

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

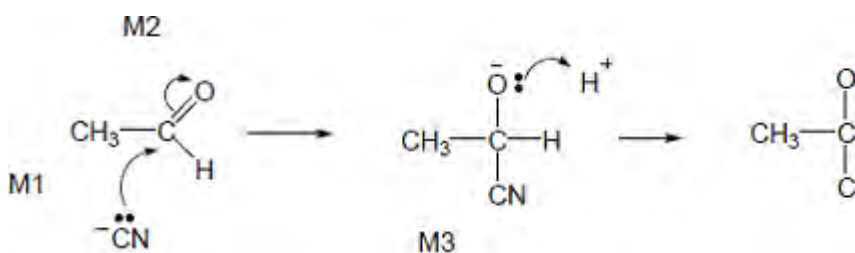


Allow $2C_3H_6O_3$

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.

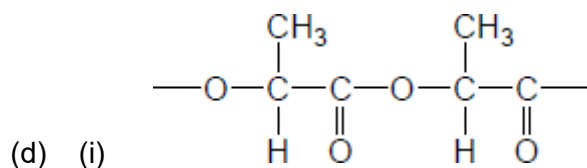
Any two out of the three marks M2 , M3 & M4

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

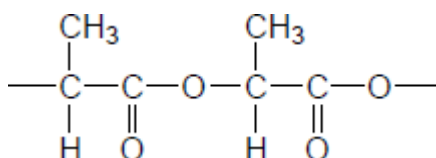
Correct ester link
allow $-COO-$

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

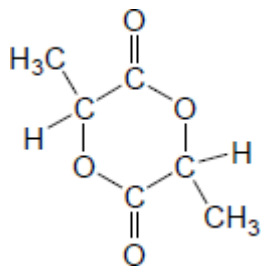
(ii) (Poly)ester ie allow ester

Not terylene.

Ignore spaces and brackets in answer.

1

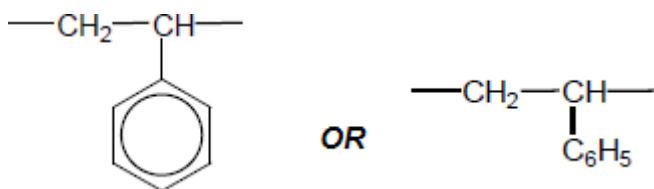
(iii)



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

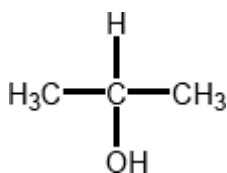
OR less oxygen

OR lower temperature.

1

[22]

M2.L

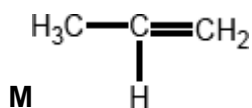


Allow $(CH_3)_2CHOH$ or $CH_3CH(OH)CH_3$

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

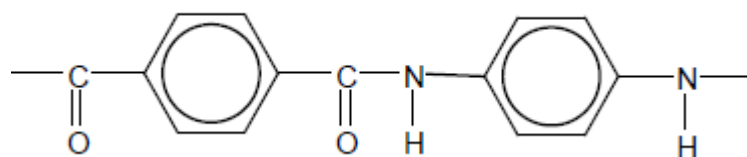
1

→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

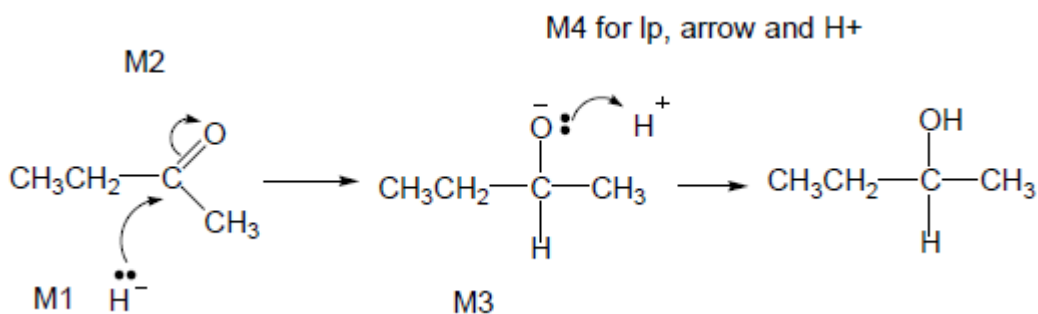
In cyclohexane 109° 28' or 109½°
Allow 108° - 110°

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) $M_r \text{CHI}_3 = 393.7$ (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 M_1 .

2.54×10^{-2} scores **M1** and **M2**.

1

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

Allow $3 \times M2$.

1

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

Allow $M3 \times 253.8$ or $M3 \times 254$

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]

