



Carbon & its Compounds

CH 4 Science | Class 10

Notes + 10 Years Integrated PYQ's



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Carbon and its Compounds

* Bonding in Carbon (covalent bond):

- ↑ Ionic compounds have high melting and boiling points and conduct electricity in solution or in the molten state.
- Most carbon compounds are poor conductors of electricity.
- ↑ Since these compounds are largely non-conductors of electricity, we can conclude that bonding in these compounds does not give rise to any ions.

- The atomic number of carbon is 6.

- In case of carbon, it has 4 electrons in its outermost shell and needs to gain or lose 4 electrons to attain noble gas configuration.

= If it were to gain or lose electrons →

- i) It would gain 4 electrons forming C^{4-} anion.
- But it would become difficult for the nucleus to hold 10 electrons (4 extra gained).
- ii) It would lose 4 electrons forming C^{4+} cation.
- But it would require a large amount of energy to remove 4 electrons leaving behind a carbon cation with 6 protons in its nucleus holding on to just 2 electrons.

→ To overcome this, Carbon shares its valence electrons (with carbon or other elements) to attain noble gas configuration.

- Many other elements share their valence electrons to attain noble gas configuration.

* Let us take an example :

→ Your friend Ashish had 2 pens.

You did not have any pen. You asked him for a pen, he gave 1 pen to you and asked you to keep it.

This way Ashish lost one pen but you gained one pen.

This is same at losing and gaining of electrons.

* But when you talk about SHARING, Ashish had 1 pen and you had no pen, so Ashish shared a pen with you where he is also using the pen and giving to you when you need it.

This is same as sharing of electrons.

* Electrons in the outermost shell are called VALENCE ELECTRONS.

→ The atomic number of Hydrogen is 1.

It has 1 electron in its K shell (Atomic no-1).

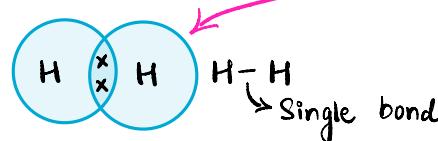
So, two Hydrogen atoms share their electrons to form a molecule of hydrogen, H₂.

Hence, attaining noble gas configuration.

(V.T 1 electron pair share $\frac{1}{2}$ each, Single (-) bond)

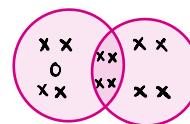
(V.T 2 electrons Pair share $\frac{1}{2}$ each, double (=) bond)

(V.T 3 electrons Pair share $\frac{1}{2}$ each, triple (\equiv) bond)



Some more examples :

- ① O₂ → * Atomic number → 8
* Configuration → 2,6
* Valence Electrons → 6



O=O
Double bond

② $N_2 \rightarrow$ * Atomic no. (Nitrogen) $\rightarrow 7$

* Configuration $\rightarrow 2, 5$

* Valence Electrons $\rightarrow 5$



Allotropes of Carbon

\rightarrow The element carbon occurs in different forms in nature with widely varying physical properties.



Graphite

Graphite :

\rightarrow In graphite, each carbon atom is bonded to three other carbon atoms in the same plane giving a hexagonal array.



Buckminster
Fullerene

Buckminster Fullerene C-60 :

20 (six) membered rings

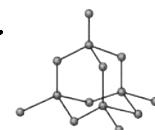
12 (five) membered rings



Diamond

Diamond :

In diamond, each carbon atom is bonded to four other carbon atoms forming a rigid three-dimensional structure.



QUESTIONS

In-text

1. What would be the electron dot structure of carbon dioxide which has the formula CO_2 ?
2. What would be the electron dot structure of a molecule of sulphur which is made up of eight atoms of sulphur? (Hint - The eight atoms of sulphur are joined together in the form of a ring.)



Answers :

① In Carbon dioxide molecule, the two oxygen atoms are bonded on either side with carbon atom by double bonds.

Thus there are 2 double bonds in CO_2 .

Carbon share its two electrons in the formation of a double bond with one oxygen atom and another two electrons with another oxygen atom.

In this process, both the oxygen atoms and the carbon atom acquire the stable electronic configuration of the noble gas neon.

② The atomic number (Z) of Sulphur is sixteen and its electronic configuration is 2,8,6.

The sulphur atom has six valence electrons.

The chemical formula of sulphur molecule is S_8 .

Each sulphur atom is linked to similar atoms on either sides by single covalent bonds and thus, completes its octet.

Homologous Series :

Hydrogen atom or atoms on these carbon chains can be replaced by any of the functional groups.

The functional group present in a carbon chain is responsible for chemical properties of the carbon compound.

For example : CH_3OH , $\text{C}_2\text{H}_5\text{OH}$, $\text{C}_3\text{H}_7\text{OH}$ and $\text{C}_4\text{H}_9\text{OH}$ are all very similar.

So the above series is a homologous series.

CH_4 and C_2H_6 → These differ by CH_2 unit.

C_2H_6 and C_3H_8 → These differ by CH_2 unit.

Hence, we can say that general formula for alkanes is C_nH_{2n+2} .
Here, 'n' stands for number of atoms.

For alkenes general formula is C_nH_{2n} and for alkynes general formula is C_nH_{2n-2} .

Try using this formula now, when we put in 'n', we get CH_4 .

When we put 2 in 'n', we get C_2H_6 .

When we put 3 in 'n', we get C_3H_8 .

पढ़ दी रात्रि है !



1 Mark Questions

1. What is the difference in the molecular formula of any two consecutive members of a homologous series of organic compounds? [CBSE 2008]
2. Write the molecular formula of the 2nd and 3rd member of the homologous series where the first member is ethyne.
[CBSE 2017]
3. Write the name and formula of the 2nd member of the series of carbon compounds whose general formula is C_nH_{2n} .
[CBSE 2012]
4. Write the molecular formula of the 2nd and the 3rd member of the homologous series whose first member is methane.
[CBSE 2017]
5. Which element exhibits the property of catenation to maximum extent and why? [CBSE 2016]
6. Draw the electron dot structure of Nitrogen molecule
[CBSE 2012,2013]
7. Ethane, with the molecular formula C_2H_6 has
 - a). 6 covalent bonds
 - b). 7 covalent bonds
 - c). 8 covalent bonds
 - d). 9 covalent bonds

3 Marks Questions

8. State the reason why carbon can neither form C^{4+} cations nor C^{4-} anions but forms covalent compounds. Also, state reasons to explain why covalent compounds:
- are bad conductors of electricity?
 - have low melting and boiling points?

[CBSE Compt. 2017, CBSE 2019]

9. Give reasons for the following:

- Element carbon forms compounds mainly by covalent bonding.
- Diamond has a high melting point.
- Graphite is a good conductor of electricity.

[CBSE 2011]

10. Carbon a member of group 14, forms a large number of carbon compounds estimated to be about three million. Why is this property not exhibited by other elements of this group?

[CBSE 2020]

11. (a) Why are most carbon compounds poor conductors of electricity?
(b) Write the name and structure of a saturated compound in which the carbon atoms are arranged in a ring. Give the number of single bonds present in this compound.

[CBSE 2018]

5 Marks Questions

12. (a) Explain why carbon forms covalent bond? Give two reasons for carbon forming a large number of compounds.
(b) Explain the formation of ammonia molecules.

Assertion Reasoning

(A) is followed by a statement of reason (R) . Mark the correct choice as:

- (a) Both assertion (A) and reason (R) are correct and reason is the correct explanation of assertion.
- (b) Both assertion (A) and reason (R) are correct but reason is not the correct explanation of assertion.
- (c) Assertion (A) is correct, reason (R) is incorrect
- (d) Assertion (A) is incorrect, reason (R) is correct

13. **Assertion:** Carbon has ability to form long carbon chains.

Reason : Carbon has unique property of ability to chain and branched chains called catenation.

14. **Assertion:** Second number of alkane is ethane (C_2H_6).

Reason : It is obtained from general formula C_nH_{2n+2} .

1 Mark Questions

Ans.1 The molecular formula of any two consecutive members of homologous series differ by CH_2 units.

Ans 2. The molecular formula of the 2nd and 3rd members of a homologous series where the first member is ethyne (C_2H_2) is formed by adding - CH_2 -:

2nd member of alkyne series = propyne (C_3H_4) $\text{CH}_3 - \text{CH}_2 - \text{C} \equiv \text{CH}$

3rd member of alkyne series = butyne (C_4H_6) $\text{CH}_3 - \text{CH}_2 - \text{C} \equiv \text{CH}$

Ans 3. C_3H_6 -----> Formula

$\text{H}_2\text{C}=\text{CH}-\text{CH}_3$ -----> Structure

Propene is the second member of the series whose general formula is C_nH_{2n} .

Ans 4. 2nd member - Ethane - C_2H_6

3rd member - Propane - C_3H_8

Ans 5. Carbon exhibits the property of catenation due to it's strong C-C bond.

Ans 6. This is the electron dot structure of nitrogen molecule.

Ans 7). b). 7 covalent bonds

3 Marks Questions

Ans 8). The atomic number of Carbon is 6 with an electronic configuration of 2, 4. Hence, carbon has 4 electrons in its valence shell. Carbon can lose or gain 4 electrons in order to gain stability. It cannot gain four electrons as carbon atom having 6 protons is very small to handle 10 electrons and it cannot donate electrons as it needs a lot of energy to do so. Hence, it cannot form C₄₊ anion or C₄₋ anion and thus forms a covalent bond.

1. Covalent compounds are formed by sharing of electrons. They don't have a free electron that is required for electricity transfer (electricity is the flow of free electrons), thus they are bad conductors.

2. Covalent compounds have low melting and boiling points because they have weak intermolecular forces between bonds. Hence, less energy/temperature is needed to break the bonds.

Ans 9). (i) It is because carbon has four valence electrons, it cannot gain or lose four electrons because high energy is needed. It can only share four electrons.

(ii) It is due to strong covalent bonds and compact structure of diamond.

(iii) It is due to presence of free electrons in graphite because each carbon is linked to three more carbon atoms.

Ans 10. This property of carbon is known as catenation which is exhibited only by carbon atom , not by other elements of this group. Due to the small size of carbon atoms , stability of carbon atoms and ability to form strong bonds , carbon gives rise to a large number of compounds linked to each other.

Ans 11. a) Electricity is conducted by moving electrons. But carbon forms covalent bonds by sharing electrons. Hence, it does not have free electrons.

(b) Cyclohexane is a saturated compound in which carbon atoms are arranged in a ring. 6 single bonds present in this compound.

Ans 12.

(a). The atomic number of Carbon is 6 with an electronic configuration of 2, 4. Hence, carbon has 4 electrons in its valence shell. Carbon can lose or gain 4 electrons in order to gain stability. It cannot gain four electrons as a carbon atom having 6 protons is very small to handle 10 electrons and it cannot donate electrons as it needs a lot of energy to do so. Hence, it cannot form C_4^+ anion or C_4^- anion and thus forms a covalent bond.

(b). Ammonia (NH_3) is made up of one atom of nitrogen and three atoms of hydrogen

Atomic number of N = 7

Electronic configuration = 2, 5

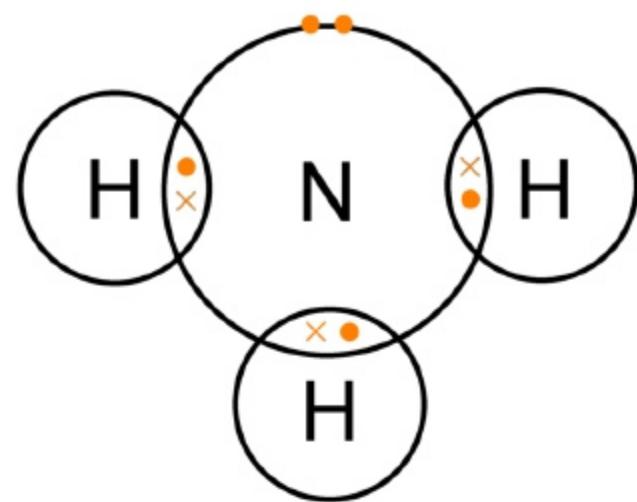
Atomic number of H = 1

Electronic configuration = 1

So hydrogen needs 1 more electron to complete its duplet and nitrogen needs three more electrons to complete its octet

Hence three hydrogen atoms will combine with nitrogen to form ammonia.

Assertion Reasoning



Ans 13. (a) Both assertion (A) and reason (R) are correct and reason is the correct explanation of assertion.

Ans 14. (a) Both assertion (A) and reason (R) are correct and reason is the correct explanation of assertion.