

# Carbon and its Compounds

## EXERCISE 1.1

### I. Multiple Choice Questions

(1 Mark)

Choose the correct answer from the given options.

- A molecule of ammonia ( $\text{NH}_3$ ) has  
(a) only single bonds (b) only double bonds  
(c) only triple bonds (d) two double bonds and one single bond
- Which of the following is the correct representation of electron dot structure of nitrogen?  
(a)  $\cdot\ddot{\text{N}}:\ddot{\text{N}}:$  (b)  $\cdot\ddot{\text{N}}::\ddot{\text{N}}:$  (c)  $\cdot\ddot{\text{N}}:\ddot{\text{N}}:$  (d)  $\cdot\text{N}::\text{N}:$
- 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
- The correct electron dot structure of a water molecule is  
(a)  $\text{H}:\ddot{\text{O}}:\text{H}$  (b)  $\cdot\text{H}:\ddot{\text{O}}:\text{H}\cdot$  (c)  $\text{H}:\ddot{\text{O}}:\text{H}$  (d)  $\text{H}:\text{O}:\text{H}$
- The molecular formula of ethene and its electron dot structure is  
(a)  $\text{C}_2\text{H}_4$ ,  $\text{H}:\overset{\text{H}}{\underset{\cdot\cdot}{\text{C}}}::\overset{\text{H}}{\underset{\cdot\cdot}{\text{C}}}:\text{H}$   
(b)  $\text{C}_2\text{H}_4$ ,  $\text{H}:\overset{\text{H}}{\underset{\cdot\cdot}{\text{C}}}::\overset{\text{H}}{\underset{\cdot\cdot}{\text{C}}}:\text{H}$   
(c)  $\text{C}_2\text{H}_2$ ,  $\text{H}:\overset{\text{H}}{\underset{\cdot\cdot}{\text{C}}}::\overset{\text{H}}{\underset{\cdot\cdot}{\text{C}}}:\text{H}$   
(d)  $\text{C}_2\text{H}_6$ ,  $\text{H}:\overset{\text{H}}{\underset{\cdot\cdot}{\text{C}}}::\overset{\text{H}}{\underset{\cdot\cdot}{\text{C}}}:\text{H}$

### 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:

- Both 'A' and 'R' are true and 'R' is correct explanation of the assertion.
  - Both 'A' and 'R' are true but 'R' is not correct explanation of the assertion.
  - 'A' is true but 'R' is false.
  - 'A' is false but 'R' is true.
- Assertion:** Carbon forms covalent compound with chlorine of formula  $\text{CCl}_4$ .  
**Reason:** Carbon has 4 valence electrons, valency 4, chlorine has 7 valence electrons, valency 1.
  - 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)

- Draw electron dot structure of  $\text{NH}_3$  molecule. Predict the total no. of bonds around N-atom.

[Delhi 2016]

OR

A molecule of ammonia has the formula  $\text{NH}_3$ . Predict the total number of bonds present around nitrogen atom.

[CBSE 2016]

- Why covalent compounds are poor conductors of electricity? [CBSE 2020]
- What would be the electron dot structure of carbon dioxide which has the formula,  $\text{CO}_2$ ? [NCERT]
- Which element exhibits the property of catenation to maximum extent and why? [Delhi 2016]
- State two characteristic features of carbon which when put together give rise to large number of carbon compounds.
- Explain why carbon generally forms compounds by covalent bonds or do not form ionic compounds.

OR

Give reason why carbon neither forms  $\text{C}^{4+}$  cations nor  $\text{C}^{4-}$  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)

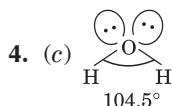
(ii) Why do ionic compounds not conduct electricity in solid state but conduct electricity in molten and aqueous state? [CBSE Sample Paper 2020-21]

## Answers 1.1

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


2. (d)  $\text{:N} \equiv \text{N:}$  It has triple bond

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



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.



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.

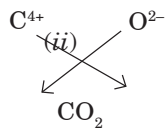
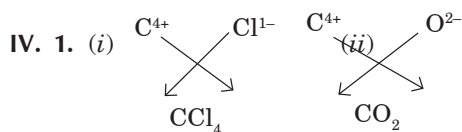
It can share four electrons to form four covalent bonds. Covalent compounds do not conduct electricity because they do not form ions. They have low melting and boiling points due to weak forces of attraction between molecules.

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.



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:

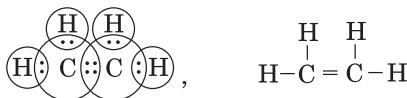
- (i) They have low melting and boiling points.
  - (ii) They do not conduct electricity in molten state and in aqueous solution.
  - (iii) They are mostly insoluble in water but soluble in organic solvents except glucose, sugar, urea, ethyl alcohol, etc.
2. (a) Carbon has electronic configuration 2, 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 overcomes 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 ( $NH_3$ ).



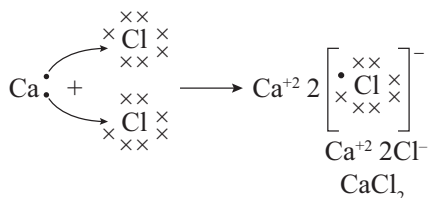
3. Carbon shows the property of catenation.  
It forms strong covalent bonds with other atoms of carbon forming long straight, branched and closed chain compounds.  
Carbon is smallest in size in group 14 with tetravalency, it can form double as well as triple bonds, therefore, it can show property of 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 ≡ N:      (iii) Triple covalent bond

$C_2H_4$  is molecular formula of Ethene



5. (i)
- |    | Z  | Electronic configuration |
|----|----|--------------------------|
| Ca | 20 | 2 8 8 1                  |
| Cl | 17 | 2 8 7                    |



- (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.

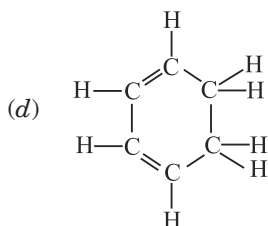
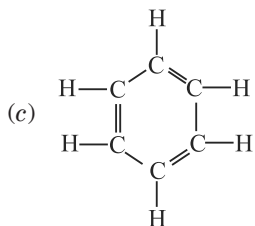
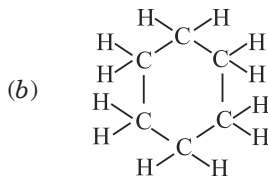
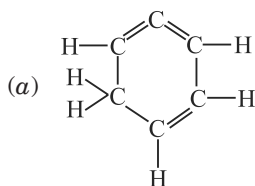
## EXERCISE 1.2

### I. Multiple Choice Questions

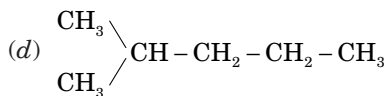
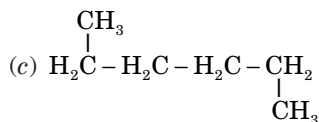
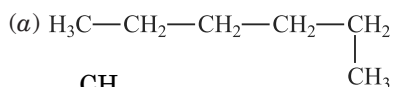
(1 Mark)

Choose the correct answer from the given options.

1. Structural formula of benzene is



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



### 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:**  $\text{C}_6\text{H}_{12}$ ,  $\text{C}_2\text{H}_4$ ,  $\text{C}_4\text{H}_8$  are alkenes and have double bond.

**Reason:**  $\text{C}_3\text{H}_4$  and  $\text{C}_5\text{H}_8$  are alkynes and have triple bond.

2. **Assertion:** Following are the members of a homologous series:



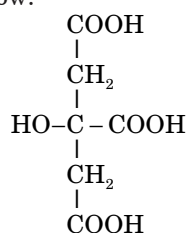
**Reason:** A series of compounds with same functional group but differing by  $-\text{CH}_2-$  unit is called a homologous series. [CBSE 2020]

### III. Very Short Answer Type Questions

(1 Mark)

- An alkene 'P' has three carbon atoms and an alcohol 'Q' has four carbon atoms. Write the formulae of P and Q.
- Write the molecular formula of benzene and state the number of double bonds in its structure. [Delhi 2013]
- What is homologous series? [Delhi 2016]
- The molecular formula of two members of a homologous series are  $\text{C}_3\text{H}_4$  and  $\text{C}_6\text{H}_{10}$ . Write the molecular formula of a member of this family with five carbon atoms in a molecule.
- Write the general formula of alkenes. Write the name of the simplest alkene. [Delhi 2015]
- Write the next homologue of each of the following: (i)  $\text{C}_2\text{H}_4$ , (ii)  $\text{C}_4\text{H}_6$  [Delhi 2016]
- Write the structure of an alcohol with three carbon atoms in the molecule.
- 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  $-\text{COOH}$  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 2<sup>nd</sup> and the 3<sup>rd</sup> 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 $-\text{CH}_2$ 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

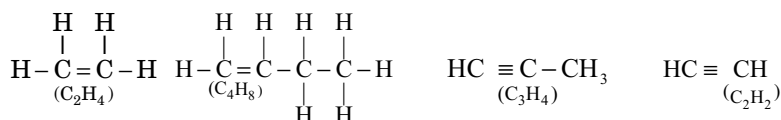
(3 Marks)

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

## Answers 1.2

- C1=CC=CC=C1

- 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  $6 \times 12 + 14 = 86\text{u}$ .  
 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,



**Characteristics:** • Each successive member differ by  $\text{CH}_2$  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  $\text{H}-\ddot{\text{O}}-\text{H}$  bond angle is about  $105^\circ$ .
- (i) Which of the following statement is true regarding the electronegativity of atoms in water molecule?
- Hydrogen is more electronegative than oxygen
  - Hydrogen is less electronegative than oxygen
  - Electronegativity is same in Hydrogen and oxygen
  - Hydrogen and oxygen do not show significant electronegativity in water
- (ii) What is the shape of water molecule?
- Linear
  - Trigonal planar
  - Bent
  - Octahedral
- (iii) Select the correct type of bonding in a water molecule
- Ionic Bonding
  - Covalent Bonding
  - Hydrogen Bonding
  - None of these
- (iv) The correct electron dot structure of a water molecule is
- $\text{H}:\ddot{\text{O}}:\text{O}$
  - $\text{H}:\ddot{\text{O}}:\text{O}$
  - $\text{H}:\ddot{\text{O}}:\text{H}$
  - $\text{H}:\text{O}:\text{O}$
- (v) The  $\text{H}-\text{O}-\text{H}$  bond angle in water molecule is
- $109.5^\circ$
  - $180^\circ$
  - $90^\circ$
  - $105.0^\circ$

**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)  $\text{CH}_4$                       (b)  $\text{C}_2\text{H}_6$                       (c)  $\text{C}_3\text{H}_8$                       (d)  $\text{C}_4\text{H}_8$
2. Which of the following is the first member of alkene?  
(a)  $\text{CH}_3$                       (b)  $\text{CH}_2=\text{CH}_2$                       (c)  $\text{CH}_3-\text{CH}=\text{CH}_2$                       (d)  $\text{CH}_2$
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:**  $\text{H}_2\text{O}$  has two covalent bonds and two lone pair of electrons.

**Reason:**  $\text{C}_n\text{H}_{2n}$  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  $\text{H}_2\text{O}$  and  $\text{NH}_3$  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.