

M1.(a) (i) 2-hydroxypropanoic acid

OR

2-hydroxypropan(-1-)oic acid

Do not penalise different or missing punctuation or extra spaces.

Spelling must be exact and order of letters and numbers as here.

Can ignore -1- before -oic, but penalise any other numbers here.

1



Allow $4C_3H_6O_3$

OR

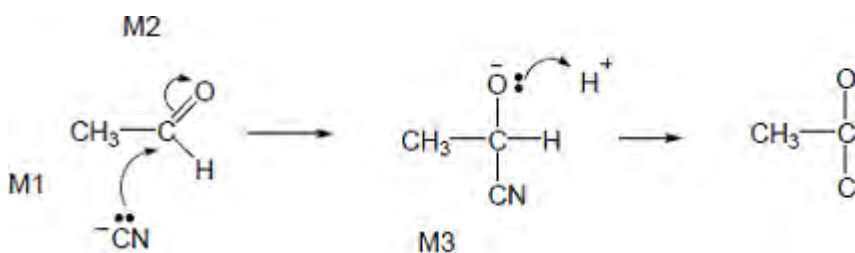


Allow $2C_3H_6O_3$

1

(b) (i) Nucleophilic addition

M4 for lp, arrow and H+



- M1 lp and minus must be on C
- M1 and M4 include lone pair and curly arrow.
- M2 not allowed independent of M1, but allow following some attempt at attack on carbonyl C
- allow M1 for correct attack on C+
- + rather than $\delta+$ on C=O loses M2
- M3 is for correct structure including minus sign but lone pair is part of M4
- Allow arrow in M4 to H of H-CN with arrow forming cyanide ion.

5

(ii) Equal mixture of enantiomers / (optical) isomers 1

(iii) (Plane) polarized light 1
If missing no further mark.

(Polarised light) rotated by single enantiomer but unaffected by racemate 1
Both needed; not allow bend, twist etc.

(c) (i) $\text{CH}_3\text{CH}(\text{OH})\text{COOH} + \text{NaOH} \rightarrow \text{CH}_3\text{CH}(\text{OH})\text{COONa} + \text{H}_2\text{O}$ 1
OR $\text{CH}_3\text{CH}(\text{OH})\text{COOH} + \text{OH}^- \rightarrow \text{CH}_3\text{CH}(\text{OH})\text{COO}^- + \text{H}_2\text{O}$
Not ambiguous mol formulae for product - must show COONa or CO₂Na or COO⁻ or CO₂⁻

(ii) $[\text{H}^+] = K_a$ **OR** $\text{pH} = \text{p}K_a$ 1

$\text{pH} = 3.86$ 1
Allow more than 2 decimal places but not fewer.

(iii) M1 buffer 1
Ignore acidic but penalise alkaline or basic.

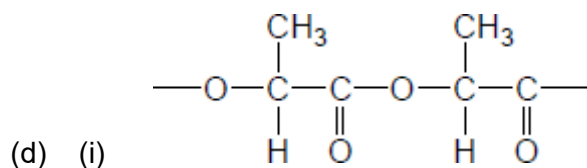
Any two out of the three marks M2 , M3 & M4

M2 Large lactate concentration in buffer
OR sodium lactate completely ionised

M3 added acid reacts with / is removed by lactate ion or A⁻ or sodium lactate or salt
OR equation $\text{H}^+ + \text{A}^- \rightarrow \text{HA}$
Ignore reaction of H⁺ with OH⁻
Ignore reference to equilibrium unless it is shown.

M4 ratio $[HA] / [A^-]$ stays almost constant
Ignore H^+ or pH remains constant.

Max 2



No marks if ester link missing

Correct ester link
allow $-COO-$

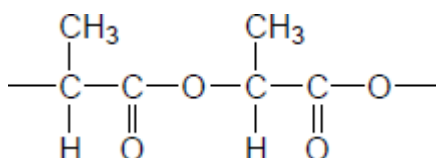
NB Correct answer scores 2

Ignore n here (compare with (d)(iv).

Ignore brackets

1

OR



All rest correct with trailing bonds

If OH or COOH on either or both ends, lose one, ie dimer scores 1

If more than two repeating units, lose 1

1

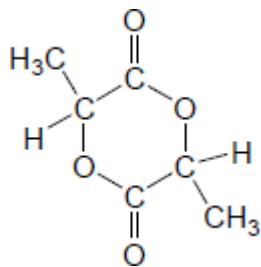
(ii) (Poly)ester ie allow ester

Not terylene.

Ignore spaces and brackets in answer.

1

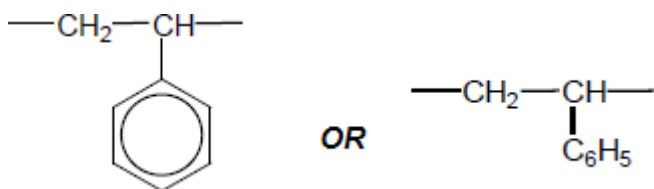
(iii)



Allow any cyclic $C_6H_8O_4$.

1

(iv)



Penalise n here (compare with (d)(i))
Ignore brackets.
Not allow Ph for phenyl.

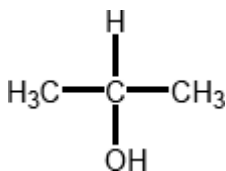
1

- (v) In landfill, no air or UV, to assist decay
OR not enough water or moisture (to hydrolyse polyester)
Allow landfill has / contains:
no or few bacteria / micro-organisms / enzymes compared with compost heap
OR less oxygen
OR lower temperature.

1

[22]

M2.L

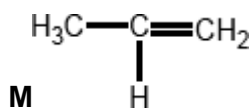


Allow $(CH_3)_2CHOH$ or $CH_3CH(OH)CH_3$

Allow name *propan-2-ol*

Penalise contradiction of name and structure

1



Allow $\text{CH}_3\text{CH}=\text{CH}_2$

Allow name propene

ignore -1- but penalise other numbers

Penalise contradiction of name and structure

1

Step 1 NaBH_4 or LiAlH_4

Zn/HCl or Sn/HCl

or H_2/Ni or H_2/Pt

Ignore name if formula is correct

ignore solvent

ignore acid (for 2nd step) but penalise acidified NaBH_4 .

Apply list principle for extra reagents and catalysts.

M1

1

(nucleophilic) addition

Addition (not nucleophilic)

Penalise electrophilic

Ignore reduction

M2

1

Step 2 conc H_2SO_4 or conc H_3PO_4 or Al_2O_3

Apply list principle for extra reagents and catalysts.

M3

1

elimination

Independent from M3

penalise nucleophilic or electrophilic

ignore dehydration

M4
1

Step 3 HBr

Apply list principle for extra reagents and catalysts.

M5
1

electrophilic addition
Independent from M5

M6
1

[8]

M3.(a) Sn / HCl **OR** Fe / HCl not conc H₂SO₄ nor any HNO₃

Ignore subsequent use of NaOH

Ignore reference to Sn as a catalyst with the acid

Allow H₂ (Ni / Pt) but penalise wrong metal

But NOT NaBH₄, LiAlH₄, Na / C₂H₅OH

1

Equation must use molecular formulae

C₆H₄N₂O₄ + 12 [H]

12[H] and 4H₂O without correct molecular formula scores 1 out of 2

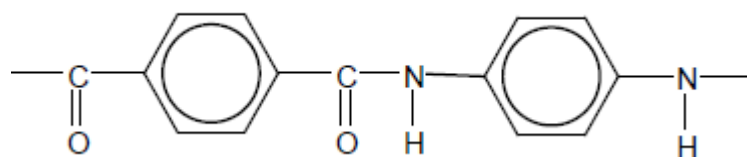
1

→C₆H₈N₂ + 4H₂O

Allow + 6H₂ if H₂ / Ni used

Allow -CONH- or -COHN- or -C₆H₄-

1



Mark two halves separately: lose 1 each for

- error in diamine part
- error in diacid part
- error in peptide link
- missing trailing bonds at one or both ends
- either or both of H or OH on ends

Ignore n

2

- (b) H_2 (Ni / Pt) but penalise wrong metal
NOT Sn / HCl, NaBH₄ etc.

1

CH₂

1

In benzene 120°

1

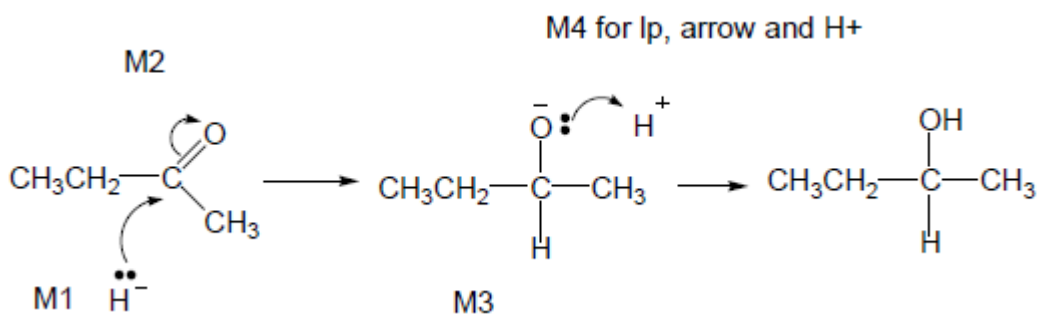
In cyclohexane 109° 28' or 109½°
Allow 108° - 110°

If only one angle stated without correct qualification, no mark awarded

1

- (c) (i) Nucleophilic addition

1



- M2 not allowed independent of M1, but allow M1 for correct attack on C+
- + rather than $\delta+$ on C=O loses M2
- M3 is for correct structure including minus sign but lone pair is part of M4
- Allow C_2H_5
- M1 and M4 include lp and curly arrow
- Allow M4 arrow to H in H_2O (ignore further arrows)

4

(ii) M1 Planar C=O (bond / group)
Not just planar molecule

1

M2 Attack (equally likely) from either side
Not just planar bond without reference to carbonyl

1

M3 (about product): Racemic mixture formed **OR** 50:50 mixture or each enantiomer equally likely

1

[17]

M4.(a) Yes, because it is oxidised to ethanal / CH_3CHO
OR it is oxidised to a compound that contains CH_3CO group
*Ignore 'primary alcohols are oxidised to aldehydes'.
Need 'yes' and an explanation to be awarded the mark.*

1

(b) $M_r CHI_3 = 393.7$ (M1)

Allow if clearly shown in a calculation.

Allow 394

1

$$\text{Moles CHI}_3 = 10 / 393.7 = 2.54 \times 10^{-2} \text{ (M2)}$$

Allow a consequential answer on an incorrect M₁.

2.54 × 10⁻² scores M1 and M2.

1

$$\text{Moles I}_2 = 7.62 \times 10^{-2} \text{ (M3)}$$

Allow 3 × M2.

1

$$\text{Mass I}_2 = 7.62 \times 10^{-2} \times 253.8 = 19.34\text{g (M4)}$$

Allow M3 × 253.8 or M3 × 254

1

$$\text{Scaling } 19.34 / 0.832 = 23.2\text{g (M5)}$$

Allow M4 / 0.832

Lose this mark if the answer is not given to 3 significant figures.

Answer without working scores M5 only.

Allow any chemically correct alternative method.

Calculations which combine several steps in one expression can score the marks for all of these individual steps.

1

(c) Remove soluble impurities

Allow 'remove excess sodium hydroxide / iodine'.

Allow 'remove excess sodium methanoate / sodium iodide'.

Allow 'remove excess reagents'.

1

(d) Will not dissolve solid / solid is insoluble in water

Allow 'will not react with solid'.

1

[8]

