ISOMERS

ISOMERS

What are Isomers?

- Isomers represent different forms, or structures, of the same molecular formula

- There are three types:
  - Structural (constitutional)
  - Stereoisomers
    - Diastereoisomers (geometric)
    - Enantiomers (optical)

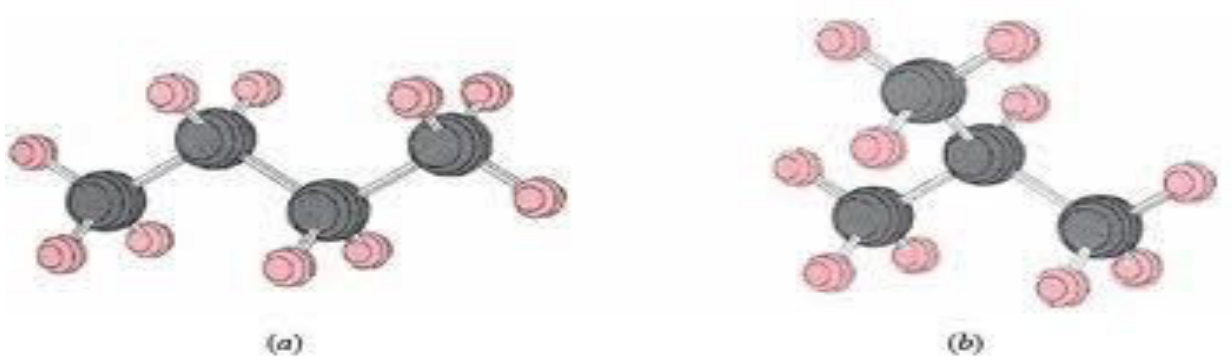
STRUCTURAL ISOMERS

STRUCTURAL ISOMERS

Structural Isomers

- Atoms are bonded together in a different arrangement

C_4H_{10}



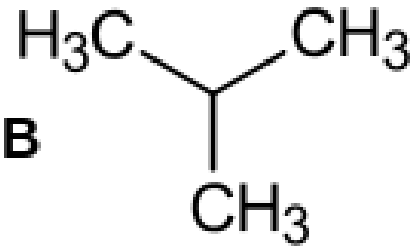
STRUCTURAL ISOMERS

Compounds with the same molecular formula but with different bonding arrangements are *structural isomers*.

Butane isomers

A

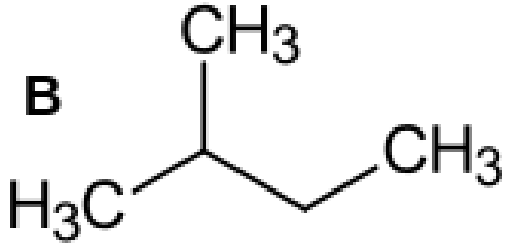
B



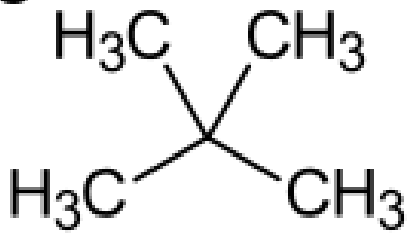
Pentane isomers

A

B

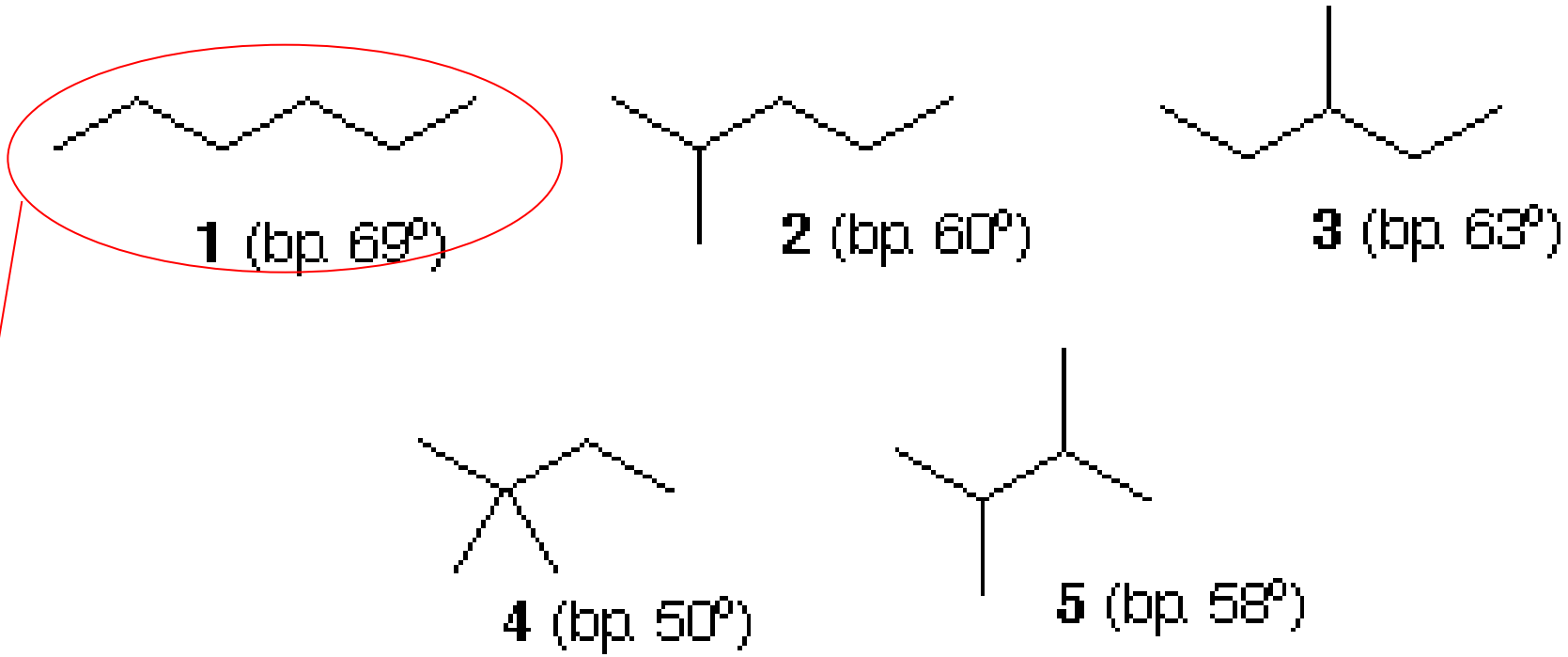


C



STRUCTURAL ISOMERS

Ex: Structural isomers of hexane + boiling points



Changing the structure affects the boiling point

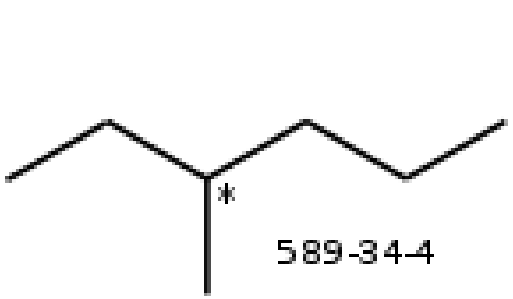
This structure can easily stack and form more London Dispersion Forces with neighbouring hexane molecules

STRUCTURAL ISOMERS

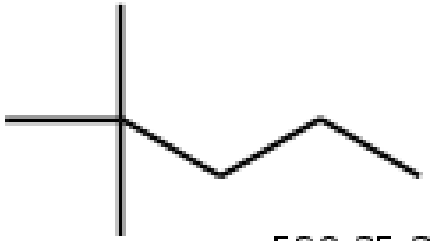
Draw all of the structural isomers of heptane using line structures:

CAS# 142-82-5

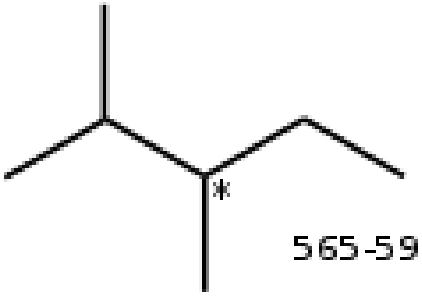
591-76-4



589-34-4

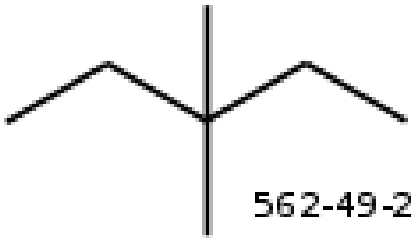


590-35-2

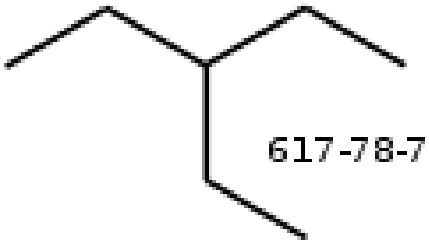


565-59-3

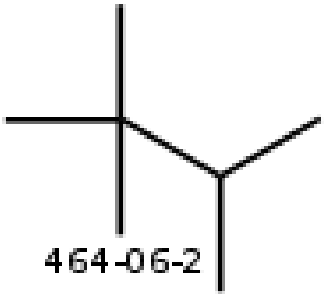
108-08-7



562-49-2



617-78-7



464-06-2

STRUCTURAL ISOMERS

The longer the chain, the greater the number of structural isomers

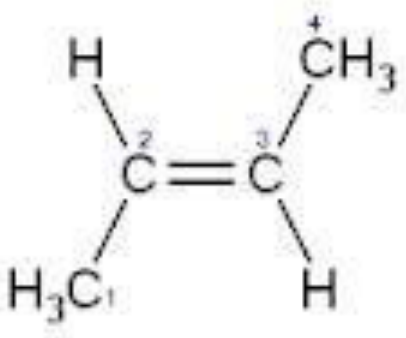
Number of Carbon Atoms	Number of Isomers
4	2
5	3
6	5
7	9
8	18
9	35
10	75
12	355
15	4347

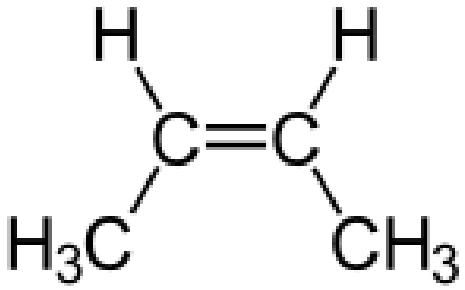
STEREOISOMERS

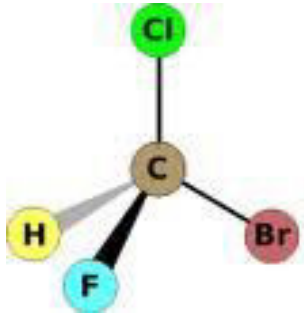
STEREOISOMERS

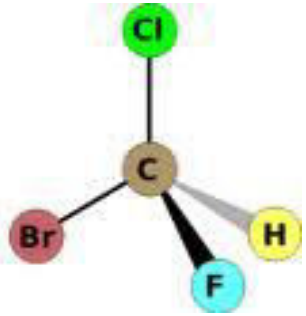
Stereoisomers

- Atoms are bonded together in the same sequence, but differ in the 3-D orientations of their atoms in space







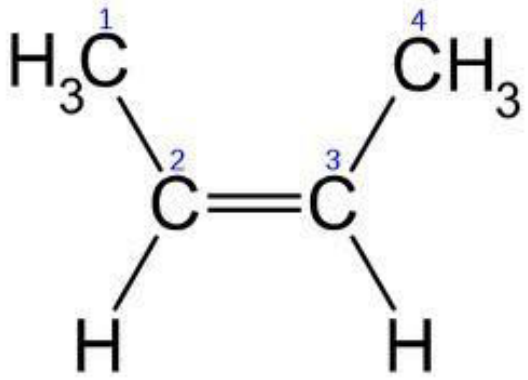


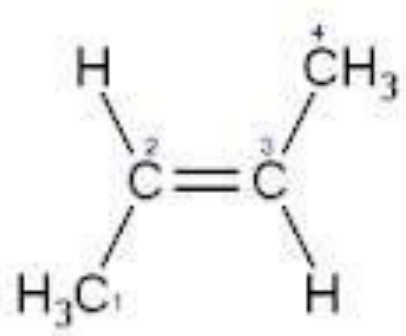
STEREOISOMERS

Diastereoisomer

- Form when each carbon atom involved in the double bond has different types of atoms or groups bonded to it

But-2-ene

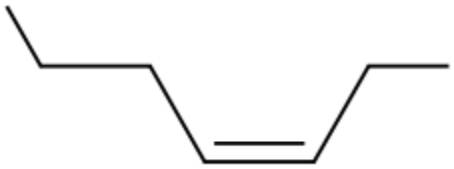




STEREOISOMERS

Cis- or Trans-?

- Cis- when 2 identical groups are on the same side of the double bond
- Trans- when 2 identical groups are on opposite sides of the double bond



cis-hept-3-ene

(2*Z*)-hept-3-ene

trans-hept-3-ene

(2*E*)-hept-3-ene

STEREOISOMERS

Draw the two diastereoisomers of pent-2-ene

cis-pent-2-ene

(2*Z*)-pent-2-ene

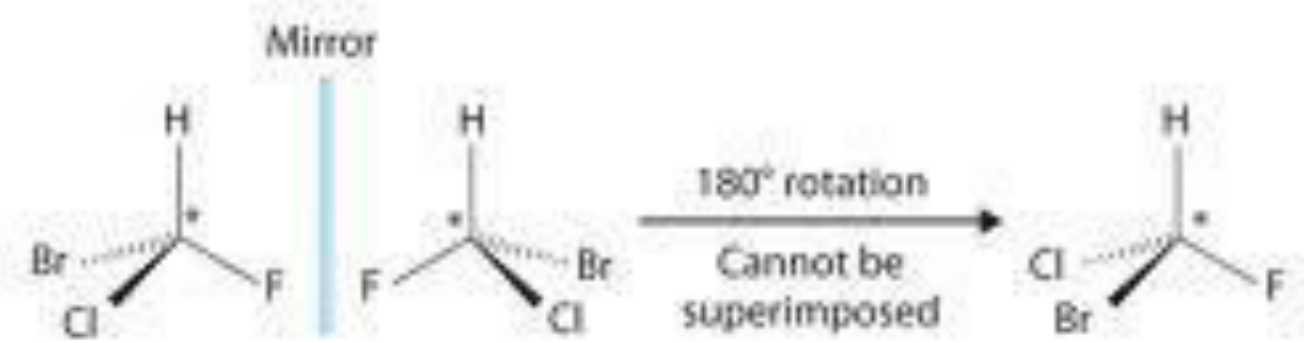
trans-pent-2-ene

(2*E*)-pent-2-ene

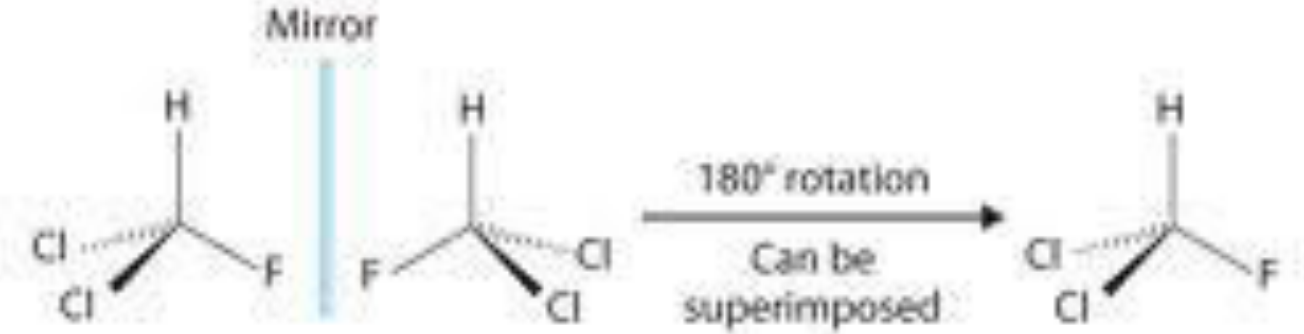
STEREOISOMERS

Enantiomers

- Molecules are mirror images of each other around a single carbon atom bonded to 4 different groups (chiral carbon)



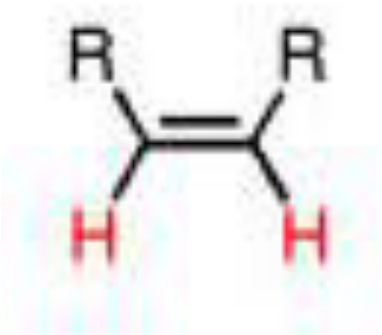
(a) Bromochlorofluoromethane

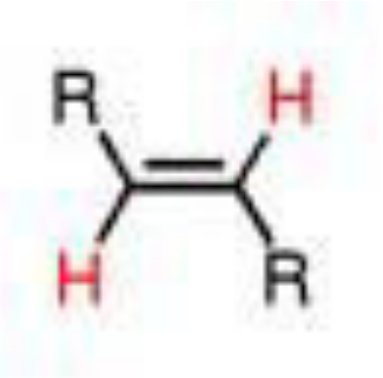


(b) Dichlorofluoromethane

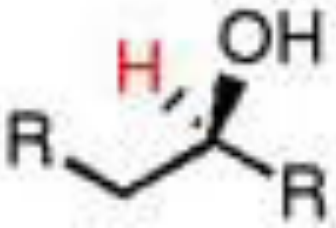
STEREOISOMERS

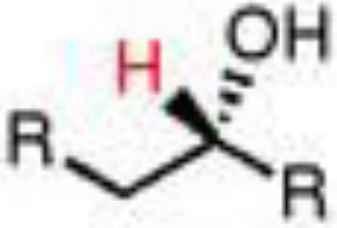
Diastereomers vs. Enantiomers





stereoisomers
(diastereomers)



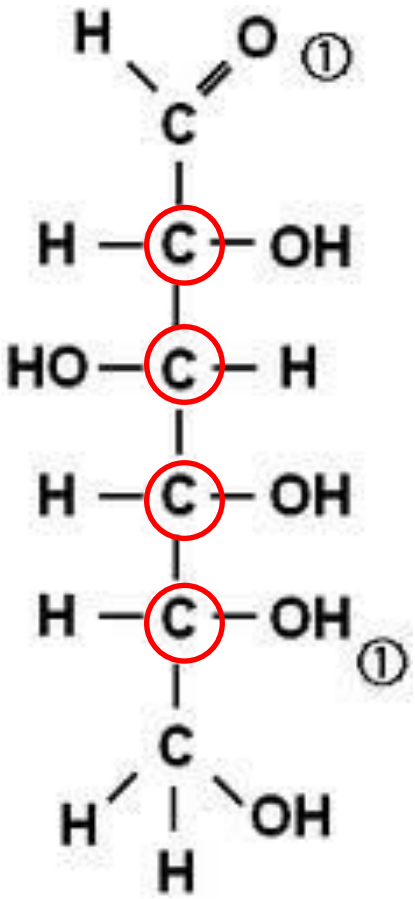


stereoisomers
(*enantiomers*)

STEREOISOMERS

For n number of chiral carbons there are 2^n number of possible stereoisomers.

Identify the number of stereoisomers of this molecule:



1. Count chiral carbons

4

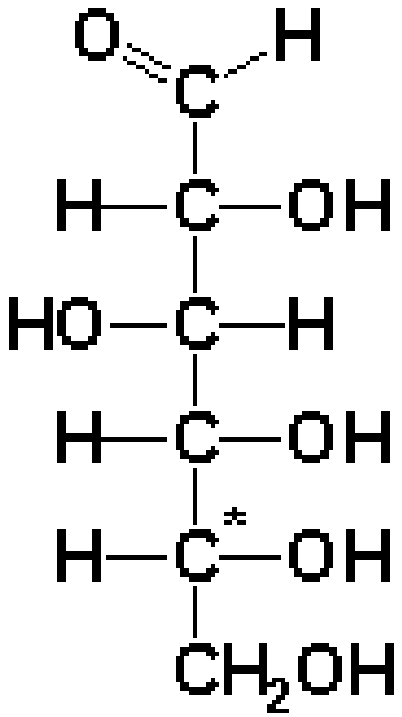
2. Use formula 2^n

$2^{(4)}$ = 16 stereoisomers

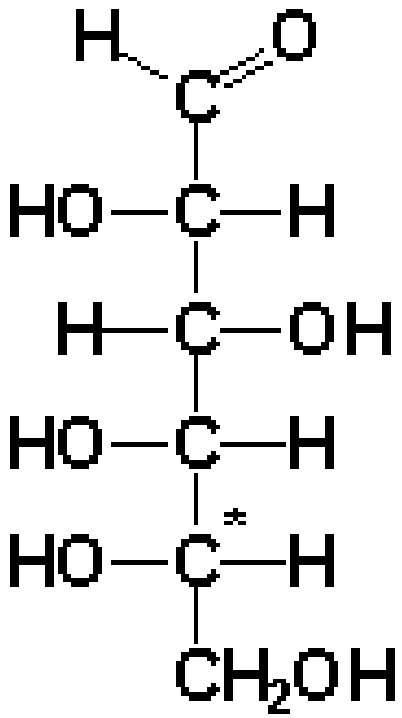
STEREOISOMERS

Glucose in its chain form has 16 stereoisomers. How many enantiomers does it have?

Two, because enantiomers are non-superimposable mirror images. The remaining 14 are diastereomers.



D-glucose



L-glucose

STEREOISOMERS

HOMEWORK:

- PG 17 # 3
- PG 23 # 1-3
- PG 27 # 7
- WORKSHEET

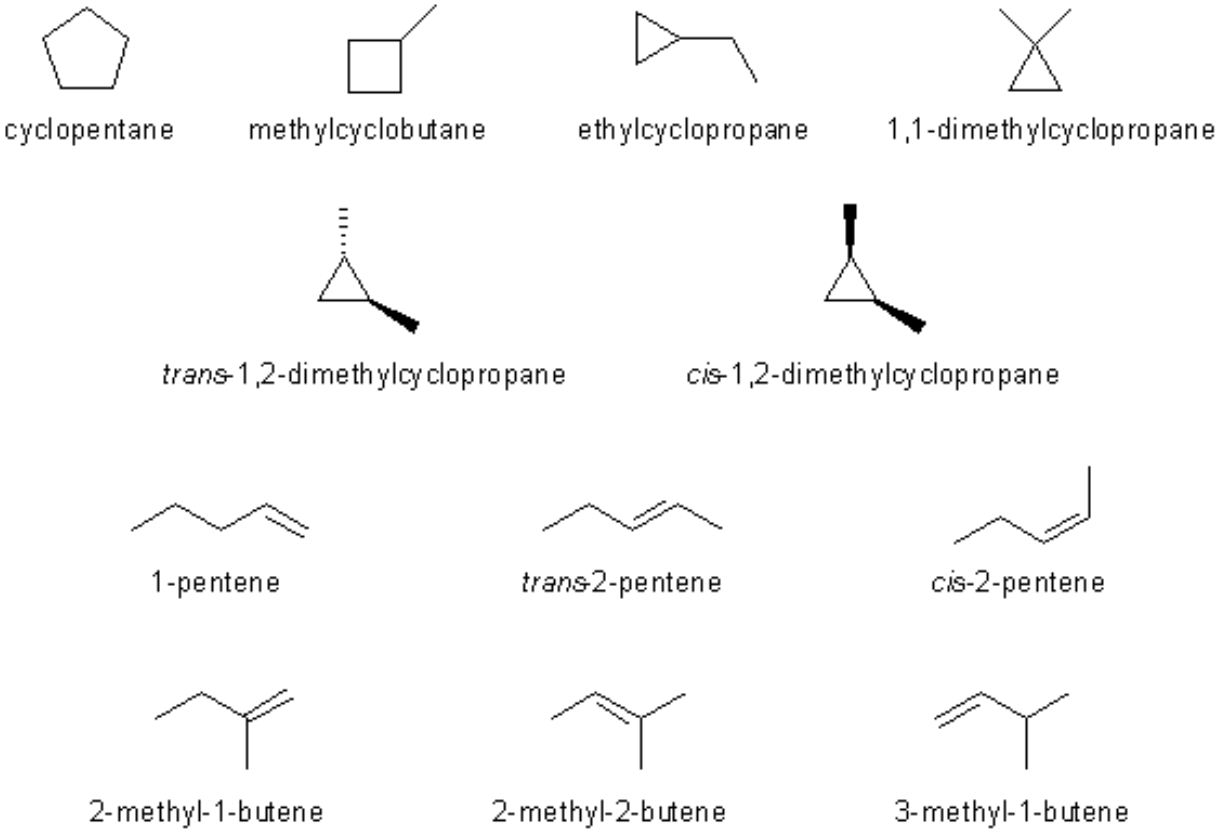
SIDE-GROUP ISOMERS

SIDE-GROUP ISOMERS

Isomers

- Isomers are chemicals which have the same chemical formula, but different arrangement of atoms.

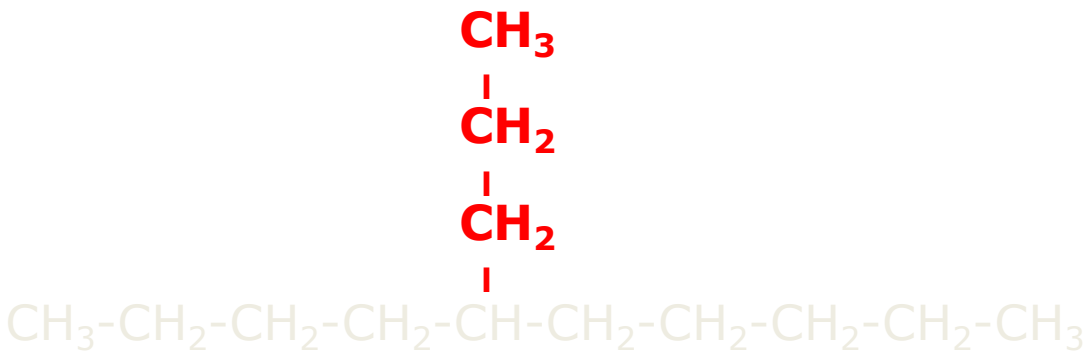
- Nomenclature should help differentiate one isomer from another.



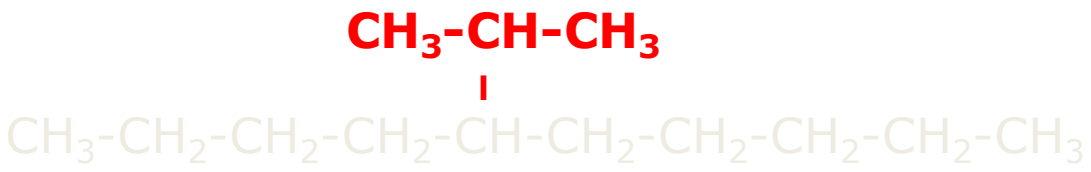
SIDE-GROUP ISOMERS

Propyl isomers:

n-propyl group



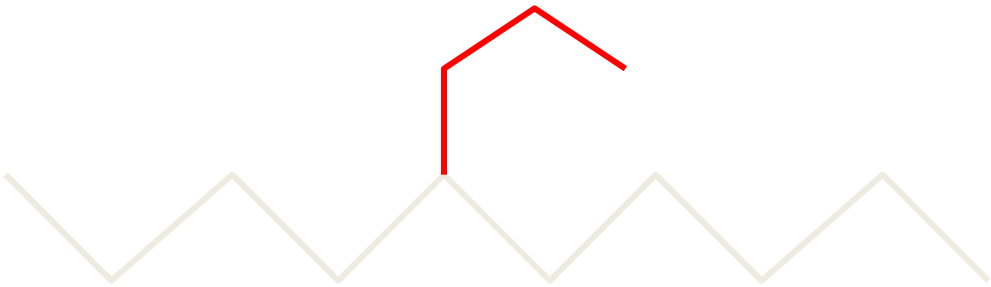
isopropyl group



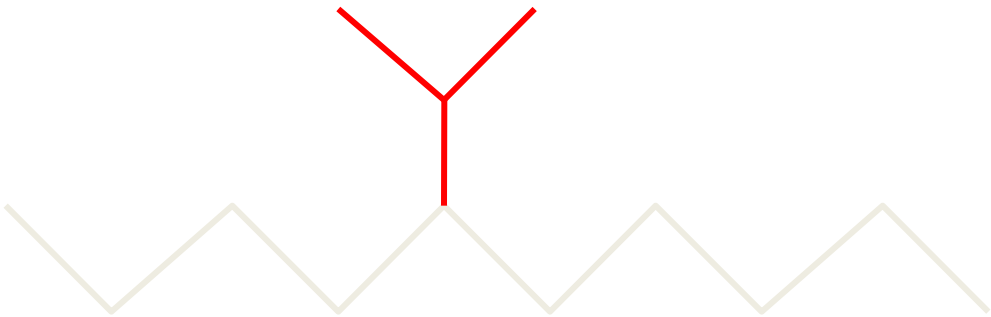
SIDE-GROUP ISOMERS

Propyl isomers:

n-propyl group



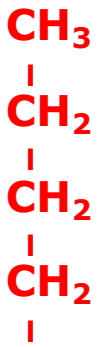
isopropyl group



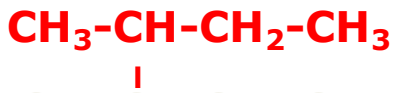
SIDE-GROUP ISOMERS

Butyl isomers:

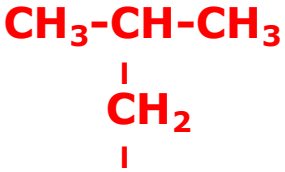
n-butyl group



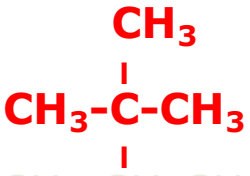
sec-butyl group
(*s*-butyl)



isobutyl group



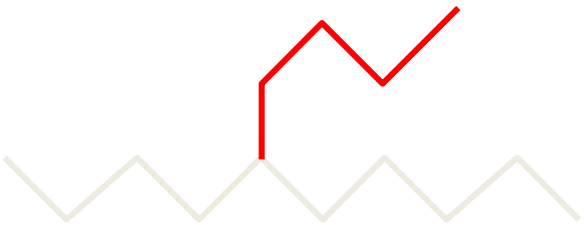
tert-butyl group
(*t*-butyl)



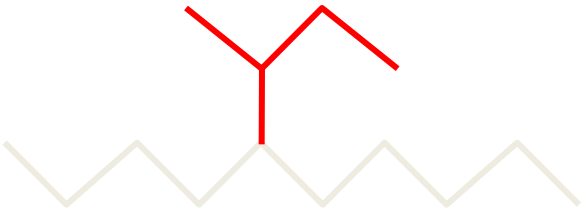
SIDE-GROUP ISOMERS

Butyl isomers:

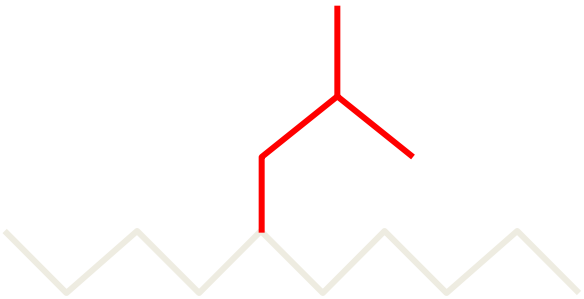
n-butyl group



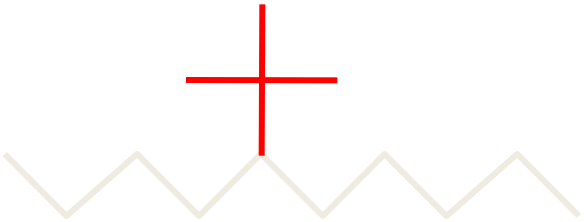
sec-butyl group
(*s*-butyl)



isobutyl group



tert-butyl group
(*t*-butyl)

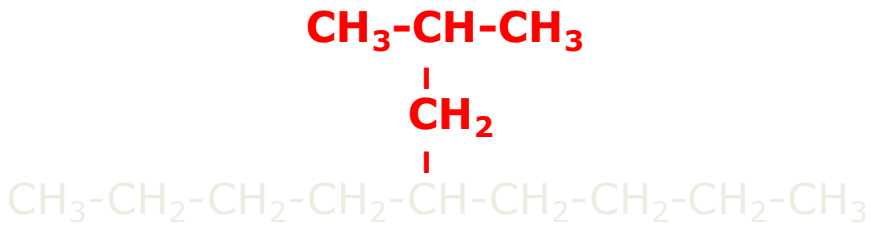


SIDE-GROUP ISOMERS

Terms:

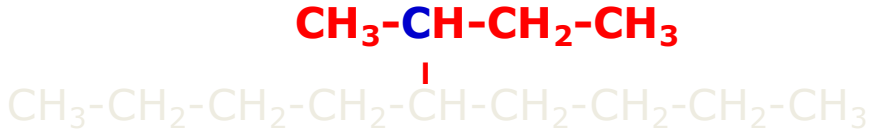
Iso – "equal"/"middle"

(unlike prefixes like "di" and "tri", the "i" in iso affects the alphabetical order)



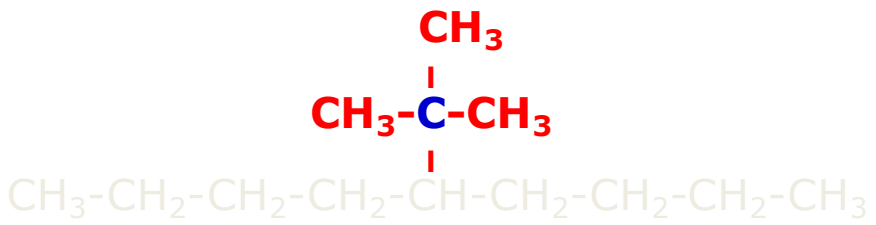
Sec – "secondary"

2 carbons adjacent to the carbon that is attached to the main chain



Tert – "tertiary"

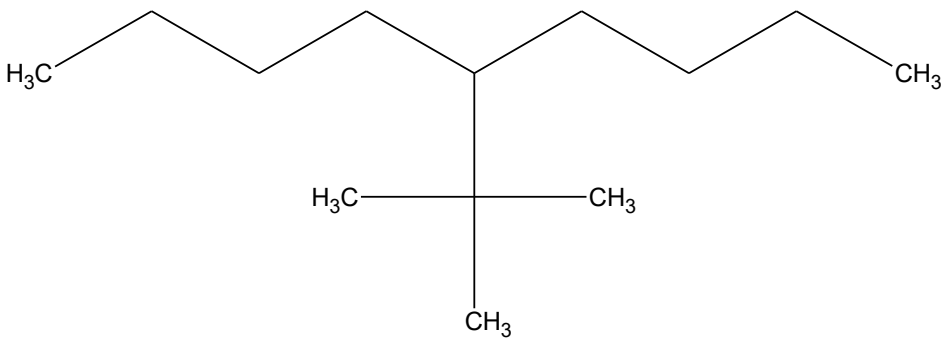
3 carbons adjacent to the carbon that is attached to the main chain

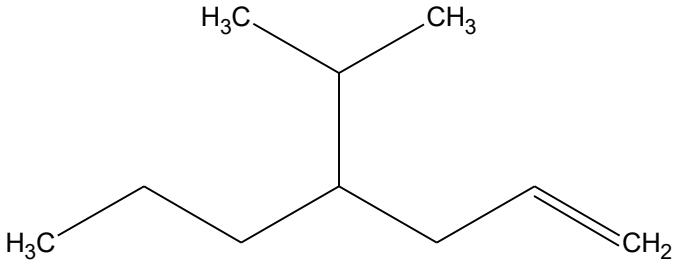


SIDE-GROUP ISOMERS

IUPAC naming system:

Name the following molecules





5-*tert*-butylnonane

4-isopropylhept-1-ene