FREE SAMPLE: THE FIRST QUESTION

Question One (17 marks)

(a) The condensed structural formula of a compound is $CH_3CH_2CH_2CH_2NH_2$.

(i) State the molecular formula and name the compound using IUPAC rules.

(ii) State the homologous series (family) it belongs to and the functional group present, and say how you can tell.

[4 marks]

(b) Draw (give the condensed structural formula of) pentan-2-ol, and state its molecular formula.

State, giving a reason, whether it is a saturated or an unsaturated compound.

[3 marks]

(c) Name all the constitutional isomers of C_4H_9Cl that are haloalkanes, and classify each as a primary, secondary or tertiary compound.

[5 marks]

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(d) The compounds 4-methylpent-2-ene ($CH_3CH=CHCH(CH_3)CH_3$), 3-methylpent-2-ene ($CH_3CH_2C(CH_3)=CHCH_3$), 2-methylprop-1-ene ($CH_2=C(CH_3)CH_3$) are alkenes.

(i) State which of them can exist as cis and trans (geometric) isomers.

(ii) For one that can, draw both isomers (cis and trans) and name them, and explain why the isomers exist.

[5 marks]

TION

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THE WORKED ANSWER TO THAT QUESTION

Question 1 (17 marks) [Naming, drawing and isomers]

(a) The condensed structural formula of a compound is $CH_3CH_2CH_2CH_2NH_2$. (i) State the molecular formula and name the compound using IUPAC rules. (ii) State the homologous series (family) it belongs to and the functional group present, and say how you can tell.

(a) Answer: $C_4H_{11}N$; name butan-1-amine; primary amine

- Evidence level: Merit (find the longest chain containing the functional group, number from the end giving the lowest locants, name branches and groups).
- (i) The molecular formula is $C_4H_{11}N$.
- The name is butan-1-amine.
- (ii) It is a primary amine because it contains an amino group, $–NH_2$.
- Achievement: Gives the correct family or functional group.
- Merit: Names the compound correctly (chain length, functional group and locants).
- Excellence: Names the compound fully correctly and explains how the numbering and the suffix/prefix are chosen: the chain is numbered so the principal group (or double bond) gets the lowest locant, then branches.

> **KEY TAKEAWAY**
> Naming: find the longest carbon chain that includes the functional group, number it from the end that gives the group the lowest number, then add branches and halogens as prefixes in alphabetical order.

(b) Draw (give the condensed structural formula of) pentan-2-ol, and state its molecular formula. State, giving a reason, whether it is a saturated or an unsaturated compound.

(b) Answer: $CH_3CH_2CH_2CH(OH)CH_3$; $C_5H_{12}O$; saturated

- Evidence level: Achieved (translate a name into a structure).
- The stem and ending give the chain length and functional group; locants give where the group and any branches are placed.
- Condensed structural formula: $CH_3CH_2CH_2CH(OH)CH_3$. Molecular formula: $C_5H_{12}O$.
- Achievement: Gives a correct structure or molecular formula.
- Merit: Gives the correct structural formula and molecular formula.
- Excellence: (unsaturation) The compound is saturated because all carbon–carbon bonds are single bonds, so it cannot add more atoms.

> **KEY TAKEAWAY**
> Drawing from a name: stem gives the number of carbons, the ending the group, and each locant says which carbon carries the group or branch; check every carbon has four bonds.

(c) Name all the constitutional isomers of C_4H_9Cl that are haloalkanes, and classify each as a primary, secondary or tertiary compound.

(c) Answer: 4 isomers: 1-chloro-2-methylpropane; 1-chlorobutane; 2-chloro-2-methylpropane; 2-chlorobutane

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• Evidence level: Excellence (systematically vary the carbon chain and the position of the functional group).

• Constitutional isomers have the same molecular formula but atoms joined in a different order. Work systematically: start with the straight chain, move the group along the chain, then shorten the chain and add branches.

• There are 4 constitutional isomers: 1-chloro-2-methylpropane ($CH_3CH(CH_3)CH_2Cl$); 1-chlorobutane ($CH_3CH_2CH_2CH_2Cl$); 2-chloro-2-methylpropane ($CH_3C(Cl)(CH_3)CH_3$); 2-chlorobutane ($CH_3CH_2CH(Cl)CH_3$).

• Check: each has formula C_4H_9Cl and no two are the same molecule.

• Achievement: Gives at least one correct isomer.

• Merit: Gives about half of the isomers with correct names.

• Excellence: Gives all 4 isomers with correct structures and names (a systematic method makes sure none are missed or repeated).

KEY TAKEAWAY

Isomers: same molecular formula, different structure; be systematic (longest chain first, then move the group, then shorten the chain and add methyl branches) and check that two drawings are not the same molecule turned round.

(d) The compounds 4-methylpent-2-ene ($CH_3CH=CHCH(CH_3)CH_3$), 3-methylpent-2-ene ($CH_3CH_2C(CH_3)=CHCH_3$), 2-methylprop-1-ene ($CH_2=C(CH_3)CH_3$) are alkenes. (i) State which of them can exist as cis and trans (geometric) isomers. (ii) For one that can, draw both isomers (cis and trans) and name them, and explain why the isomers exist.

(d) Answer: (i) none; (ii) cis/trans exist because rotation about C=C is restricted and each carbon has two different groups

• Evidence level: Excellence (check the groups on each carbon of the double bond, then explain restricted rotation).

• (i) Geometric isomers need two DIFFERENT groups on each carbon of the C=C.
4-methylpent-2-ene: no (one of the double-bond carbons has two identical groups);
3-methylpent-2-ene: no (one of the double-bond carbons has two identical groups);
2-methylprop-1-ene: no (one of the double-bond carbons has two identical groups)

• (ii) None of these compounds can be drawn as cis and trans isomers.

• Achievement: Identifies at least one correct alkene.

• Merit: Draws or names cis and trans correctly for one compound.

• Excellence: Full explanation: rotation about a C=C double bond is restricted (the π bond would have to break), so the arrangement of groups on each side is fixed; with two different groups on each carbon there are two distinct arrangements, cis (same side) and trans (opposite sides).

KEY TAKEAWAY

Geometric (cis/trans) isomerism: each C=C carbon must carry two different groups, and rotation about the double bond is restricted, so the groups stay fixed on the same side (cis) or opposite sides (trans).

LOS: Naming, drawing and isomers (91165)

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