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CHEMISTRY

ORGANIC CHEMISTRY II

Level & Board	AQA (A-LEVEL)
TOPIC:	OPTICAL ISOMERISM
PAPER TYPE:	SOLUTION - 1
TOTAL QUESTIONS	10
TOTAL MARKS	/31

Optical Isomerism - 1

1.

Similarities and Differences Between Two Optical Isomers

Similarities:

Same Atoms and Bonds:

- Both optical isomers, also known as enantiomers, have the same molecular formula.
- They contain the same types and number of atoms.
- They have identical bonding patterns and connectivity between atoms.

Molecular Formula and Structure:

- The molecular formula and structural framework are identical.

Differences:

Non-Superimposable Mirror Images:

- Optical isomers are non-superimposable mirror images of each other.
- This means that no matter how you rotate or orient one isomer, it cannot be perfectly overlaid on the other.

Optical Activity:

- They differ in the way they interact with plane-polarized light.
- One enantiomer will rotate the plane of polarization of light in one direction (clockwise or positive, designated as +, while the other will rotate it by the same angle but in the opposite direction (counterclockwise or negative, designated as −.

Chemical Properties:

- While enantiomers have identical physical properties (boiling point, melting point, density) in an achiral environment, their chemical properties can differ significantly in chiral environments.
- For example, their reactions with other chiral molecules (such as enzymes or certain drugs) can be markedly different.

(4)

2. B

(1)

3. Butanone is reduced in a two-step reaction using $NaBH_4$ followed by dilute hydrochloric acid.

(a)

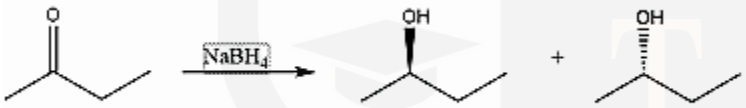
Reduction of butanone:

$CH_3CH_2COCH_3 + 2[H] \rightarrow CH_3CH_2CH(OH)CH_3$

(1)

(b) By considering the mechanism of the reaction, explain why the product has no effect on plane polarised light.

Formation of Product



Nucleophilic Attack:

- A hydride ion (H^-) from $NaBH_4$ attacks the carbonyl carbon of butanone.

Planar Carbonyl Group:

- The carbonyl group in butanone is planar.

H^- Attacks from Either Side:

- The hydride can attack from either the top or bottom face of the planar carbonyl group.

Nature of Product

Product of Step 1:

- The reaction forms 2-butanol ($CH_3CH_2CH(OH)CH_3$).

Two Chiral Forms:

- 2-butanol exists as two enantiomers: R-2-butanol and S-2-butanol.

Equal Amounts / Racemic Mixture:

- Equal amounts of each enantiomer are formed, creating a racemic mixture.

Optical Activity

Optical Isomers Rotate Polarised Light Equally:

- Enantiomers rotate plane-polarized light equally but in opposite directions.

Racemic Mixture Effects Cancel:

- In a racemic mixture, the rotations cancel each other out, resulting in no net effect on plane-polarized light.

So, the product, 2-butanol, has no effect on plane-polarized light because it is a racemic mixture.

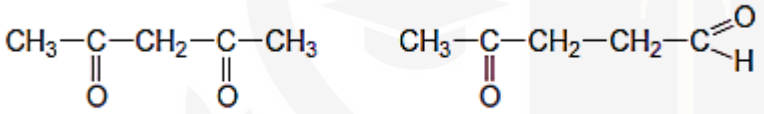
(6)

4. **D**

(1)

5. State how you could distinguish between compounds J and K by a simple test-tube reaction.

State how you could distinguish between J and K by giving the number of peaks in the ^1H n.m.r. spectrum of each compound.



J

K

Simple Test-Tube Reaction

Tollens' Test

- **J** : No reaction, no visible change, no silver mirror.
- **K**:formation of a silver mirror or grey precipitate, indicating the presence of an aldehyde group.

Fehling's/Benedict's Test

- **J**: No reaction, no visible change.
- **K**: formation of a red precipitate, indicating the presence of an aldehyde group.

^1H NMR Spectrum

Number of Peaks in the ^1H NMR Spectrum:

J: Two peaks

K: Four peaks

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6. D

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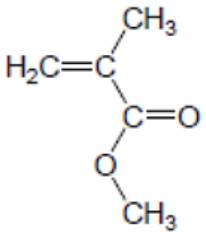
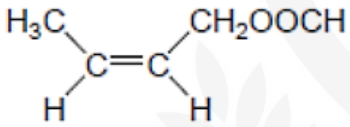
7.

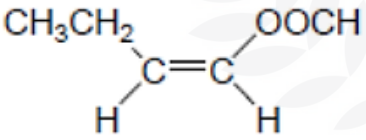
L

$H_2C=C(CH_3)COOCH_3$

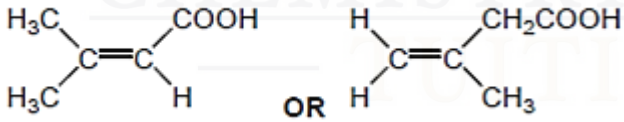


M

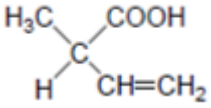




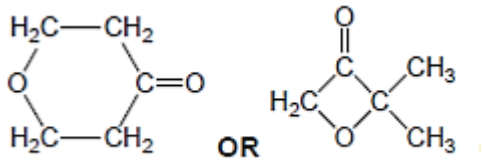
N (acid)



P (acid)



Q



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8. D

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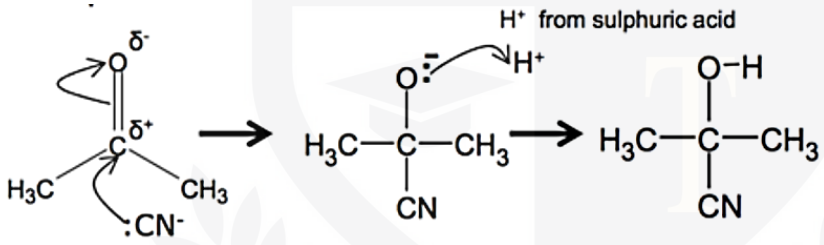
9.

Name of the mechanism: *Nucleophilic addition*

Mechanism:



(5)

10. B

(1)

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