Class 11 Chemistry · Chapter 8: Organic Chemistry – Some Basic Principles and Techniques

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

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1. Wöhler's synthesis of urea, which ended the vital-force idea, started from the inorganic compound [1]

(a) ammonium carbonate (b) ammonium chloride
(c) ammonium cyanate (d) calcium cyanamide

Answer: (c) Wöhler heated ammonium cyanate: $NH_4CNO \rightarrow NH_2CONH_2$. The other three are inorganic salts, but not the one he used.

2. A molecular model in which no bonds are shown and each atom is drawn to its van der Waals size, so that the volume the molecule occupies is seen, is the [1]

(a) framework model (b) ball-and-stick model
(c) space-filling model (d) ball-and-spring model

Answer: (c) The space-filling model shows the relative size of each atom from its van der Waals radius and no bonds. The framework model shows only bonds; ball-and-stick and ball-and-spring show both atoms and bonds.

3. The carbon atom is the most electronegative in [1]

(a) HC≡CH (b) $H_2C{=}CH_2$
(c) $H_3C{-}CH_3$ (d) CH_4

Answer: (a) Electronegativity of carbon rises with the s character of its hybrid orbitals. The sp carbon of ethyne has 50% s character, more than sp^2 (33%) or sp^3 (25%).

4. Tetrahydrofuran is a five-membered ring of four CH_2 groups and one oxygen atom. It is classified as [1]

(a) a benzenoid aromatic compound (b) a heterocyclic aromatic compound
(c) an acyclic compound (d) a heterocyclic alicyclic (non-aromatic) compound

Answer: (d) Its ring holds an atom other than carbon, so it is heterocyclic, and it is saturated, so it is alicyclic, not aromatic. Furan, its unsaturated relative, is the heterocyclic aromatic one.

5. In the direct estimation of oxygen, 0.30 g of an organic compound finally gave 0.44 g of carbon dioxide (after the CO is oxidised by I_2O_5). The percentage of oxygen in the compound is [1]

(a) 26.7% (b) 40.0%
(c) 106.7% (d) 53.3%

Answer: (d) Each mole of O_2 in the compound gives 2 mol CO_2, so 88 g CO_2 comes from 32 g O_2. % O = (32 × 0.44 × 100)/(88 × 0.30) = 53.3%. Using 44 g gives an impossible 106.7%; 40.0% is the carbon fraction 12/44; 26.7% halves the right answer.

6. Arrange the C–H bonds of ethane, ethene and ethyne in increasing order of bond length, and explain the order. [2]

Ethyne < ethene < ethane. The carbons are sp, sp^2 and sp^3 hybridised. The more s character the hybrid orbital has, the closer it is to the nucleus, and the shorter and stronger the bond it forms; sp has 50%, sp^2 33% and sp^3 25% s character.

- order ethyne < ethene < ethane (1)
- reason from s character of sp, sp^2, sp^3 (1)

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7. A laboratory must estimate nitrogen in acetamide, nitrobenzene and pyridine. For which of these will Kjeldahl's method give a correct result? Give the reason for the others. [2]

Only acetamide (its nitrogen is in an amide group). In nitrobenzene the nitrogen is in a nitro group and in pyridine it is in the ring; under Kjeldahl conditions such nitrogen does not change to ammonium sulphate, so the ammonia found is too low. Dumas' method is used for them.

- acetamide only (1)
- nitro and ring nitrogen are not converted to ammonium sulphate (1)

8. A water-immiscible oil is steam-distilled at an atmospheric pressure of 760 mm and the mixture distils at 372 K, where the vapour pressure of water is 733 mm. (a) What is the vapour pressure of the oil at this temperature? (b) State the two properties of the oil that make steam distillation suitable. [2]

(a) The mixture boils when p(oil) + p(water) = p(atmosphere): p(oil) = 760 − 733 = 27 mm. (b) The oil is steam volatile and is immiscible with water.

- p(oil) = 760 − 733 = 27 mm (1)
- steam volatile and immiscible with water (1)

9. Write the IUPAC names of: (i) $CH_3CH_2C(CH_3)_2CH_2CH(CH_3)CH_3$; (ii) $CH_3CH(Br)CH_2COOH$; (iii) $CH_3COCH_2CH_2CN$. [3]

(i) The longest chain has six carbons; numbering from the right gives the methyls 2, 4, 4 (from the left 3, 3, 5): 2,4,4-trimethylhexane. (ii) −COOH is principal, its carbon is C-1, Br on C-3: 3-bromobutanoic acid. (iii) −CN outranks the keto group; the nitrile carbon is C-1 and the C=O is on C-4 of a five-carbon chain: 4-oxopentanenitrile.

- 2,4,4-trimethylhexane (1)
- 3-bromobutanoic acid (1)
- 4-oxopentanenitrile (1)

10. (a) Compare C^+H_3 and $H_3C:^-$ in the number of electrons in the valence shell of carbon, the hybridisation of carbon and the shape. (b) Arrange the free radicals $\dot{C}H(CH_3)_2$, $\dot{C}H_3$, $\dot{C}(CH_3)_3$ and $\dot{C}H_2CH_3$ in increasing order of stability. [3]

(a) C^+H_3: carbon has a sextet; sp^2 hybridised; trigonal planar, with an empty p orbital perpendicular to the plane. $H_3C:^-$: carbon has an octet (three bond pairs and a lone pair); generally sp^3; a distorted tetrahedron. (b) $\dot{C}H_3 < \dot{C}H_2CH_3 < \dot{C}H(CH_3)_2 < \dot{C}(CH_3)_3$: stability rises from primary to tertiary.

- carbocation: sextet, sp^2, trigonal planar (1)
- carbanion: octet, sp^3, distorted tetrahedron (1)
- radical order methyl < ethyl < isopropyl < tert-butyl (1)

11. For methoxyethene, $CH_2{=}CH{-}O{-}CH_3$: (a) draw its two resonance structures, showing the electron shift with curved arrows; (b) say which structure contributes more, and why; (c) state whether the $-OCH_3$ group shows a +R or −R effect here, and which carbon becomes electron rich. [3]

(a) I: $CH_2{=}CH{-}\ddot{O}{-}CH_3$. An arrow from a lone pair on O to the O–C bond and an arrow from the C=C π bond onto the terminal CH_2 give II: $^-{:}CH_2{-}CH{=}O^+{-}CH_3$. (b) I contributes more: it has no separation of charge, while II puts the negative charge on carbon and the positive charge on the more electronegative oxygen. (c) +R: the lone pair moves away from O into the π system, so the terminal CH_2 carbon becomes electron rich.

- both structures with correct curved arrows (1)
- I is major: no charge separation; II has + on O (1)
- +R, terminal CH_2 carbon electron rich (1)