

Carbon and its Compounds

Class 10 - CBSE Science | Chapter 4 | Worksheet & Test Paper

15 MCQs | 8 board questions | 7 practice problems

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SECTION A - Multiple Choice Questions (1 mark each)

1. The electronic configuration of carbon (atomic number 6) is:

- (a) 2, 6
- (b) 2, 4
- (c) 4, 2
- (d) 2, 8, 4

2. A covalent bond is formed by:

- (a) Transfer of electrons
- (b) Sharing of a pair of electrons
- (c) Loss of electrons
- (d) Gain of electrons

3. Which of the following is NOT a property of covalent compounds?

- (a) Low melting point
- (b) Poor conductor of electricity
- (c) Good conductor of electricity
- (d) Generally insoluble in water

4. The self-linking of carbon atoms to form long chains is called:

- (a) Tetravalency
- (b) Catenation
- (c) Isomerism
- (d) Allotropy

5. Which allotrope of carbon conducts electricity?

- (a) Diamond
- (b) Graphite
- (c) Fullerene
- (d) All of them

6. The general formula of an alkyne is:

- (a) C_nH_{2n+2}
- (b) C_nH_{2n}
- (c) C_nH_{2n-2}
- (d) C_nH_n

7. The number of structural isomers of butane (C_4H_{10}) is:

- (a) 1
- (b) 2
- (c) 3
- (d) 4

8. The functional group present in ethanol is:

- (a) - CHO
- (b) - COOH
- (c) - OH
- (d) $>C=O$

9. Unsaturated hydrocarbons burn with a:

- (a) Clean blue flame
- (b) Yellow sooty flame
- (c) Colourless flame
- (d) Green flame

10. The catalyst used in the hydrogenation of vegetable oils is:

- (a) Platinum

- (b) Nickel
- (c) Iron
- (d) Copper

11. $\text{CH}_4 + \text{Cl}_2 \xrightarrow{\text{sunlight}} \text{CH}_3\text{Cl} + \text{HCl}$ is an example of:

- (a) Addition reaction
- (b) Substitution reaction
- (c) Oxidation reaction
- (d) Combustion

12. Vinegar is a solution of ethanoic acid in water of concentration about:

- (a) 1-2%
- (b) 5-8%
- (c) 20-25%
- (d) 50%

13. Ethanol heated with excess concentrated sulphuric acid at 443 K gives:

- (a) Ethanoic acid
- (b) Ethene
- (c) Ethyl ethanoate
- (d) Sodium ethoxide

14. The reaction of an ester with sodium hydroxide to give soap is called:

- (a) Esterification
- (b) Saponification
- (c) Hydrogenation
- (d) Neutralisation

15. Soap does not lather well in hard water because it forms:

- (a) A micelle
- (b) An ester
- (c) An insoluble scum
- (d) Carbon dioxide

SECTION B - Board-style Questions

1. Why does carbon form compounds mainly by sharing electrons rather than by transferring them? [3 marks]

2. Give reasons: (a) diamond is extremely hard, (b) graphite is a good conductor of electricity and feels slippery. [3 marks]

3. What is a homologous series? State any two of its characteristics with an example. [3 marks]

4. What are structural isomers? Describe the two isomers of butane. [3 marks]

5. How can you distinguish between a saturated and an unsaturated hydrocarbon experimentally? Give the reason for the difference. [3 marks]

6. What is esterification? Write the equation. What happens when the ester formed is heated with sodium hydroxide? [3 marks]

7. Explain the cleansing action of soap with reference to micelle formation. [3 marks]

8. Why does soap not work effectively in hard water? What is used instead and why? [2 marks]

SECTION C - Practice Problems

1. Write the molecular formula and the name of the alkane, the alkene and the alkyne that each contain three carbon atoms.

Hint: Apply each general formula with $n = 3$, then use the root for three carbons with the right family ending.

2. Name the following compounds: (a) $\text{CH}_3\text{-CH}_2\text{-OH}$ (b) $\text{CH}_3\text{-COOH}$ (c) $\text{CH}_3\text{-CHO}$

Hint: Count the carbon atoms for the root, identify the functional group for the ending, and remember what happens to the final 'e'.

3. An organic compound X with the molecular formula $\text{C}_2\text{H}_6\text{O}$ reacts with sodium to liberate hydrogen gas. On oxidation with alkaline KMnO_4 it gives compound Y, which turns blue litmus red. Identify X and Y and write both equations.

Hint: Which functional group reacts with sodium giving hydrogen? Then ask what that group becomes on oxidation.

4. Explain why the conversion of ethanol into ethanoic acid is called an oxidation reaction.

Hint: Compare the two molecules atom by atom - what has been added, or removed?

5. A gas jar contains an unsaturated hydrocarbon. Describe one reaction that would convert it into a saturated hydrocarbon, and state one industrial use of this reaction.

Hint: What must be added across a double bond, and what helps that addition happen?

6. Write the electron dot structure of (a) ethane, C_2H_6 and (b) ethene, C_2H_4 , and state how many shared pairs lie between the two carbon atoms in each.

Hint: Count the valence electrons each atom brings, then place shared pairs until every carbon reaches eight and every hydrogen reaches two.

7. You are given ethanol and ethanoic acid in two unlabelled test tubes. Describe a simple chemical test to identify each, stating what you observe.

Hint: Only one of them contains a group acidic enough to attack a carbonate - think about what gas that would release.

ANSWER KEY

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Section A - MCQ answers

1. (b) 2, 4

Six electrons fill as 2 in the first shell and 4 in the second - hence carbon needs 4 more electrons for an octet.

2. (b) Sharing of a pair of electrons

Carbon cannot lose or gain 4 electrons, so it shares electron pairs - that shared pair is the covalent bond.

3. (c) Good conductor of electricity

Covalent compounds have no ions and no free electrons, so they do not conduct electricity.

4. (b) Catenation

Catenation is the property of an element to bond with its own atoms; carbon shows it best because C-C bonds are very strong.

5. (b) Graphite

In graphite each carbon bonds to only three others, leaving one free electron per atom to carry current.

6. (c) C_nH_{2n-2}

Alkynes contain a triple bond and follow C_nH_{2n-2} - for example ethyne, C_2H_2 .

7. (b) 2

Butane has two isomers: the straight-chain n-butane and the branched iso-butane.

8. (c) - OH

Ethanol (C_2H_5OH) contains the alcohol group, -OH.

9. (b) Yellow sooty flame

Unsaturated compounds have a higher proportion of carbon, so they burn incompletely giving a yellow, sooty flame.

10. (b) Nickel

Nickel catalyses the addition of hydrogen across double bonds, hardening oils into vanaspati ghee.

11. (b) Substitution reaction

Chlorine replaces (substitutes) a hydrogen atom of the saturated hydrocarbon in the presence of sunlight.

12. (b) 5-8%

Vinegar contains roughly 5-8% ethanoic acid; the pure acid is called glacial acetic acid.

13. (b) Ethene

Concentrated H_2SO_4 acts as a dehydrating agent, removing water to give ethene.

14. (b) Saponification

Saponification: ester + NaOH $\rightarrow$ alcohol + sodium salt of the carboxylic acid. When the ester comes from a long-chain fatty acid (a fat or oil), that sodium salt is soap - which is where the name comes from.

15. (c) An insoluble scum

Soap reacts with the calcium and magnesium ions of hard water to give an insoluble precipitate called scum.

Section B - Model answers

1. Why does carbon form compounds mainly by sharing electrons rather than by transferring them?

Carbon has 4 electrons in its outermost shell and needs 4 more to attain the noble-gas configuration. (i) It cannot lose 4 electrons, because removing four electrons from a small atom requires an enormous amount of energy. (ii) It cannot gain 4 electrons, because a nucleus with only 6 protons could not hold 10 electrons. Therefore carbon completes its octet by SHARING its four valence electrons with other atoms, forming covalent bonds.

2. Give reasons: (a) diamond is extremely hard, (b) graphite is a good conductor of electricity and feels slippery.

(a) In diamond each carbon atom is bonded to four other carbon atoms by strong covalent bonds, forming a rigid three-dimensional network; breaking this structure requires enormous energy, so diamond is the hardest natural substance. (b) In graphite each carbon atom is bonded to only three others, forming flat hexagonal layers. The fourth electron of each atom is free to move, which makes graphite a good conductor. The layers are held together by weak forces and slide over one another, so graphite is soft and slippery.

3. What is a homologous series? State any two of its characteristics with an example.

A homologous series is a group of carbon compounds having the same functional group in which each successive member differs from the previous one by a $-CH_2-$ unit. Characteristics: (i) all members can be represented by a single general formula, e.g. alkanes C_nH_{2n+2} (CH_4 , C_2H_6 , C_3H_8); (ii) successive members differ in molecular mass by 14 u; (iii) all members show similar chemical properties, while physical properties such as melting and boiling point change gradually as the chain length increases. (any two)

4. What are structural isomers? Describe the two isomers of butane.

Structural isomers are compounds having the same molecular formula but different structural arrangements of atoms. Butane, C_4H_{10} , has two isomers: (i) n-butane, in which all four carbon atoms are joined in a straight chain, and (ii) iso-butane (2-methylpropane), in which three carbon atoms form a chain and the fourth is attached as a branch to the middle carbon. Both have the formula C_4H_{10} but different structures and slightly different physical properties.

5. How can you distinguish between a saturated and an unsaturated hydrocarbon experimentally? Give the reason for the difference.

Burn a small sample of each. A saturated hydrocarbon burns with a clean BLUE flame, while an unsaturated hydrocarbon burns with a yellow, SOOTY flame. The reason is that unsaturated compounds have a higher percentage of carbon, so they undergo incomplete combustion in the available air and unburnt carbon particles are released as soot.

6. What is esterification? Write the equation. What happens when the ester formed is heated with sodium hydroxide?

Esterification is the reaction of a carboxylic acid with an alcohol in the presence of an acid catalyst to form a sweet-smelling ester: $CH_3COOH + C_2H_5OH \rightarrow CH_3COOC_2H_5 + H_2O$. On heating the ester with sodium hydroxide, it is hydrolysed back to the alcohol and the sodium salt of the carboxylic acid: $CH_3COOC_2H_5 + NaOH \rightarrow C_2H_5OH + CH_3COONa$ (sodium ethanoate). This alkaline hydrolysis of an ester is called saponification; when the ester used is that of a long-chain fatty acid (a fat or an oil), the sodium salt obtained is soap - which is how the reaction got its name.

7. Explain the cleansing action of soap with reference to micelle formation.

A soap molecule has two parts: a long hydrocarbon TAIL which is hydrophobic (water-repelling but oil-loving) and an ionic HEAD which is hydrophilic (water-loving). When soap is added to water containing a greasy stain, the hydrocarbon tails dissolve into the oil/grease while the ionic heads remain in the water. The soap molecules arrange themselves in a spherical cluster called a MICELLE, with the dirt trapped at the centre. The micelles remain suspended in water and are washed away with the rinse water, carrying the dirt with them.

8. Why does soap not work effectively in hard water? What is used instead and why?

Hard water contains calcium and magnesium salts. Soap reacts with these calcium and magnesium ions to form an insoluble precipitate called scum, so a large amount of soap is wasted and it does not lather properly. Detergents are used instead, because the ammonium or sulphonate salts in detergents do not form an insoluble precipitate with calcium and magnesium ions, so they clean effectively even in hard water.

Section C - Solutions

1. Write the molecular formula and the name of the alkane, the alkene and the alkyne that each contain three carbon atoms.

Alkane: C_3H_8 , propane. Alkene: C_3H_6 , propene. Alkyne: C_3H_4 , propyne. (Roots: 'prop' = 3 carbons; endings -ane, -ene, -yne.)

2. Name the following compounds: (a) CH_3-CH_2-OH (b) CH_3-COOH (c) CH_3-CHO

(a) Ethanol - 2 carbons (eth) + alcohol (-ol), with the final 'e' of ethane dropped. (b) Ethanoic acid - 2 carbons + -COOH (-oic acid). (c) Ethanal - 2 carbons + -CHO (-al).

3. An organic compound X with the molecular formula C_2H_6O reacts with sodium to liberate hydrogen gas. On oxidation with alkaline $KMnO_4$ it gives compound Y, which turns blue litmus red. Identify X and Y and write both equations.

X is ethanol (C_2H_5OH) and Y is ethanoic acid (CH_3COOH). With sodium: $2C_2H_5OH + 2Na \rightarrow 2C_2H_5ONa + H_2$ (gas). On oxidation: $CH_3CH_2OH \xrightarrow{[alkaline\ KMnO_4]} CH_3COOH$, which is acidic and turns blue litmus red.

4. Explain why the conversion of ethanol into ethanoic acid is called an oxidation reaction.

In going from CH_3CH_2OH to CH_3COOH , oxygen is added to the molecule (and hydrogen is removed). Since oxidation is defined as the addition of oxygen or the removal of hydrogen, this conversion is an oxidation. The reagents used (alkaline $KMnO_4$ or acidified $K_2Cr_2O_7$) supply the oxygen and are therefore called oxidising agents.

5. A gas jar contains an unsaturated hydrocarbon. Describe one reaction that would convert it into a saturated hydrocarbon, and state one industrial use of this reaction.

Pass hydrogen over it in the presence of a nickel catalyst - an ADDITION reaction: $C_2H_4 + H_2 \xrightarrow{[Ni]} C_2H_6$. Industrially this hydrogenation is used to convert unsaturated vegetable oils into saturated vanaspati ghee.

6. Write the electron dot structure of (a) ethane, C_2H_6 and (b) ethene, C_2H_4 , and state how many shared pairs lie between the two carbon atoms in each.

(a) Ethane: each carbon shares one pair with the other carbon and one pair with each of three hydrogens - so ONE shared pair lies between the carbons (a single bond), and each carbon is surrounded by 8 electrons while each H has 2. (b) Ethene: each carbon shares with only two hydrogens, so TWO shared pairs lie between the carbons (a double bond); again each carbon reaches 8 electrons and each H reaches 2.

7. You are given ethanol and ethanoic acid in two unlabelled test tubes. Describe a simple chemical test to identify each, stating what you observe.

Add a small amount of sodium hydrogencarbonate (or sodium carbonate) to each. The test tube containing ethanoic acid gives brisk effervescence, because CO₂ is released: $2\text{CH}_3\text{COOH} + \text{Na}_2\text{CO}_3 \rightarrow 2\text{CH}_3\text{COONa} + \text{H}_2\text{O} + \text{CO}_2$ (gas). The gas turns lime water milky. Ethanol gives no reaction. (Ethanoic acid also turns blue litmus red, while ethanol does not.)

