~~Basic~~ Organic Chemistry

It is a branch of chemistry in which we study about Organic compound and their reactions.

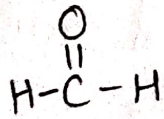
Compounds

Organic compound
↓
compound that exists in nature are known as Organic compounds

Inorganic compound
↓
Compounds that does not exists in nature are known as inorganic compounds.

CH_3-OH → wood spirit

CH_3-CH_2-OH → Grain alcohol



→ Formic acid

Chapters in 11th →

1. Basic Concept of 11th Organic
2. IUPAC
3. Isomerism
4. General Organic chemistry

Basic Concepts of Organic Chemistry

Berzelious theory [Vital force theory] →
According to Berzelious, organic compound is only exist in nature [not present in lab]

→ Wohler →

$(NH_4^+)_2SO_4^{2-}$ + K^+CNO^- ⟶ $(NH_4)_2CNO$ + K_2SO_4

Ammonium sulphate — Pottasium Cyanate

$(NH_4)_2CNO$ ↓ N_2CH_4O ⇓

$NH_2-\overset{\overset{O}{\|}}{C}-NH_2$

urea

Organic compound → Compounds which are made of C and H . eg:- CH_4, CH_3-CH_3

Why is carbon responsible to form an Organic Compound ?

→ Tetravalency

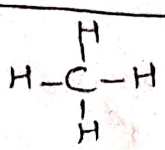
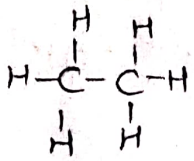
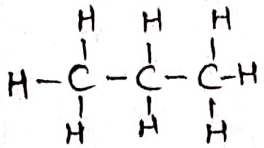
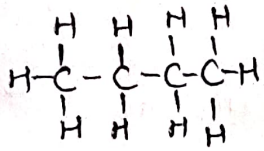
→ Combine with itself and form multiple bonds

→ Catenation

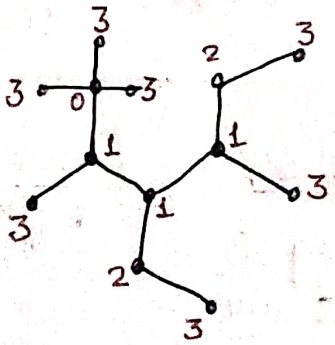
↳ Self linking of atoms of same element to form long chains, branched structures or rings.

Representation of Organic Compound →

जहां से line start हो ↑ वहां C, जहां line समाप्त हो वहां C

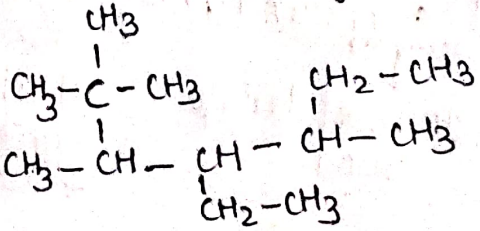
Organic Compound	Expanded form	Condensed	Bond line notation
1. Methane		CH_4	No bond line notation
2. Ethane		CH_3-CH_3 या C_2H_6	
3. Propane		$CH_3-CH_2-CH_3$ या C_3H_8	
4. Butane		$CH_3-CH_2-CH_2-CH_3$ या C_4H_{10} या $CH_3-(CH_2)_2-CH_3$	

Q. Write the molecular formula →

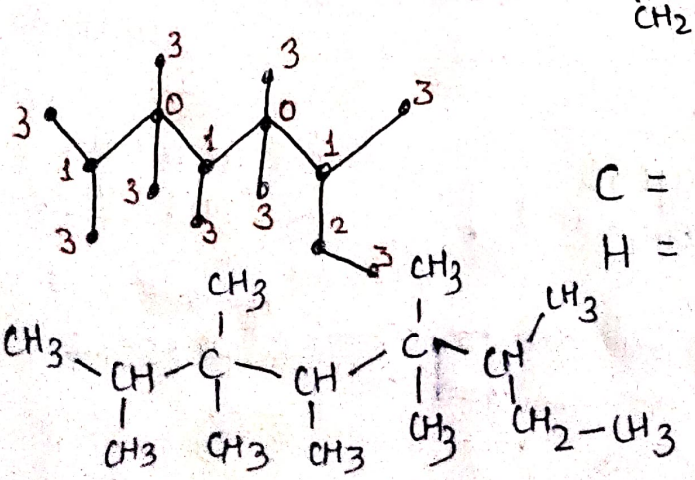
i) 

no. of C = 13

no. of H = 28



$C_{13}H_{28}$

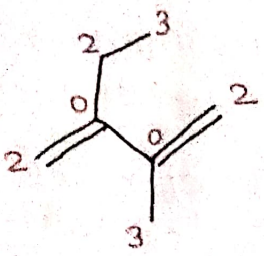
ii) 

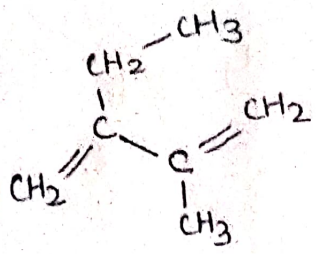
C = 15

H = 32

$C_{15}H_{32}$

iii)

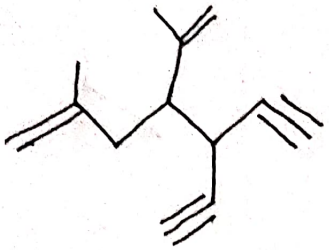


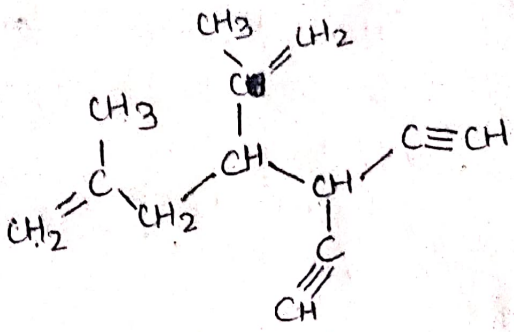


C = 7
H = 12

$C_7 H_{12}$

iv)



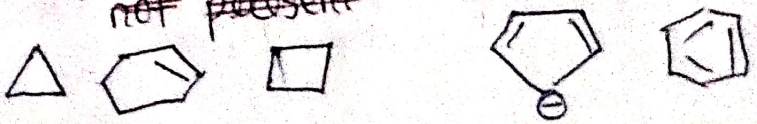


C = 13
H = ~~18~~ 16

$C_{13} H_{~~18~~ 16}$

Classification of Organic Compound →

- Organic Compound
  - Open chain / Acyclic (non-cyclic)
    - Saturated compound → only single bond
    - unsaturated compound → double / triple bond
  - closed chain (cyclic)
    - Homocyclic → अगर ring में all atoms are same then it is homocyclic
      - Aliphatic / Alicyclic compound → ~~if benzene is not present~~
      - Aromatic compound → ~~if~~ benzene ~~is~~ present
    - Heterocyclic → if in ring other atoms are present then it is heterocyclic



 → Open chain → Saturated compound

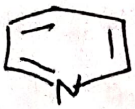
 → Closed chain → 6 member ring
→ Homocyclic
→ Alicyclic

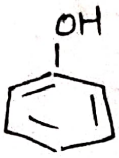
 → Open chain → unsaturated compound

 → closed → Homocyclic → Alicyclic

 → Cyclic → Heterocyclic

 → Cyclic → Homocyclic → Aromatic
Benzene

 → Cyclic → Heterocyclic

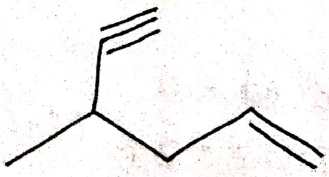
 → closed chain → Homocyclic → Aromatic

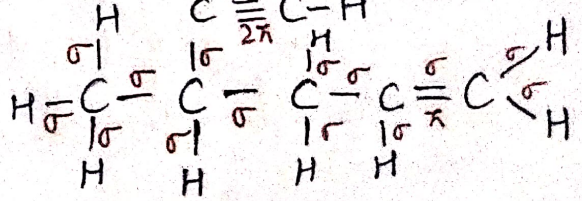
Calculation of Sigma (σ) & π bond →

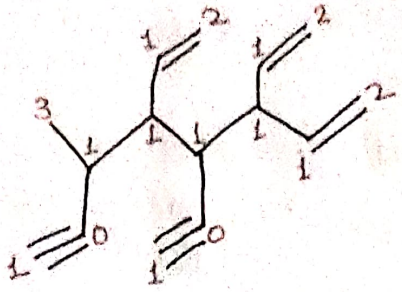
A − A → 1 bond → 1 σ bond + 0 π-bond
A = A → 2 bond → 1 σ bond + 1 π-bond
A ≡ A → 3 bond → 1 σ bond + 2 π-bond

Q. Identify the number of σ & π bonds →

σ = 16 π = 3

i)  →



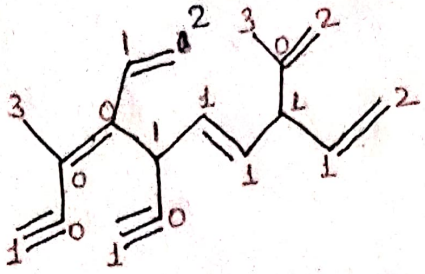
ii) 

$\pi = 7$

$(C-H)_\sigma = 18$

$(C-C)_\sigma = 14$

$\sigma = 32$

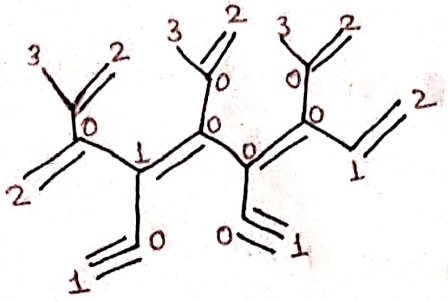
iii) 

$\pi = 8$

$(C-H)_\sigma = 20$

$(C-C)_\sigma = 17$

$\sigma = 387$

iv) 

$\pi = 11$

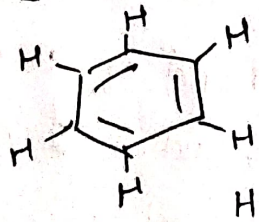
$(C-H)_\sigma = 22$

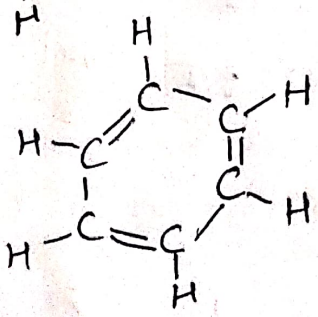
$(C-C)_\sigma = 20$

$\sigma = 42$

Q. Calculate σ, π, identify the type of organic compound, convert it to C-H form & write molecular formula.

① Benzene

Kekule 



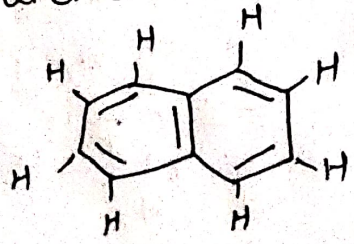
π-bond = 3

σ-bond = 12

$(C-H)_\sigma = 6$ $(C-C)_\sigma = 6$

MF $\Rightarrow C_6H_6$

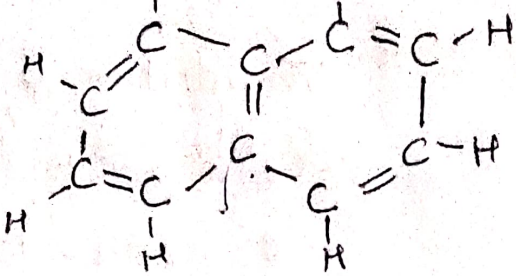
② Napthalene



π-bond = 5

$(C-H)_\sigma = 8$, $(C-C)_\sigma = 11$

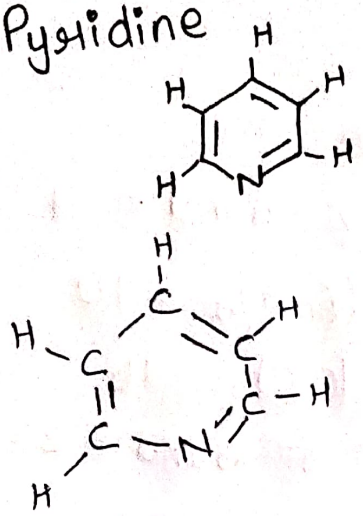
σ-bond = 11+8 = 19



Molecular formula
= $C_{10}H_8$

Cyclic → Homocyclic
↓
Aromatic compound

3. Pyridine



π-bond = 3

$(C-H)_\sigma = 5$, $(C-C)_\sigma = 4$

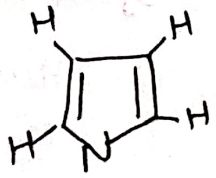
$(C-N)_\sigma = 2$

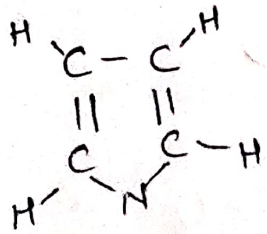
σ-bond = 5+4+2 = 11

cyclic → Heterocyclic compound

MF = C_5H_5N

4. Pyrrole →





π-bond = 2

$(C-H)_\sigma = 4$ $(C-C)_\sigma = 3$

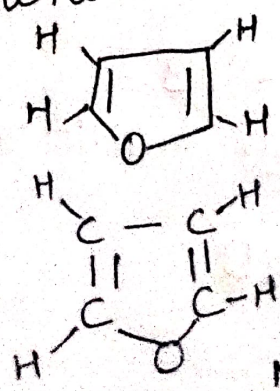
$(C-N)_\sigma = 2$ $(N-H)_\sigma = 1$

σ bond = 4+3+2+1 = 10

cyclic → Heterocyclic compound

MF → C_4H_5N

5. Furan



π-bond = 2

$(C-C)_\sigma = 3$, $(C-H)_\sigma = 4$

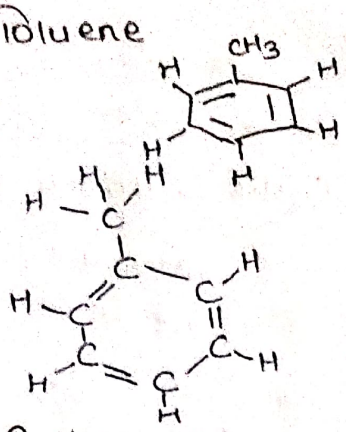
$(C-O)_\sigma = 2$

σ-bond = 9

cyclic → Heterocyclic compound

MF = C_4H_4O

6. Toluene



π-bond = 3

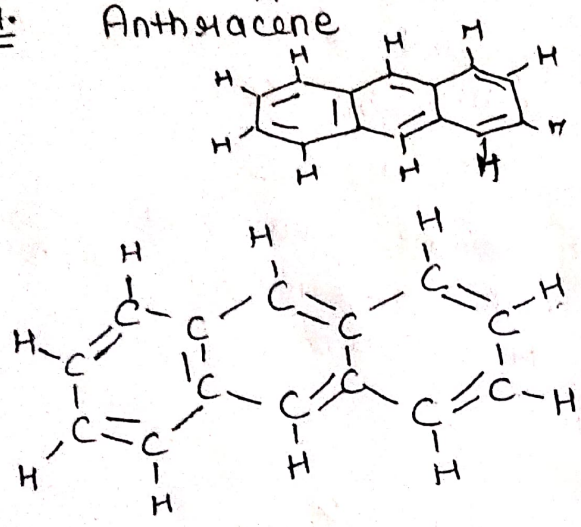
$(C-H)\sigma = 8$, $(C-C)\sigma = 7$

σ-bond = 15

cyclic → Homocyclic → Aromatic compound

MF ⇒ $C_6H_5-CH_3$ ⇒ C_7H_8

7. Anthracene



π-bond = 7

$(C-H)\sigma = 10$

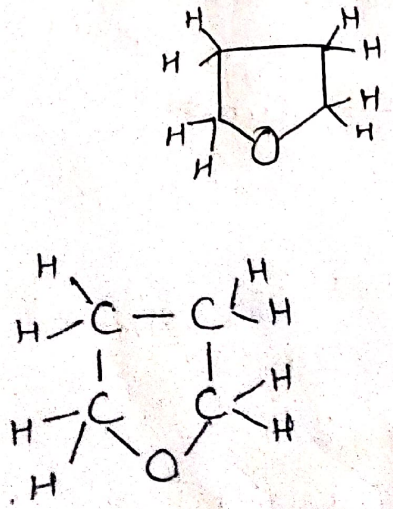
$(C-C)\sigma = 16$

σ-bond = 26

MF = $C_{14}H_{10}$

Cyclic → Homocyclic → Aromatic compound

8. Tetrahydrofuran (THF) →



π-bond = 0

$(C-H)\sigma = 8$ $(C-O)\sigma = 2$

$(C-C)\sigma = 3$

σ-bond = 13

Cyclic → Heterocyclic compound

MF ⇒ C_4H_8O

Fun

It is
Chemi

eg:-

Lie

① G

i)

ii)

iii)

iv)

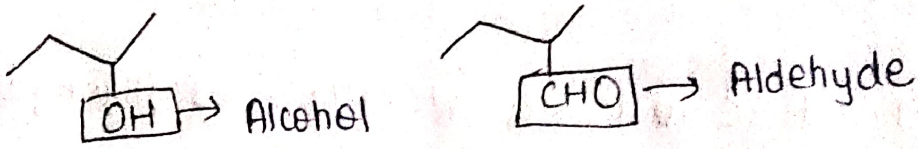
A

eg.

Functional Group →

It is the group which defines the physical / chemical properties of the given compound.

eg:-

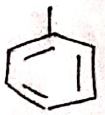


List of functional group →

① General functional groups →

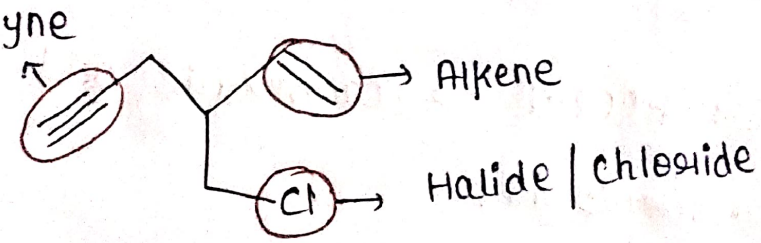
i) = → Alkene

ii) ≡ → Alkyne

iii)  → Benzene

iv) X → F, Cl, Br, I → Halides / Halogens

eg.



R → कोई carbon की chain

② Oxygen containing functional groups →

i) R-OH → Alcohol

eg:- CH_3-OH, CH_3-CH_2-OH etc.

ii) R-O-R → Ether

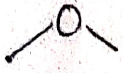
eg:- i) $CH_3-CH_2-O-CH_3$ [unsymmetrical ether]

↓

आधु-वाधु में different carbon atom की chain

 → ROR'

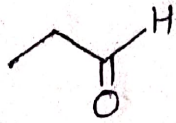
ii) CH_3-O-CH_3 [Symmetrical ether]

 → R-O-R

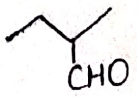
↓ आगु-बाजु के same carbon atom की chain

iii) $R-\overset{O}{\overset{\|}{C}}-H$ या R-CHO → Aldehyde

eg:-

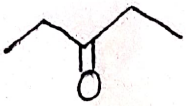


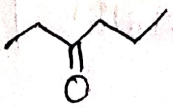
Total Carbon = 3



Total carbon = 5

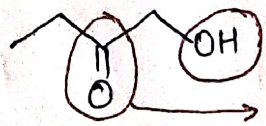
iv) $R-\overset{O}{\overset{\|}{C}}-R$ या RCOR → Ketone

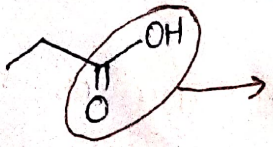
 → Symmetrical Ketone
Total carbon = 5

 → Asymmetrical Ketone
Total Carbon = 6

v) $R-\overset{O}{\overset{\|}{C}}-OH$ या RCOOH → Carboxylic acid

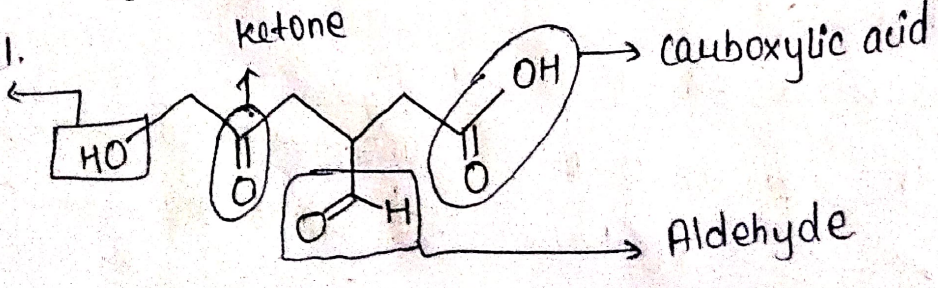
eg:- identify carboxylic acid





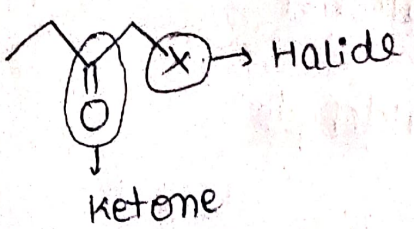
Double bond O & OH एक ही carbon atom से attached hone chahiye

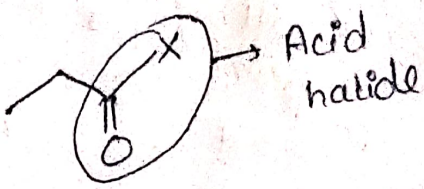
eg. Identify the no. of functional groups



vii) $R-\overset{O}{\overset{\|}{C}}-X$ या R-COX → Acid halide

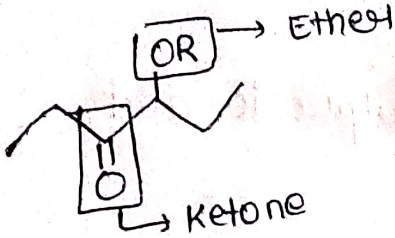
eg:-

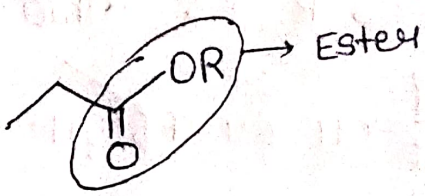




X व double bond O एक ही carbon atom से attached होने चाहिए।

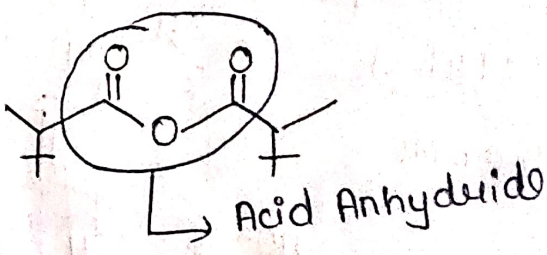
viii) $R-\overset{O}{\overset{\|}{C}}-OR$ या RCOOR → Ester

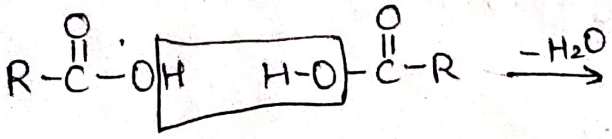




double bond O & OR एक ही carbon atom से attached होने चाहिए।

viii) Acid Anhydride →





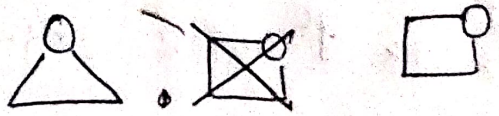
$R-\overset{O}{\overset{\|}{C}}-O-\overset{O}{\overset{\|}{C}}-R$

↓

acid anhydride

ix) Epoxide →

(Cyclic Ether)



3-membered ring

also called an Oxirane

x) R-CH=CH-OH → Enol

③ Sulphur containing functional groups →

i) $R-SH$ → Thioalcohol

ii) $R-\overset{\overset{S}{\|}}{C}-H$ → Thio aldehyde

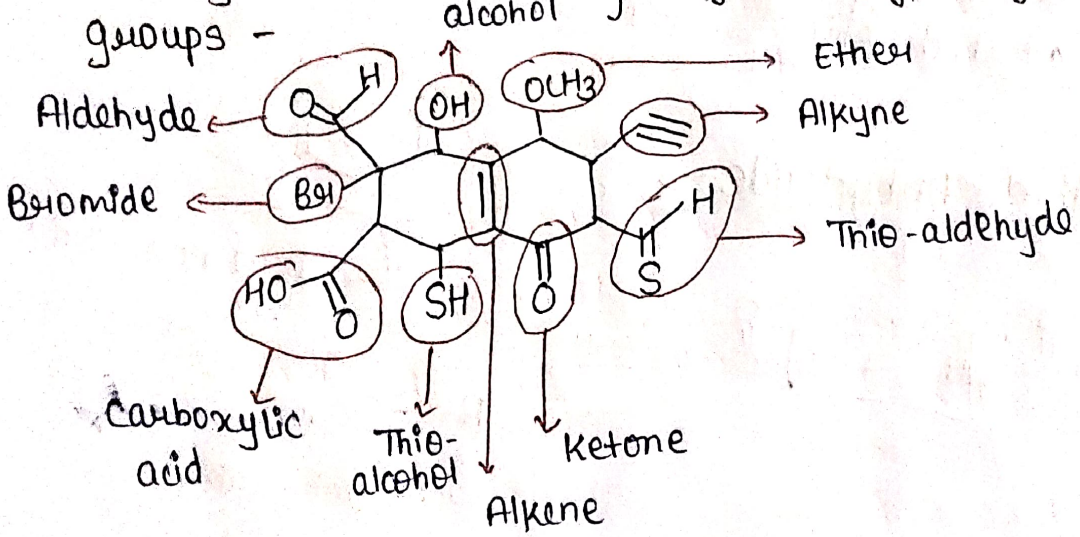
iii) $R-\overset{\overset{S}{\|}}{C}-R$ → Thio ketone

iv) $R-S-R$ → Thio ether

v) $R-\overset{\overset{O}{\|}}{C}-S-R$ → Thio ester

vi) $R-\overset{\overset{O}{\|}}{\underset{\underset{O}{\|}}{S}}-OH$ or RSO_3H → Sulphonic acid

Q. Identify the number of different types of functional groups -



④ Nitrogen Containing functional groups →

① $R-NH_2$ → 1° amine eg:- $CH_3-CH_2-NH_2$

② $R-NH-R$ → 2° amine eg:- $CH_3-CH_2-NH-CH_3$

③ $R-\underset{\underset{R}{|}}{N}-R$ → 3° amine eg:- $CH_3-CH_2-\underset{\underset{CH_2-CH_3}{|}}{N}-CH_2-CH_2-CH_3$

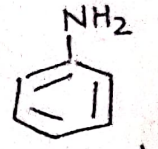
{ Nitrogen se jitne carbon connected hai utni degree }

(4) $R-\overset{\overset{O}{\|}}{C}-NH_2$ → Amide

(5) $R-CN$ → Cyanide | Nitrile

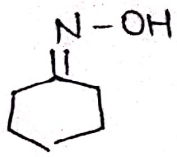
(6) $R-NC$ → Isocyanide | Isonitrile

(7) $R-CH=C-NH_2$ → Enamine

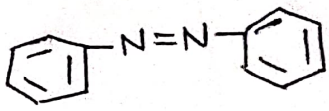
eg:- 

(Aniline)

(8) $R-CH=N-OH$ or $\begin{matrix} R \\ R \end{matrix}\!\!>\!C=N-OH$ → Oxime



(9) $R-N=N-R$ → Azo

eg:- 

(10) $R-N_3^{\oplus}$ → Azide

(11) ~~$R-CH=CH-OH$~~ →

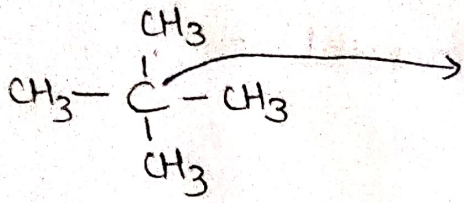
Degree of Carbon, Hydrogen, Halogen, Alcohol →

CH_4 → 0° carbon

CH_3-CH_3 → 1° carbon or Primary Carbon

$CH_3-\underset{\rightarrow}{CH_2}-CH_3$ → 2° carbon or Secondary carbon

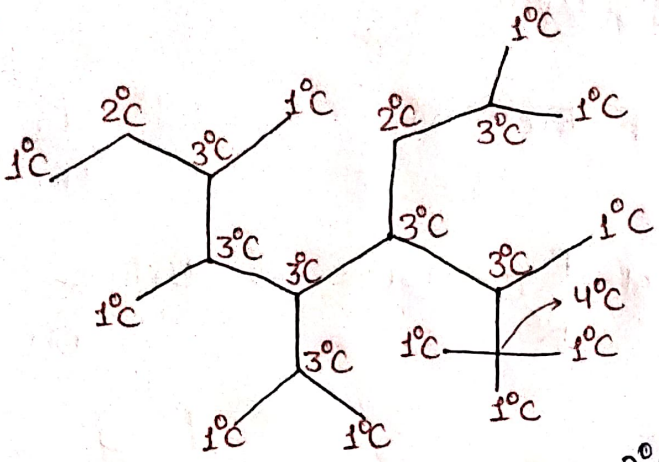
$CH_3-\overset{CH_3}{\underset{\rightarrow}{CH}}-CH_3$ → 3° Carbon or Tertiary carbon



→ 4° carbon या Quaternary carbon

एक carbon जितने carbon से attached होगा वह उतने degree का carbon होगा।

Q.



1° carbon से 3 hydrogen attached होंगे

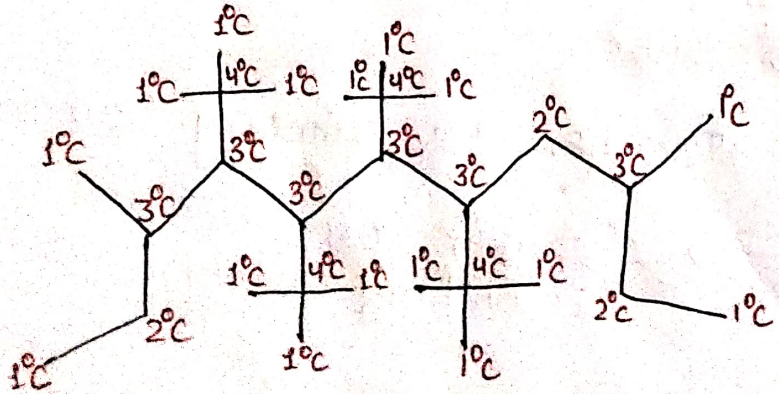
1° C पर attached hydrogen भी 1° H होंगे

2°C पर attached H भी 2°H होगा same for 3°H but 4°H नहीं होता है

1°C → 11	1°H → 33
2°C → 2	2°H → 4
3°C → 7	3°H → 7
4°C → 1	4°H → 0

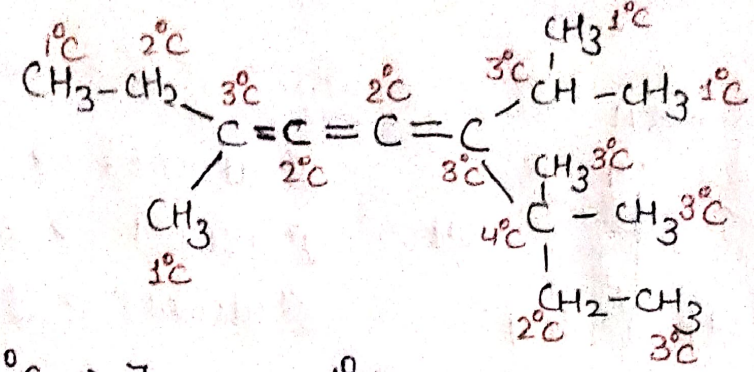
1°H count करने के लिए no. of 1°C × 3,
2°H के लिए no. of 2°C × 2, 3°H के लिए no. of 3°C × 1 for Single bond only.

Q.



1°C → 16	1°H → 48
2°C → 3	2°H → 6
3°C → 6	3°H → 6
4°C → 4	4°H → 0

Q



जब double/triple bond होगा तो $1^{\circ}H$, $2^{\circ}H$, $3^{\circ}H$ count करना पड़ेगा

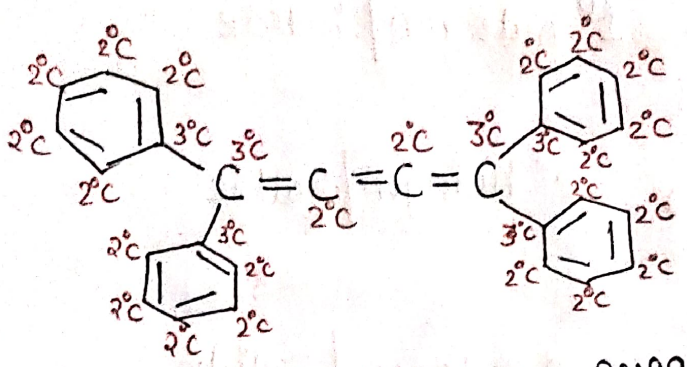
$1^{\circ}C \rightarrow 7$ $\quad 1^{\circ}H \rightarrow 21$

$2^{\circ}C \rightarrow 4$ $\quad 2^{\circ}H \rightarrow 4$

$3^{\circ}C \rightarrow 3$ $\quad 3^{\circ}H \Rightarrow 1$

$4^{\circ}C \rightarrow 1$ $\quad 0^{\circ}H \rightarrow 0$

Q.



Q. find $2x + 3y + 4z + 5w$

Ans. $x = 15$

i) no. of π-bond in given organic compound

ii) no. of $2^{\circ}C$ in given O.C. $= y = 22$

iii) no. of $3^{\circ}H$ in given O.C. $= z = 0$

iv) no. of $3^{\circ}C$ in given O.C. $= w = 6$

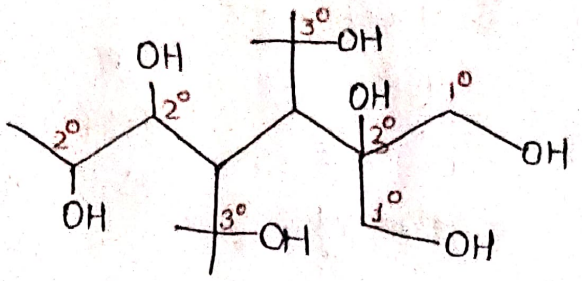
$$2x + 3y + 4z + 5w$$

$$2 \times 15 + 3 \times 22 + 4 \times 0 + 5 \times 6$$

$$30 + 66 + 0 + 30 = 126$$

- $CH_3 - OH \rightarrow 0^{\circ}$ alcohol
- $CH_3 - CH_2 - OH \rightarrow 1^{\circ}$ alcohol
- $CH_3 - \underset{CH_3}{\overset{|}{CH}} - OH \rightarrow 2^{\circ}$ alcohol
- $CH_3 - \underset{CH_3}{\overset{CH_3}{\overset{|}{\underset{|}{C}}}} - OH \rightarrow 3^{\circ}$ alcohol

Q.



1° alcohol → 2
2° alcohol → 2
3° alcohol → 3

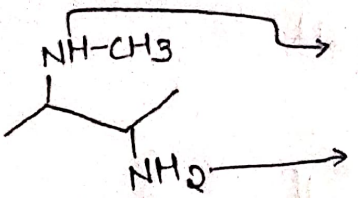
* CH_3-X → 0° halogen / halide
* CH_3-CH_2-X → 1° halogen / halide
* $CH_3-\underset{X}{\underset{|}{CH}}-CH_3$ → 2° halogen / halide
* $CH_3-\overset{CH_3}{\underset{CH_3}{\overset{|}{\underset{|}{C}}}}-X$ → 3° halogen / halide

Degree of Amines →

* $CH_3-CH_2-NH_2$ → 1° amine / Primary amine
  Nitrogen अगर 1 C से attached hai तो amine 1° का होगा
* $CH_3-CH_2-NH-CH_3$ → 2° amine / Secondary amine
  Nitrogen agar 2 carbon से attached है तो amine 2° का होगा
* $CH_3-\underset{CH_3}{\underset{|}{N}}-CH_3$ → 3° amine / Tertiary amine
  Nitrogen agar 3 carbon से attached है तो amine 3° का होगा

Q.  → 3° amine

Q.  → 2° amine

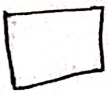
Q.  → 2° amine, 1° amine

Degree of Unsaturation →

Total number of moles of H_2 is required so that given organic compound is converted into Open chain Saturated Organic compound is known as Degree Of Unsaturation or DU.

$CH_2 = CH_2 \xrightarrow[H_2]{-1\,mole} CH_3 - CH_3$ DU → 1

$CH \equiv CH \xrightarrow[H_2]{2\,mole} CH_3 - CH_3$ DU → 2

 ⇒ CH_2-CH_2 / CH_2-CH_2 $\xrightarrow{1\,mole}$ $CH_3-CH_2-CH_2-CH_3$

DU → 1

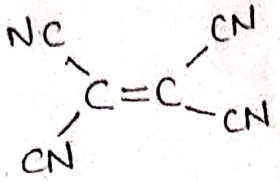
DU = no. of π bond + no. of ring

$DU = (C+1) - \left[\frac{H+X-N}{2}\right]$

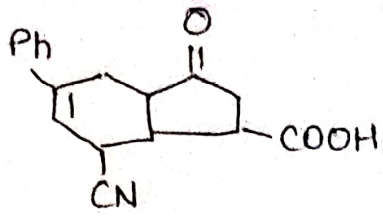
Q. Calculate the degree of unsaturation →

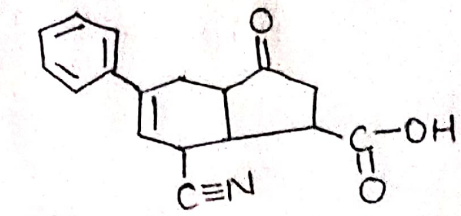
i) 

$\pi = 3$
ring = 1
DU = 3 + 1 = 4

ii) 

$\pi = 9$
ring = 0
DU = 9

iii) 



$\pi = 8$
Ring = 3

DU = 8 + 3 = 11

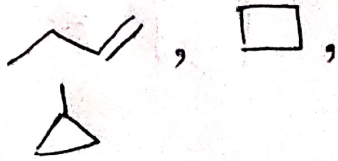
Note ⇒ Degree of unsaturation is also known as Double Bond Equivalent & Index of Hydrogen Deficiency.

Double Bond Equivalent (DBE)
Degree of unsaturation (DU)
Index of Hydrogen Deficiency (IHD)

Q. Calculate DU →

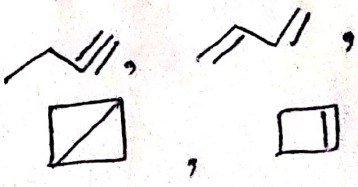
i) $C_4H_8 \rightarrow$

$DU = 5 - \left(\frac{8}{2}\right) \Rightarrow 1$

eg. 

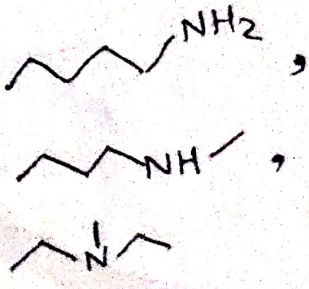
ii) $C_4H_6 \rightarrow$

$DU = 5 - \left(\frac{6}{2}\right) = 2$

eg. 

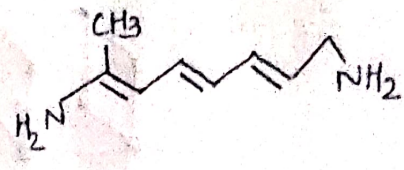
iii) $C_5H_{13}N \rightarrow$

$DU = 6 - \left(\frac{13-1}{2}\right) = 0$

eg. 

iv) $C_8H_{14}N_2 \longrightarrow$

$DU = 9 - \left[\frac{14-2}{2}\right] = 3$

eg. 

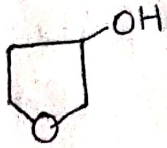
v) $C_6H_6 \longrightarrow$

$DU = 7 - \left[\frac{6}{2}\right] = 4$

eg. 

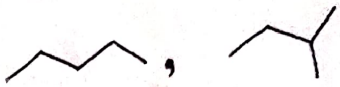
vi) $C_4H_8O_2 \longrightarrow$

$DU = 5 - \frac{8}{2} = 1$

eg. 

vii) $C_5H_{12} \longrightarrow$

$DU = 6 - \frac{12}{2} = 0$

eg. 

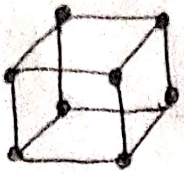
Significance of DU →

1. यदि D.U. = 1 → जो given O.C. होगा उसमें 1π bond होगा।
   ↳ जो given O.C. होगा उसमें 1 cyclic ring होगा।

2. यदि D.U. = 2 → Given O.C. में
   ↳ 2π → 2 ring → 1π + 1 ring
   → 1 ≡

3. यदि D.U. = 3 → Given O.C. में
   → 3π → 3 ring
   → 2π + 1 ring → 1π + 2 ring
   → 1 ≡ + 1 = → 1 ≡ + 1 ring

Q.



→ Cubane

C_8H_8

no. of π + no. of ring

0 + 6

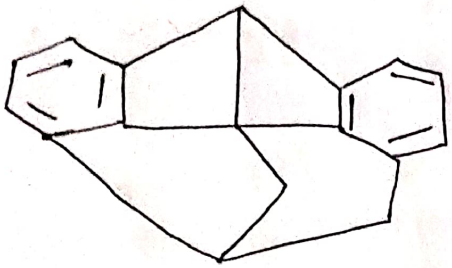
= 6

↳ $(C+1) - \left[\frac{H+X-N}{2}\right]$

$9 - \frac{8}{2} = 5$

In 3D Structure always use the formula $(C+1) - \left[\frac{H+X-N}{2}\right]$ for calculating DU

Q.



$C_{16}H_{12}$

$17 - \frac{12}{2} = 11$

Isomerism

Compounds having same molecular formula, same molecular mass but show different physical / chemical properties.

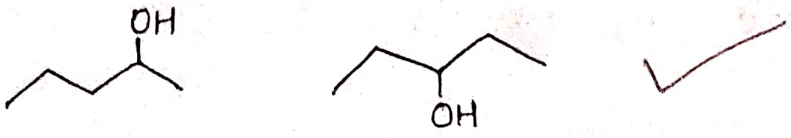
C_2H_6O

CH_3-CH_2-OH
(alcohol)
→ (liq)
→ react with NaOH

CH_3-O-CH_3
(ether)
→ (gas)
↳ does not react with NaOH

Q. Identify isomers →

i) 

ii) 

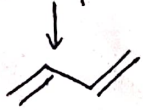
$C_5H_{12}O$ [Positional Isomers]

General formulas →

1) Alkane → C_nH_{2n+2}

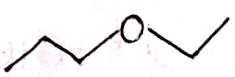
2) Alkene & Cyclo alkane → C_nH_{2n} [DU = 1]

3) Alkyne, Cyclo alkene & Dialkene [Alkadiene] → C_nH_{2n-2}



4) Alcohol & Ether → $C_nH_{2n+2}O$

eg. $CH_3-CH_2-CH_2-CH_2-CH_2-OH$ → alcohol

$C_5H_{12}O$  → Ether

5) $C_nH_{2n}O$ →

↓ DU = 1

→ Aldehyde → CH_3-CH_2-CHO → C_3H_6O

→ Ketone → $CH_3-\overset{O}{\overset{\|}{C}}-CH_3$ → C_3H_6O

→ Enol → $CH_2=CH-CH_2-OH$ → C_3H_6O

→ Enether → $CH_2=CH-O-CH_3$ → C_3H_6O

→ Epoxide →  → C_3H_6O

6) $C_nH_{2n}O_2$ → Acid [carboxylic acid] → $CH_3CH_2-\overset{O}{\overset{\|}{C}}-OH$

↓

$C_3H_6O_2$

↳ Ester → $CH_3-\overset{O}{\overset{\|}{C}}-O-CH_3$ → $C_3H_6O_2$

↳ Endiol → $CH_2=\overset{OH}{\overset{|}{C}}-CH_2-OH$ → $C_3H_6O_2$

7) Amines $\longrightarrow$ $C_nH_{2n+3}N$ {all kinds of amines}

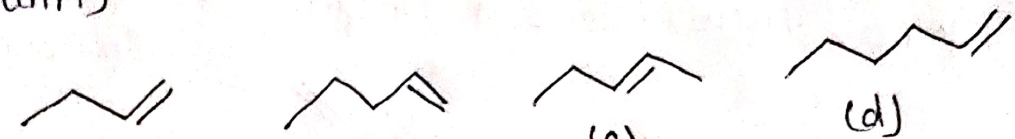
1° amine $\rightarrow$ $CH_3-CH_2-NH_2$ } $\rightarrow$ C_2H_7N

2° amine $\rightarrow$ $CH_3-NH-CH_3$ }

Homologous Series

Series in which same general formula, same functional group but different by molecular mass (differ by $-CH_2$ unit)

eg:-



(a) (b) (c) (d)

a-b $\rightarrow$ Homologous
b-c $\rightarrow$ Isomers
a-d $\rightarrow$ 2nd Homologous
b|c-d $\rightarrow$ Homologous

eg:- $CH_3-CH_2-CH_2-NH_2$, $CH_3-CH_2-NH-CH_3$, $CH_3-\underset{\underset{CH_3}{|}}{N}-CH_3$

1° amine 2° amine 3° amine

Isomers

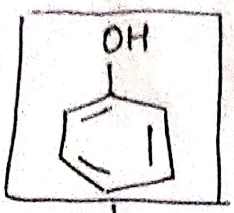
Note:- 1° amine, 2° amine & 3° amine are different functional groups.

Q.  &

$\Downarrow$

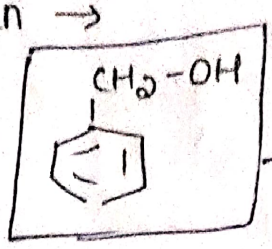
NO relation

Q. Relation between →



↳ Phenol

&



→ Alcohol

No Relation

Alcohol & Phenol are different functional groups

§ जब Benzene में OH directly connected है तब वो Phenol functional group होता है लेकिन अगर OH directly connected ना है तो वो Normal Alcohol होता है ;

Nomenclature of Organic Compounds [SKM Sir]

Intially, it was believed that organic compounds were obtained under the influence of a vital force i.e. they could not be obtained in laboratory.

First organic compound, which was accidently obtained is Urea, which was formed when KCNO & $(NH_4)_2SO_4$ were mixed to form ammonium cyanate NH_4CNO but was found to be urea, NH_2CONH_2

$$2KCNO + (NH_4)_2SO_4 \longrightarrow 2NH_4CNO + K_2SO_4$$

NH_4CNO → Expected product

NH_2CONH_2 → Observed product

$$NH_2-\overset{\overset{O}{\|}}{C}-NH_2$$

The above accident produced the following two phenomena →

i) Organic compounds can be manufactured artificially.

ii) Isomerism

Representation of formula

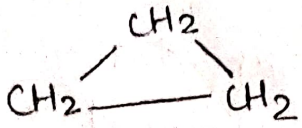
→ Bond line formula | Notation →

In this representation,

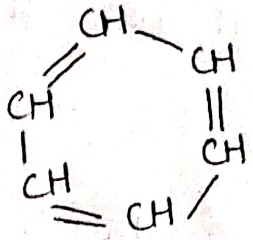
CH bond is never shown.

For example:- $CH_3-CH_2-CH_3$

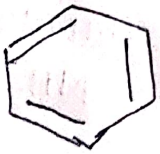
9 σ bonds

1. 

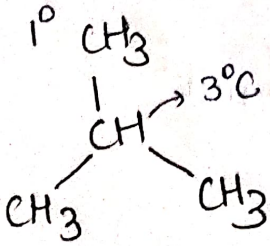
→ 2° carbons

2° 

2° carbons



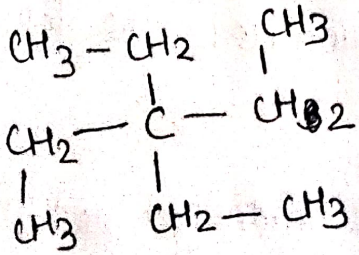
→ 12 σ bonds
3 π bonds

3. 

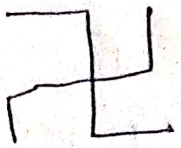
Three 1°C
One 3°C



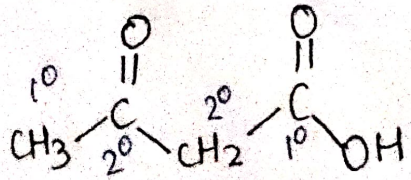
13 σ bonds

4. 

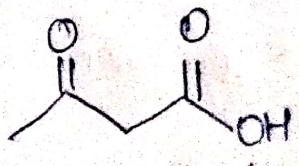
Four 1°C
Four 2°C
One 4°C



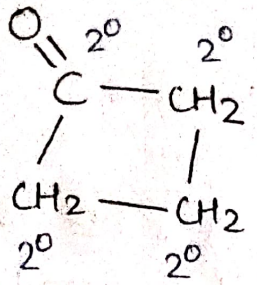
28 σ bonds

5. 

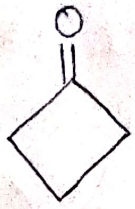
Two 1°C
Two 2°C



12 σ Bonds
2 π Bonds

6. 

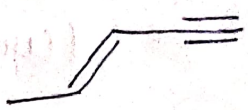
2° carbons



11 σ bonds
1 π bond

7. $CH_3 - CH = CH - C \equiv CH$
$1^0 \quad 2^0 \quad 2^0 \quad 2^0 \quad 1^0$

Three 2°C
Two 1°C



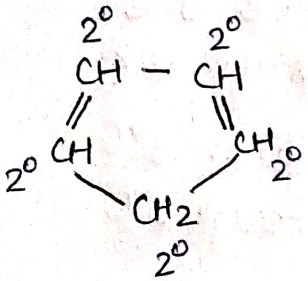
10 σ bonds
3 π bonds

8. $CH_2 = CH - CH = CH_2$

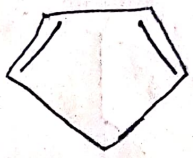
Two 1°C
Two 2°C



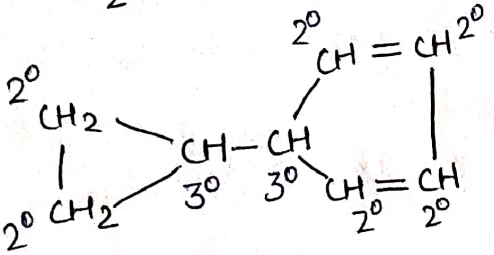
9 σ bonds
2 π-bonds

9. 

→ 2° carbons



11 σ bonds
2 π bonds

10. 

Six 2°C
Two 3°C



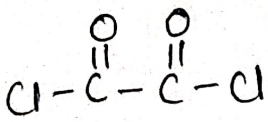
19 σ bonds
2 π bonds

11. $CH \equiv C - C \equiv CH$

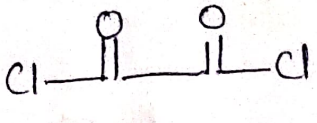
Two 1°C
Two 2°C



5 σ bonds
4 π bonds

12. 

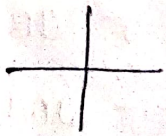
Two 1°C



5 σ bonds
2 π bonds

13. $(CH_3)_4 C$

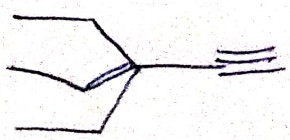
Four 1°C
One 4°C



16 σ bonds

14. $(CH_3CH_2)_3 CCH$

Four 1°C
Four 2°C
One 4°C



24 σ bonds
2 π bonds

15. $CH_3-CHCCCC(CH_3)_2$

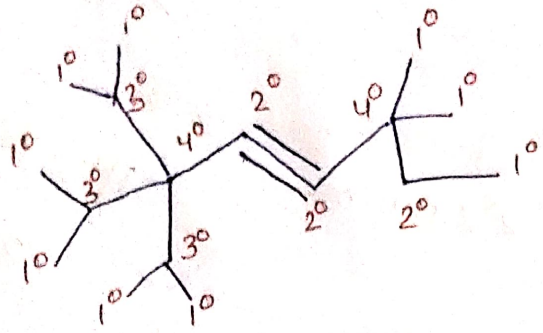
Three 1°C
Four 2°C
one 3°C



17 σ bonds
4 π bonds

Cummulated Alkene
(Cummulene)

16. $(CH_3CH(CH_3))_3CCCC(CH_3)_2(CH_2CH_3)$



Nine 1°C
Three 2°C
Three 3°C
Four 2°C

45 σ bonds
2π bonds

Sigma and pi Bond Calculation

C—C	1 σ
C=C	1 σ and 1 π
C≡C	1 σ and 2 π

Types of Carbon & Hydrogen

⊛ Carbon →

⊛ 4°C → **Quaternary carbon**

Carbon atom directly attached with 4 other carbon atoms.

Note ⇒ There is no hydrogen in 4°C.

→ Atleast 5 carbon atoms are required in a compound to have 1, 4°C

⊛ 3°C → **Tertiary Carbon**

Carbon atom directly attached with 3 other carbon atoms.

⊙ Minimum 4 carbon atoms needed to have a 3°C.

⊛ 2°C → **Secondary Carbon**

Carbon atom attached directly with 2 ~~ato~~ other carbon atoms.

⊙ Minimum 3 C atoms are needed to have a 2°C.

⊛ 1°C → **Primary Carbon**

Carbon atom attached with 1 or none carbon atom.

Hydrogen →

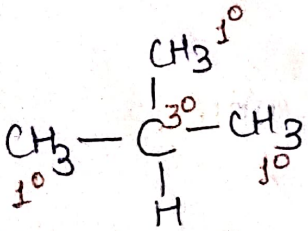
3° H → Hydrogen atoms attached with 3°C.

2° H → Hydrogen atoms attached with 2°C.

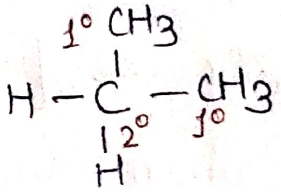
1° H → Hydrogen atoms attached with 1°C

Q. Draw structure of lowest molecular mass containing organic hydrocarbon alkane compound which contains →

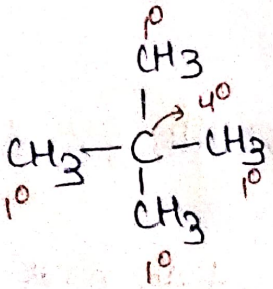
a) 1°C & 3°C only



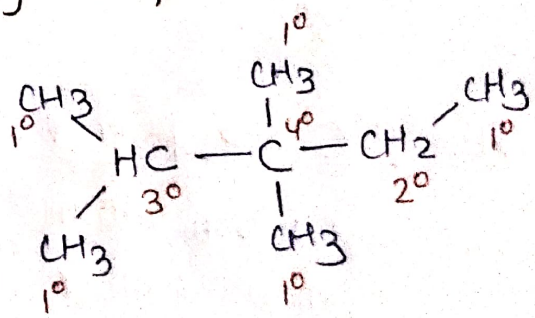
b) 1°C and 2°C only



c) 1° & 4°C only

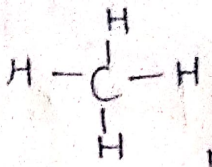


d) 1°C, 2°C, 3°C and 4°C

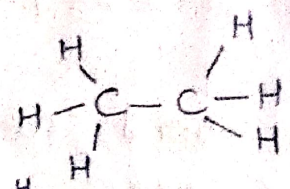


(x) Total number of hydrocarbons alkanes having 10 or less than 10 C atoms which contain all hydrogen of same type.

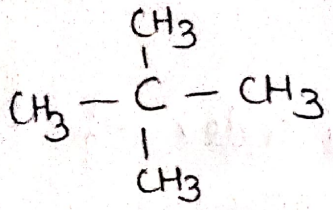
⊛ CH_4

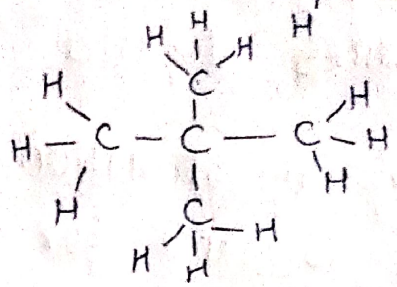


⊛ CH_2-CH_3

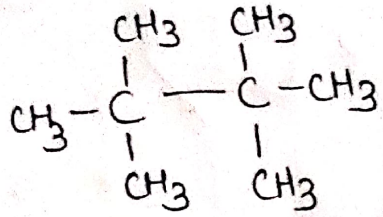


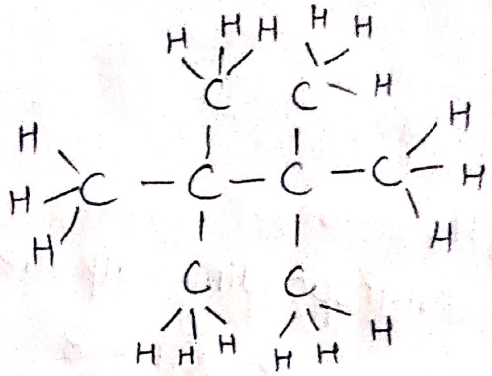
⊛





⊛





The above shown compounds are the only possible hydrocarbon alkanes for the given condition to be satisfied.

Double Bond Equivalence

Index of Hydrogen deficiency

General formulae →

Alkane → C_nH_{2n+2}

Alkene → C_nH_{2n}

Alkyne → C_nH_{2n-2}

In Alkene, the deficiency of hydrogen is 1 per C atom whereas in alkyne, the deficiency is 2 per C-atom.

index of hydrogen deficiency

Note ⇒ i) DOU / IHD = $\frac{\Delta H}{2}$

ii) A π bond carries 1 IHD, and a ring also carries 1 IHD

iii) Degree of unsaturation or index of hydrogen deficiency is same for all isomers

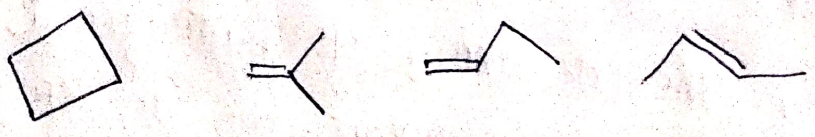
Examples :-

1. C_6H_6 →
   corresponding alkane → C_6H_{14}
   ⇒ $\Delta H = 8$
   Hence, DOU = 4

2. $C_{10}H_8$ →
   corresponding alkane = $C_{10}H_{22}$
   ⇒ $\Delta H = 14$
   Hence, DOU = 7

3. $C_{12}H_{18}$ →
   corresponding alkane = $C_{12}H_{26}$
   ⇒ $\Delta H = 8$
   Hence, DOU = 4

4. C_4H_8 →



Note ⇒ C_4H_8 is not necessarily butene as it also represents the molecular formula for cyclobutane.

Hence, molecular formula does not refer to any compound until mentioned by its name or without its structure.

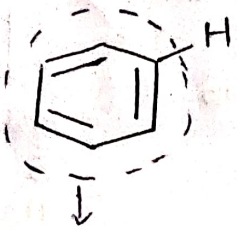
Now,

Corresponding alkane = C_4H_{10}

$\Delta H = 2$

Hence, **DOU = 1**

5.



This does not refer to any compound, instead is a group known as phenyl (ph).

Thus, benzene is denoted as - (ph-H), ph → C_6H_5-

Corresponding alkane → C_6H_{14}

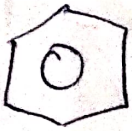
$\Delta H = 8$

⇒ **DOU = 4**

Also, as we know that each π bond along with the no. of rings carry 1 DOU, each

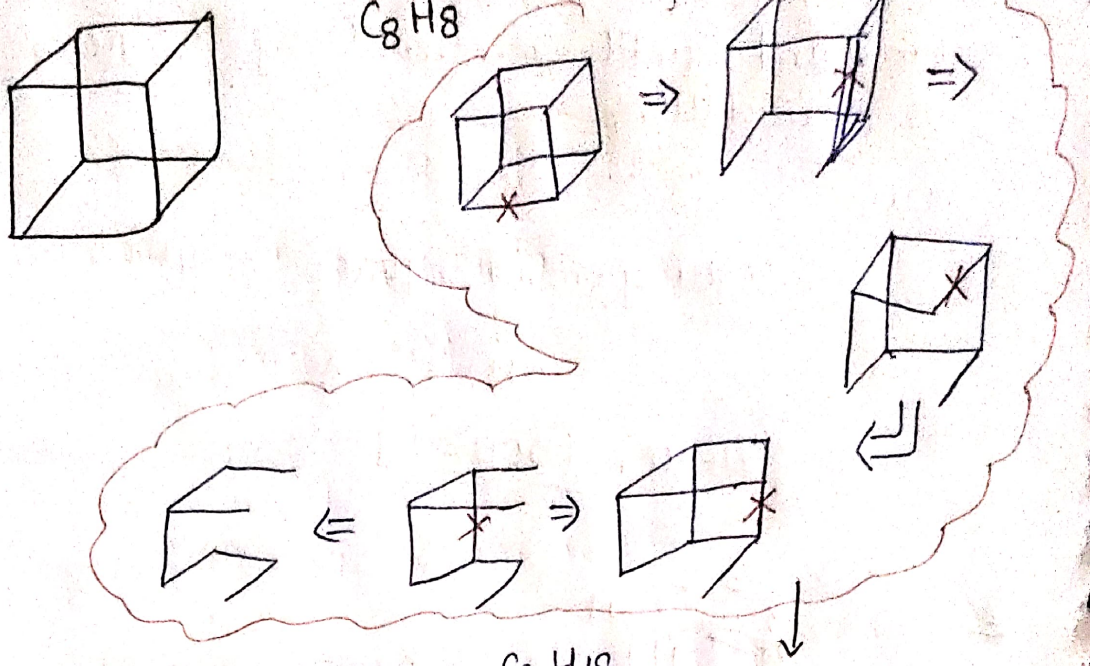
Hence, **DOU = 3 + 1 = 4**

Note ⇒ Benzene is also denoted as



The ring implies that each carbon is sp^2.

6. C_8H_8



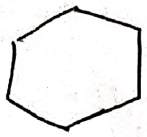
Corresponding alkane = C_8H_{18}

$\Rightarrow \Delta H = 10$

Hence, **DOU = 5**

~~No. of~~ 5 bonds ~~to~~ needed to be broken.

∴ No. of rings present = 5

7. 

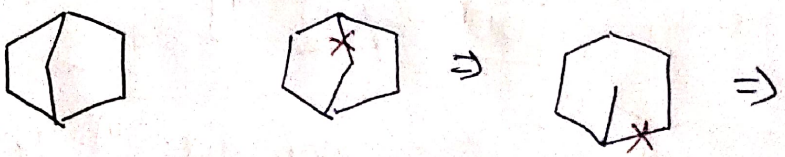
Cyclohexane

C_6H_{12}

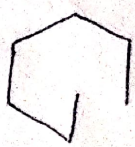
Corresponding alkane = C_6H_{14}

$\Rightarrow$ **DOU = 1**

8. C_7H_{12}

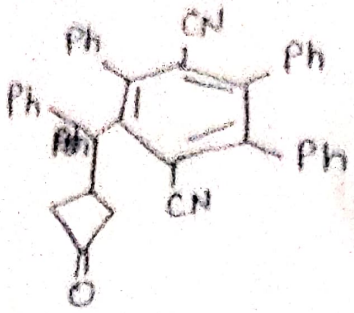


Corresponding alkane = C_7H_{16}



$\Rightarrow \Delta H = 4$

Hence, **DOU = 2**

9. 

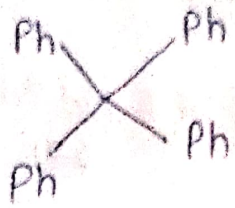
Ph groups : 5 ⇒ 5 × 4 = 20 DOU

Rings :- 1 ⇒ 1 DOU

π Bonds : 5 ⇒ 5 DOU

Hence, DOU = 26

10. $(Ph)_4C$



DOU = 4 × 4

DOU = 16

11. $(Ph)_4C_2$



DOU = 4 × 4 + 1

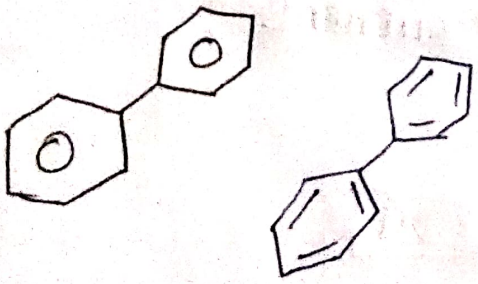
DOU = 17

12. $(Ph)_2C_2$

Ph − C ≡ C − Ph

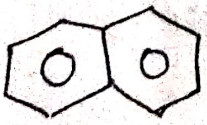
~~DOU~~ DOU = 4 × 2 + 2

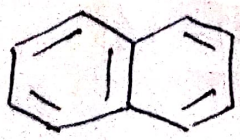
DOU = 10

13. 

~~DOU~~ DOU = 4 × 2

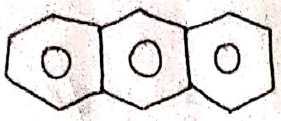
DOU = 8

14.  Napthalene

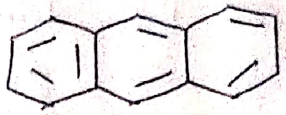


2 rings + 5 π bonds

DOU = 7

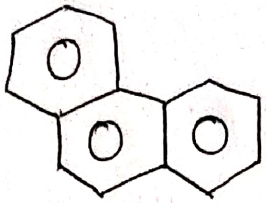
15. 

Anthracene

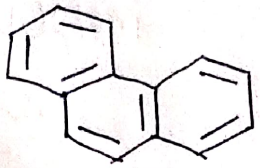


3 rings and 7 π bonds

DOU = 10

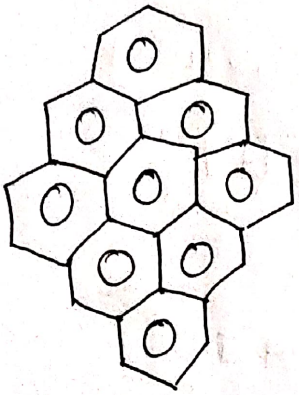
16. 

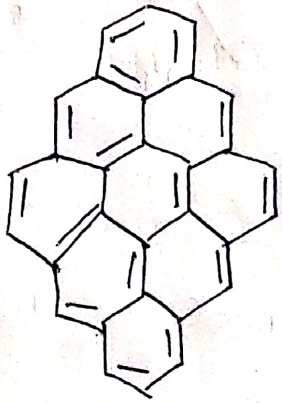
Phenanthracene



7 π bonds + 3 rings

DOU = 10

17. 

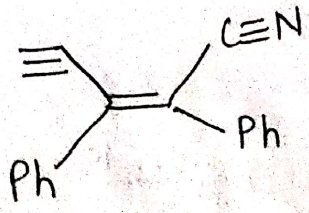


Dibenzo coronene

π Bonds ⇒ 15

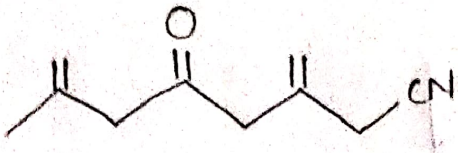
Rings ⇒ 9

Hence, DOU = 24

18. 

11 π bonds + 2 Rings

⇒ DOU = 13

19. 

5 π bonds

DOU = 5

20. Draw isomers of C_5H_8

Sol:- DOU = 2

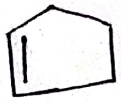
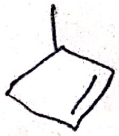
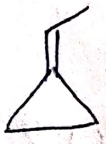
Two double bonds :-

1) $C=C=C-C-C$
2) $C=C-C=C-C$
3) $C=C-C-C=C$
4) $C-C=C=C-C$
5) $C=\underset{\underset{C}{|}}{C}-C=C$
6) $C-\underset{\underset{C}{|}}{C}=C=C$

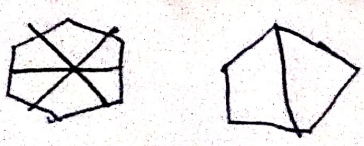
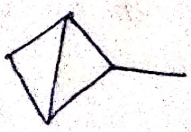
1 Triple bond →

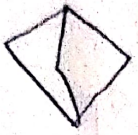
1) $C\equiv C-C-C-C$
2) $C-C\equiv C-C-C$
3) $C-C-\underset{\underset{C}{|}}{C}\equiv C$
4) $C\equiv C-\underset{\underset{C}{|}}{C}-C$

1 Ring & 1 Double Bond →

1) 
2) 
3) 
4) 
5) 
6) 
7) 
8) 
9) 
10) 
11) 
12) 

2 Rings →

1) 
2) 
3) 

4) 

5) 

Exercise

Case-1 Monovalent atoms, can be considered as H

1) $C_3H_3F \rightarrow C_3H_4$ $\quad \Delta H = 4 \Rightarrow DOU = 2$

2) $C_6H_2FClBrI \hookrightarrow C_6H_6$ $\quad \Delta H = 8 \Rightarrow DOU = 4$

3) $C_6D_4 \rightarrow C_6H_4$ $\quad \Delta H = 10 \Rightarrow DOU = 5$

4) $C_3D_2T_2FCl \hookrightarrow C_3H_6$ $\quad \Delta H = 2 \Rightarrow DOU = 1$

5) C_xH_x $\quad \Delta H = x+2 \Rightarrow DOU = \frac{x+2}{2}$

alkane:- C_xH_{2x+2}

6) C_x $\quad \Delta H = 2x+2 \Rightarrow DOU = x+1$

7) $C_6HDTF_2ClBr_2 \hookrightarrow C_6H_8$ $\quad \Delta H = 6 \Rightarrow DOU = 3$

8) C_{60} $\quad \Delta H = 122 \Rightarrow DOU = 61$

Case-2 Bivalent atoms can be neglected

9) $CO_2 \rightarrow C$ $\Delta H = 4 \Rightarrow DOU = 2$

10) $C_3O_2 \rightarrow C_3$ $\Delta H = 8 \Rightarrow DOU = 4$

11) $C_4H_4O_4 \rightarrow C_4H_4$ $\Delta H = 6 \Rightarrow DOU = 3$

12) $C_6H_4D_2F_2O_2S \hookrightarrow C_6H_8$ $\Delta H = 6 \Rightarrow DOU = 3$

13) $C_4O_4 \longrightarrow C_4$ $\Delta H = 10 \Rightarrow DOU = 5$

Case-3 → Trivalent atoms can be neglected with same no. of monovalent atoms.

14) $C_3H_7N \hookrightarrow C_3H_6$ $\Delta H = 2 \Rightarrow DOU = 1$

15) $C_2H_6N_2 \hookrightarrow C_2H_4$ $\Delta H = 2 \Rightarrow DOU = 1$

16) $C_6H_8N_2 \hookrightarrow C_6H_6$ $\Delta H = 8 \Rightarrow DOU = 4$

17) $C_2N_2 \rightarrow C_2H_{-2}$ $\Delta H = 8 \Rightarrow DOU = 4$

$N \equiv C - C \equiv N$

18) $C_4H_4N_4$ → C_4 $\quad \Delta H = 10 \Rightarrow DOU = 5$

19) $C_8H_3X_3N_2$ → C_8H_4 $\quad \Delta H = 14 \Rightarrow DOU = 7$

20) $C_xH_yX_zO_pN_q$

$$C_xH_{(y+z)}O_pN_q \rightarrow C_xH_{(y+z-q)}$$

$$\Delta H = 2x+2-y-z+q$$

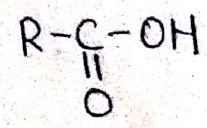
$$DOU = \frac{2x+q-y-z+2}{2}$$

$$DOU = \sum (C+1) + \frac{[N-H-X]}{2}$$

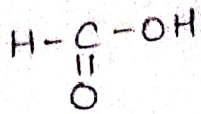
Functional Groups

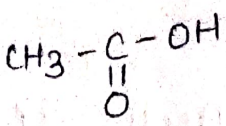
Chemically active part of a compound which is responsiple for all chemical reaction is known as Functional Group of that compound.

⊛ Carboxylic acid →

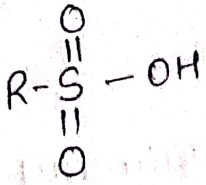


Here, R refers to a group like CH_3, CH_2-CH_3---

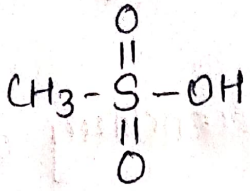
Eg:-  Formic acid (Ant acid)

 Acetic acid (Vinegar)

⊛ Sulphonic Acid :-

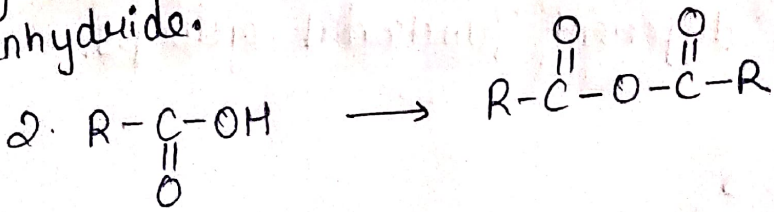


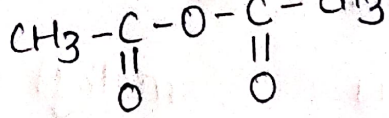
Here, R cannot be H as it won't remain an organic compound

eg.  Methane Sulphonic acid

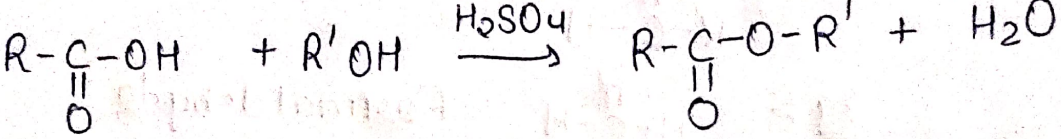
⊛ Acid Anhydride →

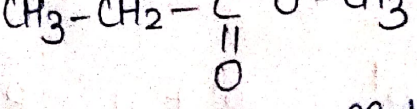
Removal of water from an acid refers to dehydration. The compound formed is acid anhydride.

2. 

eg.  Acetic anhydride

⊛ Ester (Fruity Smell) →



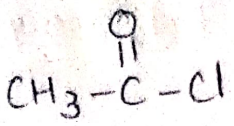
Eg:- 

Methyl ~~acetate~~ propanoate

⊛ Acid halide →

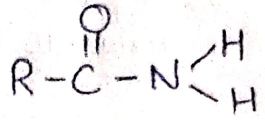


eg:-

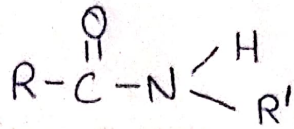


Acetic chloride

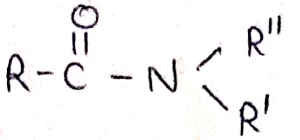
⊛ Acid amide →



Primary amide



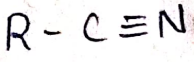
Secondary amide



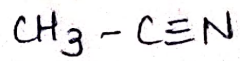
Tertiary amide

⊛ The above three amides are considered as three different functional groups.

⊛ Cyanide →

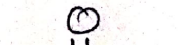


eg:-

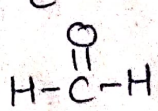


methyl cyanide

⊛ Aldehyde →

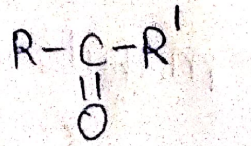


Eg :-



Formaldehyde

⊛ Ketone →



$R' \neq H$, $R \neq H$

Otherwise the compound will be like

$R-\underset{\underset{O}{\|}}{C}-H$ i.e. aldehyde

The first ketone $CH_3-\underset{\underset{O}{\|}}{C}-CH_3$ Propanone (Acetone)

⊛ Alcohol →

$R-OH$

$\boxed{R \neq H}$

CH_3-OH methanol

CH_3-CH_2-OH ethanol

⊛ Thiol →

$R-SH$

$\boxed{R \neq H}$

CH_3-SH → Methyl thiol

⊛ Amine →

$\boxed{R \neq H}$ $R-N\begin{matrix}H\\H\end{matrix}$ Primary Amine

↳ NH_3 is not an amine

$R \neq H$, $R' \neq H$ $R-N\begin{matrix}H\\R'\end{matrix}$ Secondary amine

$R \neq H$, $R' \neq H$, $R'' \neq H$ $R-N\begin{matrix}R'\\R''\end{matrix}$ Teertiary amine

⊛ Ether →

$R-O-R'$

$R \neq H$, $R' \neq H$ Eg:- CH_3-O-CH_3

(*) Thio ether →

$R-S-R'$ Eg. CH_3-S-CH_3

$R \neq H$, $R' \neq H$

(*) Thio Ketone →

$R-\underset{\underset{S}{\|}}{C}-R'$ eg. $CH_3-\underset{\underset{S}{\|}}{C}-CH_3$

(*) Nitro →

$R-NO_2$ eg. CH_3-NO_2

$R \neq H$

(*) Nitrite → $R-ONO$ eg. CH_3-ONO

$R \neq H$

(*) Nitroso → $R-NO$ eg. CH_3-NO

$R \neq H$

(*) Isocyanide → $R-NC$ eg. CH_3-NC

$R \neq H$

(*) Halide → $R-X$ eg. CH_3-Cl

$R \neq H$

(*) Diazo →

$R-N=N-R'$ eg. $CH_3-N=N-CH_3$

$R' \neq H$, $R \neq H$

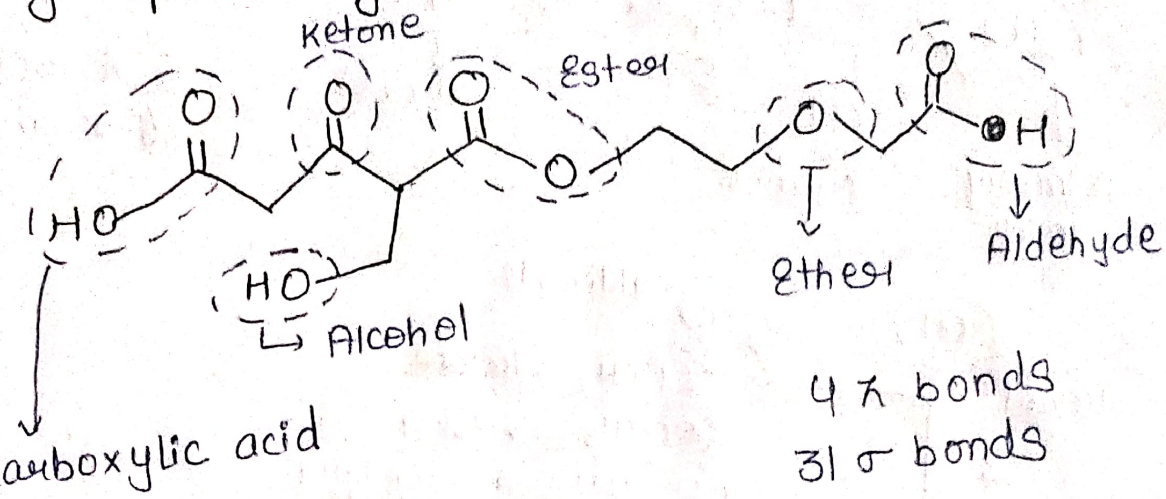
(*) Azide →

$R-N_3$ eg. CH_3-N_3

$R \neq H$

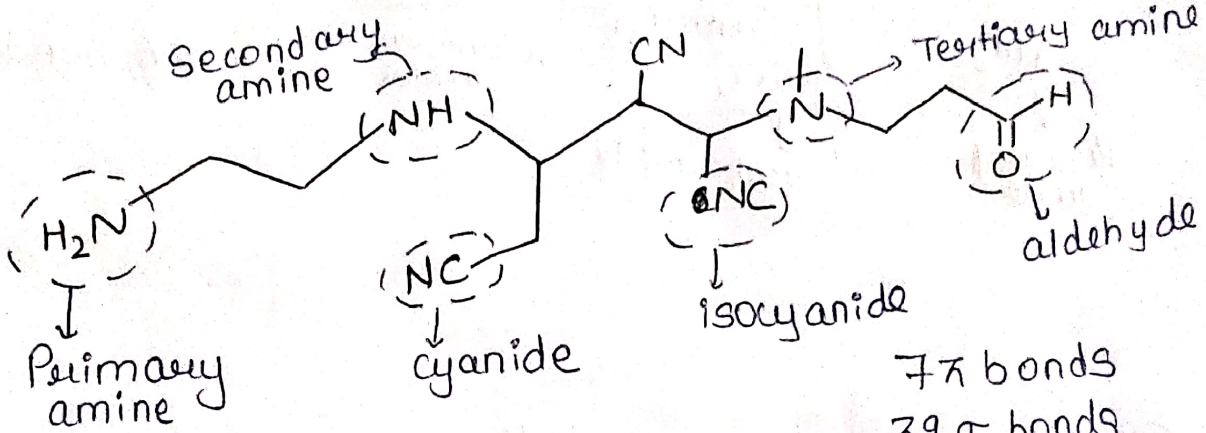
Exercise:- Count the no. of distinct functional groups along with no. of σ & π bonds.

1.



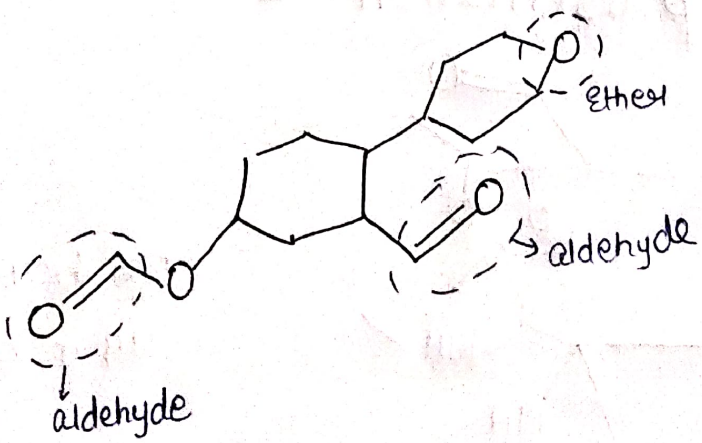
4 π bonds
31 σ bonds

2.



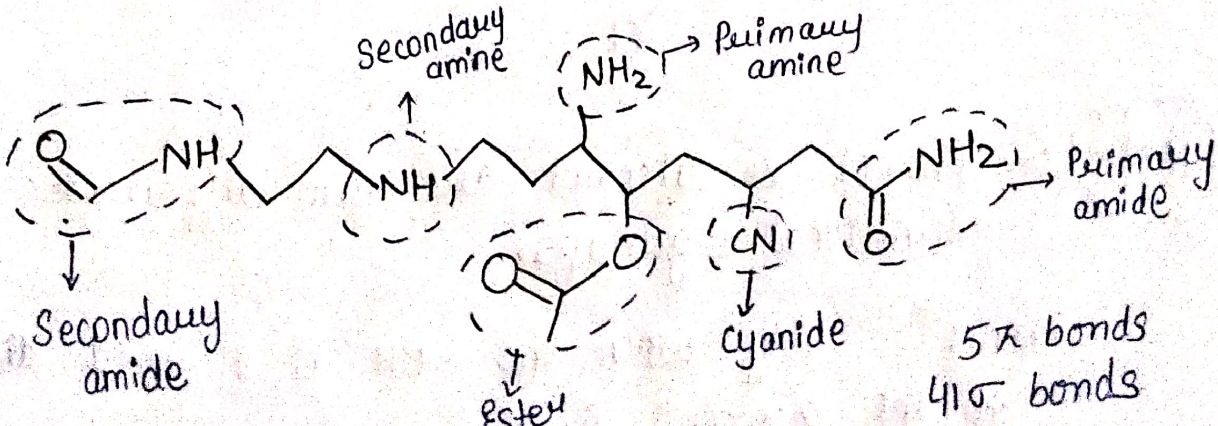
7 π bonds
39 σ bonds

3.



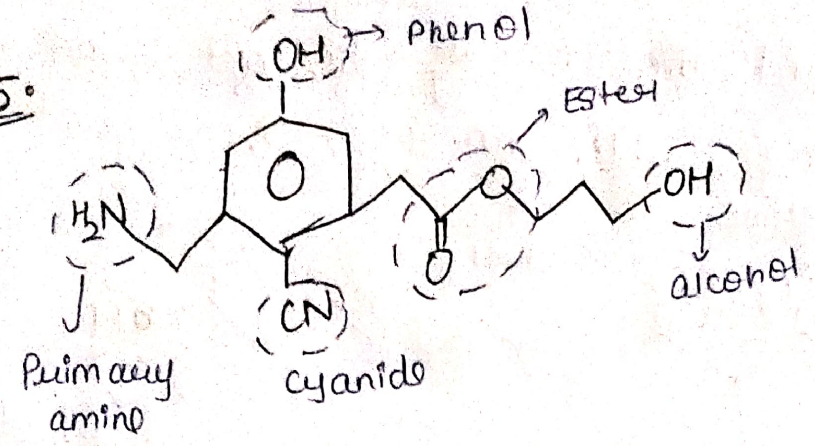
2 π bonds
37 σ bonds

4.



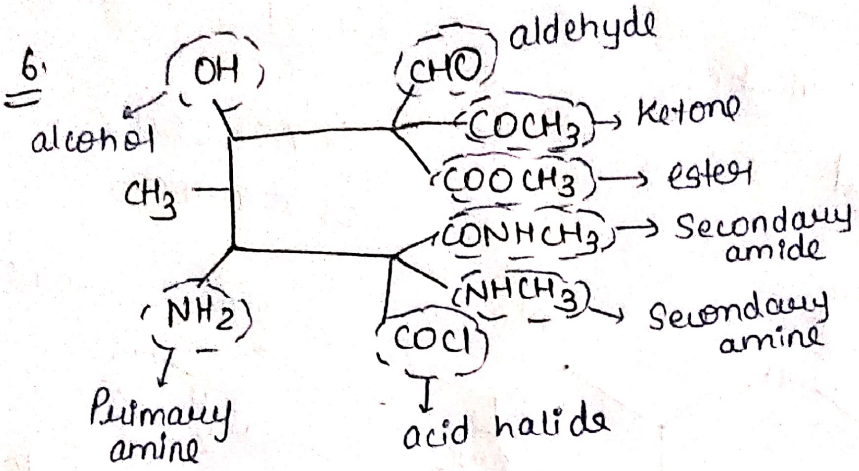
5 π bonds
41 σ bonds

5.



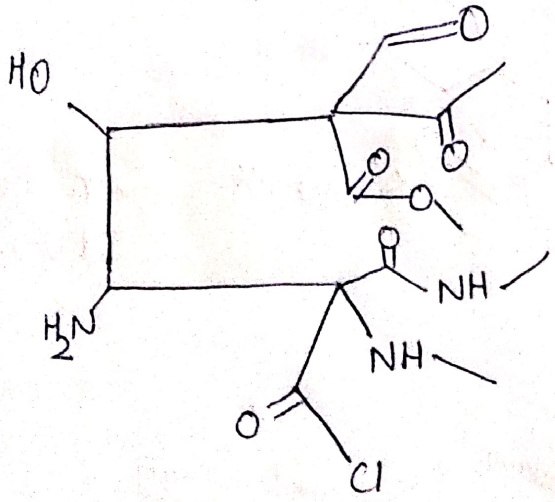
6 π bonds
36 σ bonds

6.



5π bonds

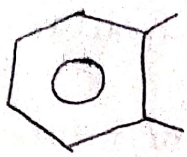
Bond Line Representation →



5π bonds
49 σ bonds

Note :- Phenol & alcohol are two different functional groups.

Phenol is only when the -OH is attached directly to the benzene rings.



OH ⇒ Phenol

CH_2-OH ⇒ Alcohol

→ Double bonds and triple bonds are considered as two different functional groups.

Homologous Series

A series of compounds having similar chemical properties (same functional groups) & difference of 14 gm in consecutive member is called homologous series.

The members are known as homologues.

* Alkane,

$H-CH_3$

$H-CH_2-CH_3$

$H-CH_2-CH_2-CH_3$

$H-R$

* Alcohol →

CH_3-OH

CH_3-CH_2-OH

$CH_3-CH_2-CH_2-OH$

$R-OH$

→ Homologous series can be represented by same general formula.

→ They have similar chemical properties.

→ They have a difference $-CH_2-$.

Exercise :- Which pair represents set of homologous.

a) $CH_3-CH_2-NH_2$ and $CH_3-CH_2-NH-CH_3$

- NO

b) CH_3-CH_2-OH and $CH_3-CH(OH)-CH_3$

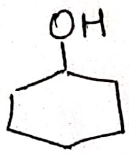
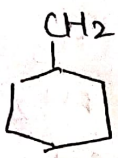
- YES

c) $CH_3-CH_2-CH_2-NH_2$ and CH_3-NH_2

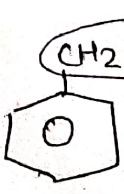
- YES

d) $CH_3-N(CH_3)-CH_3$ and $CH_3-CH_2-CH_2-CH_2-NH_2$

- NO

e)  and 

- YES

f)  Phenol and  Alcohol

- NO

g)  and 

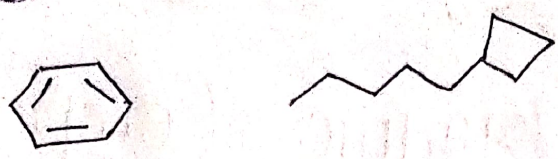
- YES

Classification Of Organic Compounds

Organic Compounds

- Open Chain / Acyclic compounds
  - Hydrocarbon
    - Saturated compounds (Alkane)
    - Unsaturated compounds
      - Alkenes
      - Alkynes
  - Non-Hydrocarbon
    - Saturated
    - unsaturated
- Cyclic compounds
  - Carbocyclic / Homocyclic
    - Aliphatic / Alicyclic compounds
    - Aromatic compounds
      - → Cyclic
      - → Planar
      - → conjugation
      - → $(4n+2)\pi$ e^-.
  - Hetero-cyclic compound

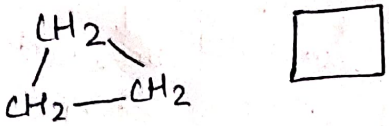
⊛ Cyclic Compounds →
It has atleast one ring [the size of ring does not matter]



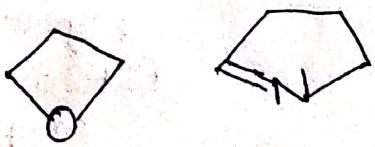
⊛ Acyclic Compounds →
The compounds of carbon which do not have any ring & have only branches or chains are known as Acyclic compounds.



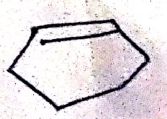
⊛ Carbocyclic Compounds →
The cyclic compounds which have ring made up of carbon only are known as carbocyclic compounds.



⊛ Heterocyclic Compounds →
The cyclic compounds which have ring in where there is one atom other than carbon are known as Heterocyclic compounds.



⊛ Aliphatic Compounds →
The cyclic compounds that do not abide the rules necessary to be called as aromatic compounds.



⊛ Aromatic compounds →

The cyclic compounds which are planar, conjugated & abide the other rules for aromatic compounds.

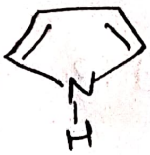


Q.

a) 

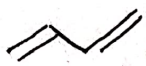
→ cyclic compound
→ carbocyclic compound
→ Aromatic compound

12 σ bonds
3 π bonds
6 π e⁻

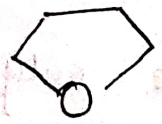
b) 

→ cyclic compound
→ Aromatic compound
→ Heterocyclic compound

10 σ bonds
2 π bonds
6 π e⁻

c) 

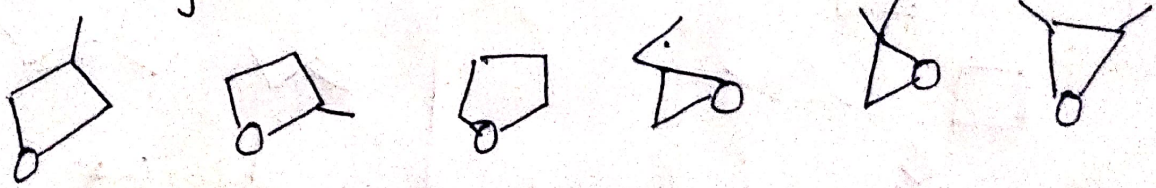
→ 9 σ bonds
→ 2 π bonds

d) 

→ Cyclic compound
→ Heterocyclic compound

13 σ bonds
0 π bonds

Q. Draw all isomers of C_4H_8O which are heterocyclic





Q. a)  i) acyclic ii) hydrocarbon

b)  iii) Homocyclic ii) Hydrocarbon

c)  iv) Aromatic iii) Homocyclic

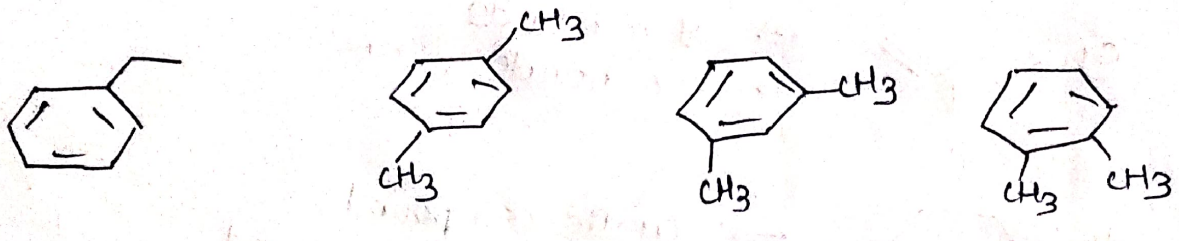
d)  v) Heterocyclic iv) Aromatic

Q. Draw all isomers of benzenoid aromatic compounds of molecular formula C_8H_{10}

$$DBE = 4$$

There wont be any 8-membered & 7 membered ring isomer.

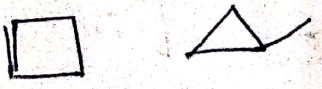
Now, 6 membered ring →



∴ the shown compounds are the only benzenoid aromatic compounds.

Q. Draw all unsaturated structural isomers of C_4H_8. DBE = 1

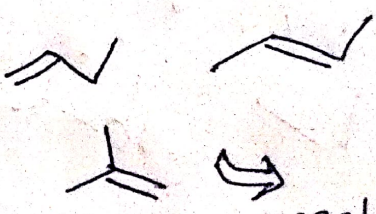
Ring



⇓

These compounds are not unsaturated, as unsaturation refers to double/triple bond.

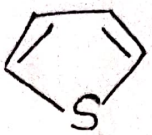
1 Double bond



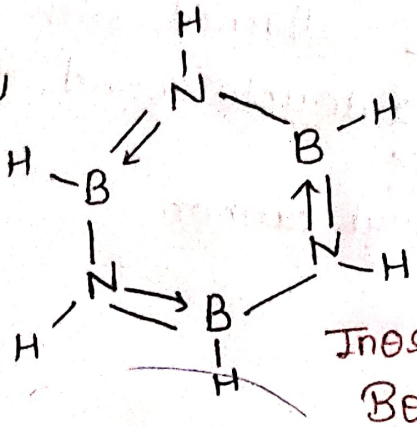
unsaturated isomers

→ C_4H_8 only has the above shown structural isomers as it has a low value of DBE, there are very less possibilities for a structural isomer.

Q. Identify aromatic compounds →

1)  Alicyclic compound

2)  Aromatic compound

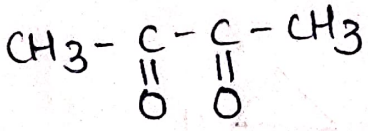
3)  Aromatic compound

Inorganic Benzene
Borazine
Borazol

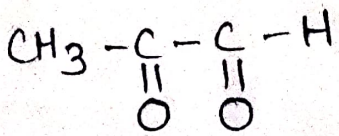
4)  Anti-aromatic compound

* Some Common & Useful Compounds →

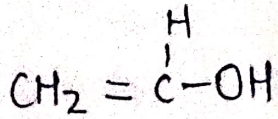
⊙ Dimethyl Glyoxal :-



⊙ Methyl Glyoxal / Pyruvialdehyde



⊙ Vinyl alcohol :-



⊙ Allyl Alcohol →

$CH_2 = CH - CH_2 - OH$

Note:- when carbon attached with a double bond with other carbon makes a bond with the functional group, it is reffered with vinyl-prefix

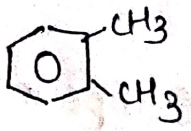
$CH_2 = C^{\swarrow}$ ← vinyl carbon

whereas when a carbon atom is attached to a carbon atom that is attached with other carbon atom with a double bond, it is refered with allyl prefix

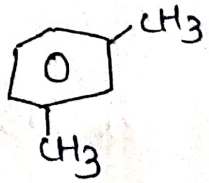
$CH_2 = CH - C^{\leftarrow}$ ← allyl carbon.

⊛ Xylene →

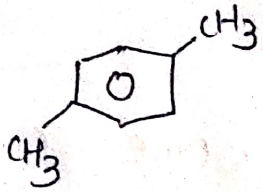
O-xylene



m-xylene



p-xylene



⊛ Carbocyclic chains →

