# A-Level Chemistry

## Addition Polymers

### Mark Scheme

**Time available: 50 minutes**
**Marks available: 43 marks**

**1.**

(a) **M1** structure of chloroethene

*Allow any correct structural representations of monomer and polymer*

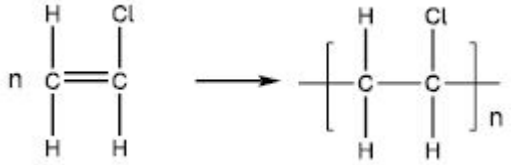
1

**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]**

**2.**

(a) **M1** $C_nH_{2n+2}$

1

**M2** $14.0n + 2.0$ or $14n + 2$

*or $2(7.0n + 1.0)$ or $2.0(7n + 1)$ or $2(7n + 1)$*

1

(b) **M1** nonane has stronger / greater / more van der Waals' forces between molecules

*or converse arguments for 2,4-dimethylbutane having lower boiling point*

*question refers to nonane if not expressly stated by candidate*

*intermolecular forces = forces between molecules*

***M1** ignore abbreviations vdW and/or imf*

**1**

**M2** nonane molecules pack closer together / more (surface) contact

***M2** ignore reference to surface area alone*

*CE=0 reference to breaking (covalent) bonds / breaking chain*

**1**

(c) $C_9H_{20} + 14O_2 \rightarrow 9CO_2 + 10H_2O$

*allow multiples; ignore any state symbols; correct structures rather than formulae are fine*

**1**

(d) **M1** nitrogen and oxygen from air react

***M1** must be at least one reference to air and no reference to nitrogen/oxygen coming from the fuel*

**1**

**M2** at high temperature

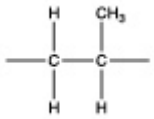
*ignore reference to pressure, heat, hot, incomplete combustion*

*if temperature is stated, must be over 1000°C*

**1**

(e) thermal (cracking)

**1**

(f) 


*allow any correct structural representation*

*ignore any n or brackets*

**1**

**[9]**

**3.** (a) nucleophilic addition

*both words needed*

*NOT any additional names*

**1**

(b) **M1** racemic (mixture) / racemate

**1**

**M2** planar (around) carbonyl / C=O

***M2*** *NOT molecule is planar*

*Allow flat for planar*

**1**

**M3** (equal chance of) attack from each side (by $CN^-$)

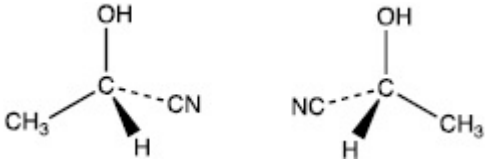
**1**

**M4** a correct structure of 2-hydroxypropanenitrile

***M4*** *any correct 2D or 3D structure*

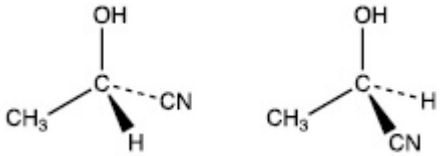
**1**

**M5** correct 3D representations of both isomers, e.g.




***M5*** *must show at least one wedge bond and one dash bond in each structure and any bonds in the plane cannot be at 180º to each other*

*second structure could be drawn as mirror image of first* ***or*** *with same orientation with two groups swapped round, e.g.*




*Allow ECF for second structure from incorrect first structure, providing molecule is chiral*

**1**

(c) **M1** conc $H_2SO_4$ or conc $H_3PO_4$

***M1*** *Allow conc to come from conditions line*

**1**

**M2** heat / 170°C

***M2*** *depends on attempt at correct reagent in* ***M1***

*Allow high temperature / hot / 100-300°C / 373 – 573 K / reflux*

*Ignore references to pressure*

*Ignore warm*

*NOT ethanolic / alcoholic*

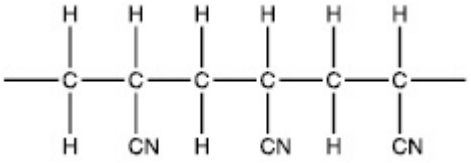
**1**

*Alternative answer*

***M1*** $Al_2O_3$

***M2*** *pass vapour over hot* $Al_2O_3$

(d)



*MUST show trailing bonds*

*Ignore any brackets or n*

*NOT C–N or C=N if CN group displayed*

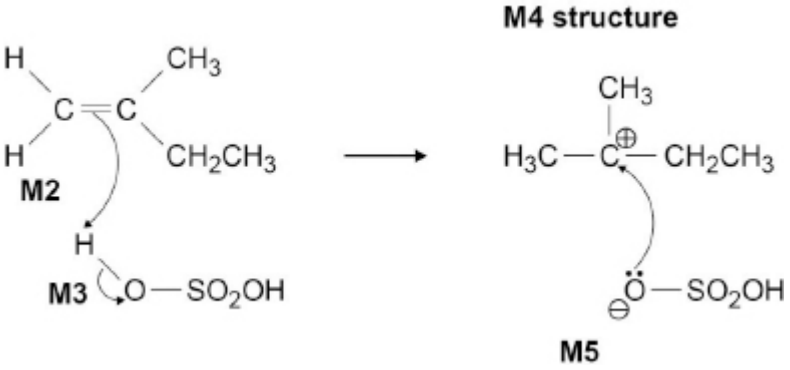
*Allow structures with CN on either C in each of the three units*

*Allow –$CH_2$–CH(CN)–$CH_2$–CH(CN)–$CH_2$–CH(CN)–*

**1**

**[9]**

**4.** (a) Electrophilic addition




*M2 for curly arrow from double bond to H*

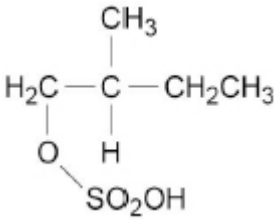
*M3 for curly arrow from O-H bond to O*

*M4 for intermediate structure including + on correct tertiary carbon*

*M5 for curly arrow from lp on O to $C^+$ (O must also be -ve)*

**M1**
**M2**
**M3**
**M4**
**M5**

(b)



*If tertiary shown here allow as ecf if primary shown in (a)*

*But explanation mark (M3) can only be awarded for tertiary being more stable*

Formed via a primary $C^+$ rather than tertiary $C^+$

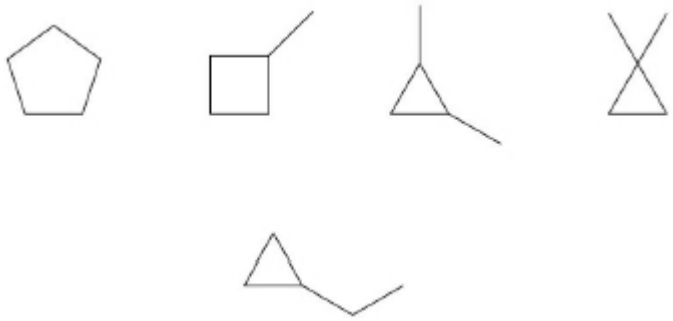
**M2**

Primary $C^+$ less stable than tertiary

*OR primary has fewer $e^-$ donating alkyl groups*

**M3**

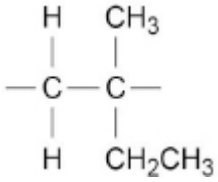
(c) Skeletal formula of cycloalkane



**1**

(d) Addition (polymerisation)

**M1**



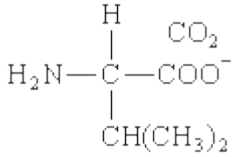
*Must have trailing bonds*

*Ignore n*

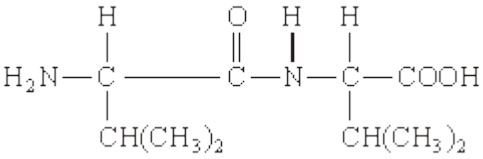
**M2**

**[11]**

**5.**

(a) (i)  **(1)**

*ignore $Na^+$ unless covalently bonded*

(ii)  **(1)**

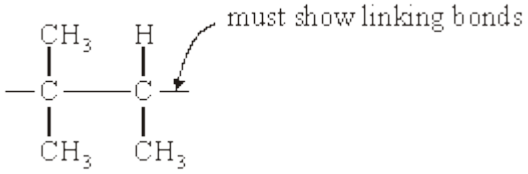
*must be dipeptide, not polymer nor anhydride*
*allow –CONH– or –COHN–*
*allow zwitterion*

(iii) hydrogen bonding **(1)**

*QL*
*Allow with dipole-dipole or v derWaals, but not dipole-dipole etc alone*

**3**

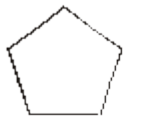
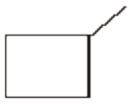
(b) (i) *Type of polymerisation*: addition(al) **(1)**

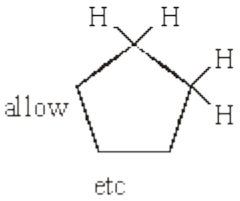
*Repeating unit*: 

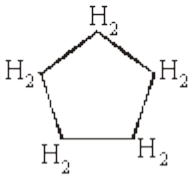
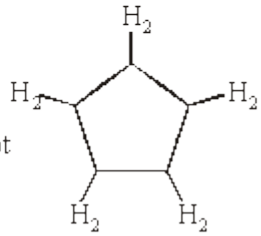
**(1)**

*not multiples*
*allow n*

(ii) $CH_3CH=CHCH_2CH_3$ **(1)** $C_2H_5$

(iii)  **(1)** or  etc



or  but not 

**4**

**[7]**