InkChemistry

ANSWER BOOK

Naming and representing organic molecules

Introduction to organic chemistry · Unit C16

AQA 3.3.1.1 · OCR A 4.1.1

16 questions · 56 marks

NAVY EDITION

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SECTION B · Standard, 3 to 5 marks

B1 NRO-Q1

B1 the molecular formula of hexane is C_6H_{14}. **B1** the empirical formula is C_3H_7, the ratio 6 : 14 divided by the highest common factor, 2. **B1** hexane is an alkane, and the general formula of the alkanes is C_nH_{2n+2}. **B1** with n = 8 the molecular formula is C_8H_{18} (octane); error carried forward from a wrong general formula. [4]

B2 NRO-Q3

B1 $CH_3CH_2CH(CH_3)CH_2OH$ is 2-methylbutan-1-ol; reject 3-methylbutan-4-ol, which numbers from the wrong end. **B1** $CH_3COCH_2CH_2CH_3$ is the ketone pentan-2-one. **B1** $CH_3CH_2COOCH_3$ is the ester methyl propanoate; reject propyl methanoate, which reverses the two parts. **B1** $CH_3CH_2CONH_2$ is the amide propanamide, the C=O carbon counting in the three-carbon stem. [4]

B3 NRO-Q5

B1 skeletal formula of the aldehyde: a four-carbon zigzag with a branch line on the third carbon from the CHO end, and the end carbon drawn with a double line to O; allow the aldehyde H written in. **B1** the aldehyde is 3-methylbutanal, numbered from the CHO carbon, with no locant for the aldehyde group. **B1** skeletal formula of the alkene: a four-carbon chain with a double line between carbons 1 and 2 and a branch line on carbon 2. **B1** the alkene is 2-methylbut-1-ene; reject 2-ethylprop-1-ene, which misses the longest chain. [4]

B4 NRO-Q7

B1 both are alcohols, members of a homologous series with the general formula $C_nH_{2n+1}OH$, each member differing from the next by CH_2. **B1** they have the same functional group, OH, which is responsible for their characteristic reactions. **B1** the reaction with dichromate takes place at the OH and the carbon joined to it, so the length of the chain makes little difference to it. **B1** propan-1-ol has one more CH_2 and so more electrons, giving stronger van der Waals forces between molecules and a higher boiling point; ignore references to hydrogen bonding if both are said to have it. [4]

B5 NRO-Q17

B1 the student has found the correct chain of five carbons, with an OH group and a methyl branch. **B1** the chain must be numbered from the end that gives the suffix group, OH, the lowest number. **B1** numbered from the other end, the OH is on carbon 2 and the methyl group on carbon 4. **B1** the correct name is 4-methylpentan-2-ol, so the student's name is wrong only in its numbering. [4]

B6 NRO-Q6

B1 the longest continuous carbon chain runs through the ethyl group and contains four carbons, not three. **B1** so the stem is butane and the remaining CH_3 is a methyl branch. **B1** numbering from the end nearer the branch puts the methyl group on carbon 2, giving 2-methylbutane. [3]

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B7 NRO-Q9 **B1** a molecular formula gives only the number of atoms of each element in a molecule. **B1** more than one compound has the formula $C_4H_8O_2$, for example butanoic acid and ethyl ethanoate; accept any two correct isomers. **B1** a structural formula shows how the atoms are arranged, so it fits only one of these compounds. [3]

B8 NRO-Q11 **M1** the molecular formula is C_3H_8O, so Mr = 3 × 12.0 + 8 × 1.0 + 16.0 = 60.0. **M1** percentage of oxygen = 16.0 ÷ 60.0 × 100. **A1** 26.7% oxygen, to three significant figures; allow 27%. [3]

B9 NRO-Q12 **B1** in propanone and butanone the C=O can only be on carbon 2; on carbon 1 the compound would be an aldehyde, so no number is needed. **B1** in a five-carbon chain the C=O can be on carbon 2 or carbon 3, which are different compounds, so a locant is needed to say which. **B1** an aldehyde group can only be at the end of a chain, so its carbon is always carbon 1 and the locant is left out. [3]

B10 NRO-Q13 **B1** the alcohol gives the suffix, so the chain is numbered from the CH_2OH carbon and the OH is on carbon 1. **B1** the C=C starts at carbon 2 and stays in the stem as -en-, giving prop-2-en-1-ol. **B1** the e of -ene is dropped before the vowel of -ol; prop-2-ene-1-ol does not earn this mark. [3]

B11 NRO-Q14 **B1** both show how the atoms are arranged, with the OH group on the second carbon of a four-carbon chain. **B1** the displayed formula shows every atom and every bond, including each C–H bond and the O–H bond. **B1** the skeletal formula shows the carbons only as line ends and corners and omits the hydrogens on carbon, but still shows the O and the H of the OH group. [3]

B12 NRO-Q15 **B1** the stem comes from the longest continuous chain of carbon atoms, here five carbons, so pentane. **B1** the chain is numbered to give the lowest set of locants at the first point of difference, 2,2,3 rather than 3,4,4. **B1** the prefixes are in alphabetical order ignoring di, so ethyl before dimethyl, with commas between numbers and hyphens between numbers and letters. [3]

B13 NRO-Q19 **B1** each carbon in ethane has four regions of electron density, four single bonds, and each carbon in ethene has three, the C=C counting as one region. **B1** the regions of electron density repel each other and get as far apart as possible. **B1** four regions give a tetrahedral arrangement at 109.5°, and three give a trigonal planar arrangement at 120°; allow 107° to 112° and 118° to 122°. [3]

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B14 NRO-Q20 **B1** the carbon of the CH_3 group has four single bonds, so it is sp^3 hybridised and tetrahedral, with bond angles of about 109.5°. **B1** the carbon of the C≡N has two regions of electron density, so it is sp hybridised and the C–C≡N angle is 180°. **B1** the C≡N bond is one σ bond and two π bonds, the π bonds formed from the two p orbitals left on the sp carbon. [3]

B15 NRO-Q21 **B1** the alcohol is cyclohexanol, with no locant because every carbon of the ring is equivalent. **B1** the methyl group on a carbon of the C=C gives 1-methylcyclohexene, the C=C carbons being 1 and 2. **B1** the methyl group on the carbon beside the C=C gives 3-methylcyclohexene; reject 6-methylcyclohexene, numbered the wrong way round the ring. [3]

SECTION C · Long, 6 marks or more

C1 NRO-Q23 **Indicative content** [6]

B1 the functional groups are OH and Br; halogens are only ever prefixes, so the alcohol gives the suffix -ol. **B1** the longest chain containing the carbon that carries the OH runs from the CH_2OH carbon to the CH_3 beyond the CHBr, five carbons, so the stem is pentan. **B1** the CH_3 on the third carbon of that chain is a branch, because counting through it gives a chain of only four carbons. **B1** the chain is numbered from the CH_2OH end so that the suffix group has the lowest locant, 1, rather than 5. **B1** with that numbering the methyl branch is on carbon 3 and the bromine on carbon 4, and the prefixes go in alphabetical order, bromo before methyl. **B1** the e of pentane is dropped before -ol, giving 4-bromo-3-methylpentan-1-ol, $C_6H_{13}BrO$, with hyphens between numbers and letters.

Levels

Level 3 (5–6 marks) every step is present and justified: the suffix chosen from the OH, the longest chain through the OH carbon, the methyl identified as a branch, the numbering from the OH end for the lowest locant, the alphabetical order of prefixes, and the correct name with its punctuation.

Level 2 (3–4 marks) the name is right and most steps are explained; why the chain is numbered from the OH end, why that chain is the longest, or why bromo comes before methyl is asserted.

Level 1 (1–2 marks) the -ol suffix or the five-carbon chain is found; the chain is usually numbered from the bromine end, which gives the wrong locants.

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