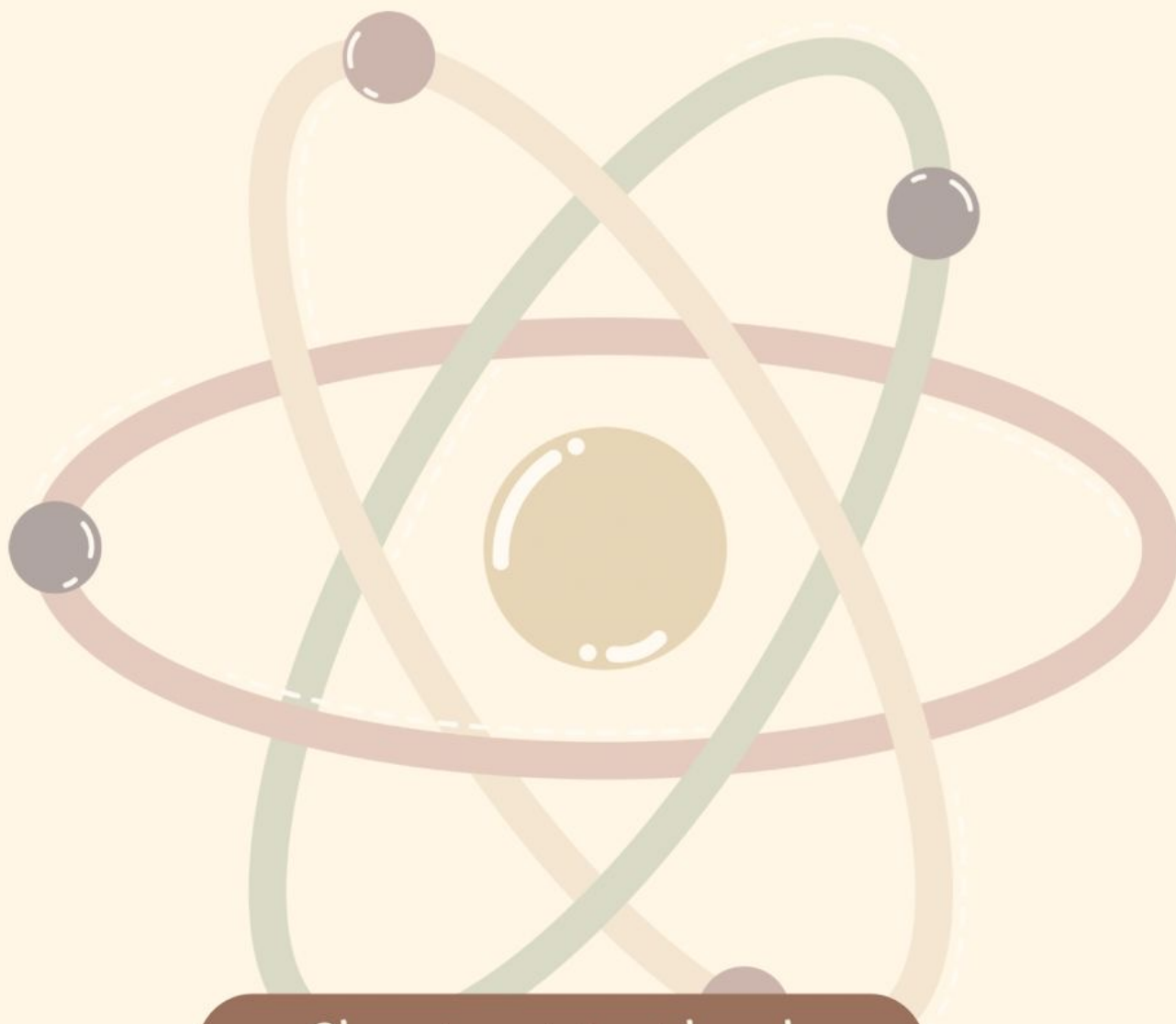


# Organic Chimestry



Chapter 1 test bank

Written by :yusra khaled

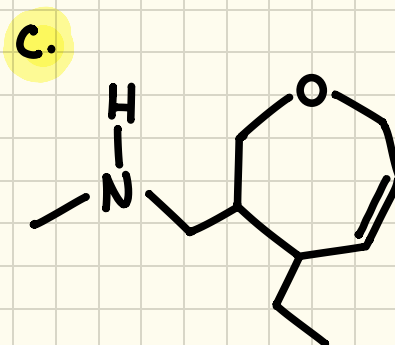
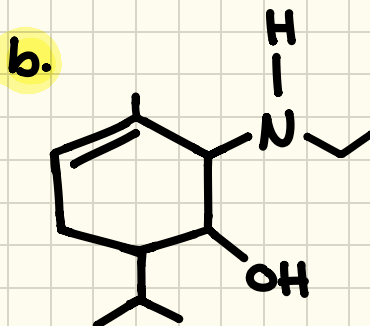
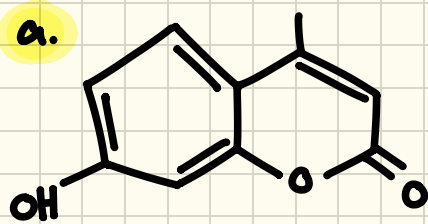


**Hemmeh asnan**



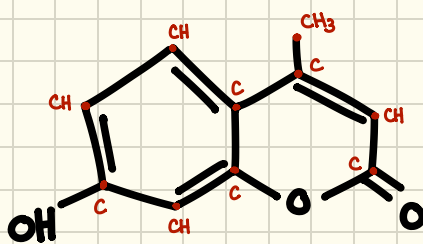
gives information about the types and numbers of atoms in compounds

Q.1. The molecular formula of the following compound is:

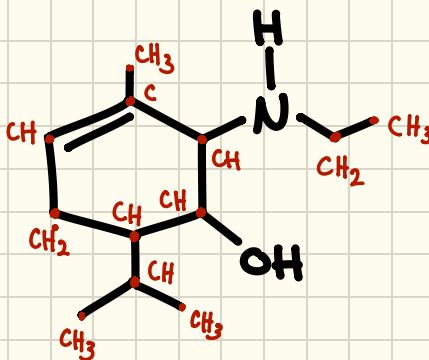


Answer:

Simply, Count the number of each atom in the compound. Write the atom with their number in this order: C.H.N.O. Halogens.

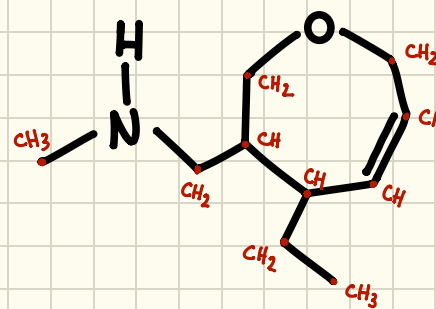


$C_{10}H_8O_3$



$C_{12}H_{23}NO$

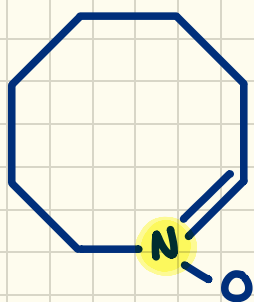
Note that (N) before (O)



$C_{10}H_{19}NO$

Q.2. What is the formal charge on each of the following:

a. N atom (Atomic Number = 7) in:



to find the formal charge we subtract the number of electrons assigned to an atom from the number of valence electrons

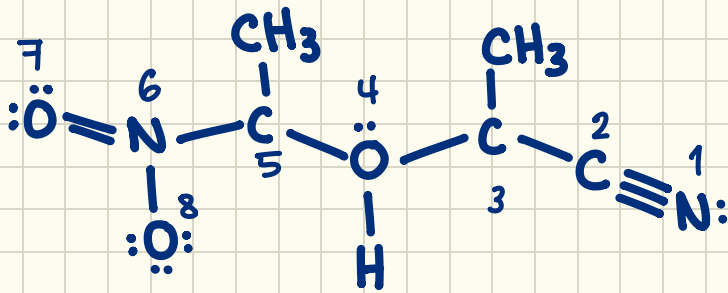
Formal Charge = Valence  $\bar{e}$  - Assigned  $\bar{e}$

So for N, Valence  $\bar{e}$  = 5

So:  $5 - 4 = +1$

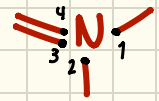


b.  $N_6$  and  $O_8$  atoms (Atomic Number  $N=7, O=8$ ) in:



Answer:

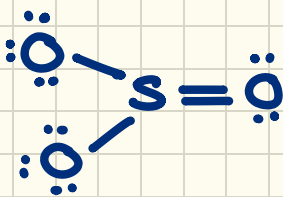
formal (N) =  $5 - 4 = +1$   
charge



formal (O) =  $6 - 7 = -1$   
charge



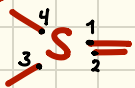
c. Sulfure atom (Atomic Number = 16) in:



Answer:

Atomic Number = 16 so: 2, 8, 6

Valence E = 6  
Assigned E = 4  $\rightarrow$  formal =  $6 - 4 = +2$   
Charge



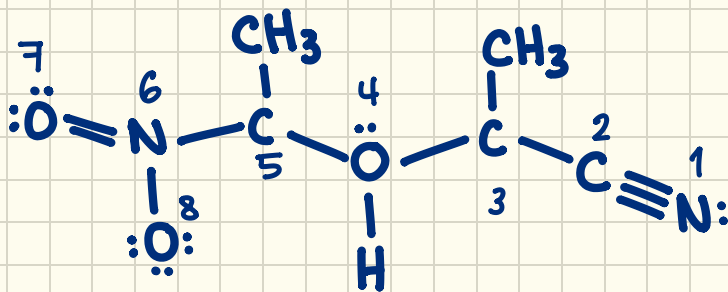
Note:

Through atomic number, you can find the number of valence electrons using electronic distribution.

Eg: Atomic Number of  $O=8 \rightarrow 2, \underline{6}$  VE=6  
 $Ca=20 \rightarrow 2, 8, 8, \underline{2}$  VE=2

- If the periodic table is available, then:  
number of group = number of VE  
Eg: N is in 5<sup>th</sup> group  
VE=5

d.  $C_3, C_5$  and  $O_7$  ( $C=6, O=8$ ) in:



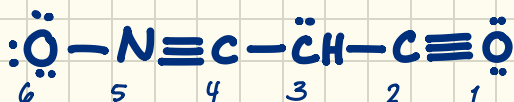
Answer:

formal  
change ( $C_3$ ) =  $4 - 3 = +1$

formal  
change ( $C_5$ ) =  $4 - 3 = +1$

formal  
change ( $O_7$ ) =  $6 - 6 = 0$

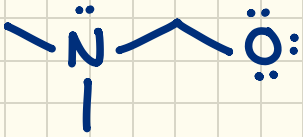
e.  $O_1$  in:



Answer:

formal  
charge =  $6 - 7 = -1$

f. N and O atoms in:



Answer:

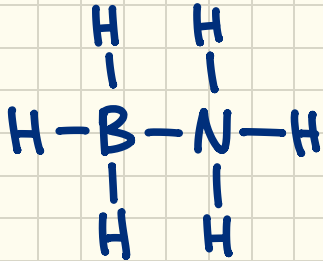
$$\text{formal (N)} = 5 - 5 = 0$$

Charge

$$\text{formal (O)} = 6 - 7 = -1$$

Charge

g. N atom in:

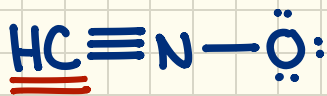


Answer:

$$\text{formal} = 5 - 4 = +1$$

Charge

h. N and C atoms in:



Answer:

$$\text{formal (N)} = 5 - 4 = +1$$

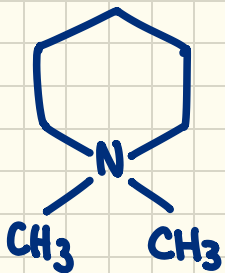
Charge

$$\text{formal (C)} = 4 - 4 = 0$$

Charge

H-C≡

i. N atom in:



Answer:

$$\text{formal (N)} = 5 - 4 = +1$$

Charge

اللهم لا تدع في غزاة جائعاً إلا أطعمته، ولا عطشاً إلا سقيته، ولا مريضاً إلا داويته، ولا جريحاً إلا شفيته، ولا أسيراً إلا فككت أسرته، ولا غائباً عن أهله إلا سالماً معافاً رددته، ولا طفلاً ولا شيخاً إلا رحمته، ولا امرأة إلا سترتها، ولا مجاهداً إلا نصرته وربطت على قلبه.

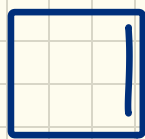
### Q.3. Structural (Constitutional) isomers:

Compounds with the same molecular formula, but different structural formula

a. Which of the following are structural isomers?



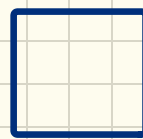
1)  $C_4H_8$



2)  $C_4H_6$



3)  $C_5H_{12}$



4)  $C_4H_8$



5)  $C_5H_{10}$

Answer:

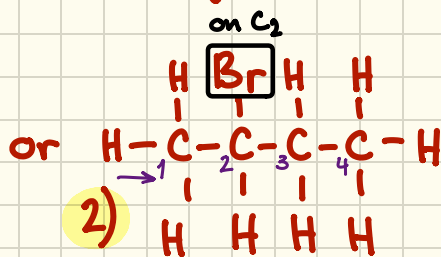
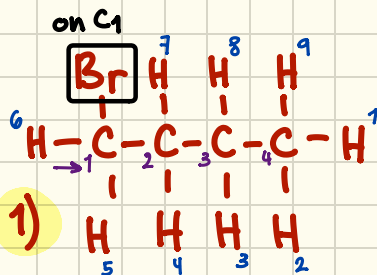
Since the molecular formula for each compound is already provided in the question, then all you have to do is look for 2 similar formulas.

Clearly 1 and 4 have different structures, but the same formula ( $C_4H_8$ )

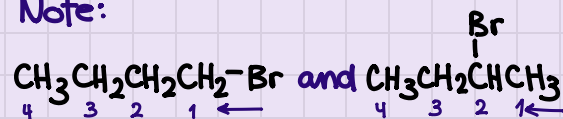
b. What is the maximum number of constitutional isomers for  $C_4H_9Br$ ?

Answer:

When finding the number of isomers for a certain compound, start first with all the possible continuous chains you can come up with.



Note:

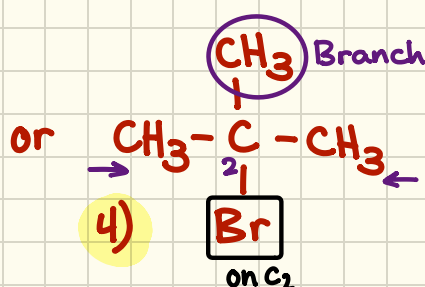
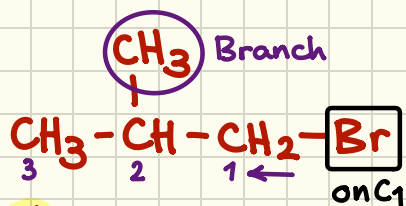


those chains are the same as 1 & 2 but numbering is from the right instead of the left

★ make sure you have the right number of H atoms

★ moving Br atom for more possibilities

if the compound have 4 or more carbons, we come up with branched chains

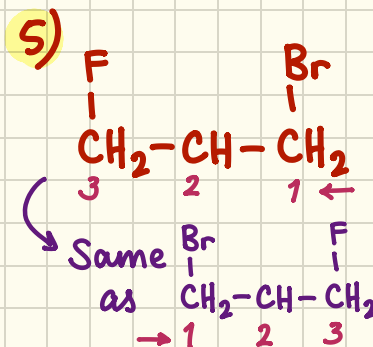
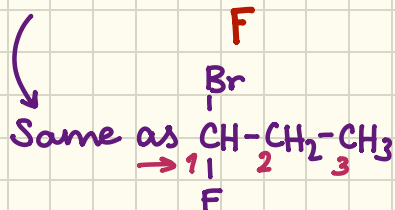
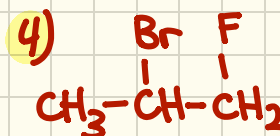
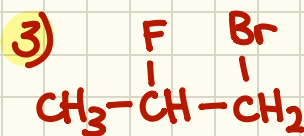
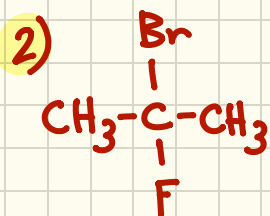
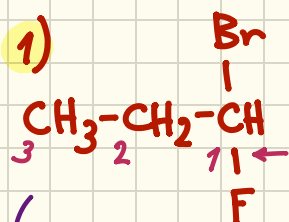


So in total there are four possible isomers for  $C_4H_9Br$

c. What is the maximum number of constitutional isomers for C<sub>3</sub>H<sub>6</sub>BrF?

Answer:

Since we have 2 halogens, they can be either on the same carbon or on different carbon atoms.



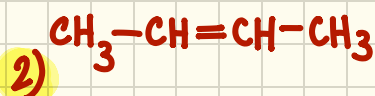
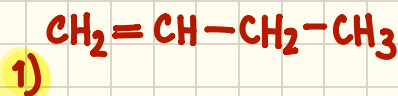
only 3 carbons, so branching is not possible.

So there are **five** possible isomers

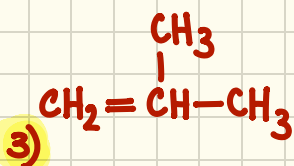
d. Draw three constitutional isomers for C<sub>4</sub>H<sub>8</sub>.

Answer:

According to the formula, the compound is an **Alkene**, meaning it contains at least one double bond. So the change will be in the position of the double bond. Starting with continuous chains:



For branched chains:



Reminder:

Alkanes:  $\text{C}_n\text{H}_{2n+2}$  (without halogen)

Alkenes:  $\text{C}_n\text{H}_{2n}$

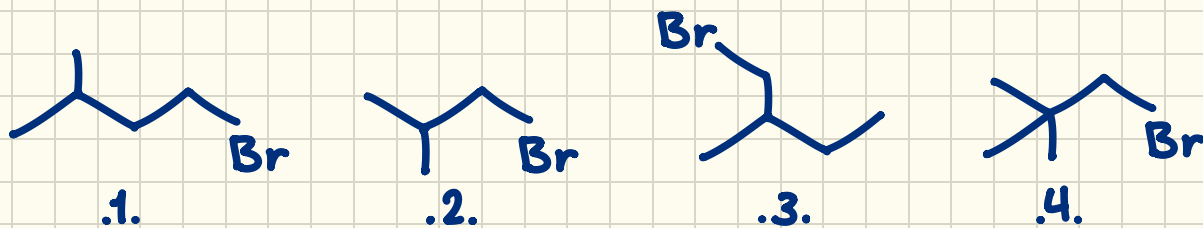
• With halogens: H atoms + halogen =  $2n + 2$

Note:

Butene (C<sub>4</sub>H<sub>8</sub>) have 5 isomers in total, but 2 of them are cycloisomers.

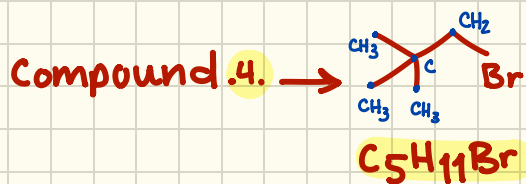
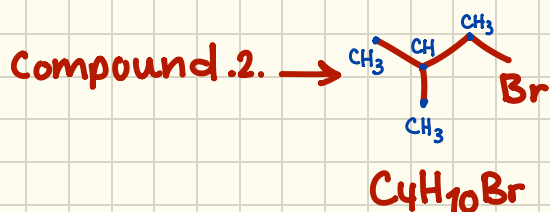
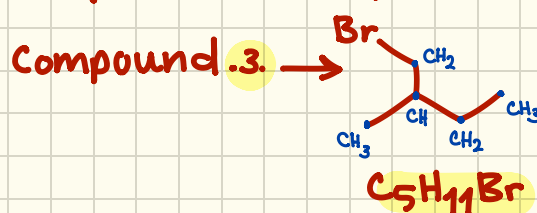
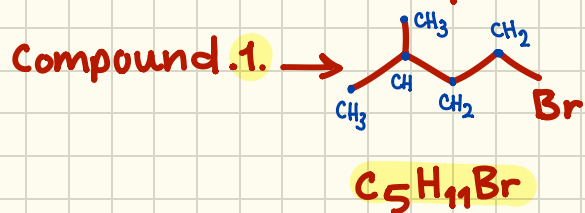
Not Required

e. Which of the following is a set of structural isomers?

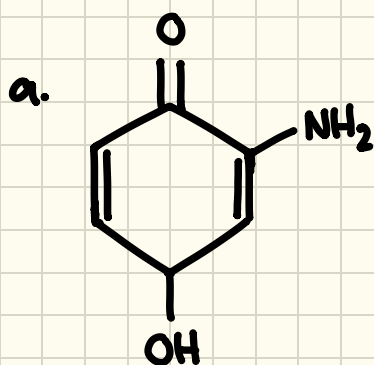


Answer:

Same as before, we look for 2 compounds with the same molecular formula. So we need to find the formula for all the compounds.



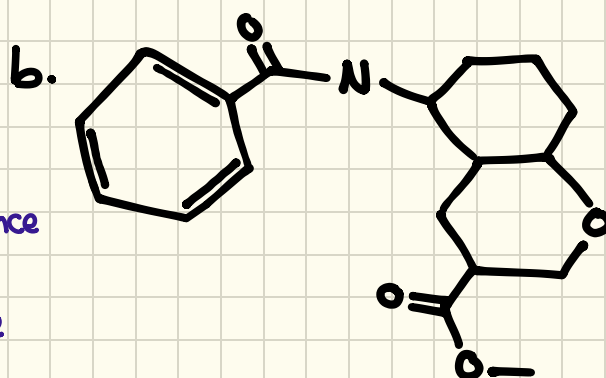
Q.4. What are the functional groups present in the following compounds?



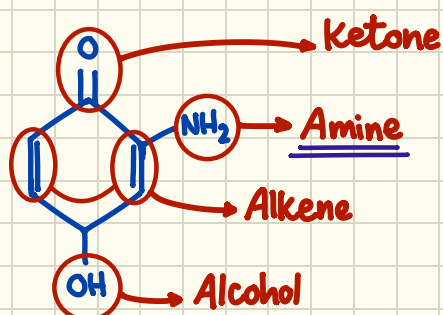
Note the difference between:

Amine  
 $R-NH_2$

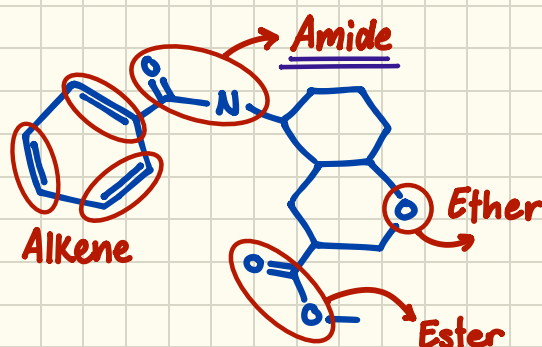
Amide  
 $R-C(=O)-N-R$



Answer:



Answer:



## Q.5. What is the correct electron-dot representation for $\text{NO}_2^-$ ?

### Answer:

Electron-dot representation (also known as Lewis structure) is a representation of the valence electrons of an atom. So for single atom:  $:\ddot{\text{O}}:$  or  $:\ddot{\text{N}}:$ .

But in order to find it for a compound, follow the steps:

#### 1. Find the total number of electrons in the compound:

$$= \text{VE of 1}^{\text{st}} \text{Element} * \text{Number of its atoms in the compound} + \text{VE of 2}^{\text{nd}} \text{Element} * \text{Number of its atoms in the compound} \dots \pm \text{Charge}$$

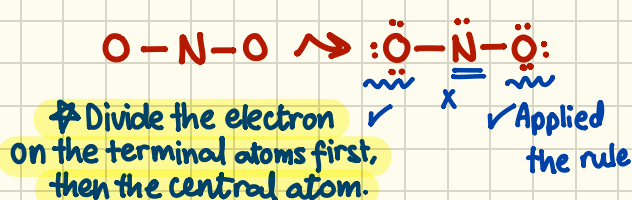
$$\text{in } \text{NO}_2 = 5 * 1 + 6 * 2 + 1 = 18$$

+ for negative charge

- for positive charge

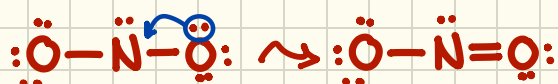
#### 2. Draw all atoms making single bonds with the central atom. After that, start dividing the rest of the electrons on the atoms, making sure they all apply the octet rule.

Note: The central atom is the atom that exists the least in the compound except for H (can't be a central atom).

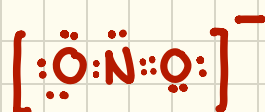


The nitrogen didn't apply the rule, and no more electrons left.

#### 3. If the central atom didn't apply the octet rule, then one of terminal atoms donate 2 (or more) electrons to make a bond.

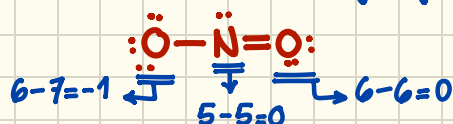


#### 4. Lastly, the overall charge (whether positive or negative) of the compound remains untouched. The final representation:



For check:

if you calculate the formal charge to all atoms in the compound it should give you -1



## Q.6. Geometry and Hybridization:

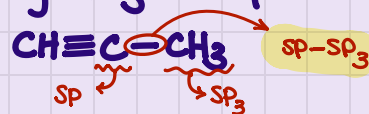
### Reminder:

- |          |                 |               |               |
|----------|-----------------|---------------|---------------|
|          | Geometry        | Angle         | Where to find |
| • $sp_3$ | Tetrahedral     | $109.5^\circ$ | Single bond   |
| • $sp_2$ | Trigonal planar | $120^\circ$   | Double bond   |
| • $sp$   | Linear          | $180^\circ$   | Triple bond   |

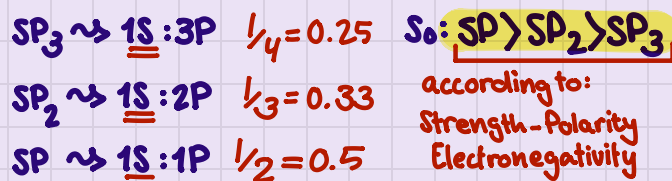
Applies to: Carbon, Oxygen, Nitrogen

Hydrogen never hybridize. If asked about an H atom, the answer is always S

The hybridization of a bond is named after the hybridization of the atoms:



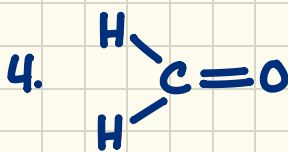
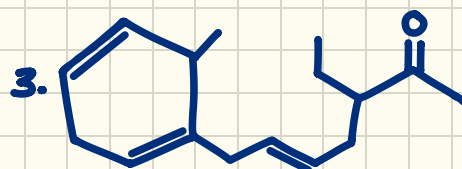
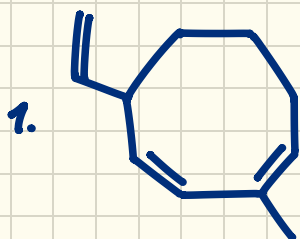
The Polarity (Strength) of a bond depends on the percentage of s-Characters



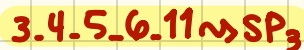
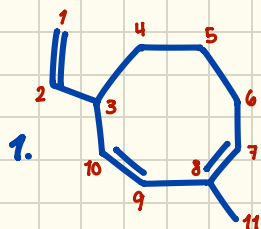
the Stronger the bond, the shorter it is:



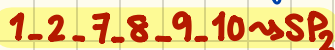
a. What is the hybridization of each atom in the following compounds?



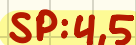
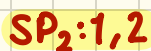
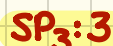
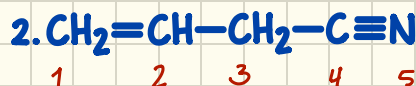
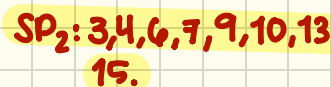
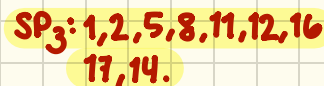
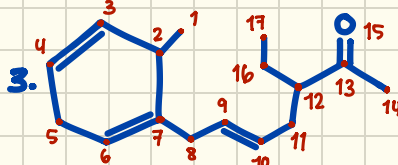
### Answer:



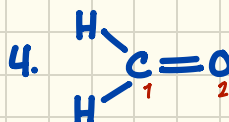
Single Bond



Double Bond



Triple Bond



b. What is the geometry, hybridization and angle of each of the following compounds?

1. C atom in:  $\text{CH}_2=\text{CH}_2$

2. C atom in:  $\text{CH}_3-\text{CH}_3$

3. C atom in:  $\text{CH}_3^+$

Answer:

1. Trigonal Planar -  $\text{sp}^2$  -  $120^\circ$

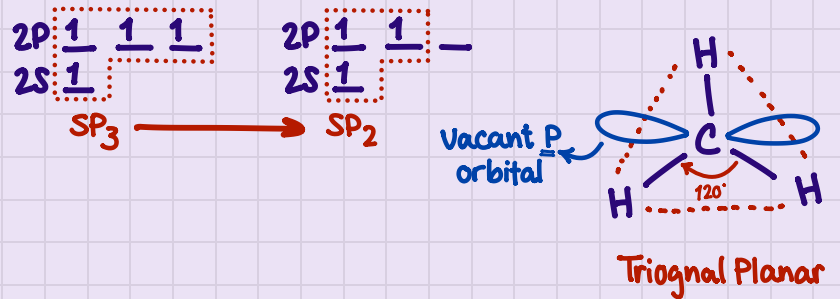
2. Tetrahedral -  $\text{sp}^3$  -  $109.5^\circ$

3. Trigonal Planar -  $\text{sp}^2$  -  $120^\circ$



Why  $\text{CH}_3^+$  hybridization is  $\text{sp}^2$  despite making no double bonds?

From the positive charge we can tell a pair of  $e^-$  got lost from the orbit, so it became  $\text{sp}^2$  instead of  $\text{sp}^3$ :



c. Which structure has the shortest single bond?

1.  $\text{CH}_2=\text{CH}-\text{CH}=\text{CH}_2$

3.  $\text{CH}_2=\text{C}=\text{CH}-\text{CH}_3$

2.  $\text{CH}\equiv\text{C}-\text{CH}=\text{CH}_2$

4.  $\text{CH}\equiv\text{C}-\text{C}\equiv\text{CH}$

Answer:

As stated before, the stronger the bond (more polar), the shorter it gets:

1.  $\text{CH}_2=\text{CH}-\text{CH}=\text{CH}_2$

$$\begin{array}{c} \text{sp}^2-\text{sp}^2 \\ 0.33+0.33 \\ =0.66 \end{array}$$

2.  $\text{CH}\equiv\text{C}-\text{CH}=\text{CH}_2$

$$\begin{array}{c} \text{sp}-\text{sp}^2 \\ 0.5+0.33 \\ =0.83 \end{array}$$

3.  $\text{CH}_2=\text{C}=\text{CH}-\text{CH}_3$

$$\begin{array}{c} \text{sp}^2-\text{sp}^3 \\ 0.33+0.25 \\ =0.58 \end{array}$$

4.  $\text{CH}\equiv\text{C}-\text{C}\equiv\text{CH}$

$$\begin{array}{c} \text{sp}-\text{sp} \\ 0.5+0.5 \\ =0.1 \end{array}$$

Highest s-Character percentage.  
Strongest bond, shortest bond.

## Q.7. Electronegativity: The ability of atom to attract the electrons of a bond

• To determine the polarity of a covalent bond, Subtract the electronegativity of the two atom, if the difference is:

1.  $< 0.5$  : Non-Polar covalent Bond    2.  $0.5 - 1.6$  : Polar covalent Bond

.Which bond is the least polar?

- a. O-H    b. N-H    c. C-F    d. C-H    e. C-O

Answer:

a. O-H $3.5 - 2.1$ $= 1.4$	b. N-H $3 - 2.1$ $= 0.9$	c. C-F $4 - 2.5$ $= 1.5$	d. C-H $2.5 - 2.1$ $= 0.4$	e. C-O $3.5 - 2.5$ $= 1$
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So a C-H bond is non-Polar

.Which bond is the most polar?

- a. C-F    b. C-Cl    c. C-O    d. C-H    e. C-C

Answer:

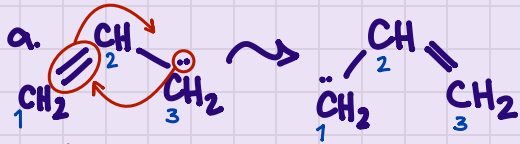
a. C-F $4 - 2.5$ $= 1.5$ most polar	b. C-Cl $3 - 2.5$ $= 0.5$	c. C-O $3.5 - 2.5$ $= 1$	d. C-H $2.5 - 2.1$ $= 0.4$	e. C-C $2.5 - 2.5$ $= 0$
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وَأذْكُرُّ رَبَّكَ إِذَا نَسِيتَ

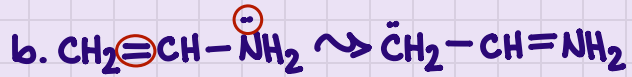
**Q.8. Resonance:** The use of two or more Lewis Structure that differ only in the distribution of valence electrons that are either non-bonding or making a  $\pi$  bond.

There are 3 cases in order to draw resonance structure:

Case.1. A double bond and a non-bonding pair of  $\bar{e}$ :

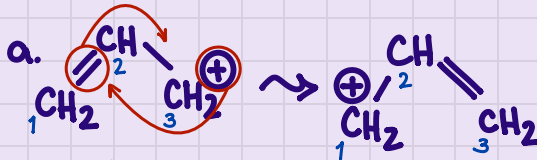


Flip their positions



**make sure that the number of each atom remains the same (No change on molecular formula).**

Case.2. A double bond and a charge:

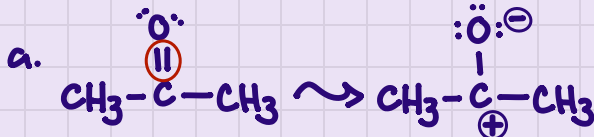


Flip their positions

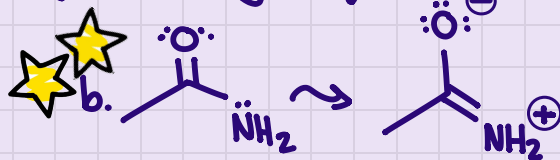


the bond with  $\text{O}_3$  broke and the electrons and negative charge went to  $\text{O}_3$ , and then a bond formed with  $\text{O}_2$  using one of its non-bonding electrons.

Case.3. A double bond and an atom with high electronegativity:



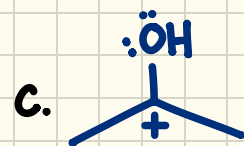
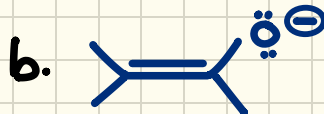
The electrons of the  $\pi$  bond are attracted to  $\text{O}$  atom due to high electronegativity, so the bond kind of collapse and a negative charge appear on the  $\text{O}$  and a positive charge appear on the  $\text{C}$ .



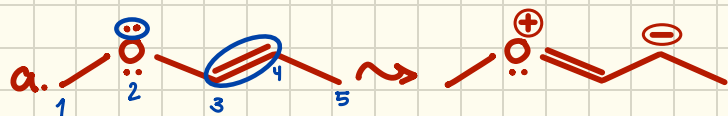
the double bond with the  $\text{O}$  broke as it attracted the electrons giving it a negative charge, and a double bond formed with the  $\text{N}$  using the non-bonding pair, giving it a positive charge.

(this is a mix of case.2. and case.3.)

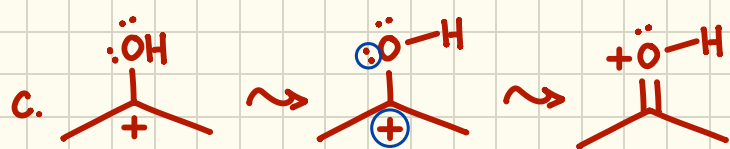
Draw a resonance structure for each of the following:



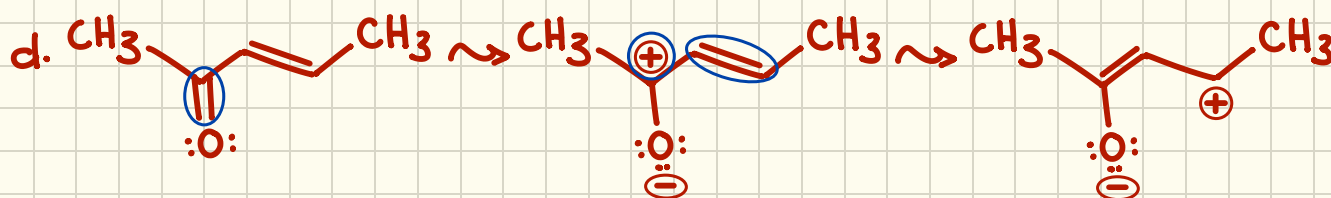
## Answer:



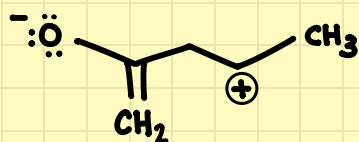
The double bond broke, and its electrons remained on C<sub>4</sub> giving it a negative charge. Meanwhile a double bond formed between C<sub>3</sub> and O using one of its non-bonding electron, giving it a positive charge.



The non-bonding electrons on Oxygen flow towards the positive charge forming a  $\pi$  bond, and due to the loss of electrons a positive charge appear on the O atom.



ملاحظة: هذه ليست الإجابة التي اعتمدت في الامتحان لسنة ٢٠٢١. هذه الإجابة بناء على القواعد المذكورة، لان الإجابة التي وضعت تم فيها تغيير أماكن بعض ذرات الهيدروجين و هذا لايجوز. إذا كنت تظن أنها اجابة خاطئة تواصل مع الفريق الأكاديمي ليتم تعديلها. الإجابة التي اعتمدت:

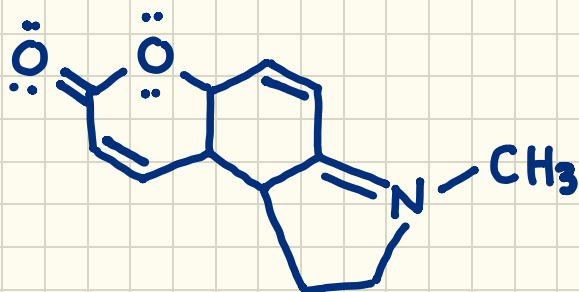


**Q.9.** Consider the following structure, then answer the questions:

a. Molecular Formula:

b. Number of  $sp_2$  and  $sp_3$  carbons:

c. Formal charge of N:



a. Molecular Formula:

b. Three functional groups:

c. A resonance structure:

