Question 25 (Answer: **B**)

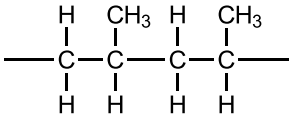
- A functional group isomer has the same molecular formula but a different functional group – here an aldehyde or ketone against an alcohol or ether.
- A chiral centre needs a carbon carrying four *different* groups.
- Check each pair for both conditions; only one pair satisfies them together.

Question 26 (Answer: **A**)

- A chiral centre needs a carbon carrying four *different* groups.
- The CH(OH) here sits between two CH_2O– chains that lead to identical halves of the molecule.
- Two identical groups means it is not a chiral centre, so the molecule has none at all.

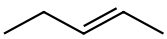
Question 26 (Answer: **C**)

- Count the features that can be fixed two ways: each C=C able to show E/Z and each chiral carbon doubles the total.
- Two such features give $2^2 = 4$ stereoisomers.
- A double bond inside a small ring does not count – the ring locks its geometry.

4(a)(i)	reduction
4(a)(ii)	PCl_5 / PCl_3 / $SOCl_2$ **OR** KCl / $NaCl$ **AND** conc. H_2SO_4 / conc.H_3PO_4
4(a)(ii)	**M1** $C_2H_5CH_2Cl + NaOH \rightarrow C_3H_6 + H_2O + NaCl$ **M2** ethanol (solvent) **AND** heat / reflux
4(a)(iv)	conc. H_2SO_4 **OR** conc. H_3PO_4 **OR** Al_2O_3 **AND** heat
4(b)(i)	addition
4(b)(ii)	**M1** (molecules that have the) same structural formula (and same molecular formula) **M2** but different 3D / spatial arrangement of atoms / groups
4(b)(iii)	 **M1** **M2** optical isomerism **M3** the methylated carbon has four different groups attached
4(b)(iv)	**M1** non-biodegradability **M2** harmful combustion products
4(c)(i)	2,3-dimethylbut-1-ene

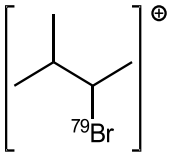
4(c)(ii)	(The spectrum is of) **X** **AND** 41 is $[CH_2=CCH_3]^+$ / 41 is $C_3H_5^+$ **OR** 43 is $[CH_3CHCH_3]^+$ / 43 is $C_3H_7^+$ **OR X** would NOT have significant peak at 54 / $[(CH_3)_2C=C^+]$ / $C_4H_6^+$ **OR X** would NOT have significant peak at 42 due to $[(CH_3)_2C^+]$ / $C_3H_6^+$
4(c)(iii)	($[M+1]^+$ / 34.7 × 100 / 1.1 = 6) $[M+1]^+ = 2.29$

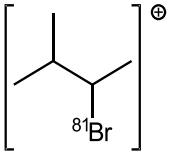
4(a)(i)	free-radical substitution
4(a)(ii)	**M1** $C_3H_8 + Cl\bullet \rightarrow CH_3CH_2CH_2\bullet + HCl$ **OR** $C_3H_8 + Cl\bullet \rightarrow C_3H_7\bullet + HCl$ **M2** $CH_3CH_2CH_2\bullet + Cl_2 \rightarrow CH_3CH_2CH_2Cl + Cl\bullet$ **OR** $C_3H_7\bullet + Cl_2 \rightarrow C_3H_7Cl + Cl\bullet$ etc **M3** $CH_3CH_2CH_2\bullet + Cl\bullet \rightarrow CH_3CH_2CH_2Cl$ **OR** $C_3H_7\bullet + Cl\bullet \rightarrow CH_3CH_2CH_2Cl$
4(a)(iii)	homolytic
4(a)(iv)	1,2-dichloropropane
4(a)(v)	**M1** (type of structural isomerism) positional **M2** (type of stereoisomerism) optical
4(b)	sodium hydroxide **AND** water
4(c)(i)	orange to green
4(c)(ii)	$CH_3CH_2CH_2OH + 2[O] \rightarrow CH_3CH_2COOH + H_2O$
4(d)(i)	condensation
4(d)(ii)	**M1** absorption labelled at approx. 1750 cm^{-1} identified as C=O **M2** absorption labelled at approx. 1650 cm^{-1} identified as C=C **M3** absorption labelled at approx. 1170 cm^{-1} identified as C—O
4(d)(iii)	(0.31 / 4.7 × 100 / 1.1) = 6 carbon atoms

4(a)(i)	**M1** (molecules with the) same molecular formula / same number of atoms of each element **M2** different structural formulae/structures
4(a)(ii)	**M1**  **M2** restricted / lack of / no rotation about C=C
4(a)(iii)	electrophilic addition

<table>
<tr><td>4(a)(iv)</td><td>M1 CH_3COCH_3 + CH_3COOH as products

M2 $(CH_3)_2C = CHCH_3 + 3[O] \rightarrow CH_3COCH_3 + CH_3COOH$</td></tr>
<tr><td>4(a)(v)</td><td>M1 (reaction proceeds via a) more stable intermediate / carbocation

M2 because of greater positive inductive effect of more alkyl groups</td></tr>
<tr><td>4(a)(vi)</td><td>M1 

M2 
</td></tr>
<tr><td>4(b)(i)</td><td>KCN in ethanol (and heat)</td></tr>
<tr><td>4(b)(ii)</td><td>$(C_2H_5)_2CHCN + 2H_2O + HCl \rightarrow (C_2H_5)_2CHCOOH + NH_4Cl$</td></tr>
<tr><td>4(b)(iii)</td><td>
<table>
<tr><th></th><th>reaction of V with propan-2-ol</th></tr>
<tr><td>type of reaction</td><td>M1 condensation</td></tr>
<tr><td>functional group formed</td><td>M2 ester</td></tr>
<tr><td>molecular formula of organic product W</td><td>M3 $C_9H_{18}O_2$</td></tr>
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