Class 10 Science · Chapter 4: Carbon and its Compounds

Answer key and marking scheme · 20 marks · about 40 minutes · based on NCERT

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1. In which of these molecules do the two atoms share the largest number of electrons between them? [1]

(a) H_2 (b) N_2
(c) O_2 (d) Cl_2

Answer: (b) H_2 and Cl_2 share one pair (2 electrons), O_2 shares two pairs (4 electrons), N_2 shares three pairs (6 electrons) in its triple bond.

2. An open-chain hydrocarbon has the molecular formula C_5H_{10}. It belongs to the [1]

(a) alkenes (b) alkanes
(c) alkynes (d) carboxylic acids

Answer: (a) C_5H_{10} fits C_nH_{2n} with n = 5, the general formula of alkenes. An alkane would be C_5H_{12}, an alkyne C_5H_8, and it has no oxygen.

3. A form of carbon whose molecule has sixty carbon atoms arranged like the panels of a football belongs to the class called [1]

(a) diamonds (b) fullerenes
(c) graphites (d) hydrocarbons

Answer: (b) Fullerenes are a class of carbon allotropes; the first identified, C-60, has its atoms arranged in the shape of a football.

4. A student suggests that carbon could reach a noble gas configuration by losing all four of its valence electrons to form C^{4+}. The main objection to this is that [1]

(a) removing four electrons would need a large amount of energy (b) a nucleus of six protons cannot hold ten electrons
(c) carbon has no electrons in its outermost shell (d) the C^{4+} ion would have eight electrons in its outermost shell

Answer: (a) Losing four electrons would need a large amount of energy, so C^{4+} does not form. Option b is the objection to C^{4-} (gaining four), not to C^{4+}.

5. A diamond in a ring and the graphite rod of a dry cell are both pure carbon. Which statement about the two is correct? [1]

(a) Both conduct electricity well because both are pure carbon. (b) They have the same physical properties but different chemical properties.
(c) They have the same chemical properties but very different physical properties. (d) In both, every carbon atom is bonded to four other carbon atoms.

Answer: (c) Diamond is the hardest substance while graphite is smooth, slippery and conducting, yet their chemical properties are the same. Only diamond has four bonds per carbon; graphite has three in a plane.

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6. A packet of cooking oil says 'rich in unsaturated fatty acids'. What does 'unsaturated' mean here, and how do the carbon chains of such an oil differ from those of an animal fat such as ghee? [2]

Unsaturated means the long carbon chains contain carbon-carbon double bonds, not only single bonds. Vegetable oils generally have long unsaturated carbon chains, while animal fats such as ghee have saturated chains, with single bonds only; oils with unsaturated fatty acids are the ones to choose for cooking.

- unsaturated: carbon chains contain double (or triple) bonds between carbon atoms (1)
- animal fats such as ghee have saturated chains (single bonds only); the oil's chains are unsaturated (1)

7. What kind of compounds are detergents, chemically? Why are they used in shampoos and laundry powders? [2]

Detergents are generally sodium salts of sulphonic acids or ammonium salts with chloride or bromide ions, each with a long hydrocarbon chain. Their charged ends do not form insoluble precipitates with the calcium and magnesium ions of hard water, so they stay effective in any water, which is why they are used in shampoos and cleaning products.

- sodium salts of sulphonic acids or ammonium salts with chloride/bromide ions, with a long hydrocarbon chain (1)
- charged ends form no insoluble precipitate with Ca^{2+}/Mg^{2+}, so they work in hard water (1)

8. Ethanol meant for a paint factory is supplied with some methanol and a dye added to it. Why is this done, and what does methanol do in the body if it is swallowed? [2]

This is denatured alcohol: methanol, a poison, and a dye are added so that industrial ethanol is unfit for drinking and is easily recognised. In the body, methanol is oxidised to methanal in the liver, which coagulates protoplasm; it also affects the optic nerve and can cause blindness or death.

- adding methanol and dye makes industrial ethanol unfit for drinking (denatured alcohol) (1)
- methanol is oxidised to methanal in the liver, coagulating protoplasm, or damages the optic nerve causing blindness (1)

9. Three forms of pure carbon are described: X is the hardest substance known; Y is smooth, slippery and conducts electricity; Z is made of molecules of sixty carbon atoms shaped like a football. Identify X, Y and Z, and explain, from the arrangement of atoms, why X is hard and why Y conducts and is slippery. [3]

X is diamond, Y is graphite, Z is a fullerene (C-60). In diamond each carbon is bonded to four others in a rigid three-dimensional structure, which makes it very hard. In graphite each carbon is bonded to three others in the same plane, giving hexagonal layers; one bond is a double bond, which leaves electrons free to move, so it conducts, and the stacked layers slide over one another, so it is slippery.

- X diamond, Y graphite, Z fullerene (C-60) (1)
- diamond: each carbon bonded to four others in a rigid 3-D structure, so hard (1)
- graphite: layers of hexagons, free electrons from the double bonds conduct, layers slide (1)

10. Name the following, and in each case state the naming rule you used: (i) $CH_3–CH_2–CH_2–CH_2–OH$ (ii) $CH_3–CO–CH_2–CH_2–CH_3$ (iii) $HC{\equiv}C–CH_2–CH_3$ [3]

(i) Four-carbon chain, butane; alcohol suffix -ol begins with a vowel, so 'e' is dropped: butanol. (ii) Five-carbon chain with a ketone group: pentane − 'e' + 'one' = pentanone. (iii) Four-carbon chain with a triple bond: 'ane' is replaced by 'yne', giving butyne.

- (i) butanol: four-carbon stem, 'e' dropped before -ol (1)
- (ii) pentanone: five-carbon stem, 'e' dropped before -one (1)
- (iii) butyne: 'ane' replaced by 'yne' for the triple bond (1)

11. Tetrachloromethane, CCl_4, boils at about 350 K and does not conduct electricity even as a liquid, while sodium chloride melts above 1000 K and conducts when molten. Explain each difference from the kind of bonding in the two compounds. [3]

In CCl_4 the carbon atom shares its four valence electrons with four chlorine atoms, forming covalent bonds; no ions are formed. The bonds within the molecule are strong but the forces between molecules are weak forces, so it boils at a low temperature. With no ions, it cannot conduct. Sodium chloride is ionic, with strong attraction between oppositely charged ions, so it melts high, and its ions move and conduct when molten.

- CCl_4 is covalent: carbon shares electron pairs with chlorine, no ions (1)
- only weak forces between CCl_4 molecules, so low boiling point (1)
- no ions in CCl_4, so no conduction; NaCl has ions that move when molten (1)