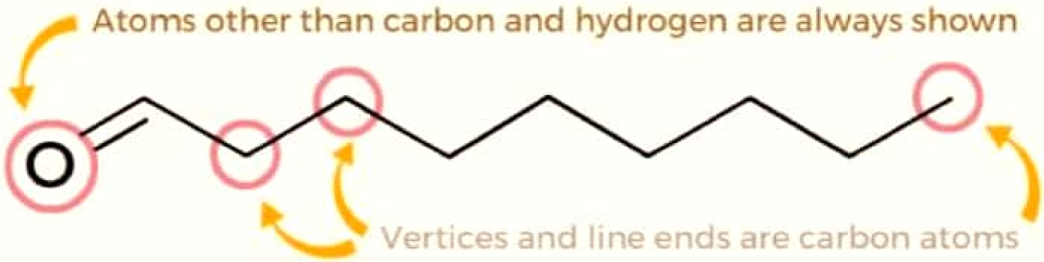
Part 1

NOMENCLATURE

A BASIC GUIDE TO DECODING ORGANIC COMPOUNDS NAME

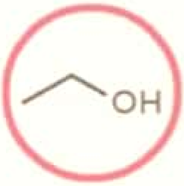
Name of an organic molecule can be long and look like a confusing mix of words and numbers. However, it follows a particular set of rules which allow it's structure to be decoded from it's name.

ORGANIC COMPOUND REPRESENTATION

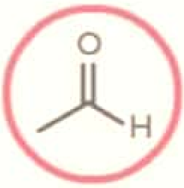


Organic molecules are usually represented using a skeletal formula. The line ends and vertices represent carbon atoms. Hydrogen atoms are implied. Atoms other than carbon and hydrogen are always shown.

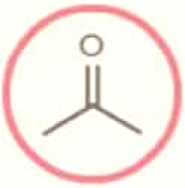
FUNCTIONAL GROUPS



ALCOHOL
Suffix:- ol
e.g.-ethanol



ALDEHYDE
Suffix:-al
e.g.-ethanal

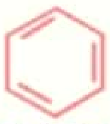


KETONE
Suffix:-one
e.g.-propanone

AMINE
Suffix:-amine
e.g.-ethanamine

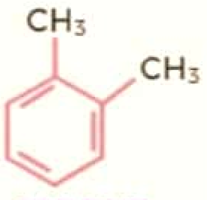
A molecule's functional group is the group of atoms that give its chemical properties and reactivity. It's usually indicated by a suffix at the end of the name, with a number indicating its position.

AROMATIC COMPOUNDS

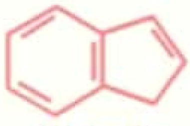


BENZENE

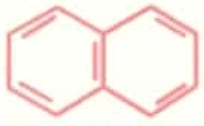
TOLUENE



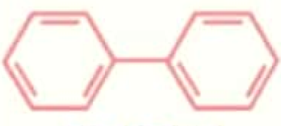
o-XYLENE



INDENE



NAPHTHALENE



BIPHENYL

Aromatic compounds also known as arenes or aromatics, are chemical compounds that contain conjugated planar ring systems with delocalized pi-electron. They should satisfy Hückel's rule.

Part 2

NOMENCLATURE

BOND TYPES

Carbon atoms can be linked by single bond, double bond or even triple bond. The name of the molecule reflects the type of bond present.


BUTANE


BUT-1-ENE


PROP-1-EN-1-OL


BUT-2-ENE


BUT-2-YNE


PROP-2-EN-1-OL

-an-present in name ⇒ molecule contains only **single bonds**

-en-present in the name ⇒ molecules contains **at least 1 double bond**

-yn-present in name ⇒ molecules contains **at least 1 triple bond**

For double and triple bond, number indicates the position of bond.

PARENT CHAIN

NUMBER OF CARBON IS DENOTED BY PREFIX

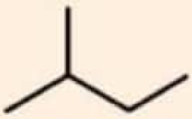
① METH-
② ETH-
③ PROP-
④ BUT-
⑤ PENT-
⑥ HEX-
⑦ HEPT-
⑧ OCT-
⑨ NON-
⑩ DEC-


BUTANE

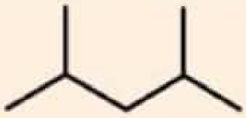

HEXANE

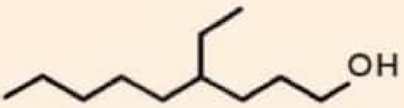
Prefix is part of the organic molecule's name that denotes how many carbons make up its **'parent chain'**. This is defined as the longest continuous connected chain of carbon atoms including the functional groups in the molecule.

SIDE CHAINS


2-METHYLBUTANE


3-METHYLPENTANE


2,4-DIMETHYLPENTANE

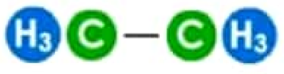

4-ETHYLNONAN-1-OL


3,5,7-TRIMETHYLDECANE

Molecules can have one or more carbons that aren't part of the **parent chain**, referred to as **'side chains'**. A number is added to show the location of the side chain on the parent chain.

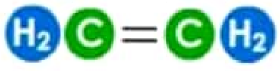
FUNCTIONAL GROUPS IN ORGANIC CHEMISTRY

ALKANE



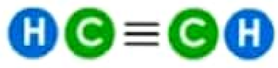
Name:- ane
e.g.ethane

ALKENE



Name:- ene
e.g.ethene

ALKYNE



Name:- yne
e.g.ethyne

ALCOHOL

Name:- ol
e.g.ethanol

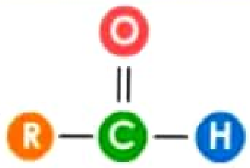
ETHER

Name:- oxy-ane
e.g.methoxyethane

HALOALKANE

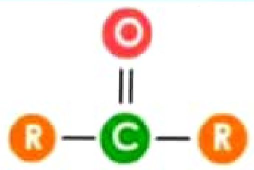
Name:- halo-
e.g.chloroethane

ALDEHYDE



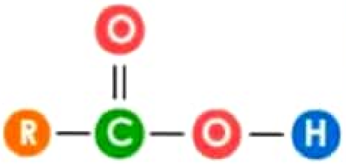
Name:- -al
e.g.ethanal

KETONE



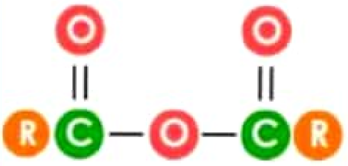
Name:- ane
e.g.propanone

CARBOXYLIC ACID



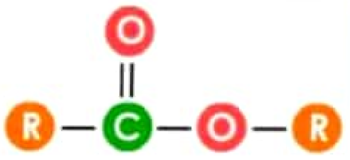
Name:- oic acid
e.g.ethanoic acid

ACID ANHYDRIDE



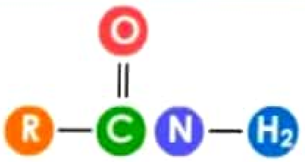
Name:- thiol
e.g.methanethiol

ESTER



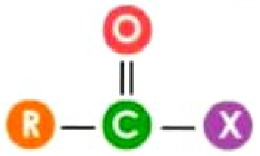
Name:- –yl –oate
e.g.ethyl ethanoate

AMIDE



Name:- amide
e.g.ethanamide

ACYL HALIDE



Name:- –oyl halide
e.g.ethanoyl chloride

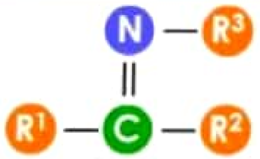
AMINE

Name:- –amine
e.g.ethanamine

NITRILE

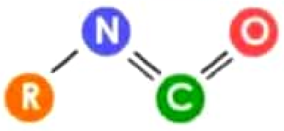
Name:- –nitrile
e.g.ethanenitrile

IMINE



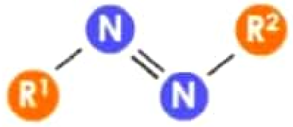
Name:- –imine
e.g.ethanimine

ISOCYANATE



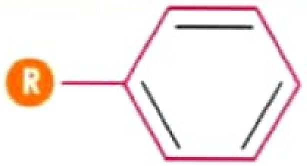
Name: –yl isocyanate
e.g.ethyl isocyanate

AZO COMPOUND



Name:- –azo–
e.g.azoethane

ARENE



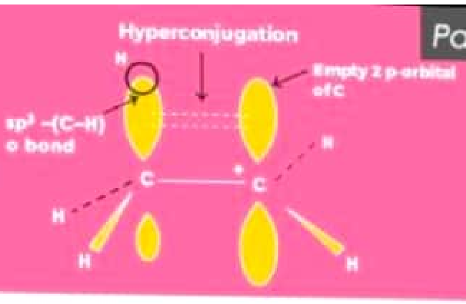
Name:- –yl benzene
e.g. ethyl benzene

THIOL

Name:- thiol
e.g.methanethiol

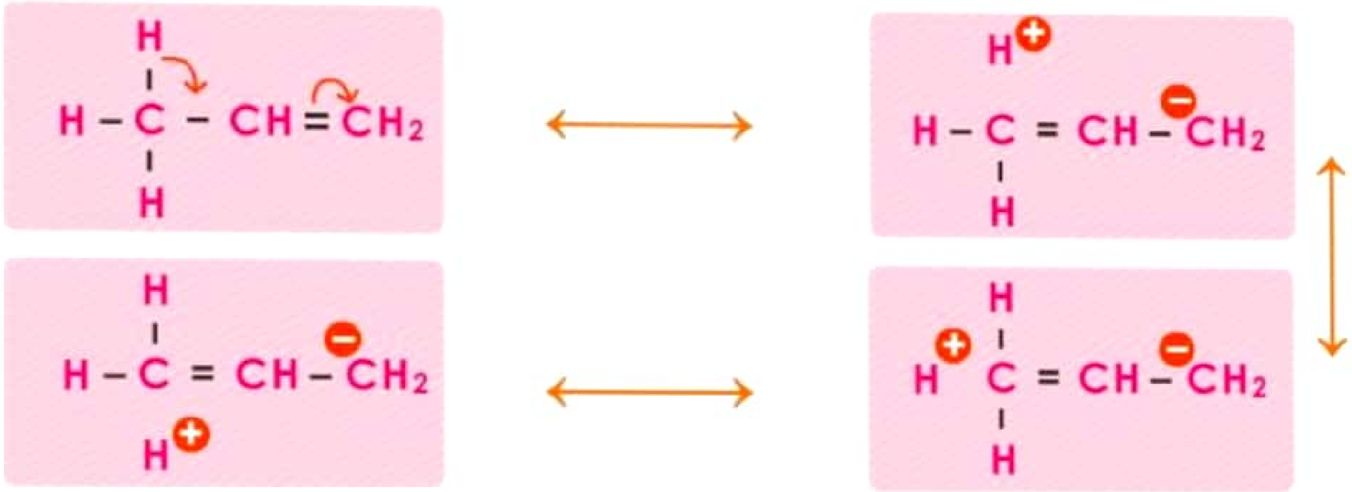
ELECTRON DISPLACEMENT

Part 1



HYPER CONJUGATION

The mechanism of electron release by an alkyl group when it is attached to an unsaturated system is called Hyper conjugation. Hyper conjugation effect takes place through the interaction of σ - electrons of C-H bond with π - electrons of double bond.



$$H_3C-CH=CH_2 \longleftrightarrow H^{\oplus}\ H_2C=CH-\overset{\ominus}{C}H_2 \longleftrightarrow H^{\oplus}\ H_2C=CH-\overset{\ominus}{C}H_2 \longleftrightarrow H^{\oplus}\ H_2C=CH-\overset{\ominus}{C}H_2$$

MESOMERIC/ RESONANCE EFFECT

The flow of electrons from one part of a conjugated system to the other caused by phenomenon of resonance is called resonance effect or mesomeric effect.

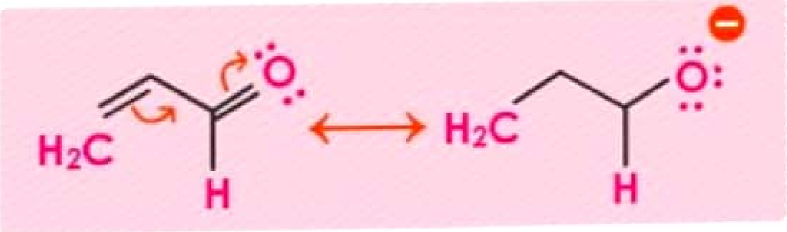
Kekule's structures

Charge-separated Dewar's structures

-M or -R effect

When the electron displacement is towards the group.

For example :- NO_2 , -CHO.



+M or +R effect

When the electron displacement is away from the group.

For example :- OH , -OR,-Cl

ELECTROMERIC EFFECT

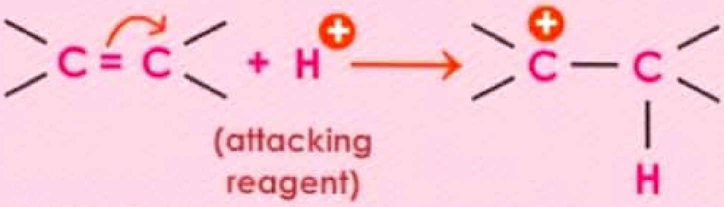
Electromeric effect is defined as the complete transfer of electrons of a multiple bond towards one of the bonded atoms at the demand of an attacking reagent.

TYPES OF ELECTROMERIC EFFECT

+E effect

When displacement of electrons is away from the atom or group.

e.g : addition of H+ to alkene.



-E effect

When displacement of electrons is towards the atom or group.

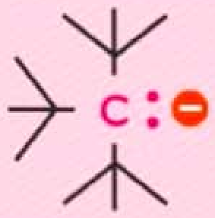
e.g : addition of cyanide ion (CN-) to the carbonyl group.

INDUCTIVE EFFECT

Inductive effect is defined as permanent displacement of shared electron pair in a carbon chain towards more electronegative atom or group.

electron withdrawal stabilizes carbocation (make less-)

electron withdrawal destabilizes carbanion (make less+)



electron release destabilizes carbanion (make more-)

electron release stabilizes carbocation (make more+)

TYPES OF INDUCTIVE EFFECT

Negative Inductive Effect (–I effect, Electron withdrawing effect)

When an electronegative atom or group (more electronegative than hydrogen) is attached to the terminal of the carbon chain in a compound, the electrons are displaced in the direction of the attached atom or group.

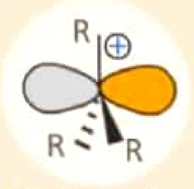
$-NO_2 > -CN > -COOH > F > Cl > Br > I > OH > C_6H_5 > H$

Positive Inductive Effect (+I effect, Electron releasing effect)

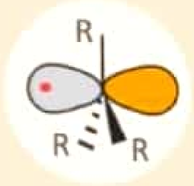
When an electropositive atom or group (more electropositive than hydrogen) is attached to the terminal of the carbon chain in a compound, the electrons are displaced away from the attached atom or group.

$(CH_3)_3C- > (CH_3)_2CH- > -C_2H_5 > -CH_3.$

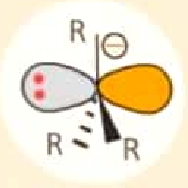
CARBOCATION & CARBANION



Carbocation



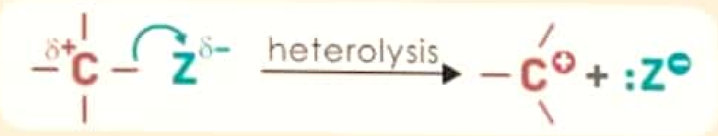
Carbon radical



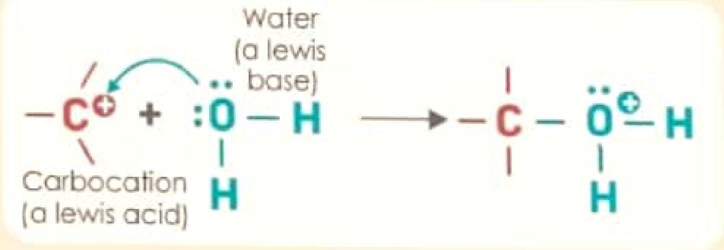
Carbanion

CARBOCATION

Ionic species with positively charged carbon atom.

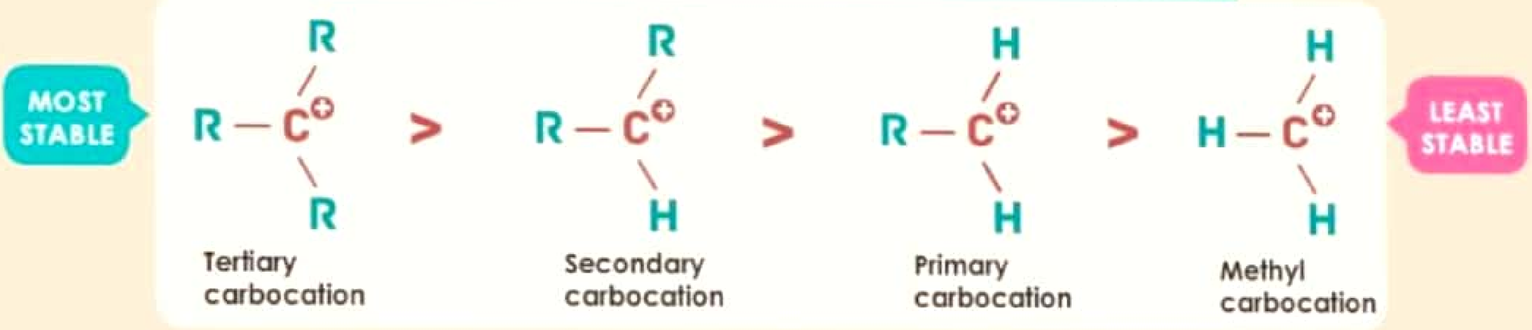


- sp₂ Hybridized
- Trigonal planor
- Incomplete octet



Carbocations are strong Lewis acids.

RELATIVE STABILITIES OF CARBOCATIONS

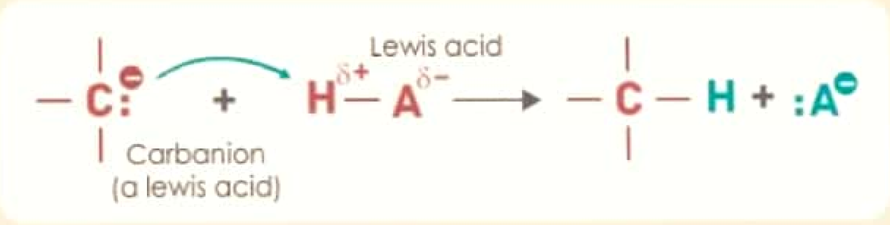


CARBANION

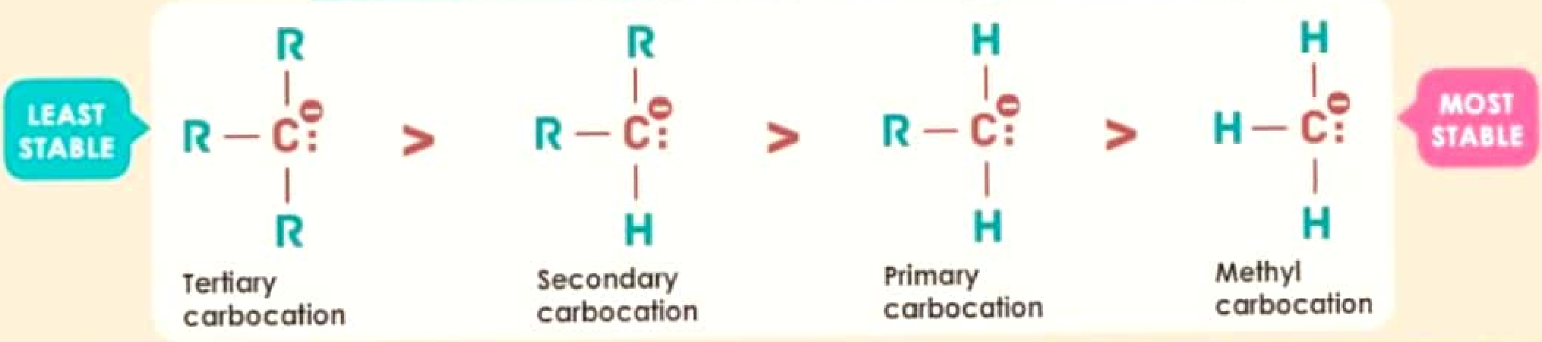
Ionic species with negatively charged carbon atom.

- sp₃ Hybridized
- Pyramidal
- Complete octet

Carbanions are strong Lewis bases and Bronsted bases.

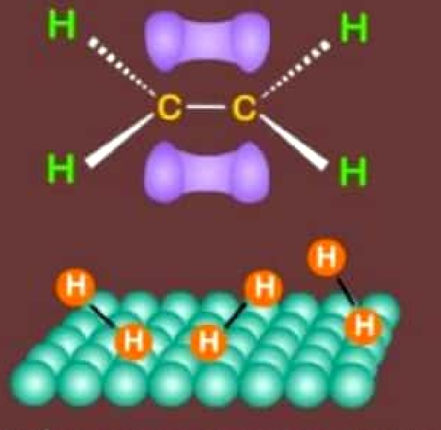


RELATIVE STABILITIES OF CARBOCATIONS

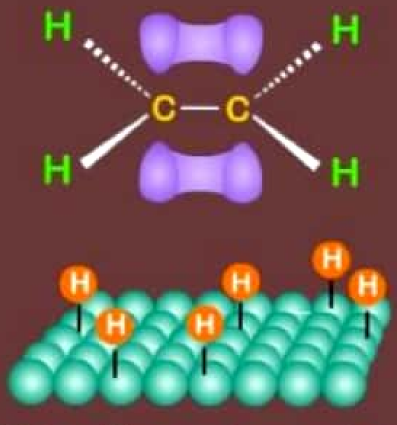


Part-I

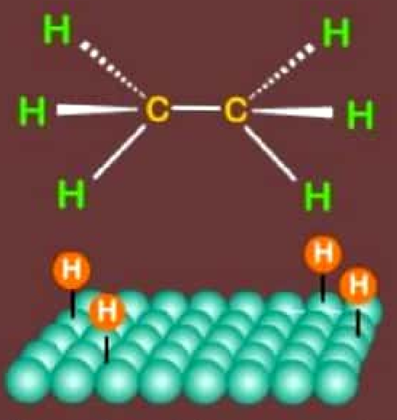
HEAT OF HYDROGENATION



Hydrogen molecules settle on the surface of the catalyst and react with metal atoms



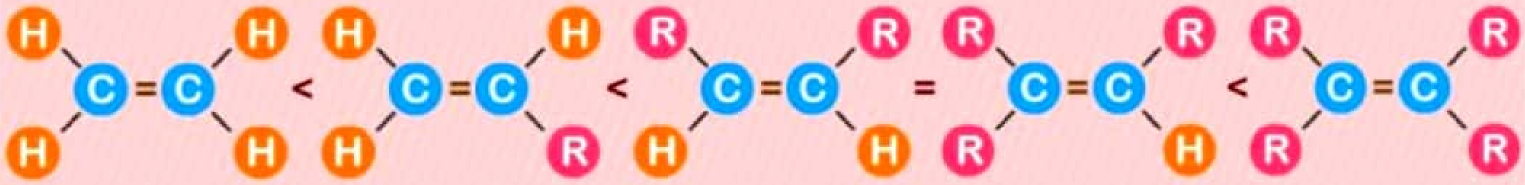
The alkene approaches the surface of the catalyst



The π bond between the two carbons is replaced by two C-H σ bonds

Heat of hydrogenation (symbol: ΔH_{hydro}, ΔH°) of an alkene is the standard enthalpy of catalytic hydrogenation of an alkene. Catalytic hydrogenation of an alkene is always exothermic. Therefore, heat of hydrogenation of alkenes is always negative.

least stable (higherΔH°)..most stable (lowerΔH°)



Not substituted

Mono-substituted alkene

Di-substituted alkene

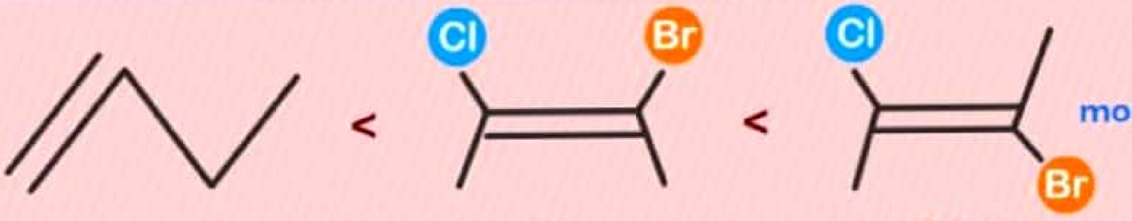
Tri-substituted alkene

Completely substituted

least substituted..most substituted

In disubstituted alkenes, trans-isomers are more stable than cis-isomers due to steric hindrance. Also, internal alkenes are more stable than terminal ones. See the following isomers of butene:

least stable



1-butene

cis-1-butene

trans-2-butene

most stable

HOH ∝ no. of π -bond is compound

If no. of π -bond is same then

$$HOH \propto \frac{1}{\text{Stability of compound}}$$

In case of alkene

$$HOH \propto \frac{1}{\text{Stability of compound}} \propto \frac{1}{\text{No. of } \alpha \text{ H}}$$

ACIDITY & BASICITY

Part-II

$H-A \rightleftharpoons H^+ + A^-$

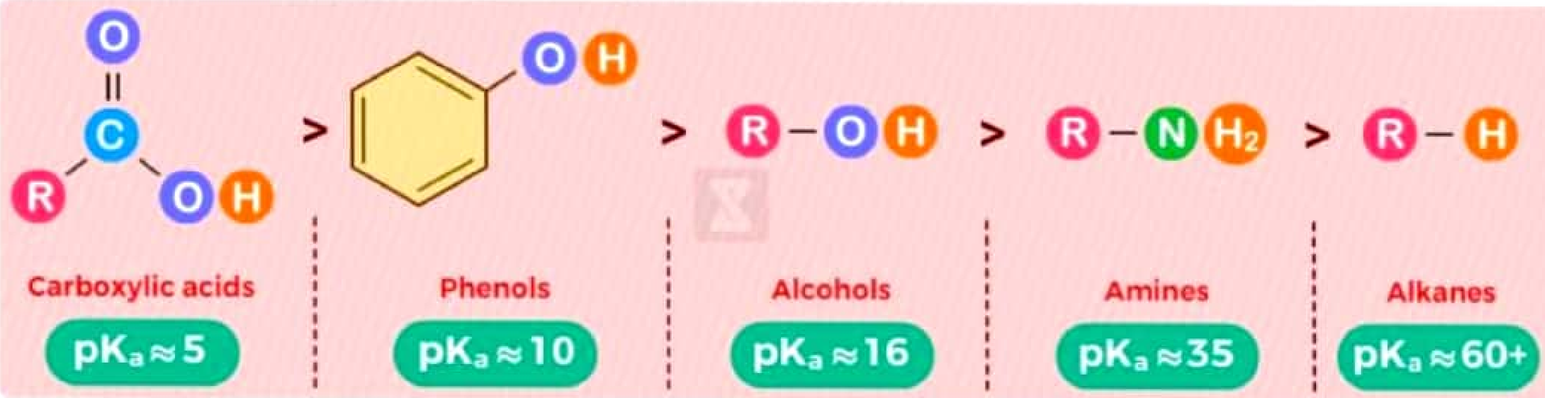
$K_a = \frac{[H^+][A^-]}{[HA]}$

$pK_a = -\log_{10} K_a$

Key factors that affect the acidity

$HF > H_2O > NH_3 > CH_4$	**Electronegativity** - The more electronegative the anionic atom in the conjugate base, the better it is at accepting the negative charge.
$HI > HBr > HCl > HF$	**Size** - The easier it is for the conjugate base to accommodate negative charge (lower charge density). The size of the group also weakens the bond H-X.
RCOOH > ROH	**Resonance** - In the carboxylate ion ($RCOO^-$) the negative charge is delocalised across 2 electronegative oxygen atoms which makes it more stable than being localised on a specific atom as in alkoxide (RO-.)

General acidity trend of common organic acids



Key factors that affect the basicity

$CH_3^- > NH_2^- > HO^- > F^-$	**Electronegativity** - The more electronegative the atom donating the electrons is, the less willing it is to share those electrons with a proton, so the weaker the base.
$F^- > Cl^- > Br^- > I^-$	**Size** - The larger the atom the weaker the H-X bond and the lower the electron density making it a weaker base.
RO- > RCOO-	**Resonance** - In the carboxylate ion ($RCOO^-$) the negative charge is delocalised across 2 electronegative atoms which makes it the electrons less available than when they localised on a specific atom as in the alkoxide (RO-.)

General basisity trend of some common organic bases