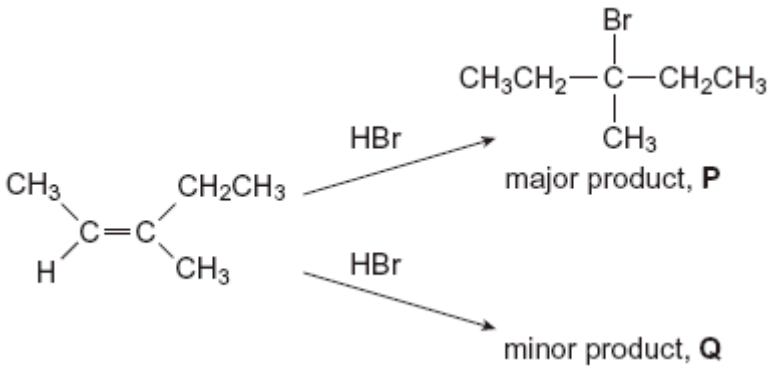
Q14.

The alkene (Z)-3-methylpent-2-ene reacts with hydrogen bromide as shown below.



(a) (i) Name the major product **P**.

_____

(1)

(ii) Name the mechanism for these reactions.

_____

(1)

(iii) Draw the displayed formula for the minor product **Q** and state the type of structural isomerism shown by **P** and **Q**.

Displayed formula for **Q**

Type of structural isomerism _____

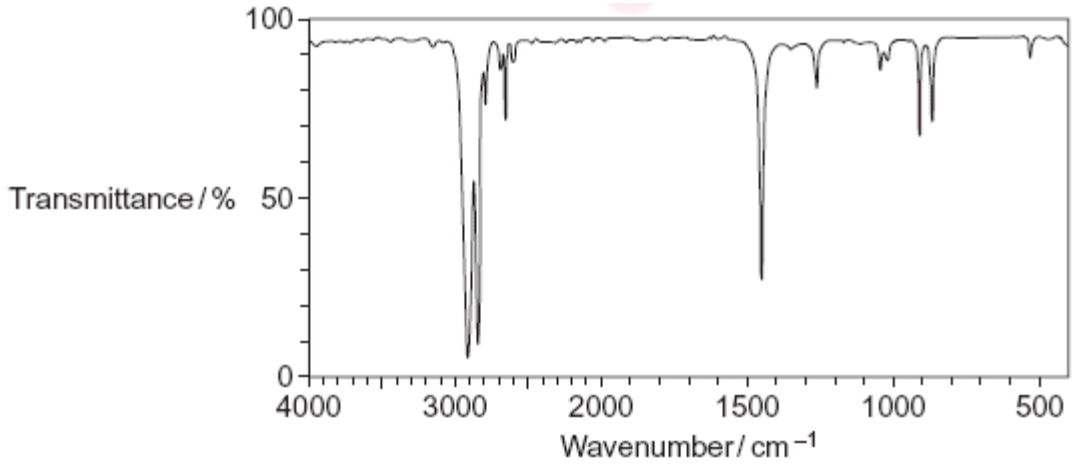
(2)

(iv) Draw the structure of the (E)-stereoisomer of 3-methylpent-2-ene.

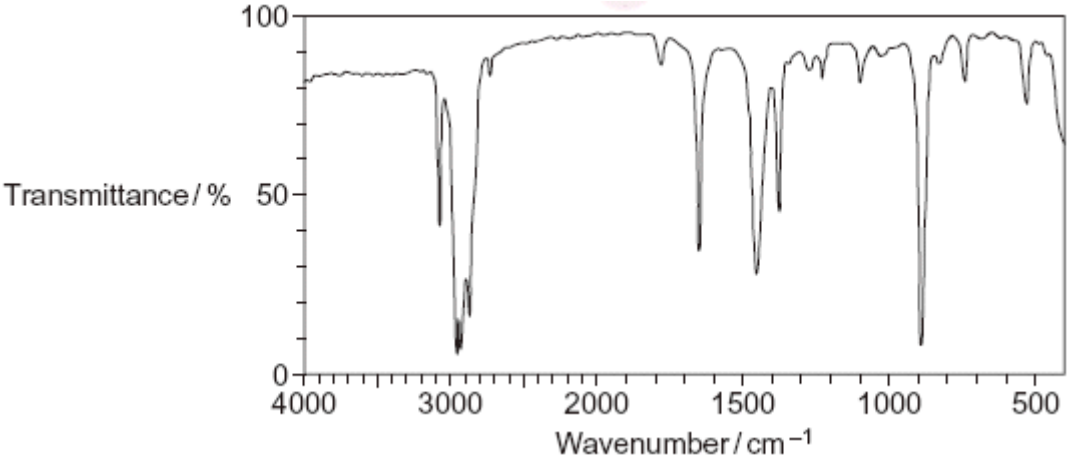
(1)

(b) The infrared spectra of two compounds **R** and **S** are shown below. **R** and **S** have the molecular formula C_6H_{12} and are structural isomers of 3-methylpent-2-ene. **R** is an unsaturated hydrocarbon and **S** is a saturated hydrocarbon.

Spectrum **1**



Spectrum **2**



(i) Identify the infrared Spectrum **1** or **2** that represents compound **R**.
Use information from the infrared spectra to give **one** reason for your answer.
You may find it helpful to refer to **Table 1** on the Data Sheet.

R is represented by Spectrum _____

Reason _____

_____

(2)

(ii) State the type of structural isomerism shown by **R** and **S**.

_____

(1)

(iii) Name **one** possible compound which could be **S**.

_____

(1)

(Total 9 marks)

Q15.

The reaction of bromine with an alkene is used in a test to show that the alkene is unsaturated.

(a) State what is meant by the term *unsaturated* as applied to an alkene.

_____

(1)

(b) Name and outline a mechanism for the reaction of bromine with but-2-ene.

Name of mechanism _____

Mechanism

(5)

(c) But-2-ene can exist as a pair of stereoisomers.

(i) State what is meant by the term *stereoisomers*.

_____

_____

_____

(2)

(ii) Draw the structure of (*E*)-but-2-ene.

_____

(1)

(Total 9 marks)

Q16.

(a) Compounds with double bonds between carbon atoms can exhibit geometrical isomerism.

(i) Draw structures for the two geometrical isomers of 1,2-dichloroethene.

Isomer 1 *Isomer 2*

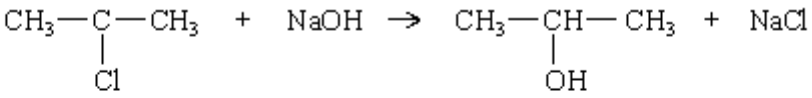
(ii) What feature of the double bond prevents isomer 1 from changing into isomer 2?

_____

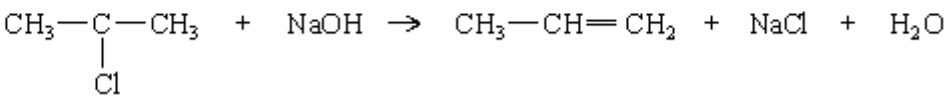
(3)

(b) When 2-chloropropane reacts with sodium hydroxide, two different reactions occur. Each reaction produces a different organic product.

Reaction 1



Reaction 2



(i) Outline a mechanism for **Reaction 1** and state the role of the hydroxide ion in this reaction.

Mechanism

Role of the hydroxide ion _____

(ii) Outline a mechanism for **Reaction 2** and state the role of the hydroxide ion in this reaction.

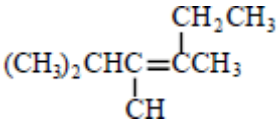
Mechanism

Role of the hydroxide ion _____

(7)

(Total 10 marks)

Q17.

The correct systematic name for  is

A 2-ethyl-3,4-dimethylpent-2-ene

B 4-ethyl-2,3-dimethylpent-3-ene

C 2,3,4-trirnethylhex-3-ene

D 3,4,5-trimethylhex-3-ene

(Total 1 mark)

Q14.

(a) (i) ***3*-bromo-*3*-methylpentane ONLY**

Must be correct spelling but ignore hyphens and commas

1

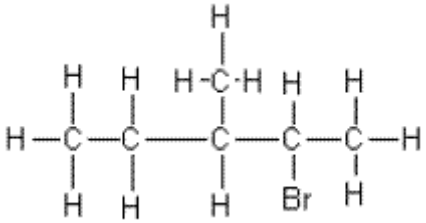
(ii) *Electrophilic addition (reaction)*

Both words needed

Accept phonetic spelling

1

(iii) **M1** *Displayed formula of 2-bromo-3-methylpentane*



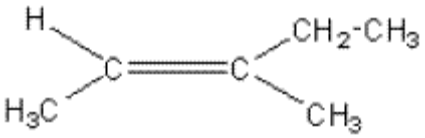
All the bonds must be drawn out but ignore bond angles

M2 *Position(al) (isomerism)*

Do not forget to award this mark

2

(iv) *Structure of (E)-3-methylpent-2-ene*



The arrangement of groups around the double bond must be clear with the ethyl group attached in the correct order. Ignore bond angles.

Accept C_2H_5 for ethyl

Be lenient on C — C bonds. The main issue here is whether they have drawn an (E) isomer.

Accept "sticks" for C — H bonds and correct skeletal formula

1

(b) (i) **M1** *R is represented by* ***Spectrum 2***

M2 *Spectrum 2 shows an infrared absorption/spike/dip/ trough/peak with any value(s)/range within the range 1620 to 1680 (cm^{-1}) OR this range quoted/identified and this is due to C=C*
OR this information could be a correctly labelled absorption on the spectrum

OR Spectrum 1 does not have an infrared absorption in range 1620 to 1680 (cm^{-1}) and does not contain C=C.

Award M1 if it is obvious that they are referring to the second spectrum (or the bottom one)

M2 depends on a correct M1

Ignore other correctly labelled peaks

Ignore reference to "double bond" or "alkene"

2

(ii) *Functional group (isomerism)*

1

(iii) *Cyclohexane*

OR

Methylcyclopentane etc.

Named correctly

Ignore structures and ignore numbers on the methyl group of methylcyclopentane

1

[9]

Q15.

(a) *Contains a C=C **OR** a double bond*

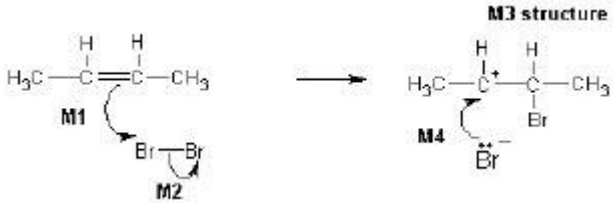
1

(b) ***Electrophilic addition***

Both words needed

1

Mechanism:



Ignore partial negative charge on the double bond.

M2 Penalise partial charges on bromine if wrong way and penalise formal charges

Penalise once only in any part of the mechanism for a line and two dots to show a bond.

M1 *Must show an arrow from the double bond towards one of the Br atoms on a Br-Br molecule.*

Deduct 1 mark for sticks.

M2 *Must show the breaking of the Br-Br bond.*

M3 *Is for the structure of the secondary carbocation with Br substituent.*

M4 *Must show an arrow from the lone pair of electrons on a negatively charged bromide ion towards the positively charged carbon atom.*

Deduct 1 mark for wrong reactant, but mark consequentially.

If HBr, mark the mechanism consequentially and deduct one mark
If but-1-ene, mark the mechanism consequentially and deduct one mark.
If both HBr and but-1-ene, mark the mechanism consequentially and deduct ONLY one mark.

4

(c) (i) ***M1*** *Compounds with the <u>same structural formula</u>*

Penalise M1 if "same structure"
Ignore references to "same molecular formula" or "same empirical formula"

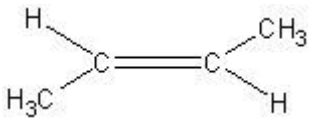
1

M2 *With <u>atoms/bonds/groups</u> arranged <u>differently in space</u>*
OR
<u>atoms/bonds/groups</u> have <u>different spatial arrangements/ different orientation</u>.

Mark independently.

1

(ii)



Award credit provided it is obvious that the candidate is drawing the <u>trans isomer</u>.

Do not penalise poor C–C bonds

Trigonal planar structure not essential

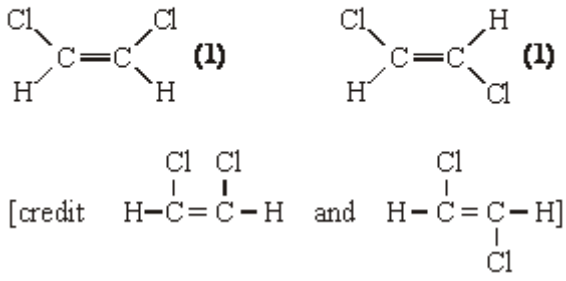
1

[9]

Q16.

(a) (i)

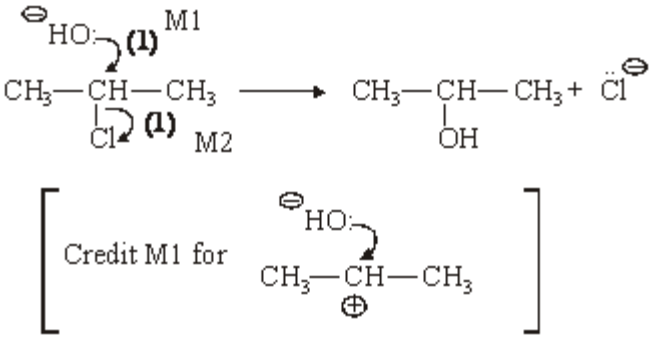
Isomer 1 either order *Isomer 2*



(ii) *restricted <u>rotation</u> OR no <u>rotation</u> OR cannot <u>rotate</u>* ***(1)***

3

(b) (i) *Mechanism:*



M1 and M2 independent

Curly arrows must be from a bond or a lone pair

Do not penalise sticks

Penalise M1 if Na—OH *precedes (penalise this once)*

Penalise incorrect $\delta+$ $\delta-$ for M2

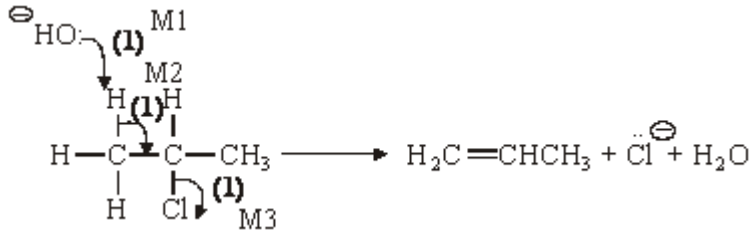
Penalise + on C atom for M2

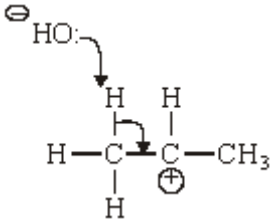
Only allow M1 for incorrect haloalkane

Role of the hydroxide ion: nucleophile ***(1)***
electron pair donor
lone pair donor

NOT nucleophilic substitution

(ii) Mechanism:





Only allow M1 and M2 for incorrect haloalkane unless RE on (i)

+ charge on H on molecule, penalise M1

M3 independent

M2 must be to correct C–C

M1 must be correct H atom

Credit M1 and M2 via carbocation mechanism

No marks after any attack of $C^{\oplus}$ *by* OH^-

Role of the hydroxide ion: base ***(1)***
proton acceptor
accepts H^+

[10]

Q17.

C

[1]