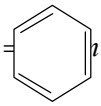
General characteristics of arenes.

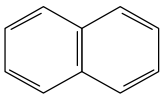
(1) All arenes have general formula $[C_nH_{2n}-6y]$. Where y is number of benzene rings and n is not less than 6.

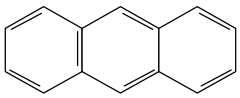
(2) Arenes are cyclic and planar. They undergo substitution rather than addition reactions.

(3)**Aromaticity or aromatic character:** The characteristic behaviour of aromatic compounds is called aromaticity. Aromaticity is due to extensive delocalisation of π-electrons in planar ring system. Huckel (1931) explained aromaticity on the basis of following rule.

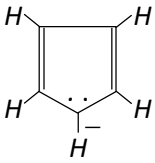
Huckel rule : For aromaticity the molecule must be planar, cyclic system having delocalised $(4n+2)\pi$ electrons where n is an integer equal to 0, 1, 2, 3,------.
Thus, the aromatic compounds have delocalised electron cloud of 2,6,10 or 14 π electrons.

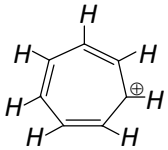
Example: $4n+2 =$  $n=4 \;; n=\frac{4}{4}=1$


Naphthalene
10 πelectrons


Anthracene
14 πelectrons

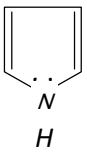
Similarly cyclolpentadienyl anion or tropylium ion are also aromatic because of containing 6π electrons (n=1).

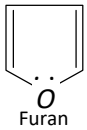

Cyclopentadienyl anion 6 π electrons

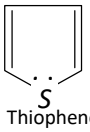

Tropyllium ion 6 π electrons

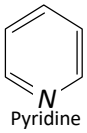

Cyclopropenyl cation (n = 0)

Hetrocyclic compounds also have 6π electrons (n = 1).


Pyrrole

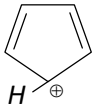

Furan


Thiophene


Pyridine

Molecules do not satisfy huckel rule are not aromatic.


Cyclopentadiene


Cyclopentadienyl cation

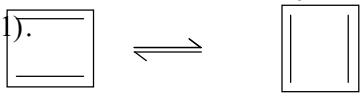

Cyclooctatetraene


Cyclopropenyl anion

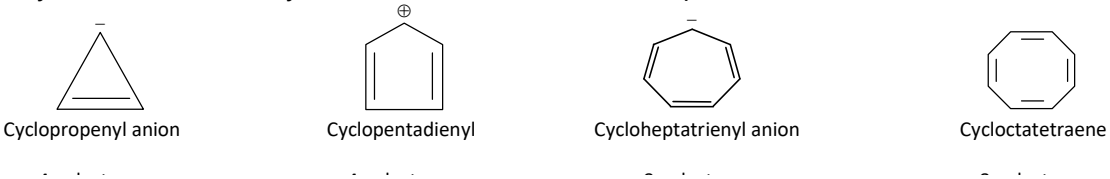
(4) **Antiaromaticity:** Planar cyclic conjugated species, less stable than the corresponding acyclic unsaturated species are called antiaromatic. Molecular orbital calculations have shown that such compounds have $4n\pi$ electrons. In fact such cyclic compounds which have $4n\pi$ electrons are called antiaromatic compounds and this characteristic is called antiaromaticity.

Example: 1,3-Cyclobutadiene, It is extremely unstable antiaromatic compound because it has $4n\pi$ electrons $(n = 1)$.

$4n = 4 \quad ; \quad n = \frac{4}{4} = 1$



Thus, cyclobutanediene shows two equivalent contributing structures and it has $n = 1$.
In terms of Huckel rule antiaromatic compounds have cyclic, planar structure with $4n\pi$ electrons. They are destabilised by resonance. Some other examples are,



Cyclopropenyl anion | Cyclopentadienyl | Cycloheptatrienyl anion | Cycloctatetraene

Comparison of aromatic and aliphatic hydrocarbons

Characteristic	**Benzene and its homologous**	**Aliphatic hydrocarbons**
Composition	These are closed ring compounds. These are represented by general formula C_nH_{2n-6}.	These are open chain compounds. These are represented by general formulae; C_nH_{2n+2} (Alkanes), C_nH_{2n} (Alkenes) and C_nH_{2n-2} (Alkynes).
Carbon percentage	These contain high percentage of carbon. In benzene C_6H_6, the carbon percentage is 92.3.	These have low percentage of carbon in comparison to aromatic hydrocarbons. In hexane, C_6H_{14}, the carbon percentage is 83.7.
Combustion	These burn with smoky flame.	These burn with non smoky flame.
Nature	These have high unsaturation. For example, benzene molecule consists three double bonds.	These are saturated as well as unsaturated.
Physical state	These are colourless liquids or solids. They have characteristic odour (Aromatic).	A few lower members are colourless gases while higher members are liquids or solids.

		Generally no characteristic odour exists.
Addition reactions	Inspite of the fact that these are unsaturated, generally resist addition reactions. These do not react with HCl, HBr, HI or $HClO$.	The unsaturated hydrocarbons show addition reactions.
Substitution reactions	Generally exhibit substitution (Electrophilic) reactions such as halogenation, nitration, sulphonation, Friedel-craft's reaction etc.	The saturated hydrocarbons show substitution reactions such as halogenation. The unsaturated hydrocarbons resist substitution reactions. Nitration and sulphonation occur with difficulty in higher alkanes. Friedel-craft's reaction is not shown by aliphatic hydrocarbons.
Stability	Highly stable.	The unsaturated hydrocarbons are less stable.
$(4n+2)$ rule	Follow $(4n+2)$ rule, i.e., contain $(4n+2)\pi$ electrons where $n = 0,1,2,3,.....$.	$(4n+2)$ rule does not apply to aliphatic unsaturated hydrocarbons.
Oxidation	Except benzene, all oxidise easily.	Alkanes do not oxidise easily while unsaturated hydrocarbons oxidise easily.