



King Saud University
College of Pharmacy
Pharm. Chem. Dept.

Pharmaceutical Organic Chemistry PHC 211

كيمياء عضوية صيدلية (٢١١ كمص)

قسم الكيمياء الصيدلية - كلية الصيدلة



LECTURE CONTENTS

- Introduction to stereochemistry.
- Types of isomers.
- Constitutional isomers.
- Stereoisomerism.
- Geometrical isomer.



Stereochemistry



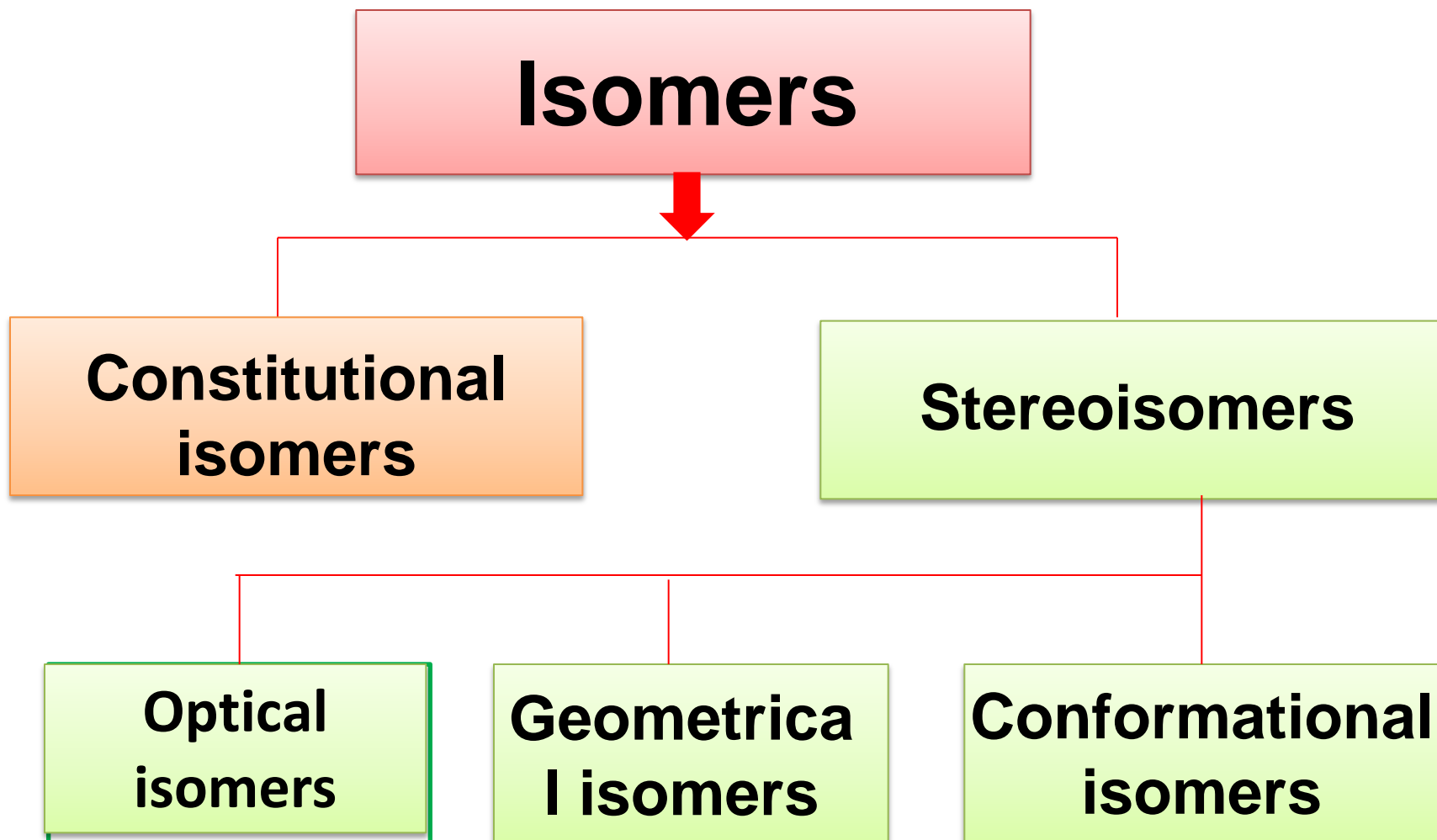
Stereochemistry

- Is the study of molecules on space. i.e. how atoms or groups in a molecule arranged in space relative to each other
-
- It is that part of the science which deals with structure in three dimensions
- Is the field of chemistry that concerned with isomerism (**stereoisomerism**).



Isomerism

- A phenomenon resulting from molecules having the same molecular formula but different arrangement
In space
- When two or more organic compounds have the same molecular formula but differ in their physical or chemical properties they are called Isomers and the phenomenon called **isomerism**.



Constitutional Isomers

Constitutional
isomers

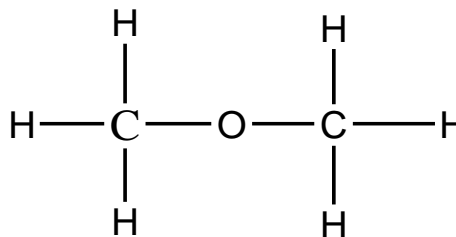
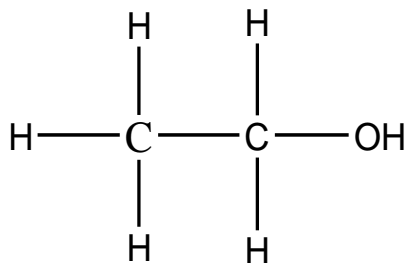


Have the same molecular
formula but different
connectivity

eg. **Ethanol & Dimethylether**

Same molecular formula, C_2H_6O

But the atoms in each compound are connected
differently





Cont.
Constitutional Isomers

➤ They differ in the way their atom are connected.

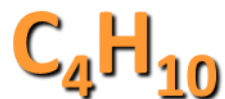
1. Chain isomerism
2. Positional isomerism
3. Functional isomerism



Chain Isomerism

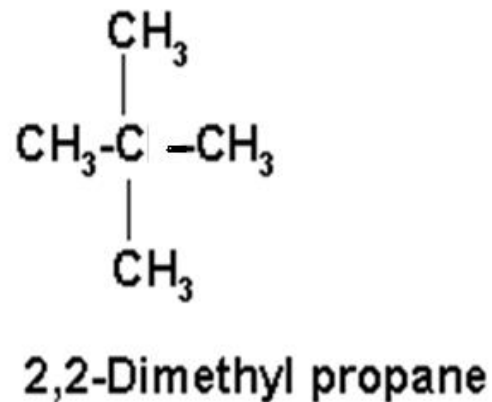
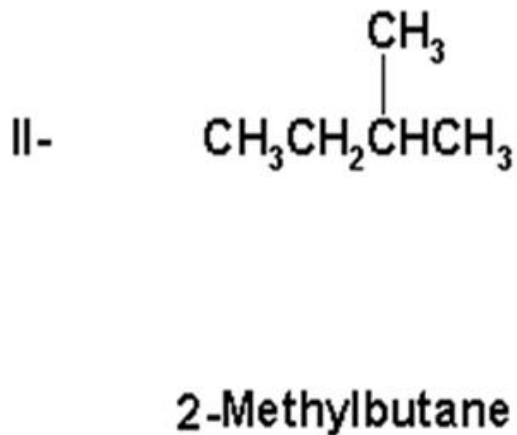
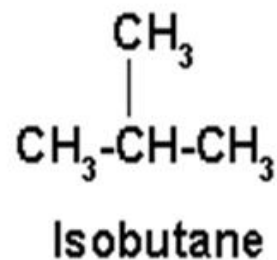
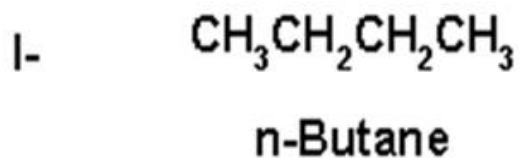
Chain isomers have the same molecular formula but differ in order in which the carbon atoms are bonded.

➤ **Predict:**



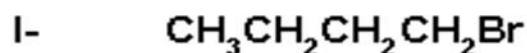
Cont.
Chain Isomerism

Answer:

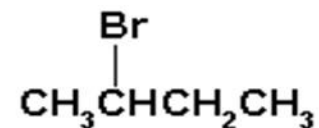


Position Isomers

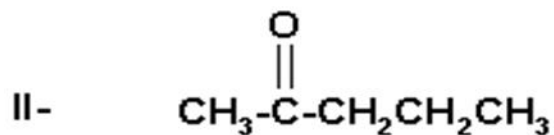
- Position isomers have the same molecular formula but differ in the position of functional group on the carbon chain.
- Examples are:-



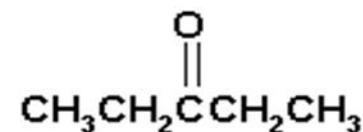
1-Bromobutane



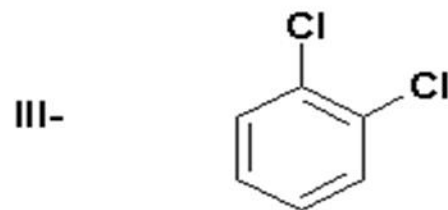
2-Bromobutane



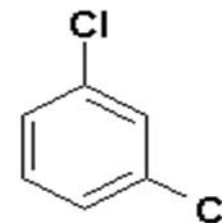
2-Pentanone



3-Pentanone



o-Dichlorobenzene



m-Dichlorobenzene



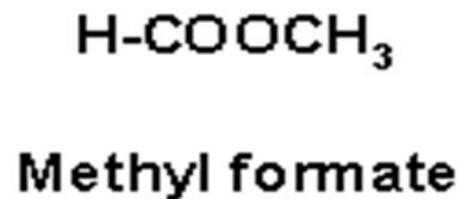
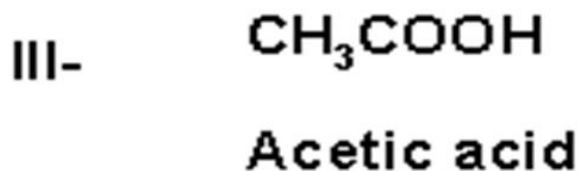
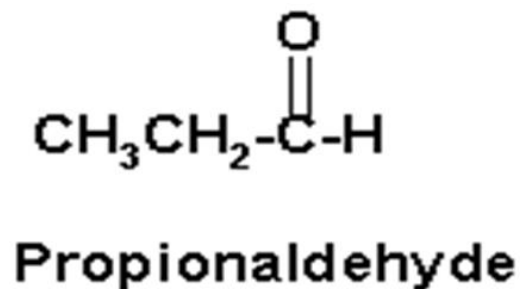
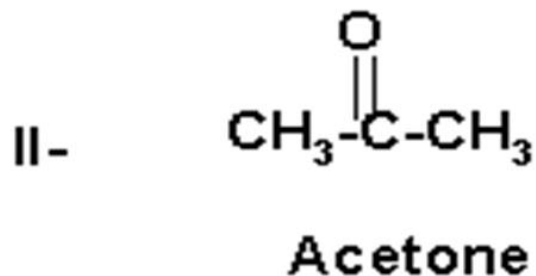
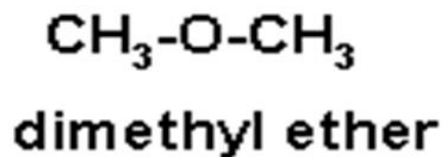
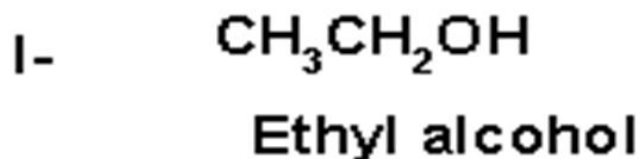
Cont.
Position Isomers

➤ **Predict**



Functional Isomers

Functional isomers have the same molecular formula but different functional groups. Examples are;

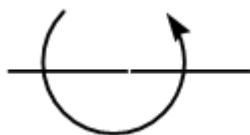


Geometric isomerism

An isomerism resulting from rigidity in molecules and occurs only in two class of compounds
alkenes and cyclic compounds

Rigidity \neq Flexibility

σ - bond



free rotation (flexibility)

π - bond



no free rotation (rigidity)

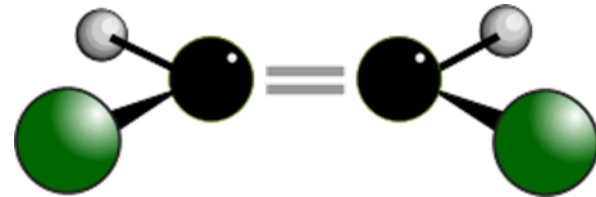
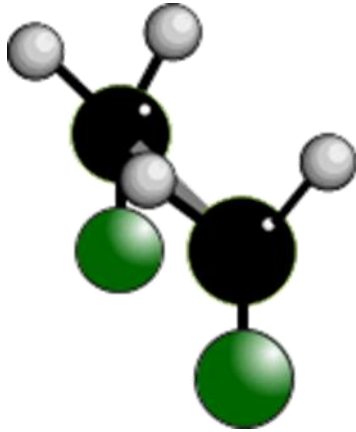
σ - bond



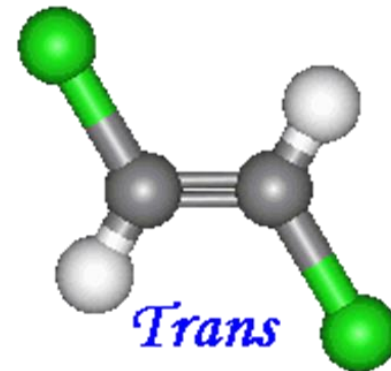
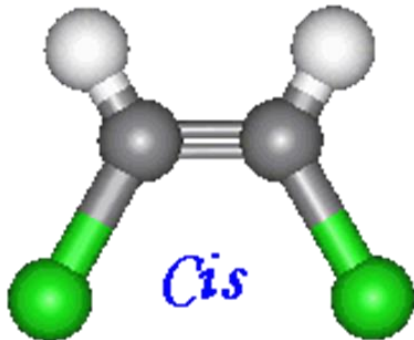
restricted rotation (semi-flexable)

Cont. STEREISOMERISM

Free rotation' of carbon- carbon single bonds

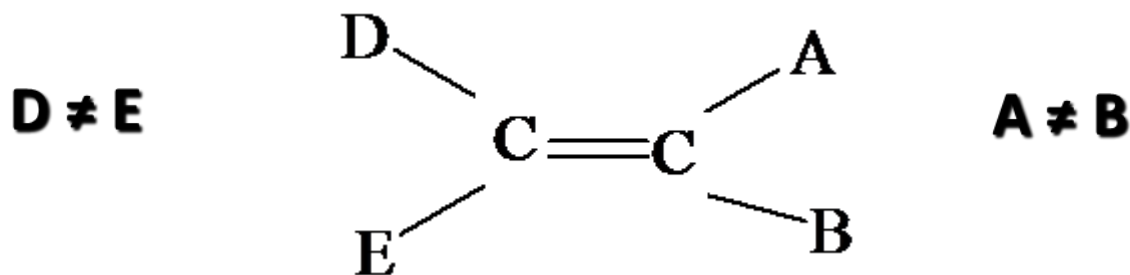


Restricted rotation' of carbon-carbon double bonds

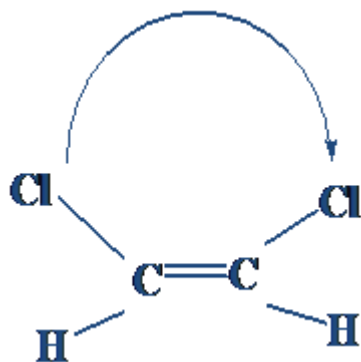


1- Geometric isomerism in alkenes

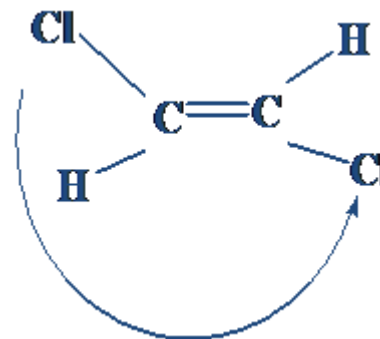
The requirement for this type of isomerism is that each carbon atom involved in the double bond has different substitution



**On same side
cis**

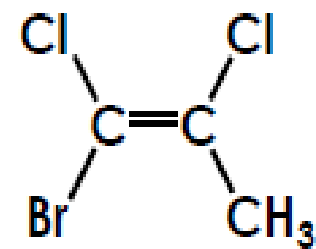
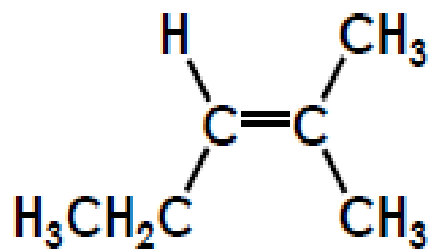
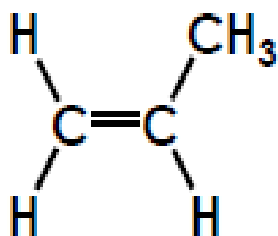


**On differ side
trans**



ACTIVITY

Are the compounds below geometric isomers?





Cont.
Geometric Isomerism in Alkenes

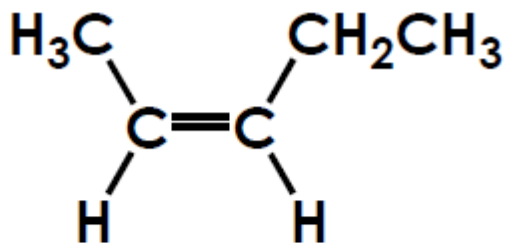
Diastereoisomers are designed cis or trans according to the priority orders or sequence rules [atomic number]



Geometrical Isomers(cis & trans)

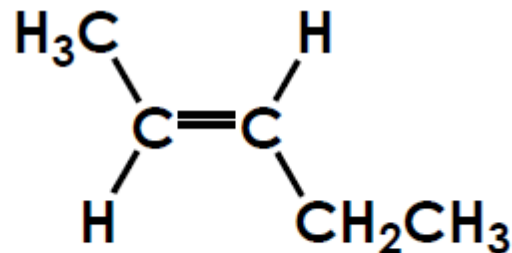
- cis-trans isomers result from restricted rotation

Restricted rotation- caused by either double bond or by cyclic system



cis-2-pentene

Isomers *cis* has hydrogens on the **same side**

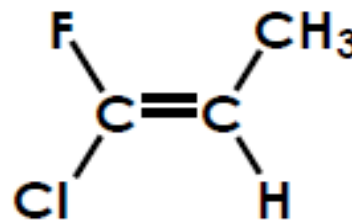
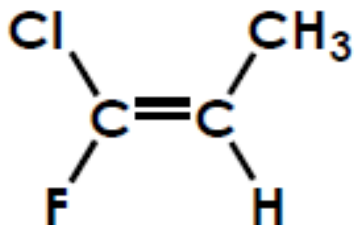


trans-2-pentene

Isomers *trans* has hydrogens on **opposite side** of the double bond

The (*E*, *Z*) system for Nomenclature of alkene

Alkenes with four different substituent



Which isomer is *cis* and which is *trans*?

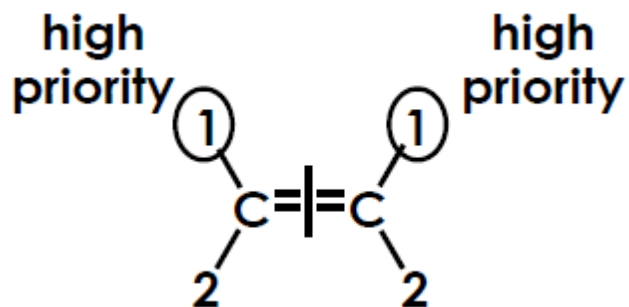
The terms *cis* & *trans* are ambiguous for the two geometric isomers.



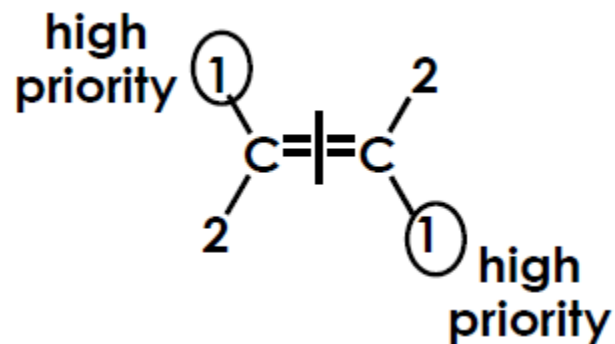
Cont.
E-Z systems

- Mostly used in trisubstituted and, tetrasubstituted double bonds.
- To name an alkene by *E-Z* system, separate the double bond into its 2 end.
- Assign priorities to groups on each C atom.
- Consider each end of the C double bond.
- Assign first and second priorities to substituent group

Cont.
E-Z systems



Two 1st priority atoms
are together (*cis*) on
the same side of the double
bond → **Z-isomer**

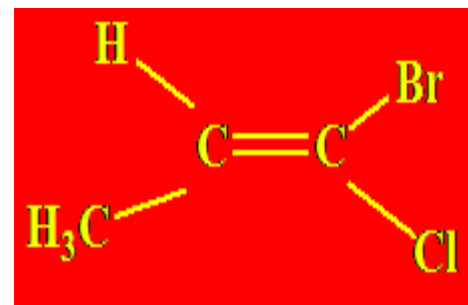
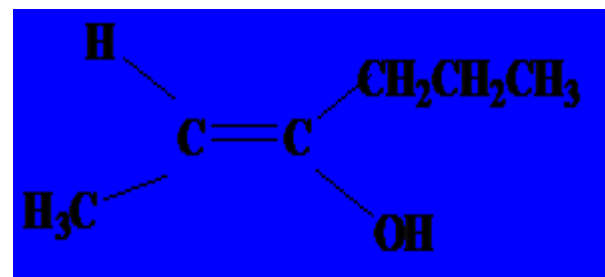
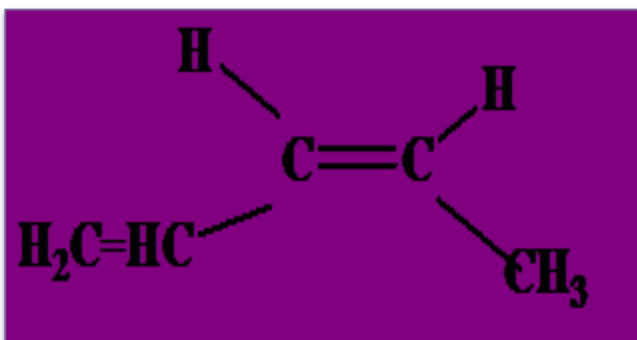


Two 1st priority atoms
are on opposite (*trans*)
side of the double
bond → **E-isomer**

Priority Rules

1- If the two atoms in question are different, the atom of highest atomic number receives the highest priority

$I > Br > Cl > \dots$



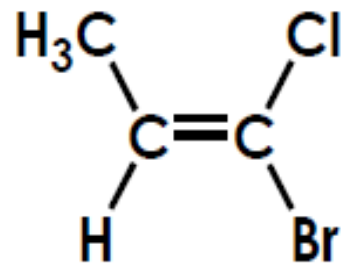
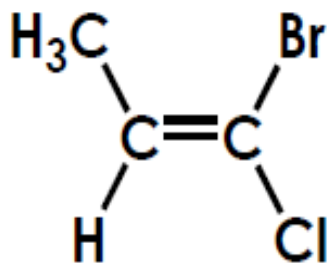
Cont. Priority Rules

Priority – based on atomic number.

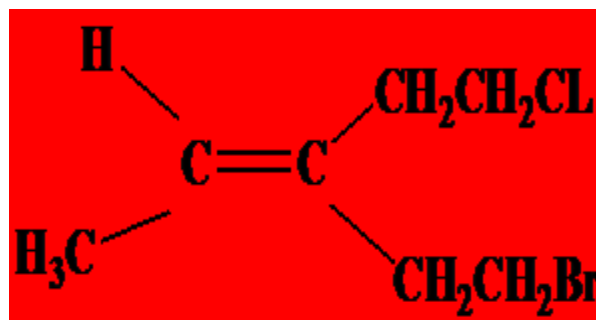
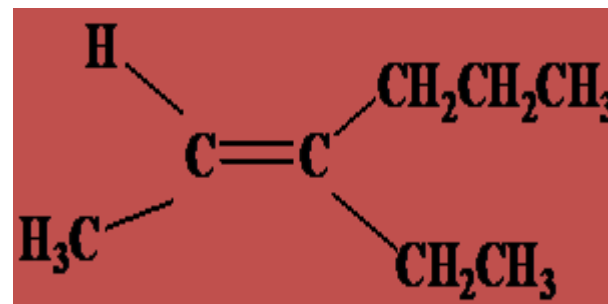
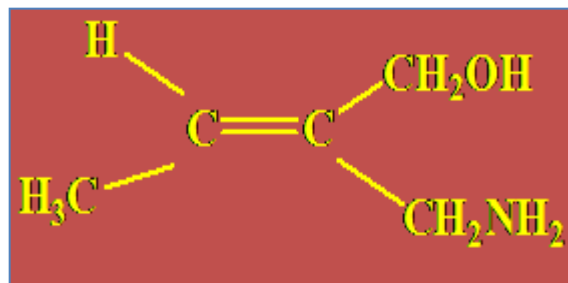
Atom with higher atomic number receive high priorities

F	Cl	Br	I	H	C	N	O
9	17	35	53	1	6	7	8

I > Br > Cl > F > O > N > C > H

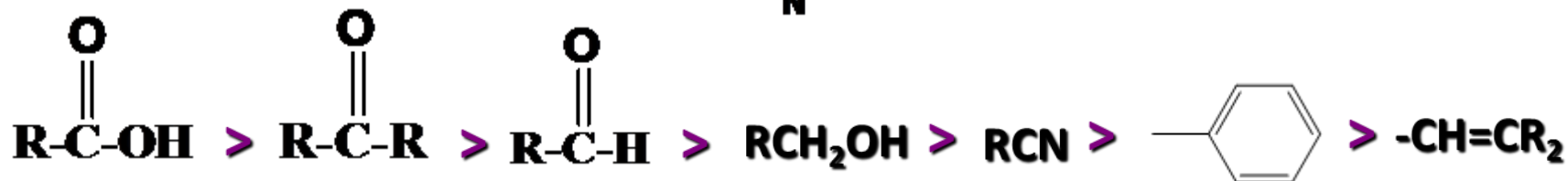
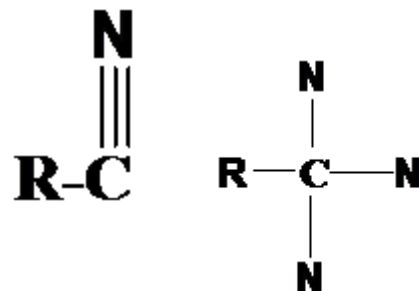
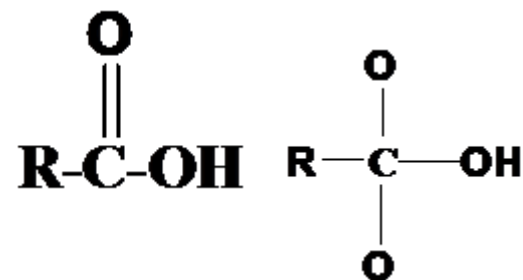
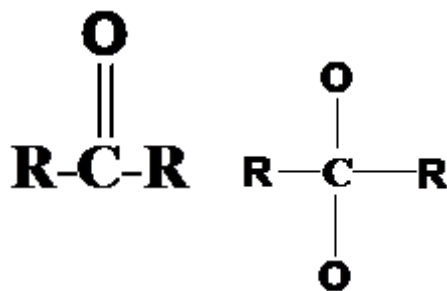


2- If the two atoms are identical, the atomic numbers of next atoms are used, until the priority is determined at the first points of difference along the chain



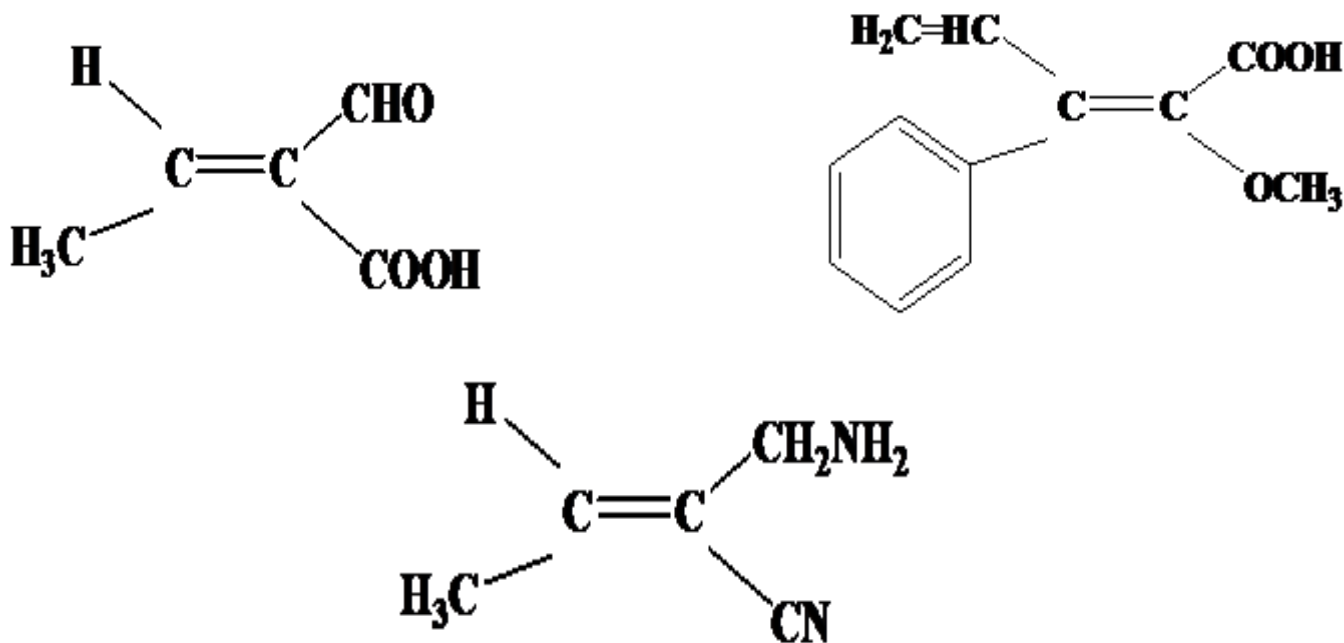
Cont.
Priority Rules

3- Atoms attached to double or triple bonds are given single-bond equivalencies, each doubly bonded atom is duplicated (or triplicated for triple bonds)

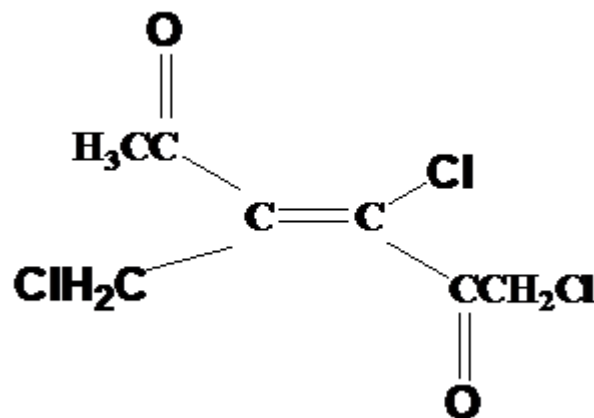
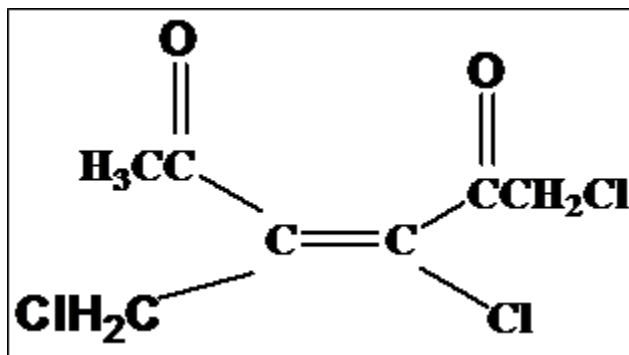


Cont.
Priority Rules

3- Atoms attached to double or triple bonds are given single-bond equivalencies, each doubly bonded atom is duplicated (or triplicated for triple bonds)



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Diastereoisomer

Problem 1

Determine which of the following compounds show *E* or *Z* isomerism.

