation

Cycloalkane هو

ولذلك تنطبق عليه

تسمية الحلقات

هذه الطريقة
لا تعتمد على
(Eg و Ax)

لتحديد trans / cis :-
① حسب اتجاهات التفرعات
كلها للأعلى / الأسفل ← cis
أحد للأعلى / الأسفل ← trans

② تحديد الـ cis / trans من طريق تحديد مواقع التفرعات وتحديد [Ax و Eg]

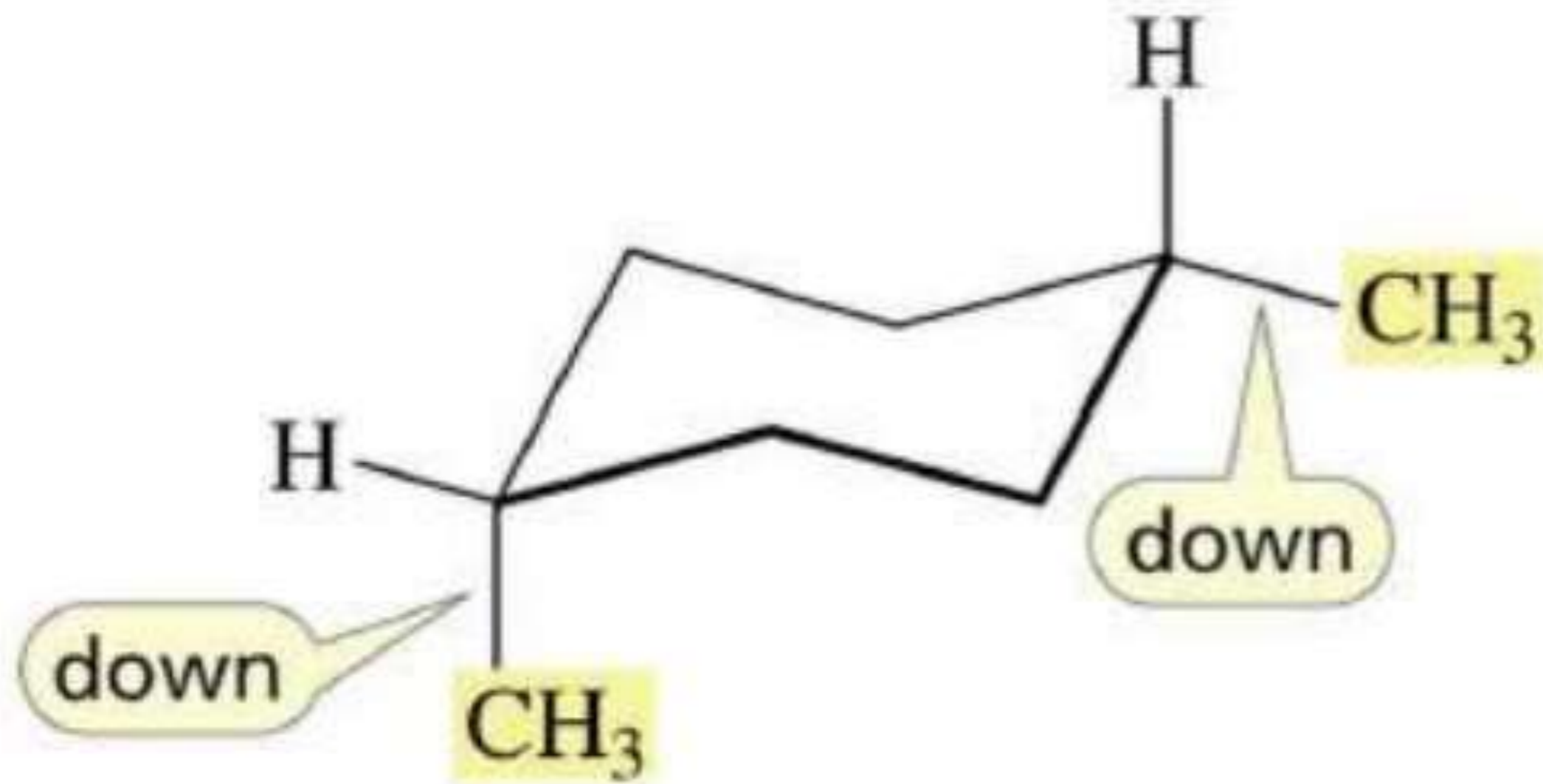
position	Cis	trans
1, 2	[e, a] or [a, e]	(e, e) or (a, a)
1, 3	[e, e] or [a, a]	[e, a] or [a, e]
1, 4	[e, a] or [a, e]	(e, e) or (a, a)

* الالاستي السبي فيه

انه ايجانفة التقزعات
رح تكون غير حبية

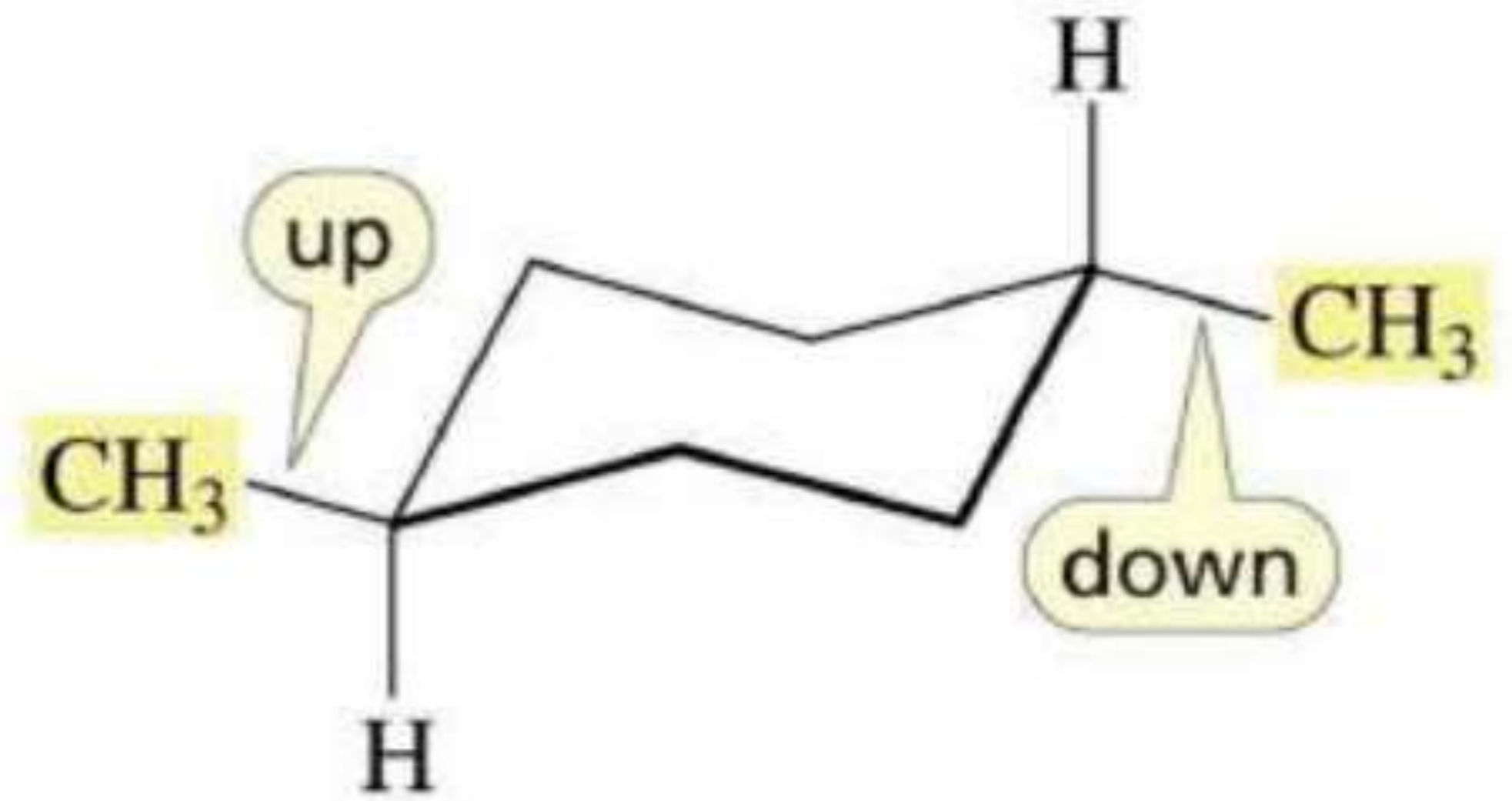
Cis and Trans Isomers

two methyl groups are on the same side of the ring



cis-1,4-dimethylcyclohexane

two methyl groups are on opposite sides of the ring

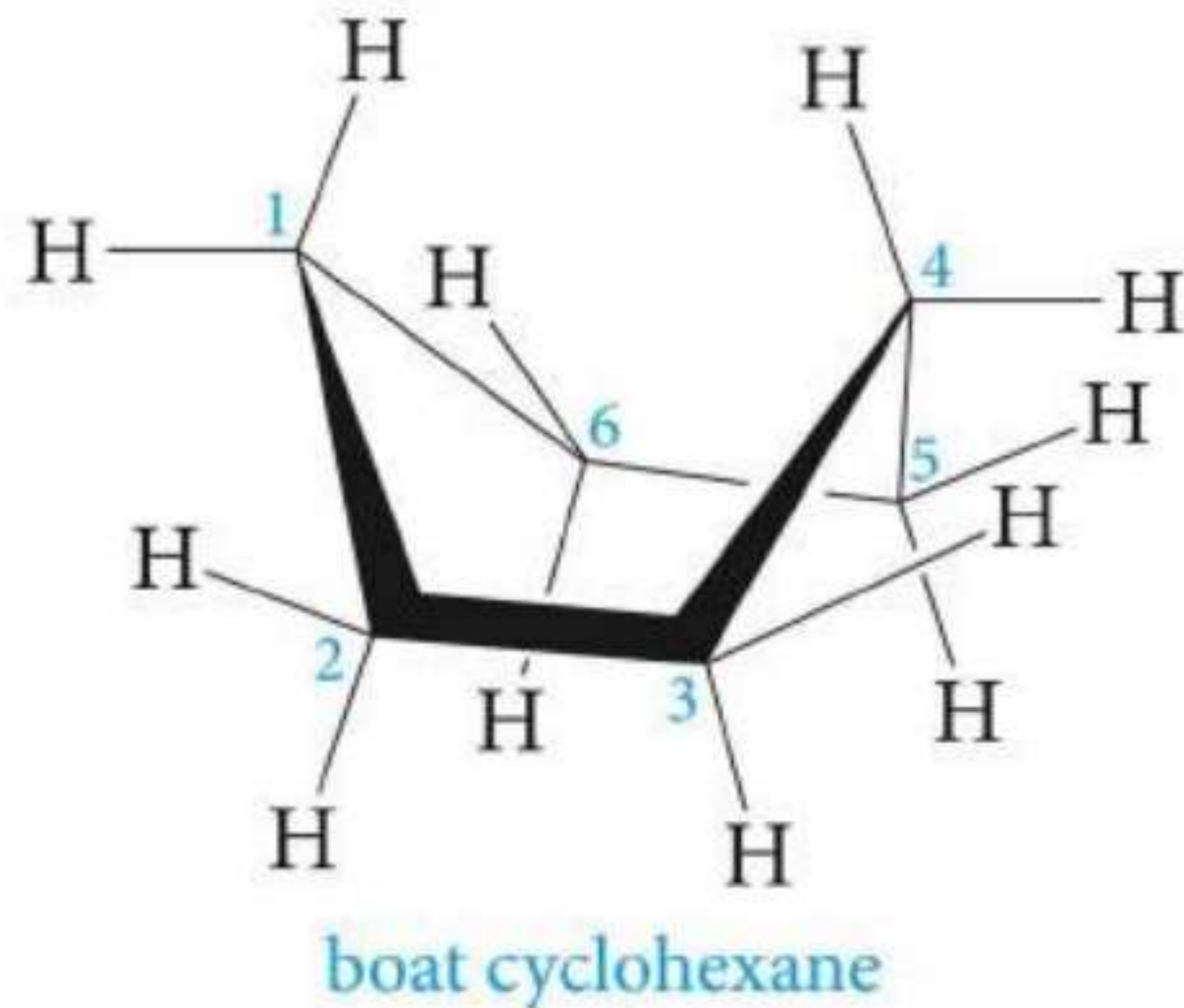
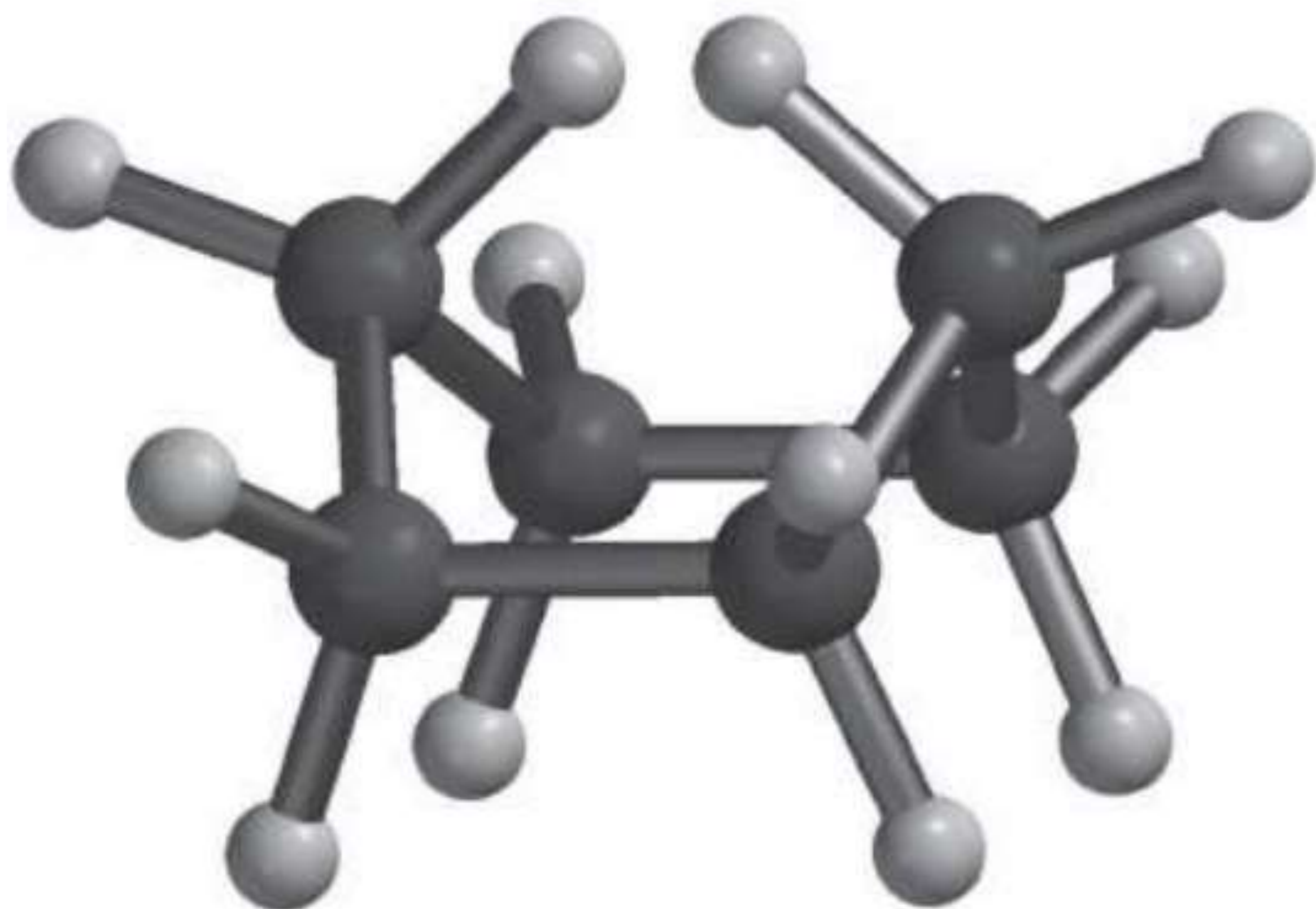


trans-1,4-dimethylcyclohexane

Conformational Isomers (cont'd)

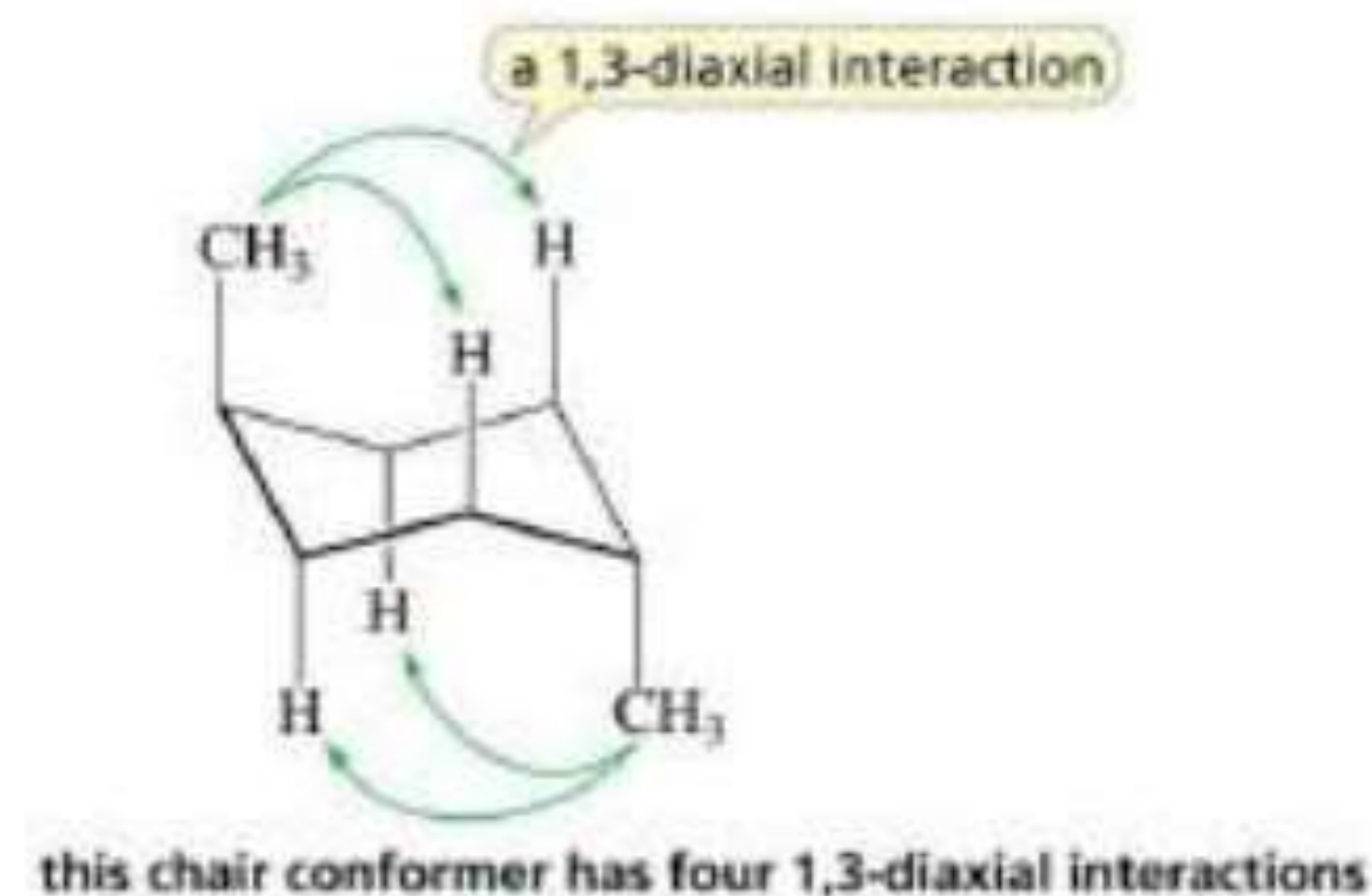
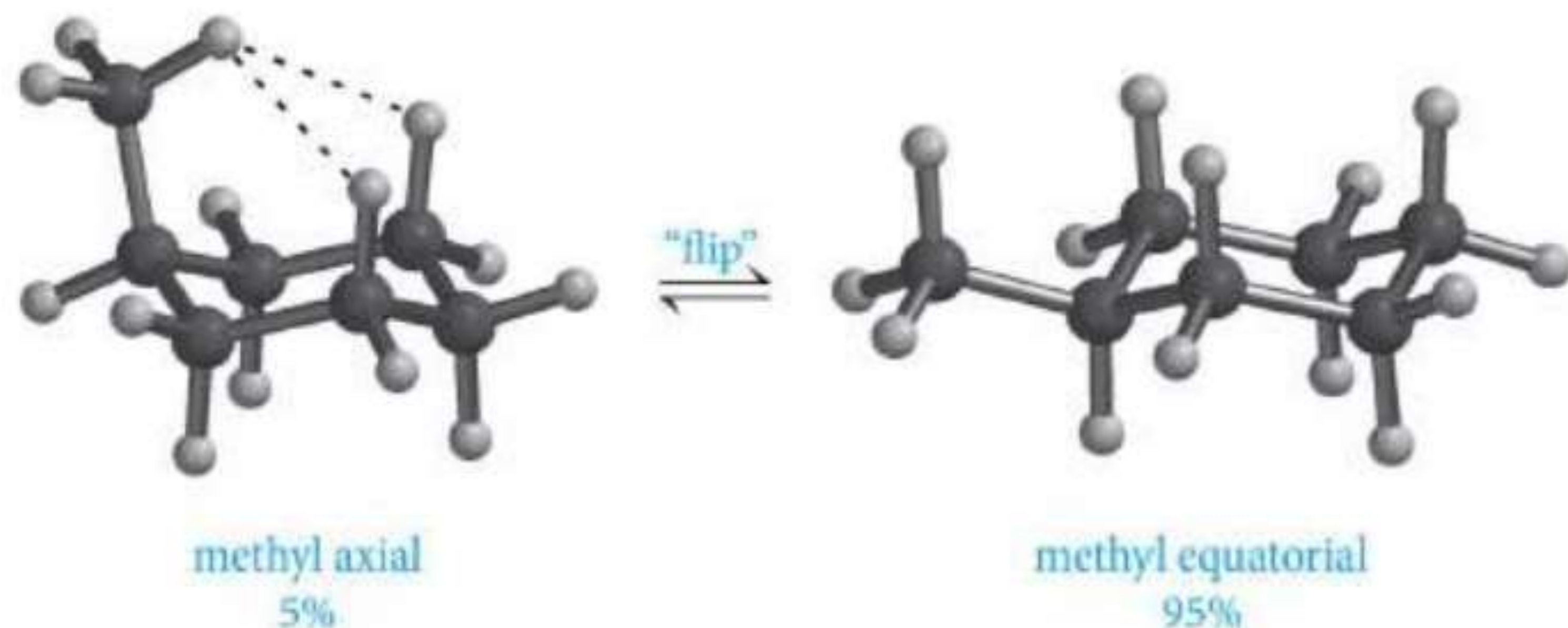
Cyclohexane cont'd:

Other conformations of cyclohexane are possible but they are higher in energy and less stable, i.e. the "boat" conformation

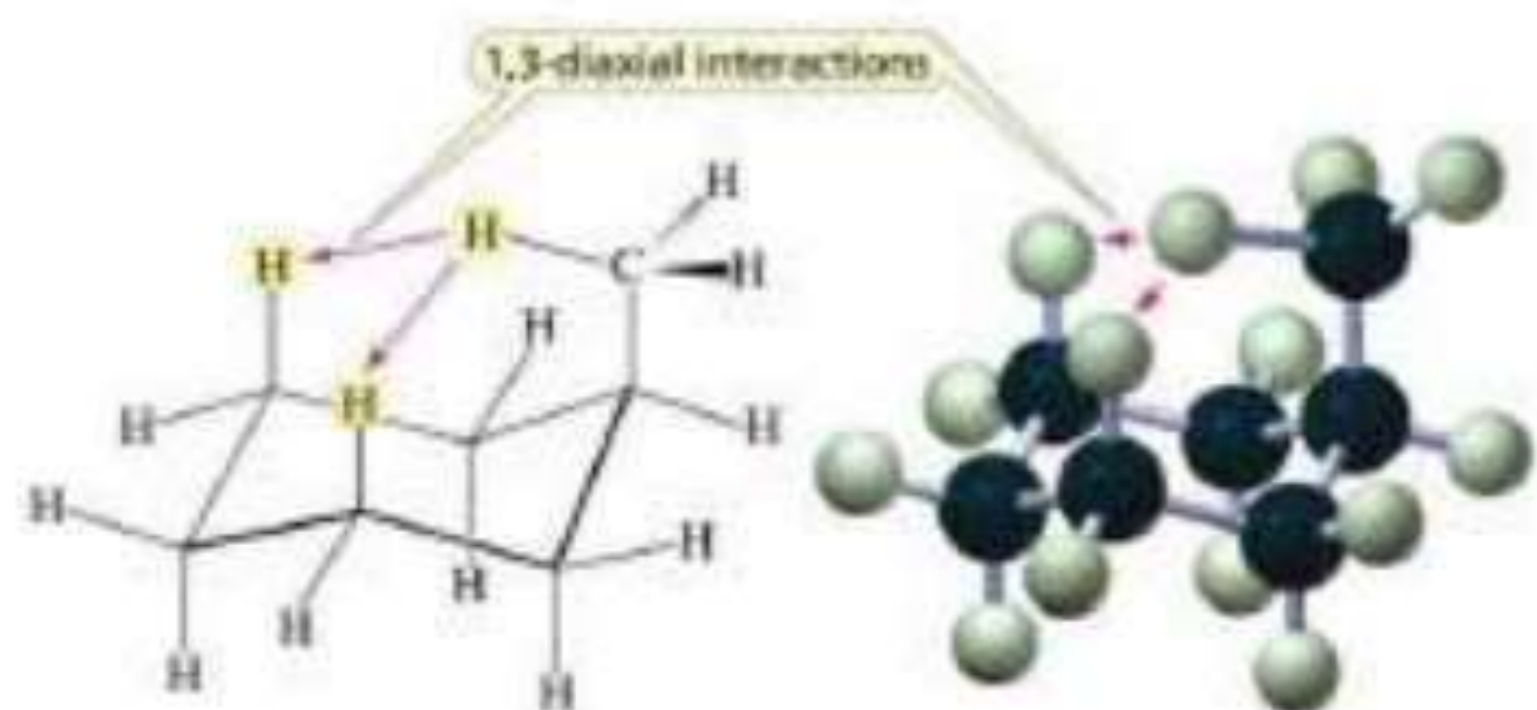


- Substituted cyclohexane: **(1,3-Diaxial Interactions)**

The addition of a methyl group on cyclohexane (methylcyclohexane) can have two conformations, the methyl can be axial or equatorial, i.e.



The equatorial is preferred as there is significantly less steric interactions than when in the axial position. This will be true for any group on a cyclohexane ring and has implications for the chemical reactivity of the compound.



Note: The larger the substituent, the more the equatorial-substituted conformer is favored.

← بين 2 إذا كان 1/3 مرتبط

إذا كان في عندي تفرعين على C 2 مختلفات

CisCycloalkane ← نفس الاتجاه []

transCycloalkane ← عكس الاتجاه []
Methyl

لنظّم قبل الاسم
بعديفاً (-)

Solid ←  [باتجاهك] أو الضحية

dash ←  [باتجاه العارضة]

planner ←  [بمستوى الصفحة]

Geometric Isomers (*Cis-trans* isomerism) → هم Cycloalkanes

① not interconvertible →
يعني بقدرش اعملهم من cis
الى trans عنه درجة حرارة الغرفة.

العم ليس التركيب + الام
ليس راحة صنع cis
والثاني trans

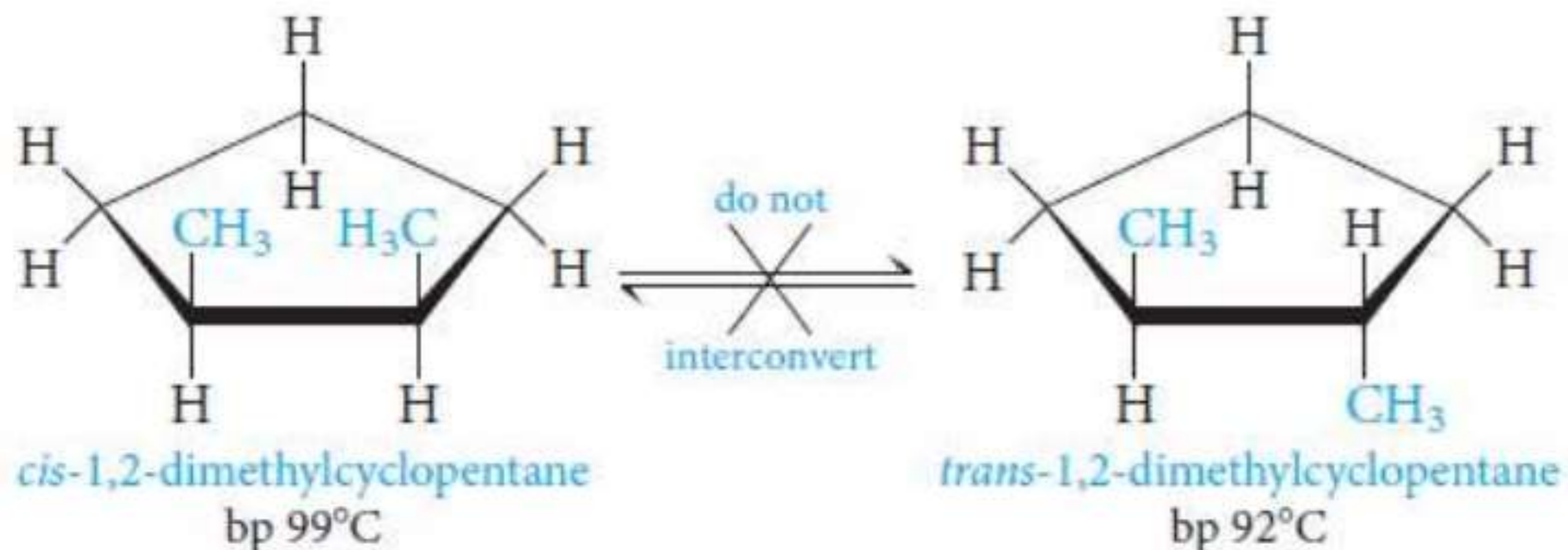
Geometric isomers (or **configurational** isomers, a subset of **stereoisomers**) are molecules which have the same chemical formula, the atoms are bonded in the same order, but located in different positions in space. Unlike conformational isomers, where the atoms are located in different location in space due to rotation about C-C single (σ) bonds, geometric isomers are not related by rotation about σ bonds. This situation arises with cyclic structures.

② different chemical + physical properties.

③ Trans more stable than cis

An example of this is 1,2-dimethylcyclopentane

These structures can not interconvert without breaking a C-C bond.



- The two methyl groups may be on the same side of the ring plane (*cis*)
- or they may be on the opposite sides (*trans*)
- *Cis*–*trans* isomers differ from one another only in the way that the atoms or groups are positioned in space. Yet this difference is sufficient to give them different physical and chemical properties
- *Cis*–*trans* isomers can be separated from each other and kept separate

Summary of Isomers (to date)

