11.1 Introduction to Organic Chemistry

Set B **Answer key**

A Multiple choice

3 MARKS

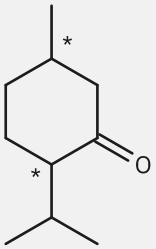
1

A 1 and 2 only [1]

1 Correct. One important thing to note when reading skeletal structures is that hydrogen atoms are not shown, and that carbon always forms 4 bonds.

2 Correct. There is no cis-trans isomerism in this molecule, so the number of stereoisomers is based on the number of chiral centres. There are only 2 chiral centres in menthone. The carbon of the side chain is not a chiral centre, as it has 2 identical methyl groups bonded to it. Hence the number of stereoisomers is $2^2 = 4$.

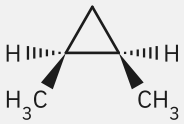
3 Wrong. Oxygen is more electronegative than carbon, so the electron density in the C=O bond is attracted towards oxygen. The carbon bonded to the oxygen carries a partial positive charge and is an electrophilic site.



2

[1]

C



Molecules that are optically active contain chiral centre(s) and have non-superimposable mirror images. These 4 molecules contain chiral centres, but the presence of chiral centres does not always mean that the molecule has a non-superimposable mirror image and hence is optically active. The presence of an internal plane of symmetry will mean that the molecule is identical (superimposable) to its mirror image and is optically inactive.

C has 2 chiral centres, but an internal plane of symmetry is present. Its mirror image is superimposable on itself, so it is optically inactive (an achiral compound, also known as a meso compound).

A There is no internal plane of symmetry in the molecule. The mirror image of A is non-superimposable on itself. It is optically active.

B Same reasoning as A.

D Same reasoning as A.

3 **A** isomerisation [1]

The molecular formula of both the reactant and the product is $RC_2H_3O_2$. Therefore both molecules are isomers of each other, with the same molecular formula.

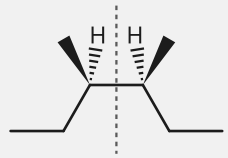
Options B and C only describe the reactions of ketones and primary alcohols separately, and not the overall process. Option D is not true, as no small inorganic molecule is lost here.

B Structured questions

20 MARKS

4 **(a)** X and Y are a pair of enantiomers, as they rotate plane polarised light in opposite directions. [1]

(b) [1]



internal plane of symmetry

Molecule Z has an internal plane of symmetry and is thus an achiral molecule, which is optically inactive. [1]

5 The C atom in CO_2 has its 2s orbital mixed with one of its three 2p orbitals to form two degenerate sp hybrid orbitals. [1]

6 The bond angle is 120° and the shape is trigonal planar around each C (*or* the hexagonal ring is planar). [1]

Each carbon atom is sp^2 hybridised and uses two of its three sp^2 hybrid orbitals to overlap head-on with the sp^2 hybrid orbitals of the adjacent carbon atoms to form C–C σ bonds. [1]

Each carbon atom has an unhybridised 2p orbital that overlaps sideways with the adjacent two 2p orbitals to form π bonds. This results in delocalised electrons in the π system. [1]

7 **(a)** addition (reduction) [1]

(b) elimination [1]

(c) (free radical) substitution [1]

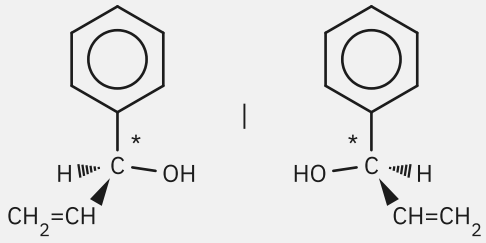
(d) elimination [1]

(e) (electrophilic) substitution [1]

8

$C_6H_5CH(OH)CH=CH_2$: optical isomerism [1]

[1]



9

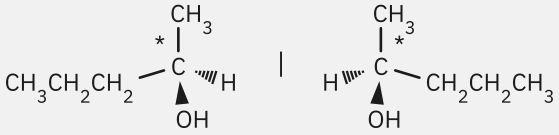
There are two lone pairs of electrons on the oxygen atom of the water molecule, which enable it to attack electron-deficient sites to form new covalent bonds. [1]

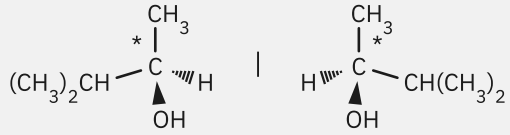
10

$CH_2ClCH_2CO_2H$ is the stronger acid, as Cl exerts an electron-withdrawing inductive effect that helps to disperse the negative charge of the anion formed when the acid dissociates in water. [1]

11

X, $CH_3CH(OH)C_3H_7$:



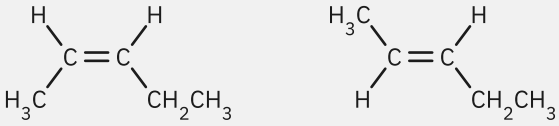


[1]

Constitutional isomerism and enantiomerism [1]

[1]

Y, $CH_3CH=CHC_2H_5$:



cis isomer trans isomer

Cis-trans isomerism [1]