Carbon and its Compounds

EXERCISE 1.1

I. Multiple Choice Questions (1 Mark)

Choose the correct answer from the given options.

1. A molecule of ammonia (NH_3) has
(a) only single bonds (b) only double bonds
(c) only triple bonds (d) two double bonds and one single bond

2. Which of the following is the correct representation of electron dot structure of nitrogen?
(a) $:\dot{\underset{\cdot\cdot}{N}}:\dot{\underset{\cdot\cdot}{N}}:$ (b) $:\dot{N}::\dot{N}:$ (c) $:\dot{\underset{\cdot\cdot}{N}}:\dot{\underset{\cdot\cdot}{N}}:$ (d) $:N\vdots\vdots N:$

3. Carbon forms four covalent bonds by sharing its four valence electrons with four univalent atoms, e.g. hydrogen. After the formation of four bonds, carbon attains the electronic configuration of
(a) Helium (b) Neon (c) Argon (d) Krypton

4. The correct electron dot structure of a water molecule is
(a) $\dot{H}\cdot\dot{\underset{\cdot\cdot}{O}}\cdot\dot{H}$ (b) $\cdot H:\dot{\underset{\cdot\cdot}{O}}\cdot H\cdot$ (c) $H:\dot{\underset{\cdot\cdot}{O}}:H:$ (d) $H:O:H:$

5. The molecular formula of ethene and its electron dot structure is
(a) C_2H_4, $H\cdot\overset{H}{\dot{C}}\vdots\overset{H}{\dot{C}}\cdot H$
(b) C_2H_4, $H:\overset{H}{\underset{\cdot\cdot}{C}}::\overset{H}{\underset{\cdot\cdot}{C}}:H$
(c) C_2H_2, $H:C\vdots\vdots C:H$
(d) C_2H_6, $H:\overset{H}{\underset{H}{\underset{\cdot\cdot}{C}}}:\overset{H}{\underset{H}{\underset{\cdot\cdot}{C}}}:H$

II. Assertion-Reason Type Questions (1 Mark)

For question numbers 1 and 2 two statements are given-one labeled as **Assertion** (A) and the other labeled **Reason** (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below:
(a) Both 'A' and 'R' are true and 'R' is correct explanation of the assertion.
(b) Both 'A' and 'R' are true but 'R' is not correct explanation of the assertion.
(c) 'A' is true but 'R' is false.
(d) 'A' is false but 'R' is true.

1. **Assertion:** Carbon forms covalent compound with chlorine of formula CCl_4.
Reason: Carbon has 4 valence electrons, valency 4, chlorine has 7 valence electrons, valency 1.

2. **Assertion:** Carbon forms very large number of compounds.
Reason: It is due to property of catenation and tetravalency

III. Very Short Answer Type Questions (1 Mark)

1. Draw electron dot structure of NH_3 molecule. Predict the total no. of bonds around N-atom. [*Delhi* 2016]

OR

A molecule of ammonia has the formula NH_3. Predict the total number of bonds present around nitrogen atom. [*CBSE* 2016]

2. Why covalent compounds are poor conductors of electricity? [*CBSE* 2020]

3. What would be the electron dot structure of carbon dioxide which has the formula, CO_2? [*NCERT*]

4. Which element exhibits the property of catenation to maximum extent and why? [*Delhi* 2016]

5. State two characteristic features of carbon which when put together give rise to large number of carbon compounds.

6. Explain why carbon generally forms compounds by covalent bonds or do not form ionic compounds.

OR

Give reason why carbon neither forms C^{4+}cations nor C^{4-} anions but form covalent compounds which are bad conductors of electricity and have low melting and boiling points. [*Delhi* 2013]

OR

Carbon has four electrons in its valence shell. How does carbon attain stable configuration? [*Delhi* 2015]

7. Why are most carbon compounds poor conductors of electricity? [*CBSE* 2018]

8. Define catenation. [*CBSE Sample Paper* 2019-2020]

9. Covalent compounds have low melting and boiling point. Why? [*CBSE* 2020]

10. How are covalent bonds formed? [*CBSE* 2020]

IV. Short Answer Type Questions-I (2 Marks)

1. Carbon, group 14 element in the periodic table, is known to form compounds with many elements. Write an example of a compound formed with (*i*) Chlorine, (*ii*) Oxygen. [*NCERT Exemplar*]

2. In electron dot structure, the valence shell electrons are represented by crosses or dots.
(*i*) The atomic number of chlorine is 17. Write its electronic configuration.
(*ii*) Draw the electron dot structure of chlorine molecule. [*NCERT Exemplar*]

3. Compare the ability of catenation of carbon and silicon. Give reasons. [*NCERT Exemplar*]

4. Give a test that can be used to confirm the presence of carbon in a compound. With a valency of 4, how is carbon able to attain noble gas configuration in its compounds? [*CBSE Sample Paper* 2020-21]

5. The number of carbon compounds is more than those formed by all other elements put together. Justify the statement by giving two reasons. [*CBSE Sample Paper* 2020-21]

V. Short Answer Type Questions-II (3 Marks)

1. What are covalent compounds? Why are they different from ionic compounds? List their three characteristic properties. [*Delhi* 2016]

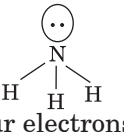
2. (*a*) Explain why carbon forms covalent bond? Give two reasons for carbon forming a large number of compounds.
(*b*) Explain the formation of ammonia molecule. [*CBSE Sample Paper* 2018-19]

3. 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? Explain. [*CBSE* 2020]

4. Atoms of an element contain five electrons in its valence shell. This element is the major component of air. It exists as a diatomic molecule.
(*i*) Identify the element.
(*ii*) Show the bond formed between two atoms of this element.
(*iii*) Write the nature of bond between the two atoms.

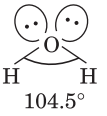
5. (*i*) Explain the formation of calcium chloride with the help of electron dot structure. (At numbers: Ca = 20; Cl = 17)
(*ii*) Why do ionic compounds not conduct electricity in solid state but conduct electricity in molten and aqueous state?. [*CBSE Sample Paper* 2020-21]

Answers 1.1

I. 1. (*a*) It has three single bonds and one lone pair. 

2. (*d*) :N ≡ N: It has triple bond

3. (*b*) Carbon attains 8 electrons after sharing four electrons and acquire stable configuration of Neon.

4. (*c*) 

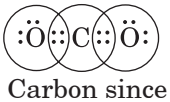
5. (*b*) C_2H_4, H:C::C:H

II. 1. (*a*) Both 'A' and 'R' are true and 'R' is correct explanation of the assertion.

2. (*a*) Both 'A' and 'R' are true and 'R' is correct explanation of the assertion.

III. 1.  , It has 3 bonds around N-atom.

2. It is because covalent compounds do not form ions.

3. 

4. Carbon since it forms strong covalent bond, due to smaller atomic size.

5. (*i*) Catenation (*ii*) Tetravalency of carbon.

6. Carbon as 4 valence electrons. It cannot lose 4 electrons because very high amount of energy is needed. It also cannot gain four electrons because 6 protons cannot hold 10 electrons.

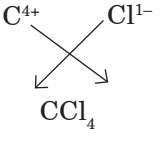
It can share four electrons to form four covalent bonds. Covalent compounds do not conduct electricity because they do not form ions. They have low melting and boiling points due to weak forces of attraction between molecules.

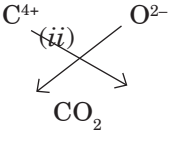
7. Carbon compounds form covalent bonds/do not dissociate into ions/do not have charged particles (ions).

8. The property of self-linking of atoms of an element through covalent bonds in order to form straight chain, branched chains or cyclic chains of different sizes is called catenation.

9. It is because they have weak van der Waal's forces of attraction between molecules therefore have low melting and boiling points.

10. Covalent bonds are formed by equal sharing of electrons.

IV. 1. (*i*) 

(*ii*) 

2. (*i*) Cl (2,8,7) (*ii*) 
Chlorine molecule ≡ :Cl–Cl:

3. Carbon shows catenation property to more extent than silicon. It is because C–C bond is stronger than Si–Si bond because carbon is smaller in size than silicon.

4. – Burn compound in air/ oxygen; Gas evolved turns lime water milky
– By sharing its four valence electrons with other elements.

5. • Due to self linking ability of carbon/catenation
• Since carbon has a valency of four it can form bonds with four other atoms of carbon or atoms of some other mono-valent element.
• Due to small size of carbon it forms very strong and (or) stable bonds with other elements

V. 1. Those compounds which are formed by equal sharing of electrons are called covalent compounds.

They are different from ionic compounds since ionic compounds are formed by transfer of electrons from one atom to another.

Properties:

(*i*) They have low melting and boiling points.
(*ii*) They do not conduct electricity in molten state and in aqueous solution.
(*iii*) They are mostly insoluble in water but soluble in organic solvents except glucose, sugar, urea, ethyl alcohol, *etc*.

2. (*a*) Carbon has electronic configuration 2, 4. It could gain four electrons forming C^{-4} anion or lose 4 electrons to form C^{+4} cation . Both are not possible due to energy considerations. Carbon overcome this problem by sharing electrons and forming covalent compounds. Two reasons for forming large number of compounds:

(1) Catenation (2) Tetra valency

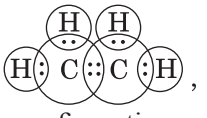
(*b*) **Formation of NH_3 molecule**

Three hydrogen atoms each share their 1 electron with nitrogen to form three covalent bonds and make an ammonia molecule (NH_3).

3. Carbon shows the property of catenation.
It forms strong covalent bonds with other atoms of carbon forming long straight, branched and closed chain compounds.
Carbon is smallest in size in group 14 with tatravalency, it can form double as well as triple bonds, therefore, it can show property of catenation to maximum extent and forms 3 million compounds other elements cannot show property of catenation to this extent due to larger size form weaker covalent bond and cannot form double or triple bonds.

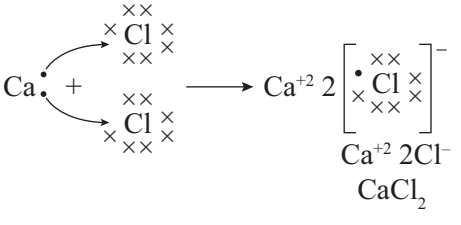
4. (*i*) Nitrogen (*ii*)  $:N \equiv N:$ (*iii*) Triple covalent bond

C_2H_4 is molecular formula of Ethene

 , $H-\overset{H}{\underset{|}{C}}=\overset{H}{\underset{|}{C}}-H$

5. (*i*)

		Z	Electronic configuration
Ca	–	20	2 8 8 1
Cl	–	17	2 8 7



$Ca^{+2}\ 2\left[\cdot\underset{\times}{\overset{\times\times}{Cl}}\times\right]^-$

$Ca^{+2}\ 2Cl^-$

$CaCl_2$

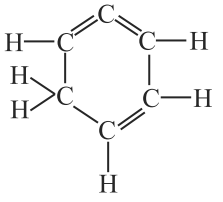
(*ii*) Ionic compounds do not conduct in solid state due to absence of free ions but they conduct electricity in molten and aqueous state due to presence of free ions.

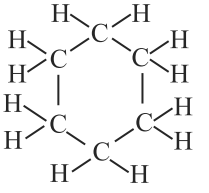
EXERCISE 1.2

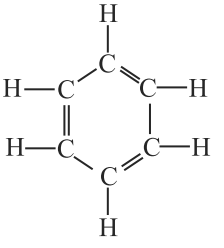
I. Multiple Choice Questions (1 Mark)

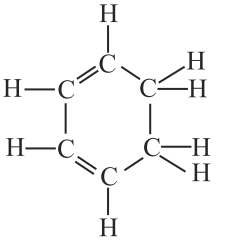
Choose the correct answer from the given options.

1. Structural formula of benzene is

(*a*) 

(*b*) 

(*c*) 

(*d*) 

2. Which of the following is not a straight chain hydrocarbon?

(*a*) $H_3C—CH_2—CH_2—CH_2—CH_2$ with CH_3 branch

(*b*) $H_3CCH_2CH_2CH_2CH_2CH_3$

(*c*) $CH_3-H_2C-H_2C-H_2C-CH_2-CH_3$

(*d*) $(CH_3)_2CH-CH_2-CH_2-CH_3$

II. Assertion-Reason Type Questions (1 Mark)

For question numbers 1 and 2 two statements are given-one labeled as **Assertion** (A) and the other labeled **Reason** (R). Select the correct answer to these questions from the codes (*a*), (*b*), (*c*) and (*d*) as given below:

(*a*) Both 'A' and 'R' are true and 'R' is correct explanation of the assertion.

(*b*) Both 'A' and 'R' are true but 'R' is not correct explanation of the assertion.

(*c*) 'A' is true but 'R' is false.

(*d*) 'A' is false but 'R' is true.

1. Assertion: C_6H_{12}, C_2H_4, C_4H_8 are alkenes and have double bond.
Reason: C_3H_4 and C_5H_8 are alkynes and have triple bond.

2. Assertion: Following are the members of a homologous series:
$CH_3OH, CH_3CH_2OH, CH_3CH_2CH_2OH$
Reason: A series of compounds with same functional group but differing by $-CH_2-$ unit is called a homologous series. [*CBSE* 2020]

III. Very Short Answer Type Questions (1 Mark)

1. An alkene 'P' has three carbon atoms and an alcohol 'Q' has four carbon atoms. Write the formulae of P and Q.

2. Write the molecular formula of benzene and state the number of double bonds in its structure. [*Delhi* 2013]

3. What is homologous series? [*Delhi* 2016]

4. The molecular formula of two members of a homologous series are C_3H_4 and C_6H_{10}. Write the molecular formula of a member of this family with five carbon atoms in a molecule.

5. Write the general formula of alkenes. Write the name of the simplest alkene. [*Delhi* 2015]

6. Write the next homologue of each of the following: (*i*) C_2H_4, (*ii*) C_4H_6 [*Delhi* 2016]

7. Write the structure of an alcohol with three carbon atoms in the molecule.

8. Write the molecular formula of alcohol derived from butane. [*Delhi* 2016]

9. Write the molecular formula of an alkyne containing 10 atoms of hydrogen.

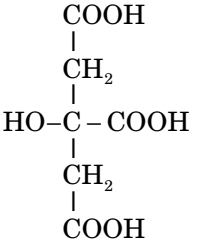
10. Write the name and molecular formula of the fourth member of alkane series. [*Delhi* 2016]

11. Write the name and formula of second member of homologous series with general formula C_nH_{2n+2} [*Delhi* 2015]

12. Write the name and formula of second member of homologous series having general formula C_nH_{2n-2}. [*Delhi* 2016]

13. Which of the following organic compounds belong to the same homologous series:
C_2H_6, C_2H_6O, $C_2H_6O_2$, CH_4O

14. The formula of citric acid is shown below:



State the name of —COOH functional group in citric acid. [*Delhi* 2014]

15. The molecular formula of 'A' is $C_{10}H_{18}$ and 'B' is $C_{18}H_{36}$. Name the homologous series to which they belong. [*Delhi* 2014]

16. Write the next homologous of CH_3CH_2OH and HCOOH.

17. Write the molecular formula of first two members of homologous series having functional group Cl. [*Delhi* 2017]

18. Write the molecular formula of the 2nd and the 3rd member of the homologous series whose first member is methane (CH_4). [*AI* 2017]

19. How many covalent bonds are there in a molecule of ethane (C_2H_6)? [*NCERT*]

20. Write the electron dot diagram of ethane (C_2H_6) molecule. [*Delhi* 2011]

21. Write the number of covalent bonds in propane, C_3H_8. [*Delhi* 2016]

22. Write the number of covalent bonds in the molecule of butane (C_4H_{10}). [*Delhi* 2015]

23. State the valency of the carbon atom in (*i*) an alkane (*ii*) an alkyne.

24. Name a cyclic unsaturated carbon compound. [*CBSE* 2020]

25. Which of the following is not observed in a homologous series? Give reason for your choice.

(*a*) Change in chemical properties (*b*) Difference in $-CH_2$ and 14u molecular mass

(*c*) Gradation in physical properties (*d*) Same functional group [*CBSE Sample Paper* 2020-21]

IV. Short Answer Type Questions-I (2 Marks)

1. The general formula of three compounds A, B and C is C_nH_{2n}. 'B' has the highest boiling point and 'C' has the lowest boiling point.

(*i*) Mention the type of compounds A, B and C.

(*ii*) Which of these has minimum number of carbon atoms?

(*iii*) Name the homologous series to which A, B and C belong [*Delhi* 2016]

2. Select alkenes and alkynes from the following:

C_2H_4, C_3H_4, C_2H_2, C_4H_8

Write their structural formula also. [*Delhi* 2014, 2015]

3. An alkane has molecular weight 86. Write its molecular formula. What will be its physical state? [**HOTS**]

V. Short Answer Type Question-II (3 Marks)

1. What is homologous series of carbon compounds? Give an example and list its three characteristics. [*CBSE* 2019]

Answers 1.2

I. 1. (*c*) It has 6 C–C bonds, 6 C–H bonds and three C = C bonds.

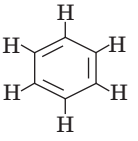
2. (*d*) It is branched chain hydrocarbon.

II. 1. (*b*) Both 'A' and 'R' are true but 'R' is not correct explanation of the assertion.

2. (*a*) Both 'A' and 'R' are true and 'R' is correct explanation of the assertion.

III. 1. 'P' is $CH_3–CH=CH_2$, 'Q' is $CH_3CH_2CH_2CH_2OH$

2. C_6H_6, It has three double bonds



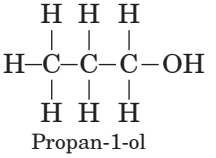
3. It is a series of organic compounds having same functional group and similar chemical properties.

4. C_5H_8

5. C_nH_{2n}, Ethene is simplest alkene.

6. (*i*) C_3H_6, (*ii*) C_5H_8

7. $CH_3CH_2CH_2OH$ or



Propan-1-ol

8. C_4H_9OH or $CH_3CH_2CH_2CH_2OH$ (Butan-1-ol)

9. C_6H_{10}

10. C_4H_{10}, Butane ($CH_3CH_2CH_2CH_3$)

11. C_2H_6, Ethane

12. C_3H_4, Propyne

13. C_2H_6O (C_2H_5OH) and CH_4O (CH_3OH)

14. Carboxylic acid

15. 'A' belongs to Alkynes, 'B' belongs to Alkenes.

16. $CH_3 – CH_2 – CH_2OH$. Propanol and, CH_3COOH ethanoic acid

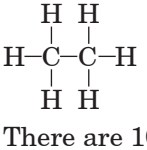
17. The general formula of the compounds having –Cl functional group is $C_nH_{2n+1}Cl$. Its two members are:

(*i*) CH_3Cl (*ii*) $CH_3 – CH_2 – Cl$

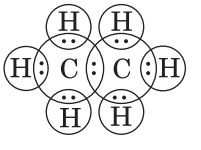
18. (*i*) CH_3CH_3 (Ethane); where *n* is 2

(*ii*) $CH_3CH_2CH_3$ (Propane); where *n* is 3

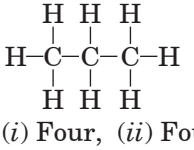
19. There are 7 covalent bonds.



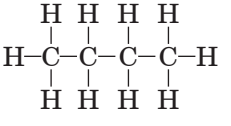
20.



21. There are 10 covalent bonds.

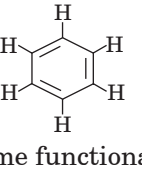


22. There are 13 covalent bonds.



23. (*i*) Four, (*ii*) Four

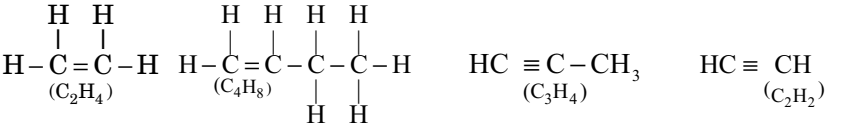
24. Benzene is cyclic unsaturated carbon compound.



25. (*a*) It does not occur due to the presence of the same functional group.

IV. 1. (*i*) Unsaturated hydrocarbons with double bonds.
(*ii*) 'C' has minimum boiling point, so 'C' has minimum no. of C-atoms.
(*iii*) Alkene

2. C_2H_4 and C_4H_8 are alkenes, C_3H_4 and C_2H_2 are alkynes.



3. C_6H_{14} has molecular weight of $6 \times 12 + 14 = 86$u.
It is in liquid state at room temperature.

V. 1. The series of organic compounds having same functional group and similar chemical properties is called homologous series. For example,

Alkane:	CH_4	C_2H_6	C_3H_6
	Methane	Ethane	Propane

Characteristics: • Each successive member differ by CH_2 unit.
• They have gradation in physical properties.
• They have similar chemical properties due to presence of same functional group.

CASE STUDY QUESTION

1. Water is a simple molecule consisting of one oxygen atom bonded to two different hydrogen atoms. Because of the higher electronegativity of the oxygen atom, the bonds are polar covalent (polar bonds). The oxygen atom attracts the shared electrons of the covalent bonds to a significantly greater extent than the hydrogen atoms. The molecule has a bent structure, the H—Ö—H bond angle is about 105°.

(*i*) Which of the following statement is true regarding the electronegativity of atoms in water molecule?
(*a*) Hydrogen is more electronegative than oxygen
(*b*) Hydrogen is less electronegative than oxygen
(*c*) Electronegativity is same in Hydrogen and oxygen
(*d*) Hydrogen and oxygen do no show significant electronegativity in water

(*ii*) What is the shape of water molecule?
(*a*) Linear (*b*) Trigonal planar (*c*) Bent (*d*) Octahedral

(*iii*) Select the correct type of bonding in a water molecule
(*a*) Ionic Bonding (*b*) Covalent Bonding (*c*) Hydrogen Bonding (*d*) None of these

(*iv*) The correct electron dot structure of a water molecule is
(*a*) H·Ö·O (*b*) H:Ö·O (*c*) H:Ö:H (*d*) H:O:O

(*v*) The H—O—H bond angle in water molecule is
(*a*) 109.5° (*b*) 180° (*c*) 90° (*d*) 105.0°

Ans. (*i*) (*b*) (*ii*) (*c*) (*iii*) (*b*) (*iv*) (*c*) (*v*) (*d*)

ASSIGNMENT

Total Marks : 20

I. Multiple Choice Questions (1 Mark)

Choose the correct answer from the given options.

1. Which of the following does not belong to the same homologous series?
(*a*) CH_4 (*b*) C_2H_6 (*c*) C_3H_8 (*d*) C_4H_8

2. Which of the following is the first member of alkene?
(*a*) CH_3 (*b*) $CH_2=CH_2$ (*c*) $CH_3–CH=CH_2$ (*d*) CH_2

3. How many valence electrons are present in carbon?
(*a*) 2 (*b*) 3 (*c*) 4 (*d*) 5

4. Graphite conducts electricity because
(*a*) it has free carbon atoms (*b*) it has free electrons
(*c*) its one layer can slip over another layer (*d*) None of these

II. Assertion-Reason Type Questions (1 Mark)

Note: Use instructions as given in exercises of the chapter.

1. Assertion: H_2O has two covalent bonds and two lone pair of electrons.
Reason: C_nH_{2n} is the general formula of alkene.

2. Assertion: Carbon has a strong tendency to either lose or gain electrons to attain noble gas configuration.
Reason: Carbon has four electrons in its outermost shell and has tendency to share electrons with carbon or other elements.

III. Very Short Answer Type Questions (1 Mark)

1. What do you mean by catenation ?

2. Draw the electron dot structure of propyne.

IV. Short Answer Type Questions-I (2 Marks)

1. How are covalent bonds formed?

2. Draw electron dot structure of H_2O and NH_3 molecule.

V. Short Answer Type Questions-II (3 Marks)

1. Draw the structures of three allotropes of carbon.

VI. Long Answer Type Questions (5 Marks)

1. (*i*) What is homologous series of carbon compounds? Give an example and list its three characteristics.
(*ii*) Compare the ability of catenation of carbon and silicon.