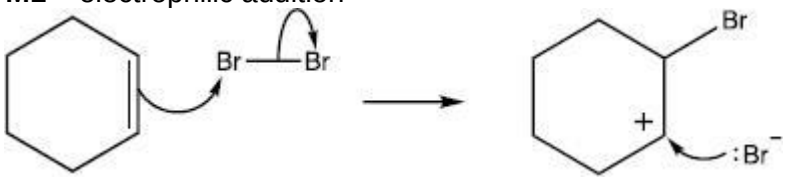
Mark schemes

Q1.

(a) **M1** electrophilic addition



*All arrows are double-headed. Penalise one mark from the total for **M2-5** 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

1

M2 must show an arrow from the double bond towards a Br atom in a Br–Br molecule

***M2** ignore partial negative charges on the double bond*

1

M3 must show the breaking of the Br–Br bond

***M3** penalise incorrect partial charges on the Br–Br bond and penalise formal charges*

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

1

M4 is for the structure of the correct carbocation

1

M5 must show an arrow from the lone pair of electrons on the Br^- towards the positively charged atom of <u>their</u> carbocation

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

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

1

(b) **M1** C=C electron rich / area of high electron density

***M1** ignore idea that C=C is negative or highly electronegative*

1

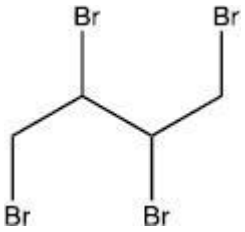
M2 Br-Br becomes polarised

1

M3 δ+ Br attracted to C=C

1

(c)



Must be skeletal structure

1

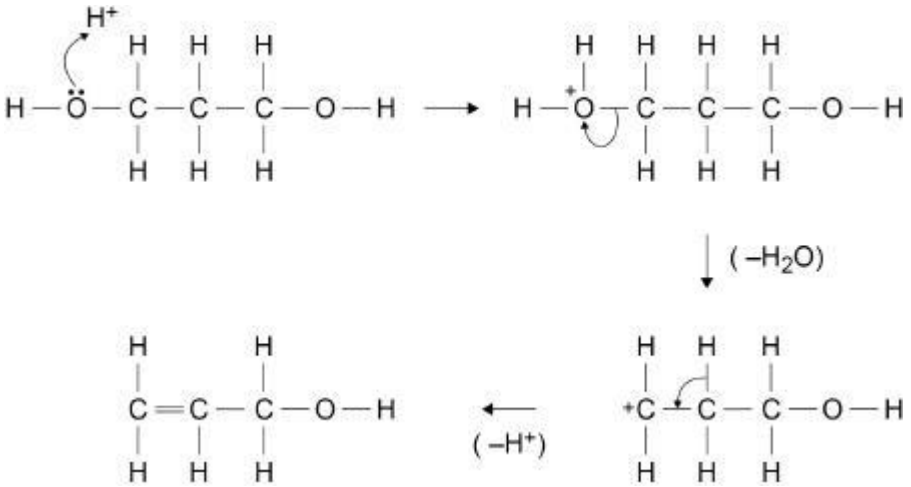
[9]

Q2.

(a) nucleophilic substitution

1

(b) **M1** elimination



1

M2 arrow from lone pair on O to H^+

1

M3 1st intermediate **and** arrow from C–O^+H_2 bond to O

1

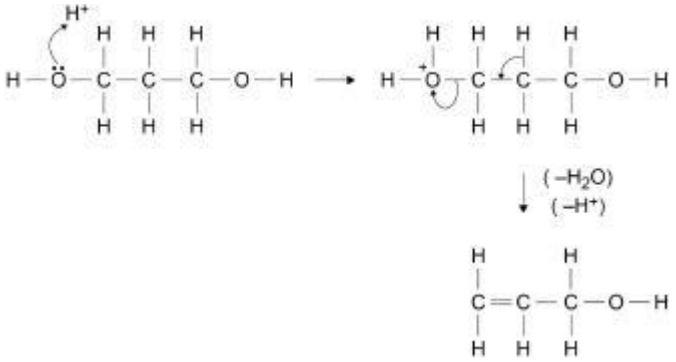
M4 2nd intermediate (carbocation) **and** arrow from a correct C–H bond to correct C–C to form C=C

Max 2 of 3 marks (M2-4) *for wrong organic reactant (ignore structure of product)*

M3 *and* ***M4*** *can be scored in one concurrent step:*

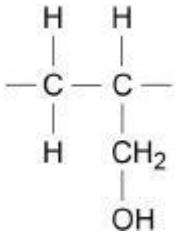
M3 for correct intermediate and arrow from C–O^+H_2 bond to O

M4 *for arrow from a correct C–H bond to correct C–C to form C=C 1*



1

(c)

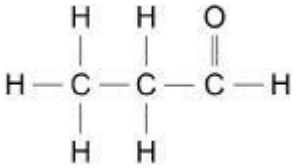


Any correct structural representation

Ignore any brackets and/or n

1

(d)



Structure in any form

1

[7]

Q3.

D

$(CH_3)_2CHCH=CH_2$

[1]

Q4.

(a) **M1** structure of chloroethene

Allow any correct structural representations of monomer and polymer

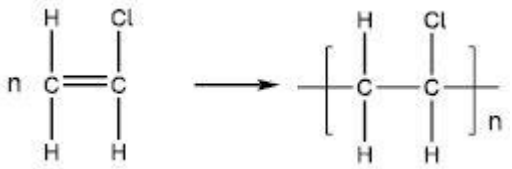
1

M2 structure of PVC

M2** allow correct repeating unit, but penalise incorrect use of bracket in **M3

1

M3 correct use of n on both sides of equation



M2** and **M3** could score as ECF from incorrect **M1

1

(b) **M1** no reaction / yellow-orange

***M1** ignore brown; ignore red; ignore 'nothing'; ignore 'no observation'*

1

M2 polymer is saturated / does not contain double bond(s)

1

(c) **M1** $C_{24}H_{38}O_4$

***M2** allow make less brittle; ignore making more elastic*

1

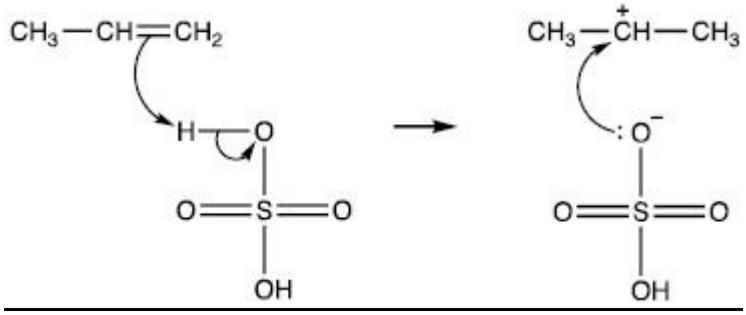
M2 makes it more flexible

1

[7]

Q5.

(a) **M1** <u>electrophilic addition</u>



*All arrows are double-headed. Penalise one mark from the total for **M2-5** 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

1

M2 must show an arrow from the double bond towards the H atom of the H_2SO_4 molecule

*For **M2/3**, the full structure of H_2SO_4 does not need to be shown, but the key features for the mechanism should be*

*shown and the formula must be correct. Penalise only once in **M2/3** an incorrect but genuine attempt at the structure of sulfuric acid*

***M2** ignore partial negative charges on the double bond*

1

M3 must show the breaking of the H-O bond in H_2SO_4

***M3** penalise incorrect partial charges on the H–O bond and penalise formal charges*

1

M4 is for the structure of the correct carbocation

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

1

M5 must show an arrow from the lone pair of electrons on the negatively charged oxygen of HSO_4^- towards the positively charged atom of their carbocation drawn

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

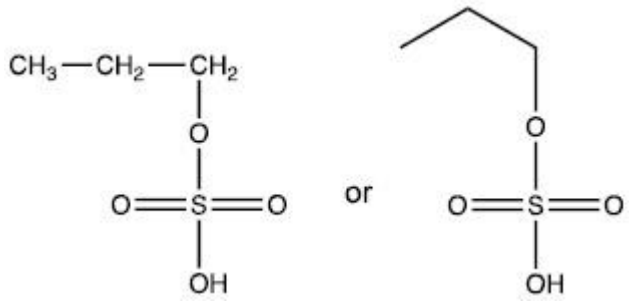
1

*If attack is shown from C=C to H^+ rather than H_2SO_4, then allow **M2** but not **M3***

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

*For **M5**, the full structure of HSO_4^- is not essential, but attack must come from a lone pair on an individual oxygen on HSO_4^-, but the – sign could by anywhere on the ion (e.g.: OSO_3H^-)*

(b)



Any correct structural formula, including OSO_3H bonded through O to correct C

1

(c) **M1** idea that **E** is formed from/via more stable carbocation

***M1-2** Allow carbonium ion in place of carbocation*

1

M2 idea that 2^{y} carbocation is more stable than 1^{y} carbocation

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

1

Ignore reference to inductive effect

*Penalise **M1** if answer suggests that the products are carbocations (but could score **M2**)*

*In order to access **M1** and/or **M2** there must be some reference to carbocations (carbonium ions) by name or structure or description*

[8]

Q6.

A

It displays E-Z isomerism

[1]

Q7.

D

[1]

Q8.

C

[1]

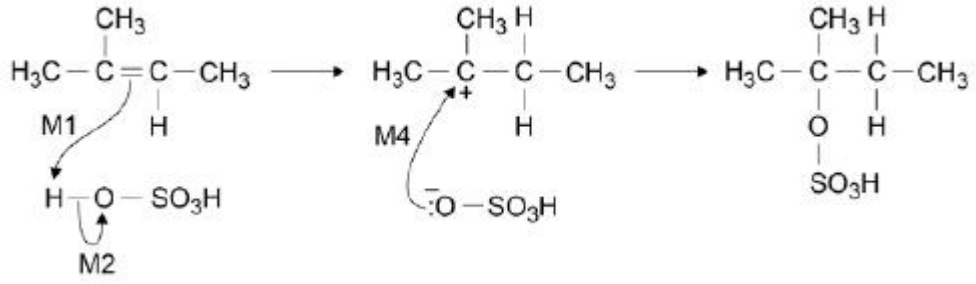
Q9.

C

[1]

Q10.

(a)



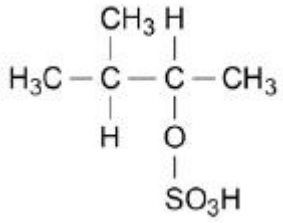
M1, M2 and M4 are awarded for the three curly arrows shown on the

mechanism
(1 mark for each correct)

M3 is for the structure of the carbocation intermediate

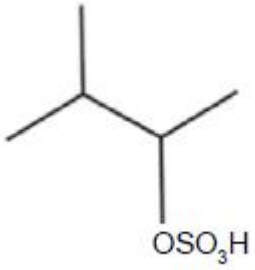
4

(b)



Correct answers include:

- *the displayed formula*
- *structural formulae such as* $CH_3CH(CH_3)CH(OSO_3H)CH_3$
- *skeletal formulae such as*



1

(c) The major product is formed via a tertiary carbocation intermediate and the minor product is formed via a secondary carbocation intermediate

1

The tertiary carbocation is more stable than the secondary carbocation

1

[7]

Q11.

C

[1]

Q12.

B

[1]

Q13.

C

[1]

Q14.

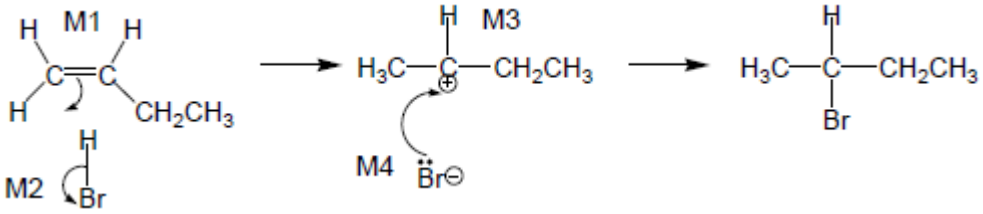
(a) HBr **OR** HCl **OR** H_2SO_4

Allow HI or HY

1

(b) Electrophilic addition

1



Allow consequential marking on acid in 12.1 and allow use of HY

4

(c) The major product exists as a pair of enantiomers

1

The third isomer is 1-bromobutane (minor product)

1

Because it is obtained via primary carbocation

1

[9]

Q15.

C

[1]