DESCRIPTION OF PERIOD SUBSHELL

ALLEN CAREER INSTITUTE KOTA (RAJASTHAN)
path to success

TABLE

(C) % s – character

Electronegativity $\propto$ %s – Character of Hybridised atom

$\boxed{\text{EN} \propto \text{\% s-character.}}$

Hybridisation . SN (Steric No.) = No of σ bond + lone pair

S.N	Hybridisation	% S character
2	sp	$= \frac{1}{2} \times 100 = 50\%$
3	sp^2	$= \frac{1}{3} \times 100 = 33.3\%$
4	sp^3	$= \frac{1}{4} \times 100 = 25\%$
5	sp^3d	$= \frac{1}{5} \times 100 = 20\%$
6	sp^3d^2	$= 1/6 \times 100 = 16.6\%$

Ex. which of following has higher EN of Carbon.

③	②	①
CH_4	$CH_2=CH_2$	$CH\equiv CH$
sp^3	sp^2	sp

%s. $\frac{1}{4}\times 100$ $\quad$ $\frac{1}{3}\times 100$ $\quad$ $\frac{1}{2}\times 100$

EN order = ① > ② > ③

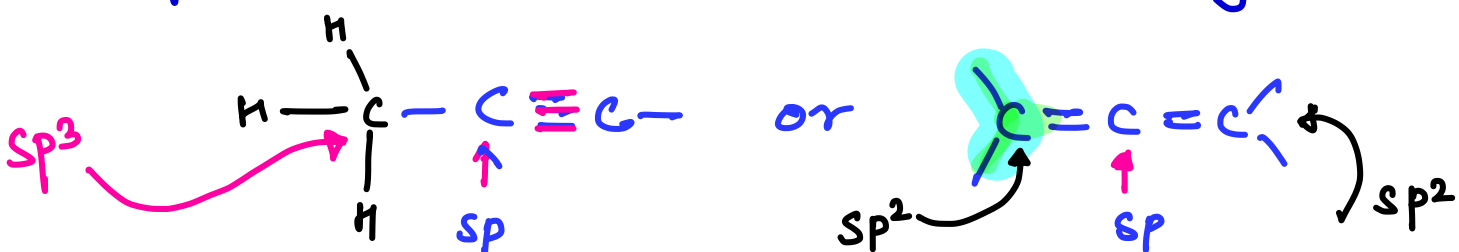
Ex. How many valency does Carbon have

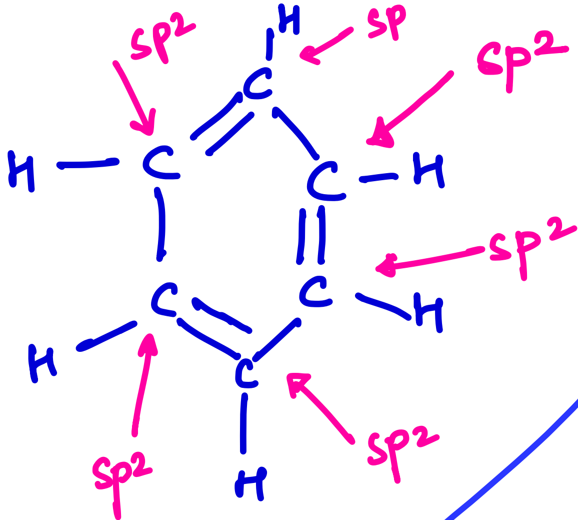
Ans 4

- If. All four bonds of Carbon are single bond then carbon will sp^3 hybridised.

- If 1 double bond is present in carbon then it is sp^2 hybridised.

- If 1 triple bond or two double bond are present in carbon then sp hybridised.

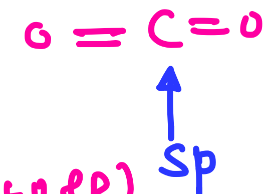




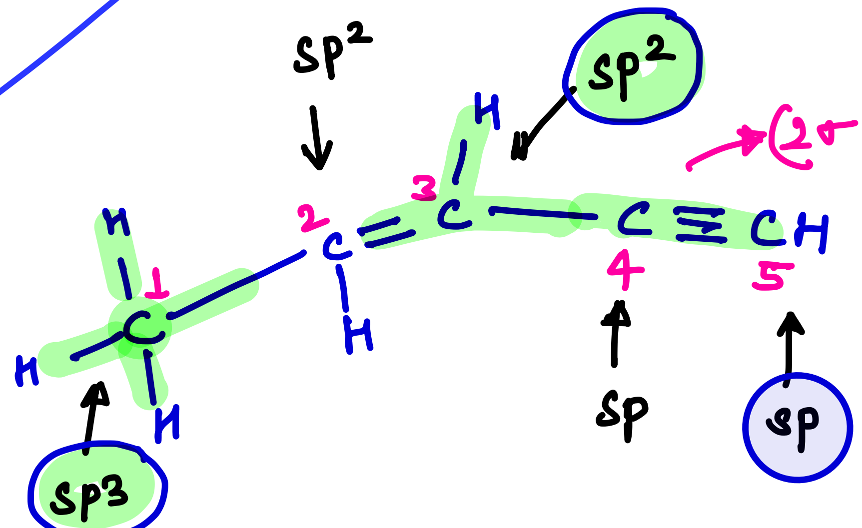
Q. Compare EN of Carbon 1, 3, 5

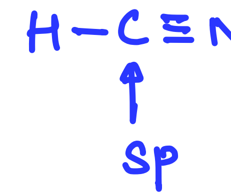
order $5 > 3 > 1$

$SN = (3\sigma + 0\,lp) = 3$



$(2\sigma + 0\,lp)$





$SN = 4\sigma + 0\,lp$
$= 4$

✓ * If there are multiple bonds b/w atoms. (A – A)

EN (Triple bond) > EN (double bond) > EN (Single Bond)

Ex. Compare EN of O in O_2 and H_2O_2

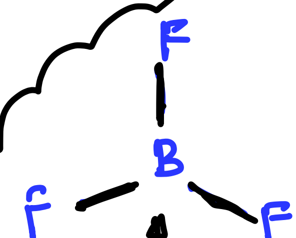
Sol^n

$O = O$ > $H - O - O - H$

Single bond ⟶ σ bond

double bond ⟶ 1σ and 1π

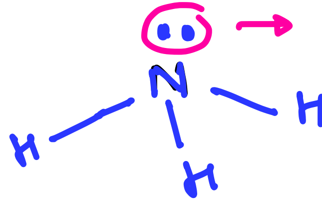
triple Bond ⟶ 1σ and 2π



$3\sigma + 0$ lp

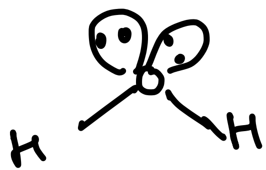
→ sp^2

NH_3



→ unshared e^- pair is called lone paired

$S.N = 3+1 = 4 \rightarrow sp^3$



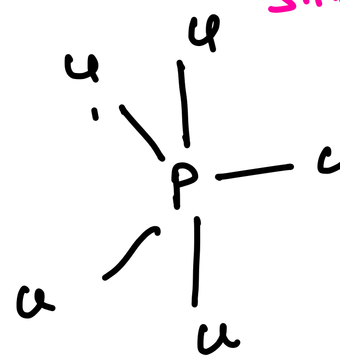
$S.N = 2+2 = 4$

sp^3

PCl_5

$S.N = 5$

sp^3d



$\sigma = 5$, $l.p = 0$

DESCRIPTION OF PERIOD SUBSHELL

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TABLE

(A) Generally electronegativity decreases down the group.

Exception no (1)

EN (Ga) > EN (Al)

(B) In period on moving from left to right electronegativity increases regularly.

Exception (2)

4th — 14th group.

EN

6th period Elemen > 4th period element > 5th period element

(for inert gases EN is considered as zero, due to their stable configuration they do not participate in chemical bond formation)

Except. (Kr, Xe) some electronegativity.

DESCRIPTION OF PERIOD SUBSHELL TABLE

(A) Metallic and non metallic nature :

Generally metals have low electronegativity and non metals have high electronegativity, so we can say metallic character increases down the group but decreases along a period.

$\boxed{\text{Non Metallic Nature} \propto \text{EN}}$

L $\longrightarrow$ R

Nonmetallic Nature increases

T $\downarrow$ B

Nonmetallic character decreases.

(B) Bond energy :

By increasing difference in electronegativity of bonded atoms, bond length decreases and hence bond energy increases

$$\boxed{\text{Bond energy} \propto \text{Electronegativity difference}}$$

HF > HCl > HBr > HI

(C) Bond polarity :

Bond polarity ∝ ΔEN

Ex. HF > HCl > HBr > HI

$\delta = 0$ $\delta = 0$

H — H] No Ionic nature

2.1 2.1

ΔEN = 0

$\delta+$ $\delta-$

H — F] Some Ionic Nature

EN 2.1 4.0

ΔEN → 1.9

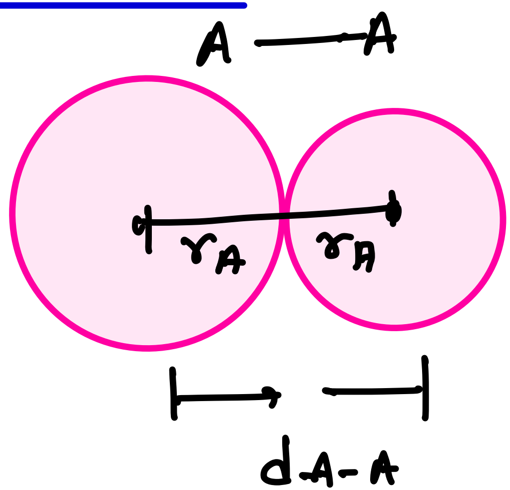
$\delta+$ $\delta-$

H — Cl

2.1 3.0

ΔEN 0.9

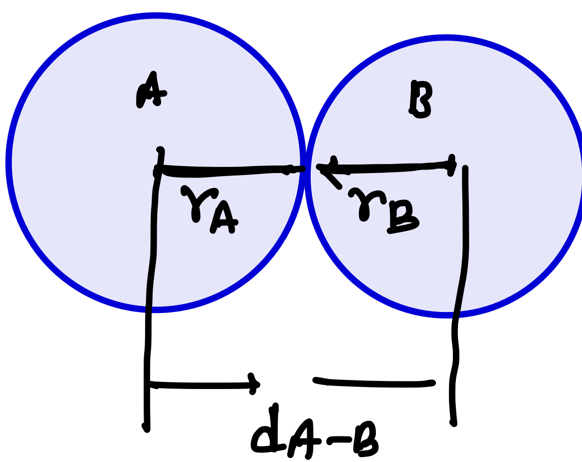
Co-valent Radius



$r_A = \frac{d_{A-A}}{2}$ (BL)

$^{\delta+}A - B^{\delta-}$

EN (A) = EN (B)



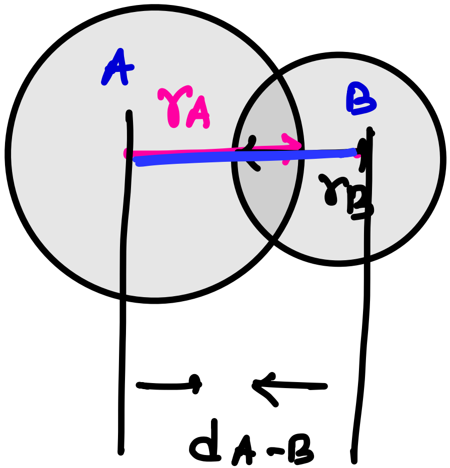
Bond Length of A-B

$d_{A-B} = r_A + r_B$

✓ $d_{A-B} = \frac{d_{A-A}}{2} + \frac{d_{B-B}}{2}$

(iii)

$EN(A) \neq EN(B)$



$$d_{A-B} = r_A + r_B - 0.09\,|X_A - X_B|$$

Michal showalker formula

$$\boxed{d_{A-B} = \frac{d_{A-A}}{2} + \frac{d_{B-B}}{2} - 0.09\,|X_A - X_B|}$$

Ex. If bond Length of hydrogen is 120 pm what will radius of hydrogen atom.

$$r_H = \frac{d_{H-H}}{2} = \frac{120}{2} = 60\,pm$$

Ex. If internuclear distance of hydrogen (H_2) and fluorine (F_2) are found 2 A°, 4 A° respectively find bond Length of HF. (EN(F) = 4, EN(H) = 2.1)

$$d_{H-F} = \frac{d_{H-H}}{2} + \frac{d_{F-F}}{2} - 0.09(1.9)$$

$$= 1 + 2 - 0.171 \Rightarrow 2.829\ A^{o}$$

Ex. If atomic radius of oxygen is 3 A° and chlorine is 4 A° find internuclear distance of OCl (EN(Cl) = 3.0, EN(O) = 3.5,

$$d_{O-Cl} = r_O + r_{Cl} - 0.09\,(0.5)$$

$$d_{O-Cl} = 4 + 3 - 0.045$$

$$d_{O-Cl} = 6.955 \text{ A}^\circ$$

DESCRIPTION OF PERIOD SUBSHELL

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path to success

TABLE

(D) Schoemaker and Stevenson law :

If in a diatomic molecule electronegativities of A – B have more difference. Then actual bond length will be reduced. As per schoemaker & Stevenson– The reduction in bond length depends on the difference in electronegativities of atoms by following manner -

$$d_{A-B} = r_A + r_B - 0.09 (X_A - X_B)$$

Here X_A is E.N. of A & X_B is E.N. of B

DESCRIPTION OF PERIOD SUBSHELL

ALLEN CAREER INSTITUTE
path to success
KOTA (RAJASTHAN)

TABLE

Ex. If bond length of Cl_2 = 198pm, Bond length of H_2 =74pm, Find out the bond length of H–Cl ?
(EN of Cl is 3.0, EN of H is 2.1)

Solution.

$d_{H-Cl} = r_{Cl} + r_H - 0.09\,(X_{Cl} - X_H)$

$r_{Cl} = 198 / 2 = 99\text{pm},$

$r_H = 74/2 = 37\text{ pm}$

$d_{H-Cl} = 99 + 37 - 0.09\,(3.0 - 2.1)$

$= 136 - (0.09 \times 0.9)$

$= 136 - 0.081$

$= 135.919\text{pm}$

3) To determine % Ionic nature (IC) in a bond

$$A —— B$$

χ_A χ_B

$$\Delta EN = |\chi_A - \chi_B|$$

$$\boxed{\% IC = 16 \Delta EN + 3.5 (\Delta EN)^2}$$

Ex. find the EN for when A-B bond will be 50 % Ionic.

sol

$$50 = 16x + 3.5x^2$$

$$3.5x^2 + 16x - 50 = 0$$

$$x = \frac{-16 + \sqrt{256 - 4(3.5) \times (-50)}}{2 \times 3.5}$$

$$x = \frac{-16 + \sqrt{256 + 700}}{7}$$

$$x = \frac{-16 + \sqrt{956}}{7}$$

$$x = \frac{-16 + 30.91}{7} = 2.13$$

$\Delta EN > 2.1$

Practically

$\Delta EN > 1.9$

theoratically		Practically	
$\lvert X_A - X_B \rvert \geq 2.1$	ionic Nature.	$\lvert X_A - X_B \rvert \geq 1.9$	ionic Nature.
$\lvert X_A - X_B \rvert < 2.1$	Co-valent Nature.	$\lvert X_A - X_B \rvert < 1.9$	Co-valent Nature.

Ex. Find Nature ionic or Co-valent in following.

(1) $CsCl$ $\quad \lvert (0.7 - 3.0) \rvert = 2.3$ ionic

(2) HCl $\quad \lvert 2.1 - 3 \rvert = 0.9$ Co-valent

(3) H_2S $\quad \lvert 2.1 - 2.5 \rvert = 0.4$ Co-valent

(4) NH_3 $\quad \lvert 3 - 2.1 \rvert = 0.9$ Co-valent.

Ex. Find % IC in following According Henery smith formula.

HW

(1) $CsCl$ $\Delta EN = 3 - 0.7 = 2.3$

$IC\% = 16 \Delta EN + 3.5 (\Delta EN)^2$

$= 16 \times 2.3 + 3.5 (2.3)^2$

$=$

(2) HCl

(3) H_2S

(4) NH_3

(5) CsF

(6) LiF

(7) $NaCl$

DESCRIPTION OF PERIOD SUBSHELL

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TABLE

(E) Nature of bonds :

According to Hanny & Smith formula

% ionic character = $16 (X_A - X_B) + 3.5 (X_A - X_B)^2$

Here X_A = Electronegativity of A

X_B = Electronegativity of B

Calculation of oxidation No. :-

Oxidation Number :- Real or hypothetical charge on atom or group of atom known as oxidation No. of that atom or group of atom.

- Real - Zn^{+2}, S^{-2}, PO_4^{-3}, CO_2, NH_4^+ etc.

  O.N = +2, −2, −3, 0, +1

- Hypothetical :- EN (B) > EN (A)

$\overset{\delta+}{H} - \overset{\delta-}{Cl}$: $\underset{+1}{H} - \underset{-1}{Cl}$

$\underset{+1}{A} - \underset{-1}{B}$, $\underset{+2}{A} = \underset{-2}{B}$, $\underset{+3}{A} \equiv \underset{-3}{B}$, $\underset{+2}{A} \rightarrow \underset{-2}{B}$

- $\underset{0}{A} - \underset{0}{A}$, $\underset{0}{A} = \underset{0}{A}$, $\underset{0}{A} \equiv \underset{0}{A}$)

- All homoatomic molecules have oxidation No = 0

- Note ÷ Algebric sum of oxidation number of each atom in group of atom equals to oxidation no of group of atom.

Ex = SO_4^{-2} with S → a, O → $(-b)$

$a + (-b) \times 4 = -2$

NH_4^+ with N → x, H → y

$x + 4y = +1$

H_2SO_4 with H → p, S → q, O → r

$2p + q + 4r = 0$

Trusted Table

Elements	oxidation
IA [Li, Na, K, Rb, Cs]	+1
IIA [Be, Mg, Ca, Sr, Ba]	+2
IIIA [Al, Ga, In]	+3
F	−1
H	+1
O	−2
Cl	−1
N	−3
Br	−1
I	−1
S	−2
P	−3

Application ①

Ex. $FeCl_3$

oxidation No

$Cl = -1$

$a + (-1) \times 3 = 0$

$\boxed{a = +3}$

⇒ $FeCl_2$

oxidation No of

$Cl = -1$

$b + (-1) \times 2 = 0$

$b = +2$

Applicable 2 : $\underline{HF}$ oxidation No of $F = -1$

$x + (-1) = 0$

$x = +1$

oxidation No. of $H = +1$

HCl oxidation No of $H = +1$

$(+1) + x = 0$

$x = -1$

oxidation No of chlorine.

Hydrolyth CaH_2 oxidatioN No of $Ca = +2$

$2 + 2x = 0$

$2x = -2$

$\underline{x = -1}$

Oxidation No of hydrogen

is $= -1$ [hydride]