Mark schemes

Q1.

(a)

This question is marked using levels of response. Refer to the Mark Scheme Instructions for Examiners for guidance on how to mark this question.	
Level 3 5-6	**All stages are covered and each stage is generally correct and virtually complete.** (6 v 5) Answer is well structured, with no repetition or irrelevant points, and covers all aspects of the question. Accurate and clear expression of ideas with no errors in use of technical terms.
Level 2 3-4	**All stages are covered but stage(s) may be incomplete or may contain inaccuracies OR** **two stages are covered and are generally correct and virtually complete.** (4 v 3) Answer has some structure and covers most aspects of the question. Ideas are expressed with reasonable clarity with, perhaps, some repetition or some irrelevant points. If any, only minor errors in use of technical terms.
Level 1 1-2	**Two stages are covered but stage(s) may be incomplete or may contain inaccuracies OR** **only one stage is covered but is generally correct and virtually complete.** (2 v 1) Answer includes statements which are presented in a logical order and / or linked.
Level 0 0	Insufficient correct chemistry to gain a mark.

Stage 1 - **What stereoisomers are (1 'covered' or 'virtually complete')**
1a same structure/structural formula
1b different arrangement of atoms/bonds in space

Stage 2 - ***E-Z isomerism occurs (1 'covered ', 2 'virtually complete')***
2a lack of rotation around C=C
2b each C atom of C=C has (two) different groups attached
2c this is *E*

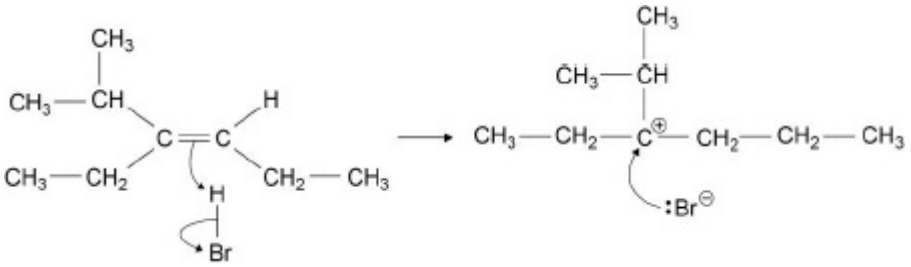
Stage 3 - **Justify *E*/*Z* (2 'covered", 3 'virtually complete')**
3a indicates in some way that CH_3CH_2 is higher priority than H on RHS C
3b as atomic number of C is higher than H or C = 6 v H = 1
3c indicates in some way that $(CH_3)_2CH$ is higher priority than CH_3CH_2 on LHS C
3d as atomic numbers of atoms joined to C (joined to C=C) are higher for $(CH_3)_2CH$ than CH_3CH_2 or 6,6,1 v 6,1,1

3e highest priority groups on opposite sides (of C=C)

6

(b) **M1** Electrophilic addition

M2-5



M2 Arrow from C=C bond towards H of HBr

M3 Breaking of H-Br bond

M4 Correct carbocation

M5 Arrow from lone pair of Br^- to positively charged C of their carbocation

*All arrows are double-headed. Penalise one mark from the total for **2-5** if half headed arrows are used. Do not penalise the "correct" use of "sticks"*

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

M2 Ignore partial negative charges on the double bond

M3 Penalise incorrect partial charges on the H-Br bond and penalise formal charges

Penalise M4 if there is a bond drawn to the positive charge

*Max 3 of 4 marks (M2-5) for wrong organic reactant or wrong carbocation (ignore structure of product); for example, correct mechanism for compound **L** would score 3/4 for **M2-5**)*

For M5, credit attack on a partially positively charged carbocation structure, but penalise M4 for the structure of the carbocation

5

(c) **M1** Idea that **K** is formed from/via/has/by the more stable carbocation (intermediate)

M1 and M2 must refer to stability of carbocations (ignore reference to stability of products). M1 and M2 are penalised if answer suggests that the products are carbocation.

M2 Idea that major product from tertiary carbocation rather than secondary carbocation

M2 Allow descriptions in terms of number of alkyl groups attached to positive C atom

M3 Idea of stability from greater (positive) inductive effect (from more alkyl/C groups) or more electron-releasing alkyl/C groups

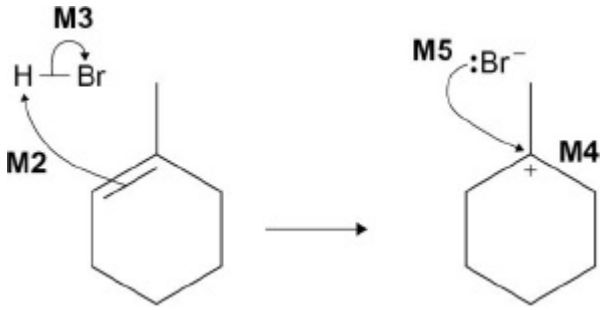
M3 Must be a comparison; could refer to 3 v 2 electron-releasing alkyl/R/C groups (but allow ECF from M2 for number of alkyl groups)

3

[14]

Q2.

(a) **M1** electrophilic addition



M2 must show an arrow from the double bond towards the H atom of the HBr molecule

M3 must show the breaking of the H-Br bond

M4 is for the structure of the correct carbocation (the added H does not need to be shown)

M5 must show an arrow from the lone pair of electrons on the negatively charged Br towards the positively charged atom of their carbocation drawn

All arrows are double-headed. Penalise one mark from the total if half headed arrows are used

Do not penalise the "correct" use of "sticks"

Penalise only once in mechanism for a line and two dots to show a bond

Mechanism can involve skeletal or structural formulae. If skeletal, do not penalise presence of hydrogen atoms (and bonds)

***Max 3 of 4 marks** (**M2-5**) for wrong organic reactant or wrong carbocation (ignore structure of product)*

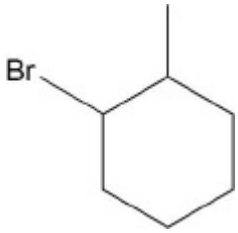
*Ignore partial negative charges on the double bond in **M2***

*Penalise incorrect partial charges on the H-Br bond or formal charges in **M3***

*Penalise **M4** if there is a bond drawn to the positive charge*

*For **M5**, credit attack on a partially positively charged carbocation structure, but penalise **M4** for the structure of the carbocation.*

(b) **M1**



M1 *Penalise inclusion of —H bonds*

(allow carbonium ion in place of carbocation)

M2 idea that 1-bromo-1-methylcyclohexane is formed from/via or has more stable carbocation

M2 *and* ***M3*** *must refer to stability of carbocations (ignore reference to stability of products)*

M3 idea that major product from tertiary carbocation rather than secondary carbocation

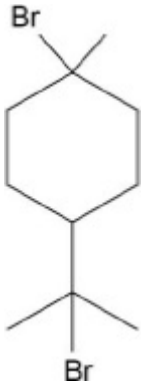
M3 *allow descriptions in terms of number of alkyl groups attached to positive C atom*

M4 idea of stability from greater (positive) inductive effect (from more alkyl/C groups) or more electron-releasing alkyl/C groups

M4 *must be a comparison*

4

(c)



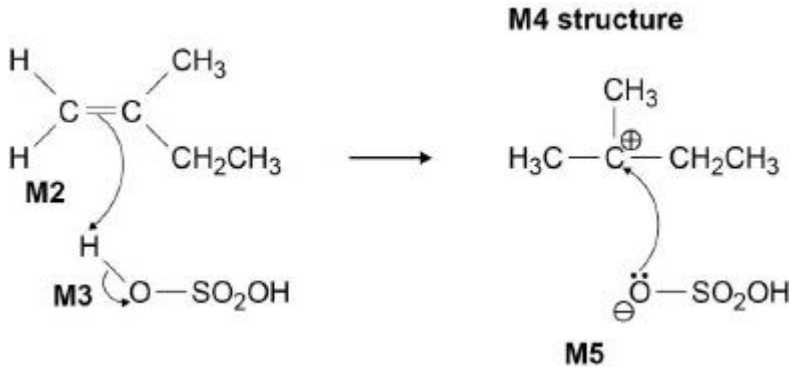
Any correct form of the structure

1

[10]

Q3.

(a) Electrophilic addition



NB Allow fully displayed or other structural formulae

if H_2O used as electrophile − max 4 ONLY

M2 must show an arrow from = of C=C towards the H atom of the H−O bond or HO that is part of H−O−S−… on a compound with molecular formula H_2SO_4

M2 could have arrow to H^+ in which case M3 would be for an independent H−O bond break on a compound with formula H_2SO_4

M3: must use an arrow to show the breaking of the H−O bond

M3 ignore partial charges unless wrong

M4: is for the correct carbocation structure

NOT M4 if primary carbocation shown.

M5: must show an arrow from a lone pair of electrons on the correct oxygen of the negatively charged ion towards the positively charged carbon atom

M5 NOT HSO_4

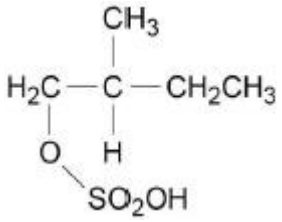
credit as shown or as: OSO_3H − in which case negative charge can be shown anywhere ECF from H_2SO_3 in M2

NB: The arrows are double-headed

***IGNORE** subsequent use of water to hydrolyse hydrogensulfate*

M1M2M3M4M5

(b)



If tertiary shown here allow as ECF for M1 if primary shown in (a)

M1

(major) product formed via more stable carbocation OR tertiary carbocation more stable (than primary)

Must be clear refers to intermediate and not product

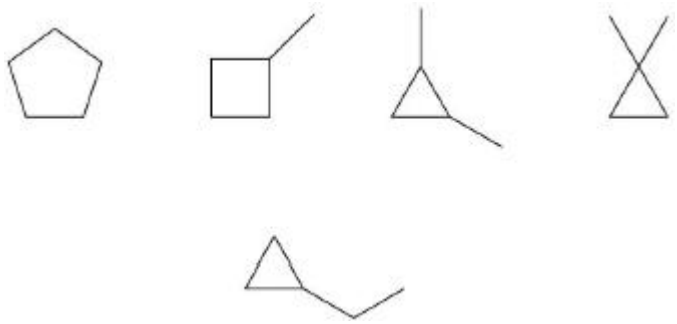
M2

Due to electron-releasing character / (positive) inductive effect of three alkyl groups (as opposed to one)

Primary has one e^- donating alkyl group

M3

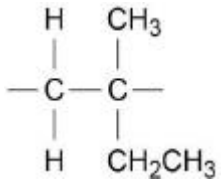
(c) Skeletal formula of cycloalkane



ignore structure of 2-methylbut-1-ene

1

(d) Addition (polymerisation)



Not additional

Penalise incorrect attachment of ethyl group

Must have trailing bonds

Ignore n and brackets

Ignore structure of 2-methylbut-1-ene

M1M2

[11]