Organic Chemistry: John McMurry

Dr. Rouaida Abou Samra

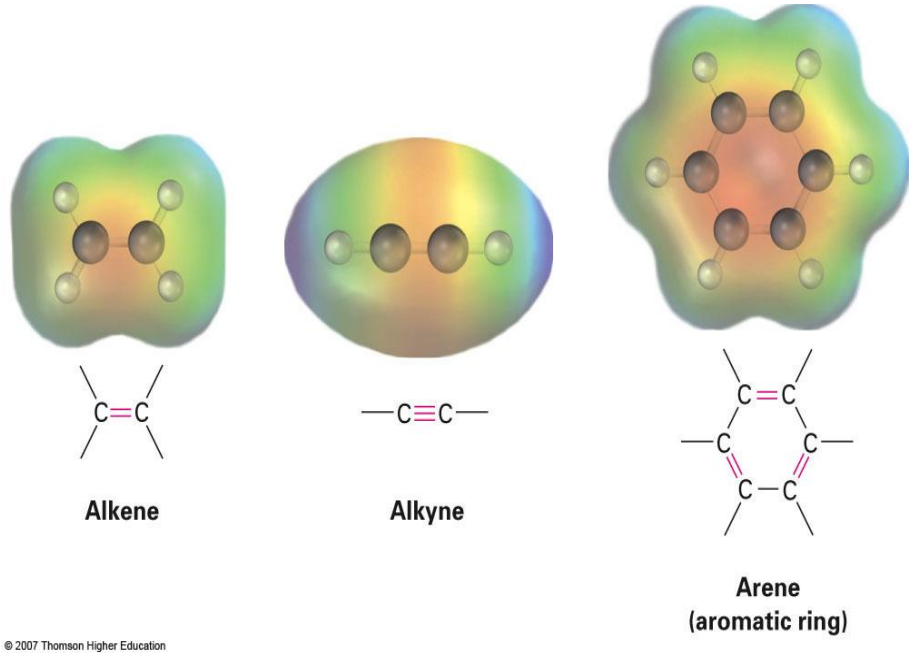
الزمر الوظيفية الحاوية على روابط مختلفة C-C

Alkenesتحتوي الالكنات:
على رابطة ثنائية double bond C=C

تحتوي الالكينات: Alkynes

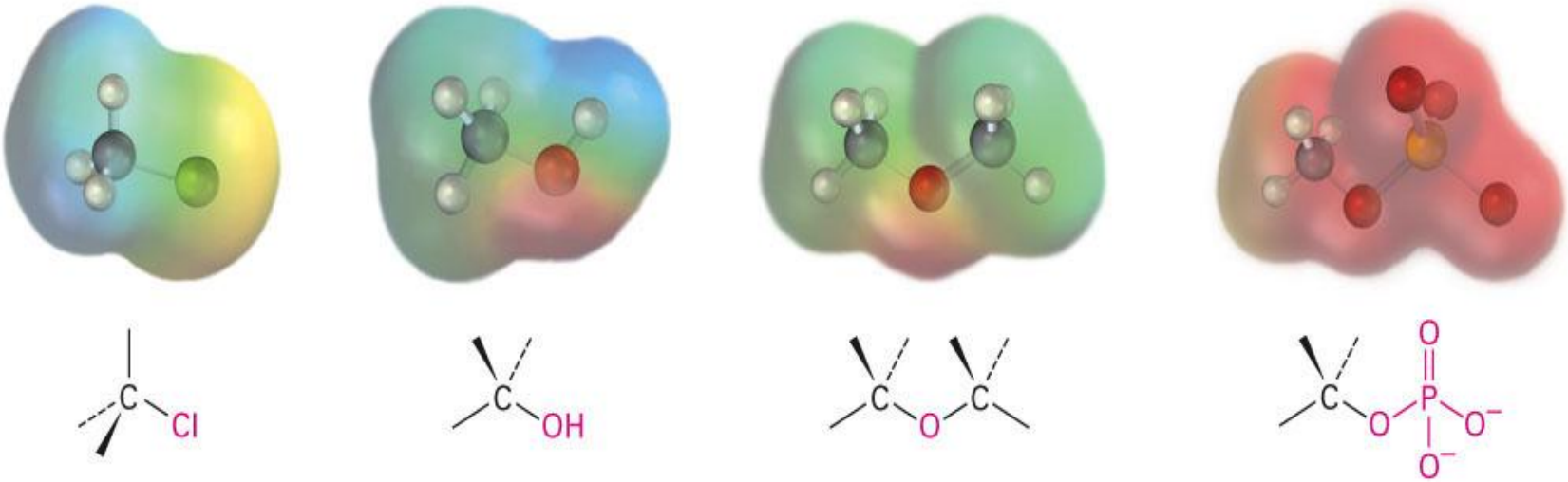
على رابطة ثلاثية triple bond C≡C

تحتوي الارينات :Arenes
على انواع خاصة من الروابط بحيث تتناوب الاربطة المضاعفة مع الاربطة الاحادية



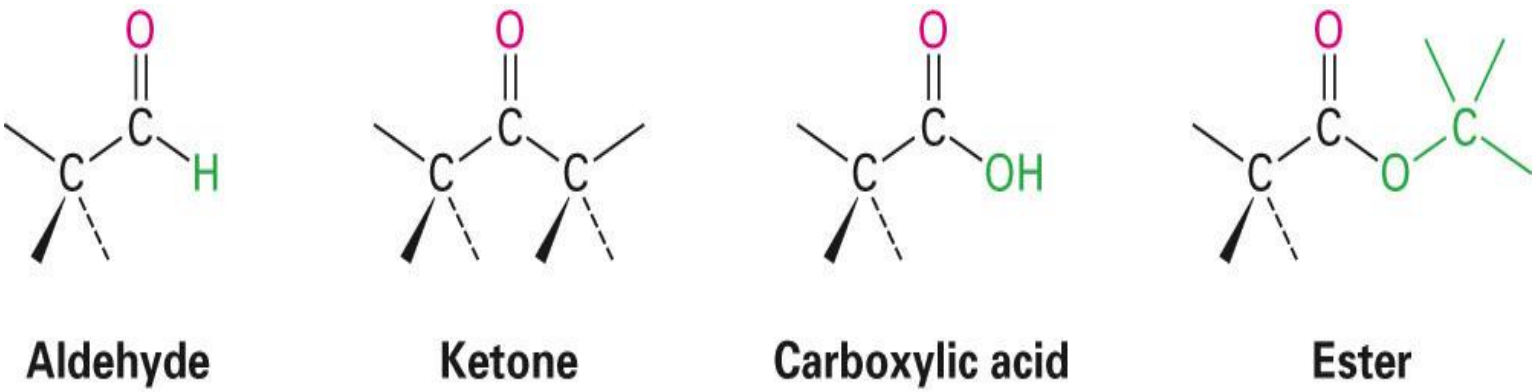
Functional Groups with Carbon Singly Bonded to an Electronegative Atom

مجموعات وظيفية مؤلفة من كربون مرتبط برابطة احادية مع ذرة كهرسلبية



Alkyl halide (haloalkane) | Alcohol | Ether | Phosphate

Groups with a Carbon–Oxygen Double Bond (Carbonyl Groups) مجموعات وظيفية من كربون = اوكسجين



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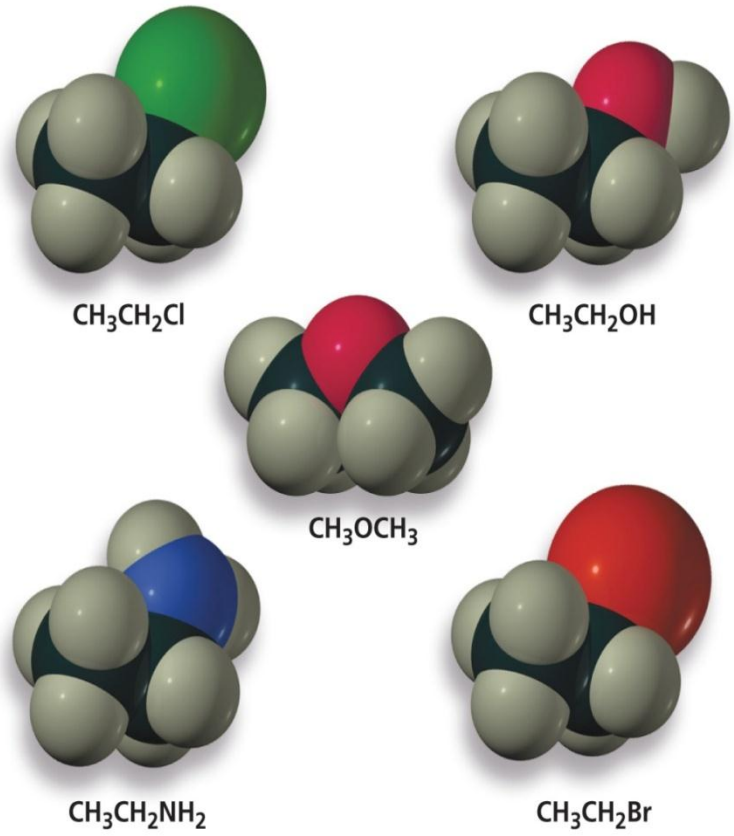


المركبات العضوية

Alkanes

الألكانات

Alkanes الالكانات

- Alkanes are hydrocarbons containing only single bonds

- الالكانات هي فحوم هيدروجينية(hydrocarbons) تحتوي على رابطة احادية -C-C-

- الصيغة العامة لها : General formula: C_nH_{2n+2}

Table 2.1 Nomenclature and Physical Properties of Straight-Chain Alkanes

Number of carbons	Molecular formula	Name	Condensed structure	Boiling point (°C)	Melting point (°C)	Density[a] (g/mL)
1	CH_4	methane	CH_4	−167.7	−182.5	
2	C_2H_6	ethane	CH_3CH_3	−88.6	−183.3	
3	C_3H_8	propane	$CH_3CH_2CH_3$	−42.1	−187.7	
4	C_4H_{10}	butane	$CH_3CH_2CH_2CH_3$	−0.5	−138.3	
5	C_5H_{12}	pentane	$CH_3(CH_2)_3CH_3$	36.1	−129.8	0.5572
6	C_6H_{14}	hexane	$CH_3(CH_2)_4CH_3$	68.7	−95.3	0.6603
7	C_7H_{16}	heptane	$CH_3(CH_2)_5CH_3$	98.4	−90.6	0.6837
8	C_8H_{18}	octane	$CH_3(CH_2)_6CH_3$	125.7	−56.8	0.7026
9	C_9H_{20}	nonane	$CH_3(CH_2)_7CH_3$	150.8	−53.5	0.7177
10	$C_{10}H_{22}$	decane	$CH_3(CH_2)_8CH_3$	174.0	−29.7	0.7299
11	$C_{11}H_{24}$	undecane	$CH_3(CH_2)_9CH_3$	195.8	−25.6	0.7402
12	$C_{12}H_{26}$	dodecane	$CH_3(CH_2)_{10}CH_3$	216.3	−9.6	0.7487
13	$C_{13}H_{28}$	tridecane	$CH_3(CH_2)_{11}CH_3$	235.4	−5.5	0.7546
⋮	⋮	⋮	⋮	⋮	⋮	⋮
20	$C_{20}H_{42}$	eicosane	$CH_3(CH_2)_{18}CH_3$	343.0	36.8	0.7886
21	$C_{21}H_{44}$	heneicosane	$CH_3(CH_2)_{19}CH_3$	356.5	40.5	0.7917
⋮	⋮	⋮	⋮	⋮	⋮	⋮
30	$C_{30}H_{62}$	triacontane	$CH_3(CH_2)_{28}CH_3$	449.7	65.8	0.8097

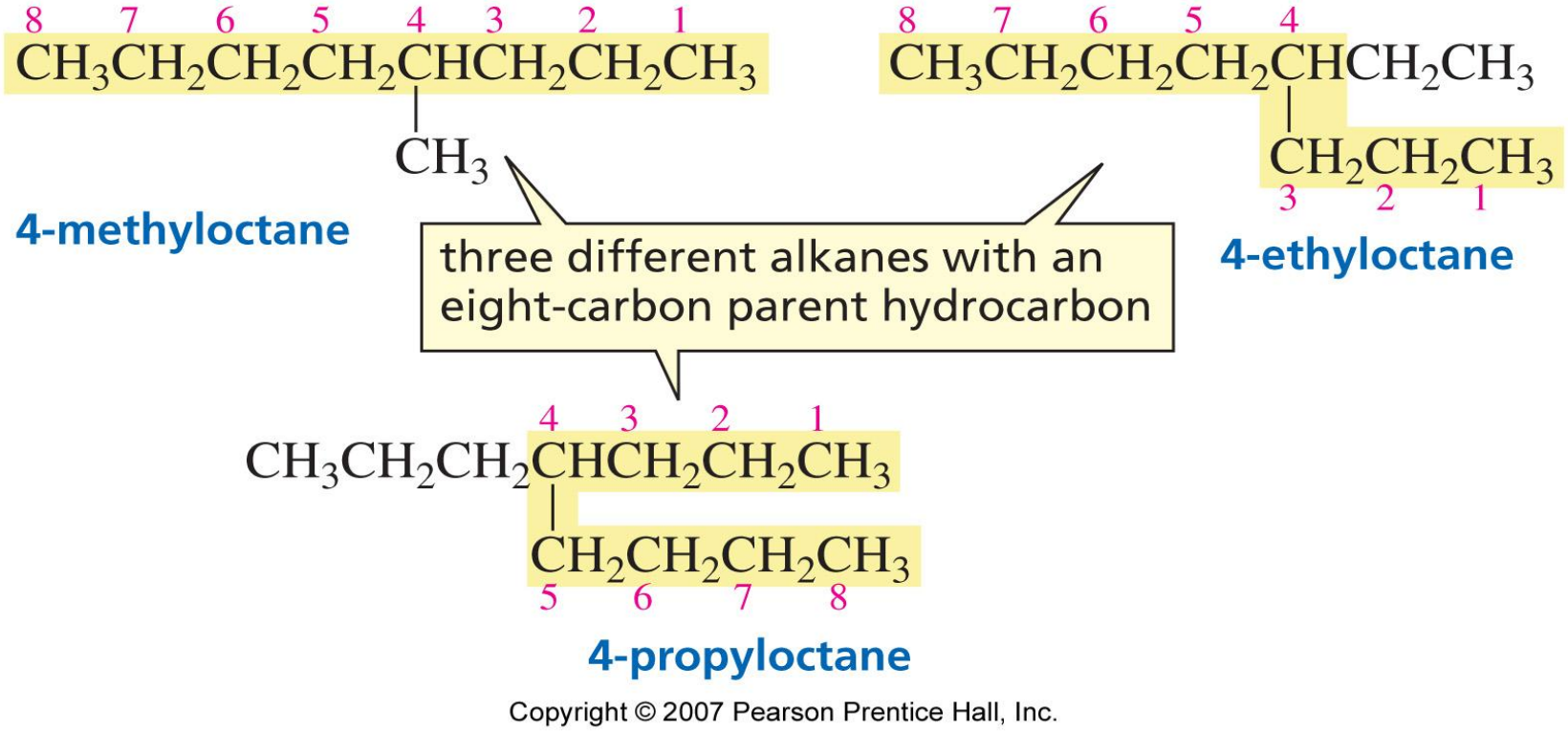
[a]Density is temperature dependent. The densities given are those determined at 20°C ($d^{20°}$).

Naming Alkanes

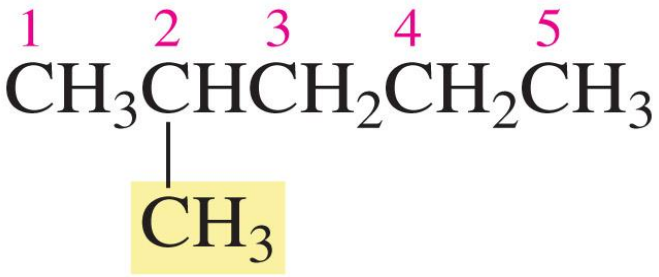
- Compounds are given systematic names by a process that uses

Nomenclature of Alkanes
تسمية الالكانات

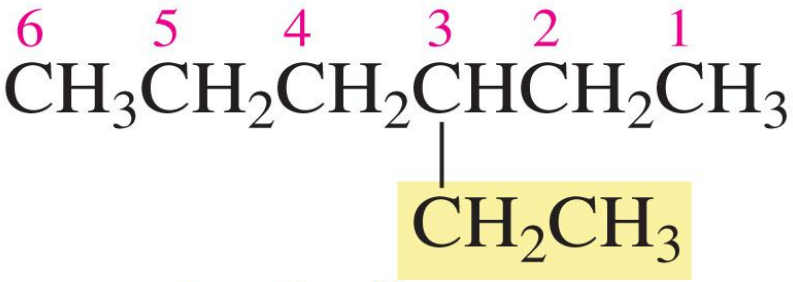
1. Determine the number of carbons in the longest chain



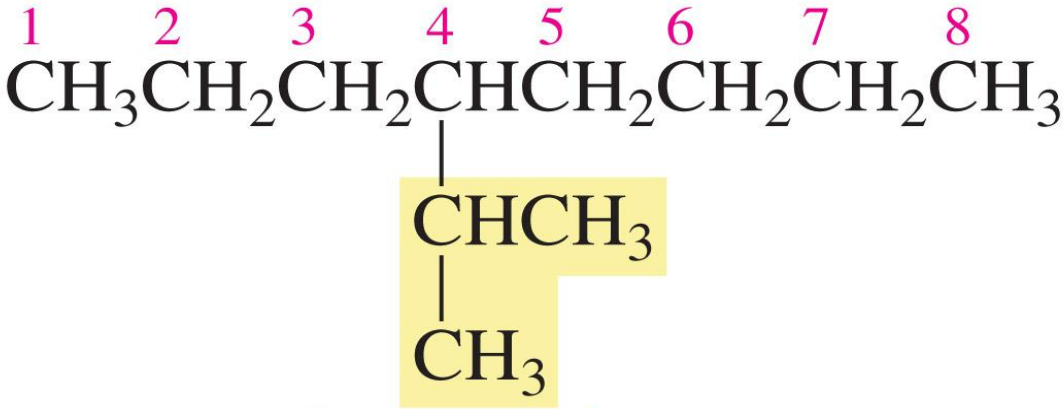
2. Number the chain so that the substituent gets the lowest number



2-methylpentane



3-ethylhexane



4-isopropyloctane

3. Number the substituents to yield the lowest possible number in the number of the compound

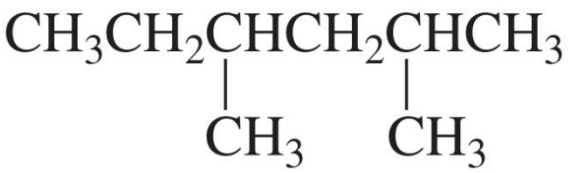
5-ethyl-3-methyloctane

not

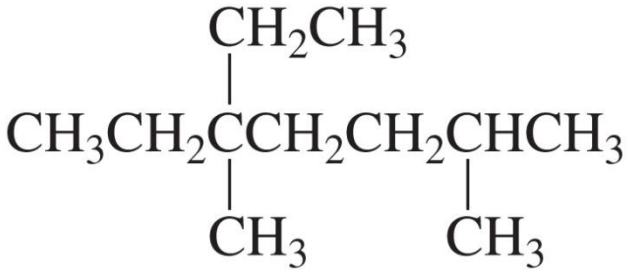
4-ethyl-6-methyloctane

because 3 < 4

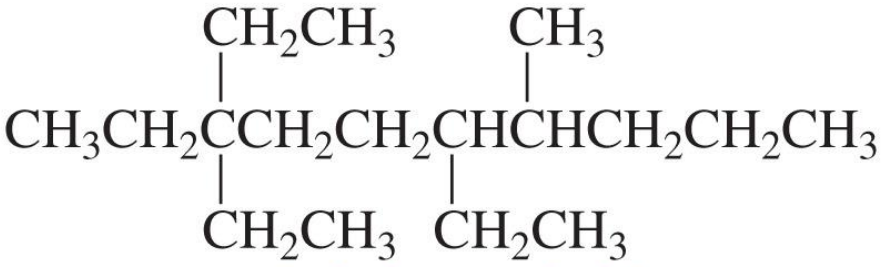
substituents are listed in alphabetical order



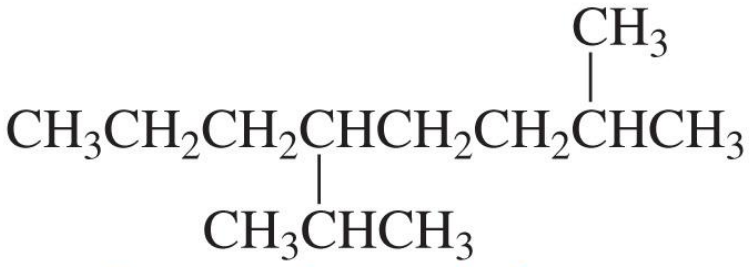
2,4-dimethylhexane



5-ethyl-2,5-dimethylheptane

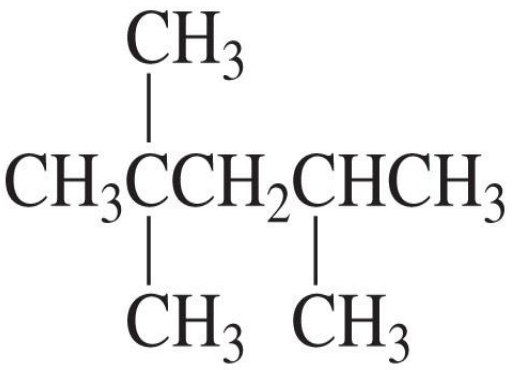


3,3,6-triethyl-7-methyldecane



5-isopropyl-2-methyloctane

4. Assign the lowest possible numbers to all of the substituents

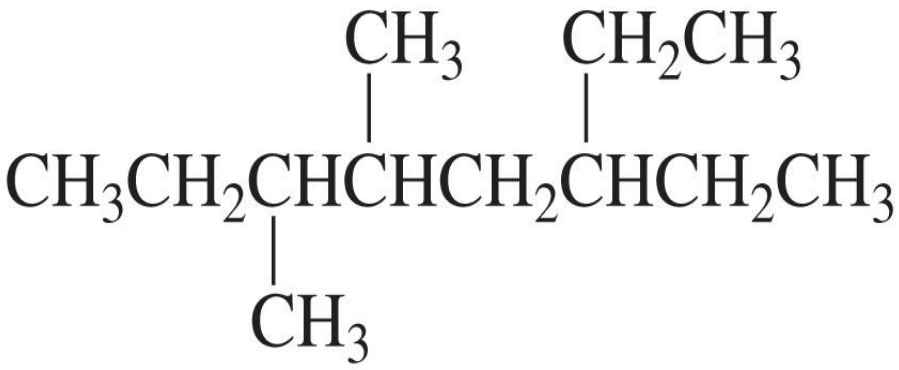


2,2,4-trimethylpentane

not

2,4,4-trimethylpentane

because 2 < 4



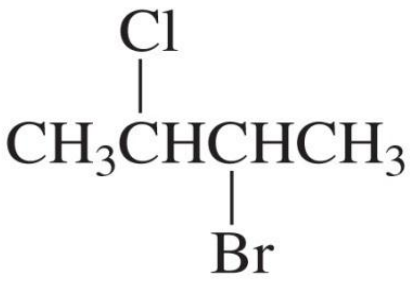
6-ethyl-3,4-dimethyloctane

not

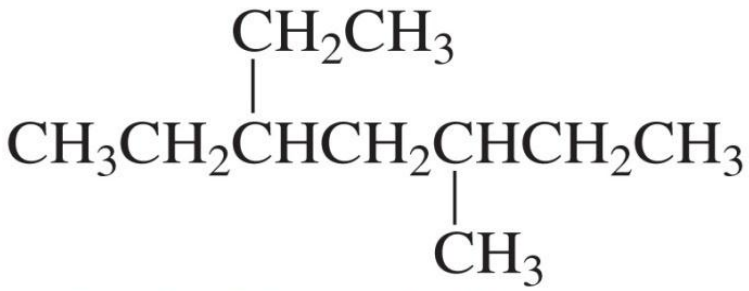
3-ethyl-5,6-dimethyloctane

because 4 < 5

5. If the same substituent numbers are obtained in both directions, the first group cited receives the lower number

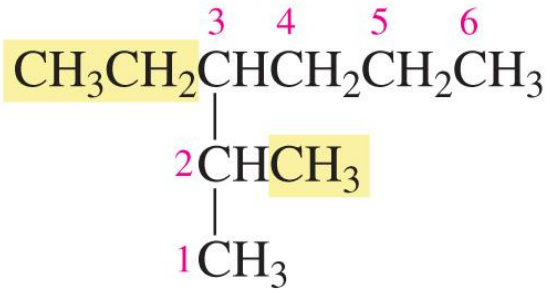


2-bromo-3-chlorobutane
not
3-bromo-2-chlorobutane

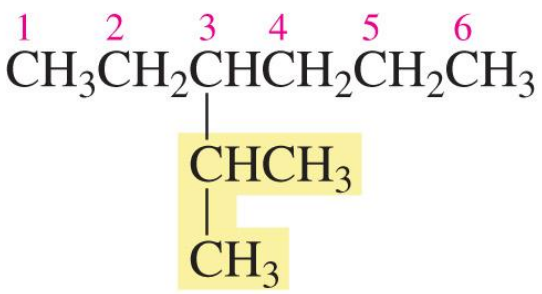


3-ethyl-5-methylheptane
not
5-ethyl-3-methylheptane

6. If a compound has two or more chains of the same length, the parent hydrocarbon is the chain with the greatest number of substituents



3-ethyl-2-methylhexane (two substituents)

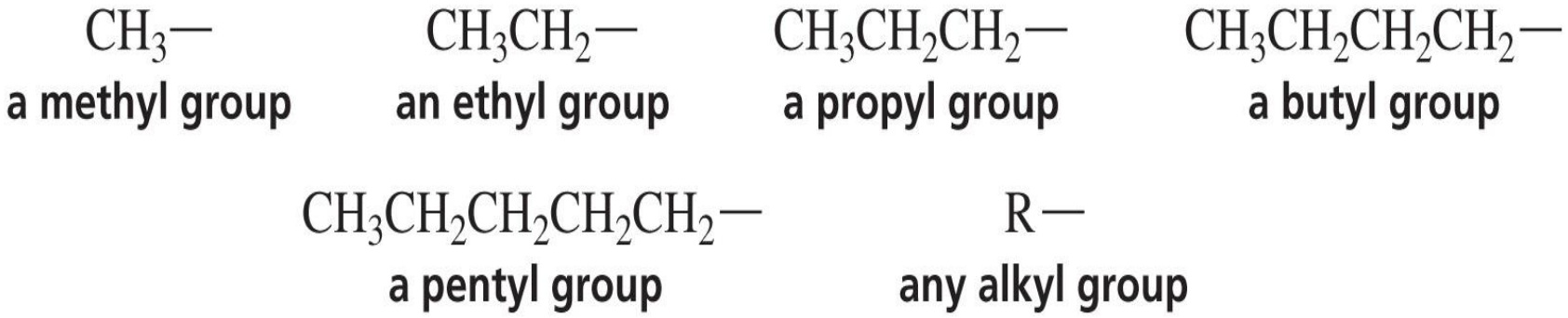


not

3-isopropylhexane (one substituent)

Nomenclature of Alkyl Substituents

Removing a hydrogen from an alkane results in an alkyl substituent



Numbers are used only for systematic names but not common names

common name: isohexane

systematic name: 2-methylpentane

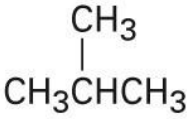
المماكبات البنيوية

- المماكبات التي تختلف بكيفية ترتيب الذرات في السلاسل تسمى المماكبات البنيوية
- مركبات اخرى غير الالكانات يمكن ان تكون مماكبات بنيوية الواحدة بالنسبة للاخرى
- يجب ان يكون لها نفس الصيغة الجزيئية

Table 3.2 Number of Alkane Isomers

Formula	Number of isomers
C_6H_{14}	5
C_7H_{16}	9
C_8H_{18}	18
C_9H_{20}	35
$C_{10}H_{22}$	75
$C_{15}H_{32}$	4,347
$C_{20}H_{42}$	366,319
$C_{30}H_{62}$	4,111,846,763

Different carbon skeletons
C_4H_{10}



2-Methylpropane (isobutane)

and

$CH_3CH_2CH_2CH_3$

Butane

Different functional groups
C_2H_6O

CH_3CH_2OH

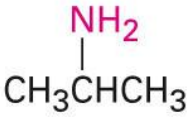
Ethanol

and

CH_3OCH_3

Dimethyl ether

Different position of functional groups
C_3H_9N



Isopropylamine

and

$CH_3CH_2CH_2NH_2$

Propylamine

Constitutional Isomers

- Isomers that differ in how their atoms are arranged in chains are called **constitutional isomers**
- Compounds other than alkanes can be **constitutional isomers** of one another
- They must have the same molecular formula to be isomers

Table 3.2 Number of Alkane Isomers

Formula	Number of isomers
C_6H_{14}	5
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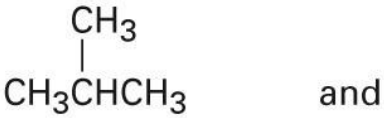
Different carbon skeletons
C_4H_{10}

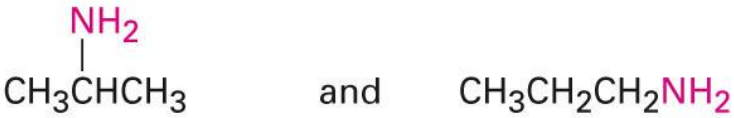


2-Methylpropane (isobutane) and **Butane**

Different functional groups
C_2H_6O

Ethanol and **Dimethyl ether**

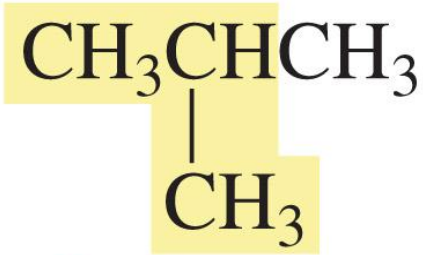
Different position of functional groups
C_3H_9N



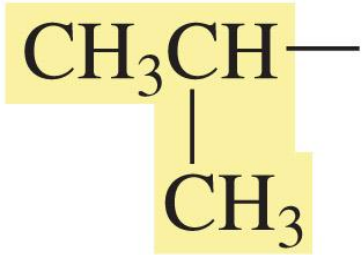
Isopropylamine and **Propylamine**

Constitutional isomers have the same molecular formula, but their atoms are linked differently

butane

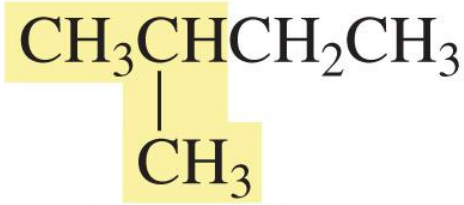


isobutane

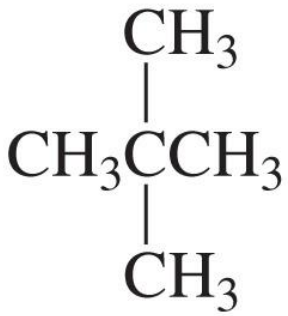


an "iso" structural unit

pentane



isopentane



2,2-dimethylpropane

تمثيل بنية الالكانات

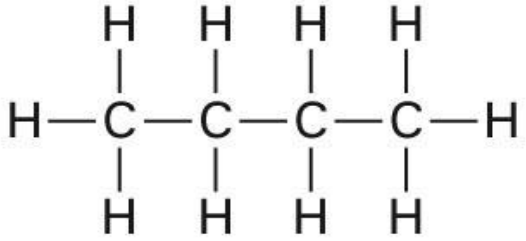
يمكن تمثيل صيغة الالكانات باشكال مختلفة :

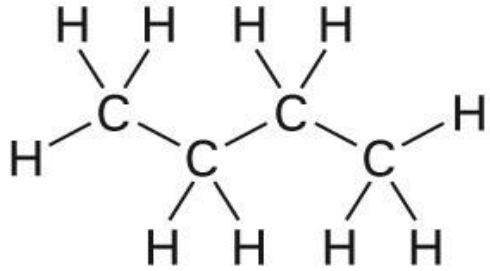
- بنية مكثفة (**Condensed**) لا تكتب فيها الروابط ، تكتب فيها الذرات فقط مثال

$CH_3CH_2CH_2CH_3$ (butane)

$CH_3(CH_2)_2CH_3$ (butane)

- بنية منشورة تكتب فيها جميع الروابط مع الكربون والهيدروجين
- او مختصرة على روابط بين كربون كربون وعدد ذرات الهيدروجين





$CH_3—CH_2—CH_2—CH_3$ $CH_3CH_2CH_2CH_3$ $CH_3(CH_2)_2CH_3$

Alkyl Groups

- **Alkyl group** – remove one H from an alkane
  (a part of a structure)
- General abbreviation "R" (for Radical, an incomplete species or the "rest" of the molecule)
- Name: replace -*ane* ending of alkane with -*yl* ending
  - CH_3 is "methyl" (from methane)
  - CH_2CH_3 is "ethyl" from ethane

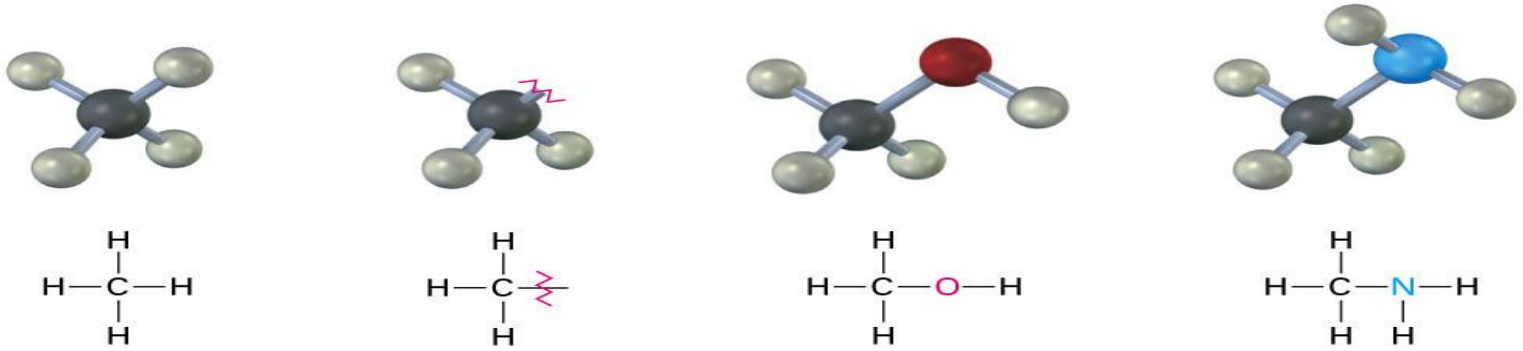


Table 3.4 Some Straight-Chain Alkyl Groups

Alkane	Name	Alkyl group	Name (abbreviation)
CH_4	Methane	$-CH_3$	Methyl (Me)
CH_3CH_3	Ethane	$-CH_2CH_3$	Ethyl (Et)
$CH_3CH_2CH_3$	Propane	$-CH_2CH_2CH_3$	Propyl (Pr)
$CH_3CH_2CH_2CH_3$	Butane	$-CH_2CH_2CH_2CH_3$	Butyl (Bu)
$CH_3CH_2CH_2CH_2CH_3$	Pentane	$-CH_2CH_2CH_2CH_2CH_3$	Pentyl, or amyl

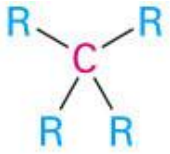
Types of Alkyl groups

- Classified by the connection site
  - a carbon at the end of a chain (primary alkyl group)
  - a carbon in the middle of a chain (secondary alkyl group)
  - a carbon with three carbons attached to it (tertiary alkyl group)

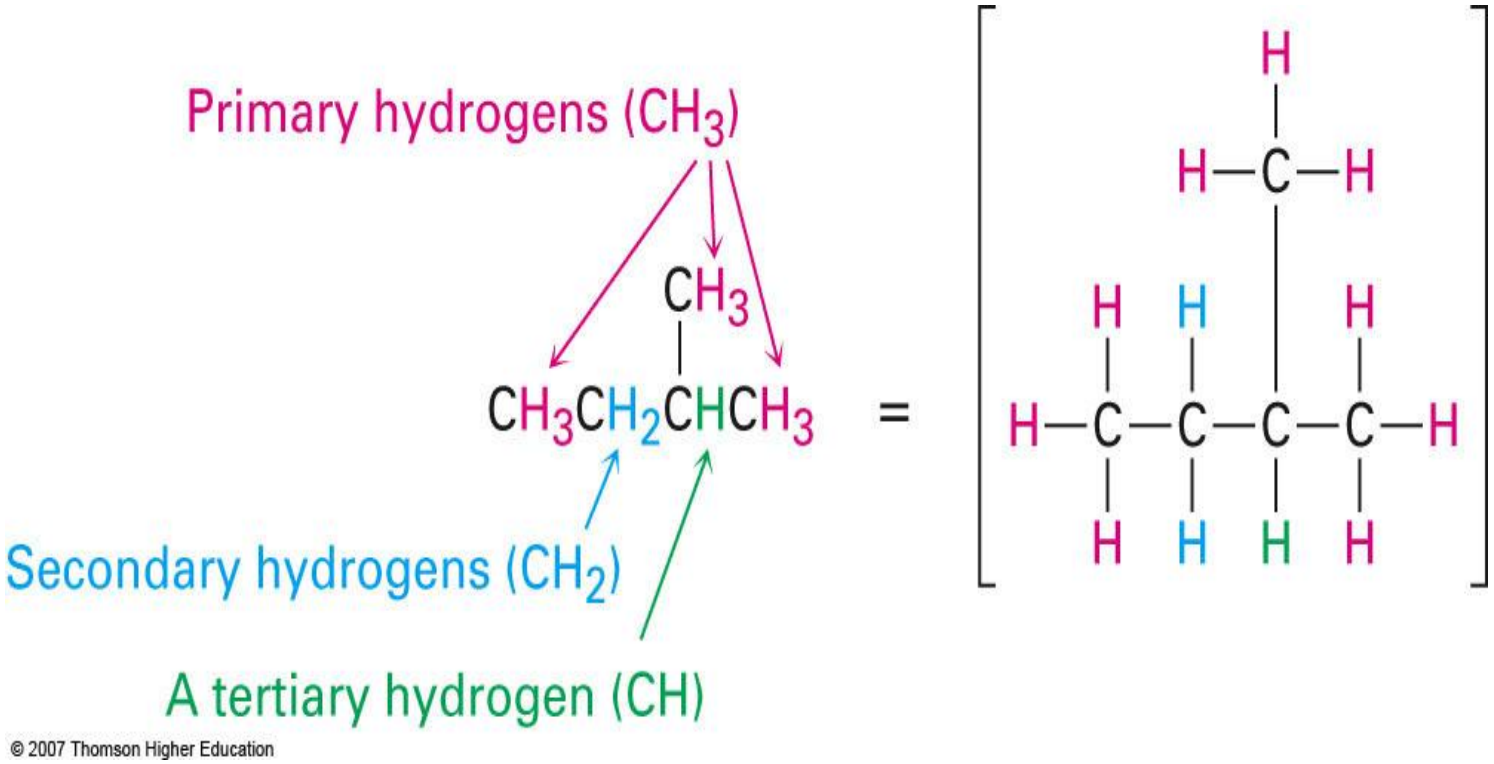
Primary **carbon (1°) is bonded to one other carbon.**

Secondary **carbon (2°) is bonded to two other carbons.**

Tertiary **carbon (3°) is bonded to three other carbons.**

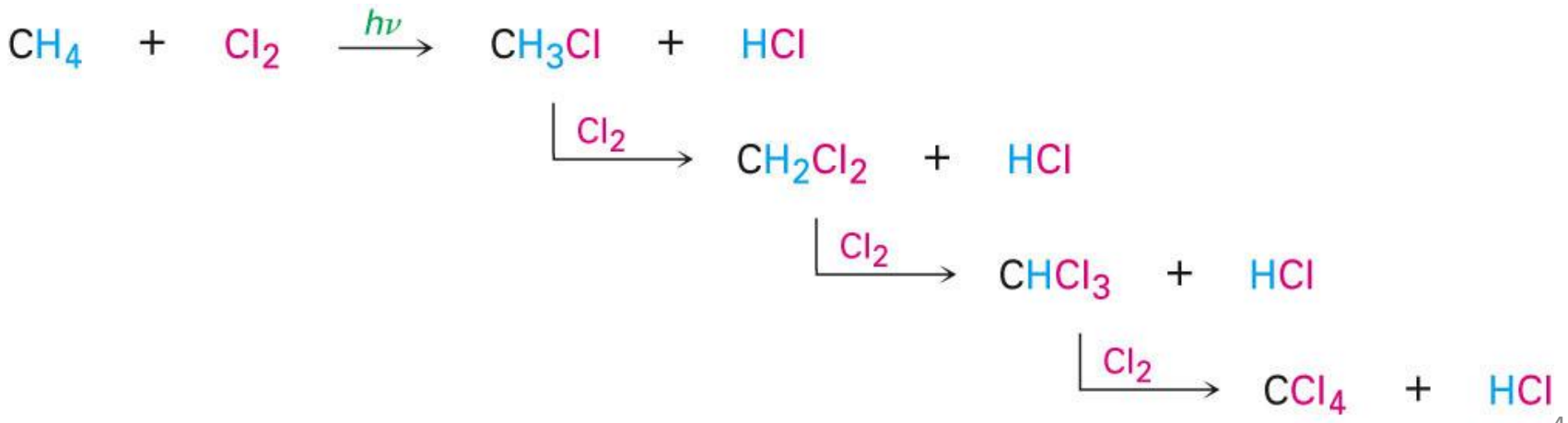


Quaternary **carbon (4°) is bonded to four other carbons.**



Chemical Properties :الصفات الكيميائية

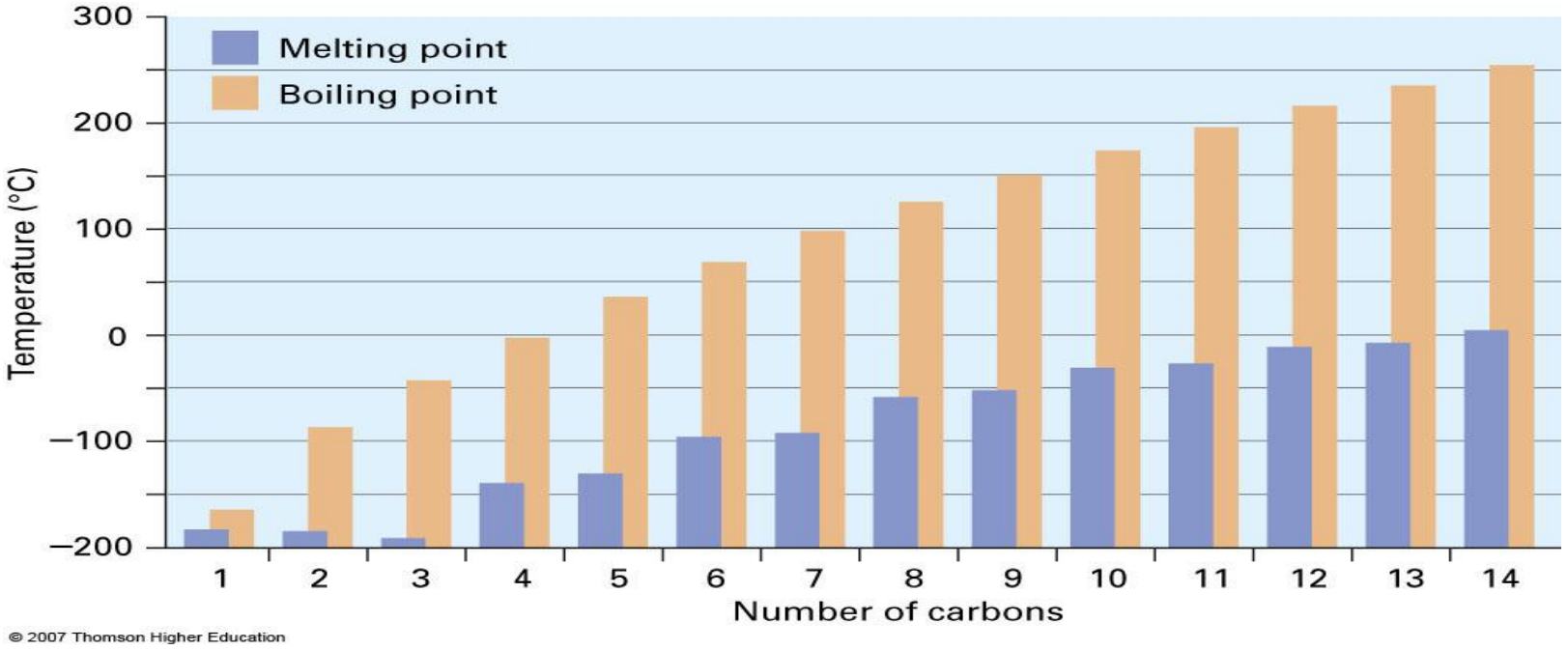
- Called **paraffins** (low affinity compounds) because they do not react as most chemicals
- They will burn in a flame, producing carbon dioxide, water, and heat
- They react with Cl_2 in the presence of light to replace H's with Cl's (not controlled)



Physical Properties :الصفات الفيزيائية

- Boiling points and melting points increase as size of alkane increases
- Dispersion forces increase as molecule size increases, resulting in higher melting and boiling points

- تزداد كل من درجة الغليان درجة الانصهار مع زيادة طول الالكان
- تزداد قوى التبعثر مع زيادة حجم الجزيئة مما يزيد من درجة الغليان والانصهار



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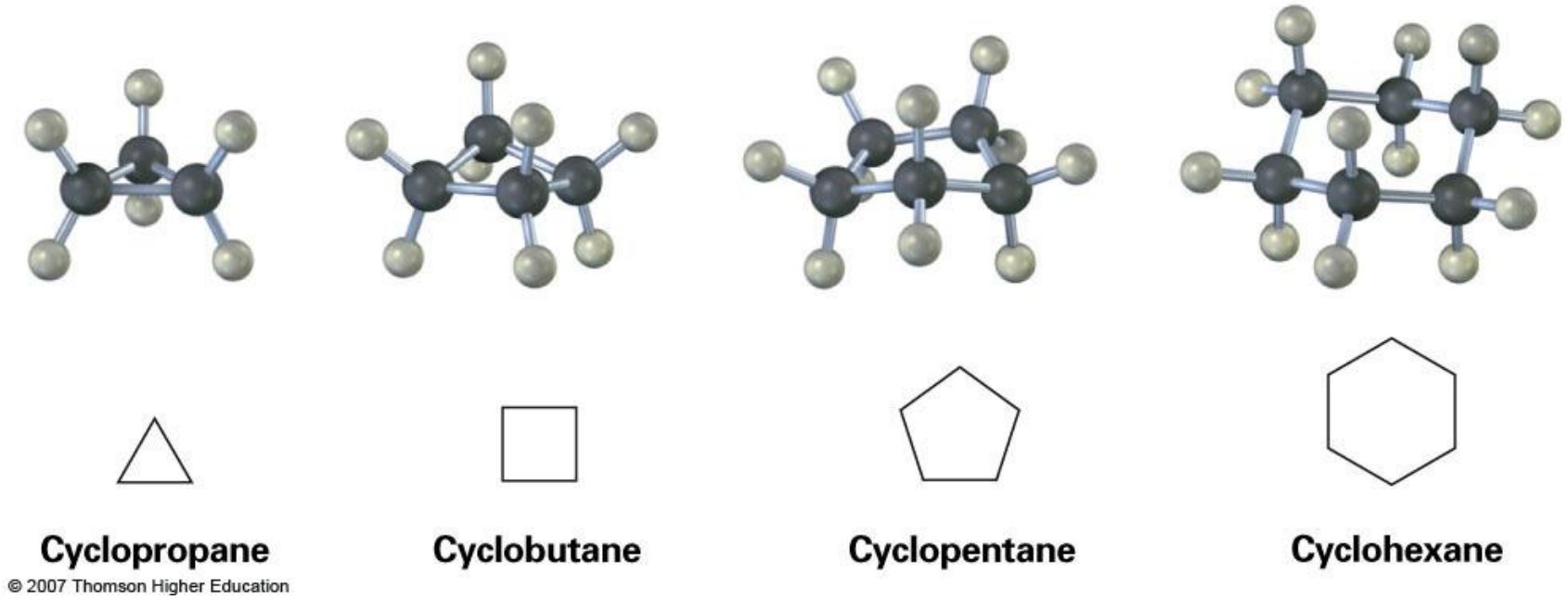
المركبات العضوية
Cycloalkanes
الالكانات الحلقية

Cycloalkanes تسمية الالكانات الحلقية

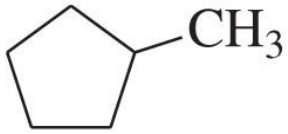
- **Cycloalkanes** are saturated cyclic hydrocarbons
- Have the general formula (C_nH_{2n})

- **Cycloalkanes** هي مركبات عضوية مشبعة
- الصيغة العامة لها : **(C_nH_{2n})**

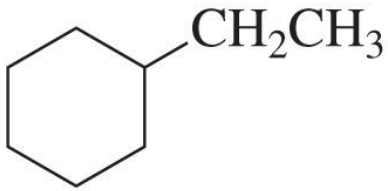


Nomenclature of Cycloalkanes

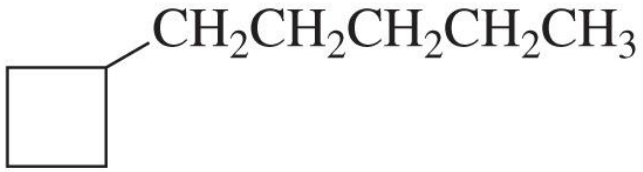
1. No number is needed for a single substituent on a ring



methylcyclopentane

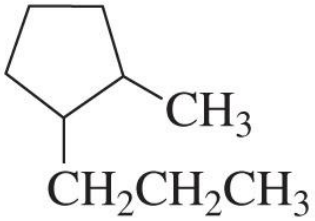


ethylcyclohexane

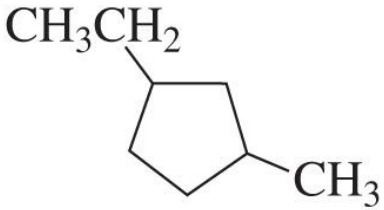


1-cyclobutylpentane

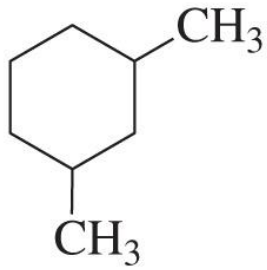
2. Name the two substituents in alphabetical order



1-methyl-2-propylcyclopentane



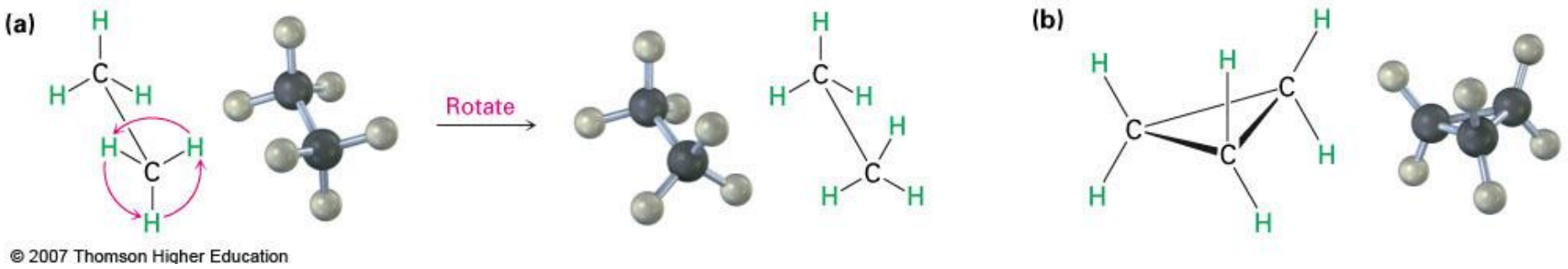
1-ethyl-3-methylcyclopentane



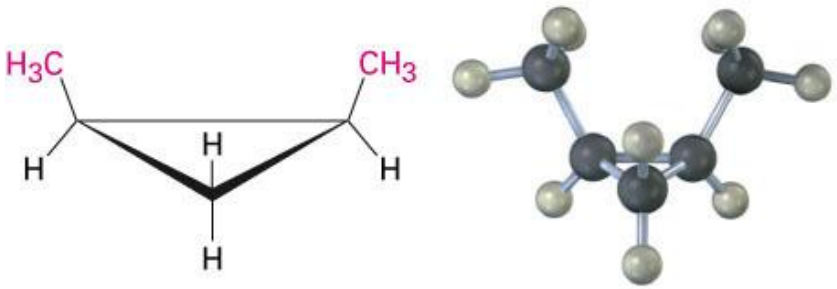
1,3-dimethylcyclohexane

Cis-Trans Isomerism in Cycloalkanes
التماكب المقرون – المفروق في الالكانات الحلقية

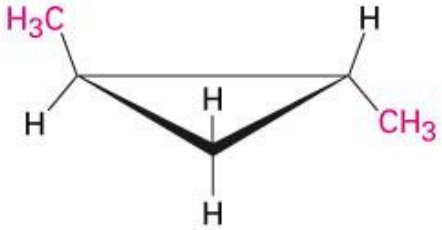
- **Cycloalkanes are less flexible than open-chain alkanes**
- **Much less conformational freedom in cycloalkanes**

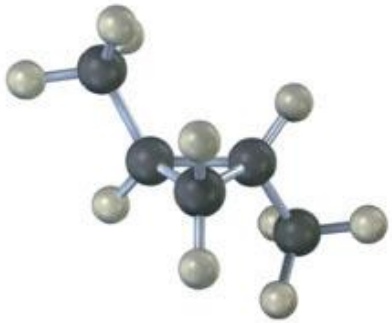


- Because of their cyclic structure, cycloalkanes have 2 faces as viewed edge-on “top” face “bottom” face
- Therefore, **isomerism** is possible in substituted cycloalkanes
- There are two different 1,2-dimethyl-cyclopropane isomers



***cis*-1,2-Dimethylcyclopropane**



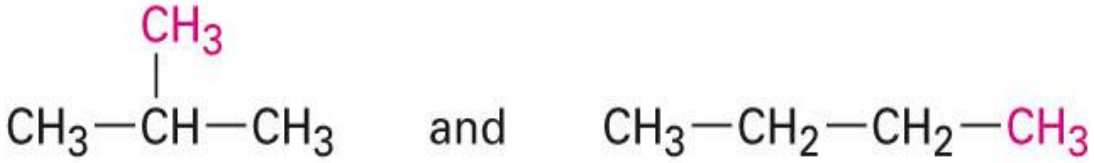


***trans*-1,2-Dimethylcyclopropane**

Stereoisomerism : المماكبات الفراغية

- المركبات التي ترتبط ذراتها بنفس الترتيب لكن تختلف في شكلها ثلاثي الابعاد تعرف باسم المماكبات الفراغية

Constitutional isomers
(different connections between atoms)



Stereoisomers
(same connections but different three-dimensional geometry)