Question - 01

Which type of polymer is **not** hydrolysed by heating with concentrated aqueous sodium hydroxide?

A poly(alkene) ⬭

B poly(amide) ⬭

C poly(ester) ⬭

D protein ⬭

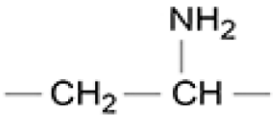
A

poly(alkene)

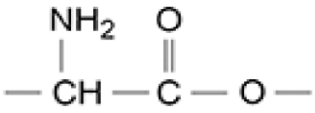
Question - 02

Which is the repeating unit of a polyamide?

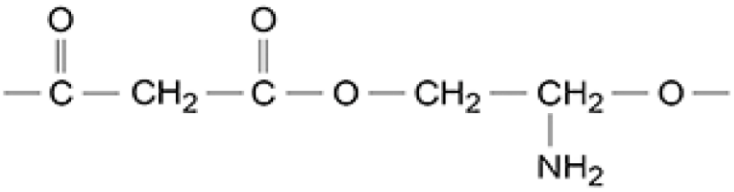
A



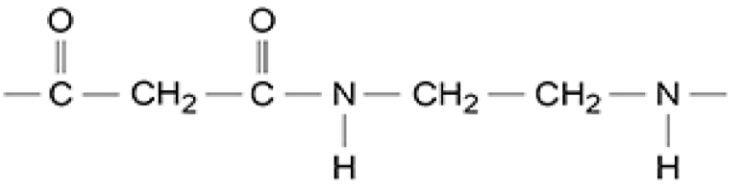
B



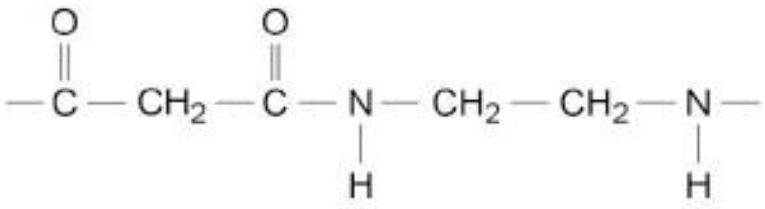
C



D



D



Question - 03

Which polymer has hydrogen bonding between the polymer chains?

A Kevlar ⬭

B PVC ⬭

C poly(phenylethene) ⬭

D Terylene ⬭

A

Kevlar

Question - 04

This question is about ethanedioic acid (HOOCCOOH) and the ethanedioate ion ($^{-}$OOCCOO^{-}).

(a) Ethanedioic acid reacts with propane-1,3-diol ($HOCH_2CH_2CH_2OH$) to form a polyester.

Draw the repeating unit of this polyester.

(2)

(b) Explain why polyesters are biodegradable but polyalkenes are not biodegradable.

_____

_____

_____

_____

_____

_____

(2)

(c) Sodium ethanedioate is used to find the concentration of solutions of potassium manganate(VII) by titration. The equation for this reaction is

$$2\ MnO_4^- + 16\ H^+ + 5\ C_2O_4^{2-} \rightarrow 2\ Mn^{2+} + 8\ H_2O + 10\ CO_2$$

A standard solution is made by dissolving 162 mg of $Na_2C_2O_4$ (M_r = 134.0) in water and making up to 250 cm^3 in a volumetric flask.

25.0 cm^3 of this solution and an excess of sulfuric acid are added to a conical flask.
The mixture is warmed and titrated with potassium manganate(VII) solution.
The titration is repeated until concordant results are obtained.
The mean titre is 23.85 cm^3

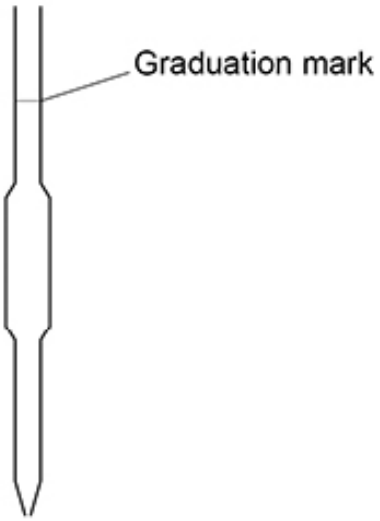
Calculate the concentration, in mol dm^{-3}, of the potassium manganate(VII) solution.

Concentration _____ mol dm^{-3}

(4)

(d) **Figure 1** shows the 25.0 cm^3 pipette used to measure the sodium ethanedioate solution.

Figure 1



On **Figure 1**, draw the meniscus of the solution when the pipette is ready to transfer 25.0 cm^3 of the sodium ethanedioate solution.

(1)

(e) Potassium manganate(VII) is oxidising and harmful.
Sodium ethanedioate is toxic.

Suggest safety precautions, other than eye protection, that should be taken when:

- filling the burette with potassium manganate(VII) solution
- dissolving the solid sodium ethanedioate in water.

Filling the burette _____

_____

Dissolving the solid _____

_____

(2)

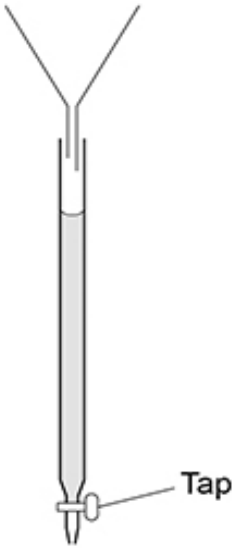
(f) State the colour change seen at the end point of each titration.

_____

(1)

(g) **Figure 2** shows the burette containing potassium manganate(VII) solution.

Figure 2



Give **two** practical steps needed before recording the initial burette reading.

1 _____

2 _____

(2)

(h) When $Na_2C_2O_4(aq)$ is added to a solution containing $[Fe(H_2O)_6]^{3+}$ ions, a reaction occurs in which all six water ligands are replaced by ethanedioate ions.

Explain why the replacement of the water ligands by ethanedioate ions is favourable. In your answer refer to:

- the enthalpy and entropy changes for the reaction
- how the enthalpy and entropy changes influence the free-energy change for the reaction.

_____

_____

_____

_____

_____

_____

_____

_____

_____

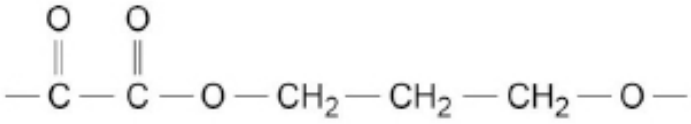
_____

_____

_____

(6)

(a)



M1 ester link including C–O–C

ignore *brackets and 'n'*

allow *$(CH_2)_3$*

–O– at either end but ***not*** *both*

1

M2 rest of structure including trailing bonds

not *M2 if more than one repeating unit*

allow *for one mark –OOCCOOCH$_2$CH$_2$CH$_2$– as long as trailing bonds included*

1

(b) polyesters: C=O/C–O **OR** polar bonds / chain **AND**
polyalkenes: (only) C–C **OR** non-polar bonds / chain

not *just 'polyesters are polar'*

not *M1 if C=C mentioned*

1

(polyesters) susceptible to nucleophilic attack / can be hydrolysed

1

(c) **M1** amount of $Na_2C_2O_4 = \frac{0.162}{134.0} = 0.00121$ mol

M1 x $\frac{2}{5}$

1

M2 stoichiometry $(\frac{2}{5})$ (4.84×10^{-4})

1

M3 scaling (÷10)

$= 0.00121 \times \frac{2}{5} \div 10 = 4.84 \times 10^{-5}$ mol

M2 ÷ 10 (conc/40)

M3 x $\frac{1000}{23.85}$

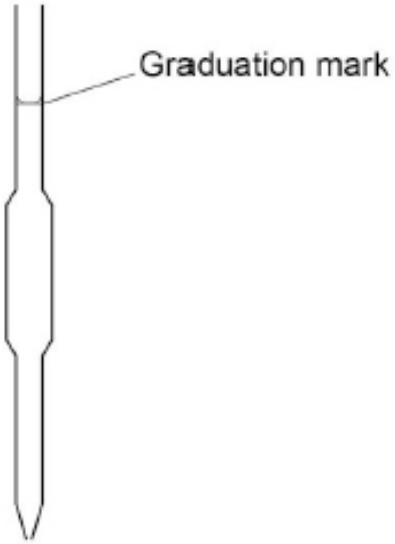
1

M4 concentration of $MnO_4^- = \frac{4.84 \times 10^{-5}}{\frac{23.85}{1000}} = 0.00203$ mol dm^{-3}

Min 2 sig figs

1

(d)



Meniscus <u>curved</u> with the bottom of the curve on the horizontal line

1

(e) (burette) fill below/at eye level

ignore *make sure tap closed / funnel / gloves*

1

(solution) wear gloves

allow *wash/rinse hands after any spillage* ***not*** *fume cupboard*

ignore *lab coat / stir carefully*

1

(f) colourless to pink/pale purple

not *just purple*

not *'clear' for 'colourless'*

1

(g) remove funnel

1

ensure jet is filled / no (air) bubbles

allow *open tap to fill space below tap*

1

(h)

This question is marked using Levels of Response. Refer to the Mark Scheme Instructions for Examiners for guidance.	
Level 3 **5-6 marks**	All stages are covered and each stage is generally correct and virtually complete. Answer is communicated coherently and shows a logical progression from Stage 1 to Stages 2 and 3 Covers at least 2 point for stage 1, 1 for stage 2 and 2 for stage 3. If given equation must show correct stoichiometry for six marks
Level 2 **3-4 marks**	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. Answer is communicated mainly coherently and shows a logical progression from Stage 1 to Stages 2 and 3.
Level 1 **1-2 marks**	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. Answer includes isolated statements but these are not presented in a logical order.
Level 0	Insufficient correct chemistry to gain a mark.

Stage 1 - ΔH

1a ΔH negligible

1b make & break same number of bonds 1c make & break same type of bonds / bonds have similar enthalpies

Stage 2 - ΔS

2a increase in entropy

2b increase in particles in solution / from 4 to 7 particles (ecf from incorrect equation showing increase in no. of moles)

Stage 3 - ΔG

3a $\Delta G = \Delta H - T\Delta S$

3b ΔG negative (for forward reaction)

3c correct discussion of why ΔG is negative based on ΔH and TΔS

6

Question - 05

Which polymer is **not** hydrolysed when heated with aqueous alkali?

A Kevlar ⬭

B Nylon 6,6 ⬭

C Poly(propene) ⬭

D Terylene ⬭

C

Poly(propene)

Question - 06

Suberoyl chloride, $ClOC(CH_2)_6COCl$, is commonly used in the manufacture of polymers.

Which compound can form a polymer with suberoyl chloride?

A $H_2NCH_2CH_2NH_2$ ⬭

B $ClOCCH_2COCl$ ⬭

C $CH_3CH_2CONH_2$ ⬭

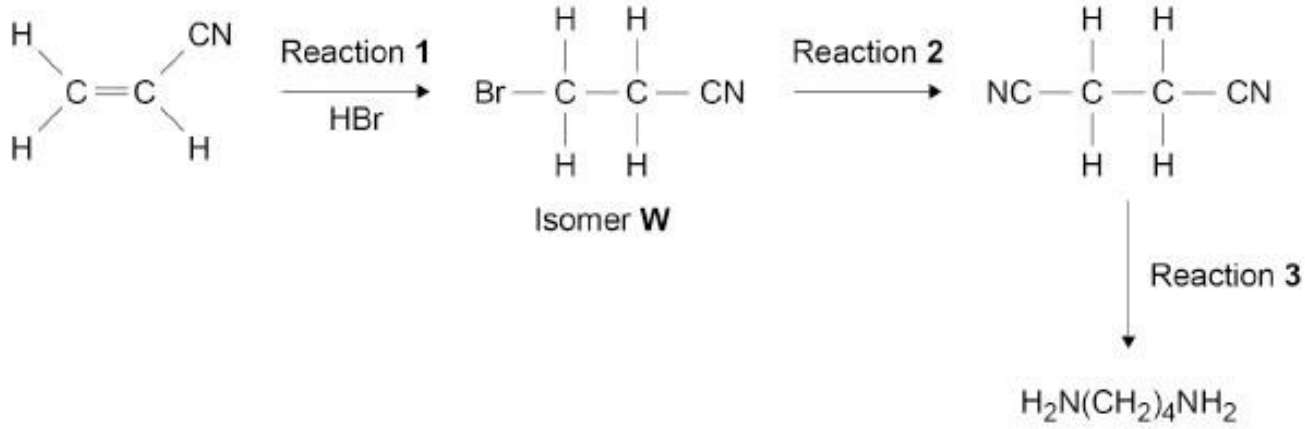
D $HOOCCH_2COOH$ ⬭

A

$H_2NCH_2CH_2NH_2$

Question - 07

Acrylonitrile, $H_2C=CHCN$, can be used as a starting material for the synthesis of butane-1,4-diamine, as shown in this reaction scheme.



(a) Use IUPAC rules to name isomer **W**.

_____

(1)

(b) Reaction **1** produces a mixture of **W** and two other isomers.

Draw the structures of the two other isomers.

Explain, by considering the mechanism of this reaction, why all three isomers are formed.

_____

_____

_____

_____

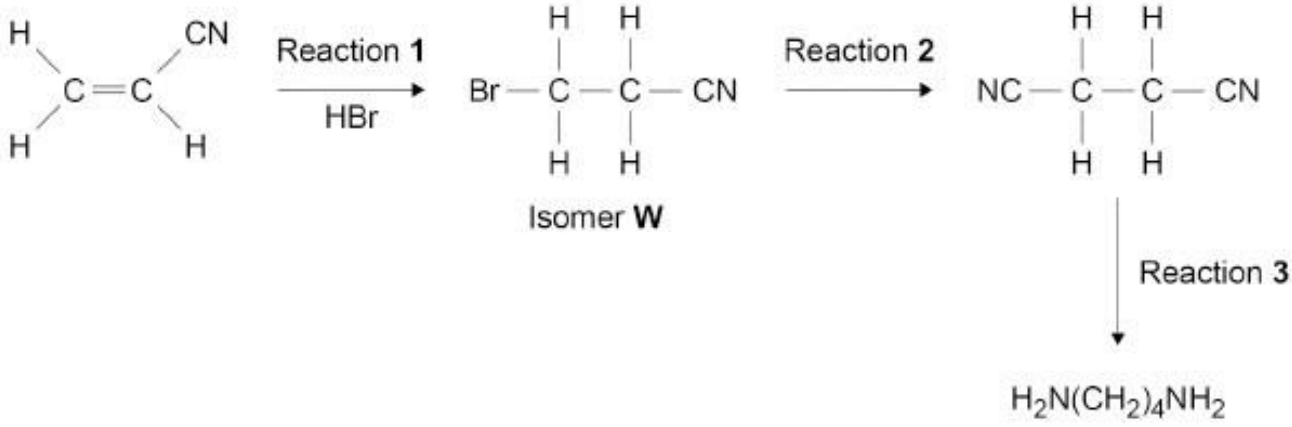
_____

_____

_____

(6)

The reaction scheme is repeated here.



(c) Identify the reagent that is warmed with isomer **W** in reaction **2**.

State the other reaction condition needed.

Reagent _____

Condition _____

(2)

(d) State the reagent and reaction conditions needed for reaction **3**.

Give an equation for reaction **3**.

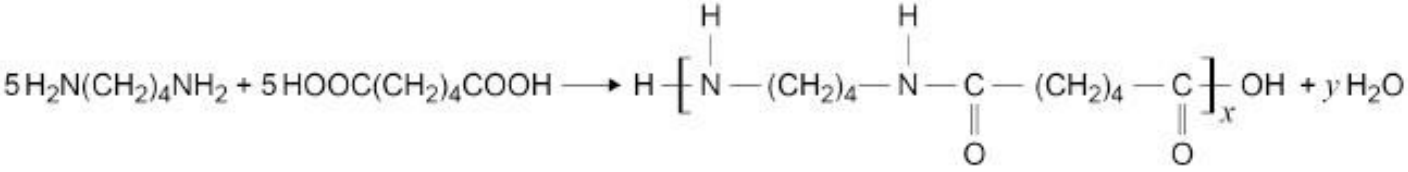
Reagent and conditions _____

Equation

_____

(2)

(e) An incomplete equation for the formation of nylon 4,6 from five molecules of butane-1,4-diamine and five molecules of hexanedioic acid is shown.

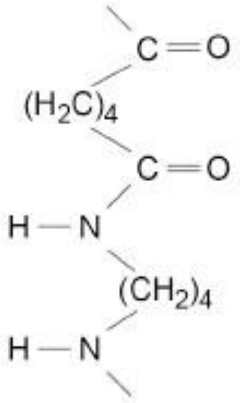


Deduce the values of x and y in this equation.

x _____ y _____

(2)

(f) The figure below shows a section of the nylon 4,6 polymer molecule.



Draw, on the figure above, another section of nylon 4,6 polymer showing two hydrogen bonds between the two sections.

Draw, on the figure above, another section of nylon 4,6 polymer showing two hydrogen bonds between the two sections.

(2)

(a) 3-bromopropanenitrile

Allow 3-bromopropane-1-nitrile

1

(b)

This question is marked using levels of response. Refer to the Mark Scheme Instructions for Examiners for guidance on how to mark this question.	
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Level 1 **1-2 marks**	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. Answer includes isolated statements but these are not presented in a logical order.
Level 0 **0 marks**	Insufficient correct chemistry to gain a mark.

Indicative Chemistry content

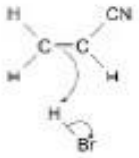
Stage 1 Types of Isomers formed

1a $CH_3CHBrCN$

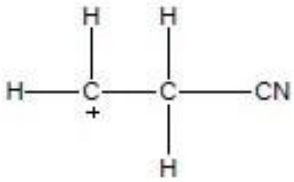
1b Exists as two Optical isomers / enantiomers

Stage 2 Mechanism

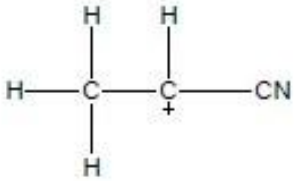
2a 2 curly arrows



2b Intermediate structure primary carbocation OR



2c Alternative Intermediate structure secondary carbocation OR



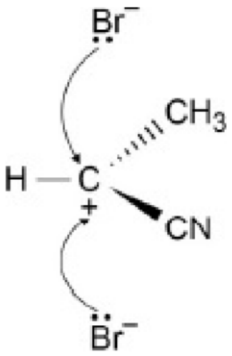
Stage 3 Optical isomerism

3a 2-bromo isomer has chiral carbon / C with four different groups / non superimposable mirror images

OR

3b Optical because (secondary) C^+ planar

3c So can be attacked from above or below



6

(c) M1 KCN or NaCN

Penalise acid in M1

M2 Aqueous AND ethanol (alcohol)

2

(d) M1 H_2 and Ni/Pt/Pd

Allow $LiAlH_4$ and (Dry) ether BUT <u>not</u> $NaBH_4$

M2 $NCCH_2CH_2CN + 4H_2 \rightarrow H_2N(CH_2)_4NH_2$

Allow with 8[H]

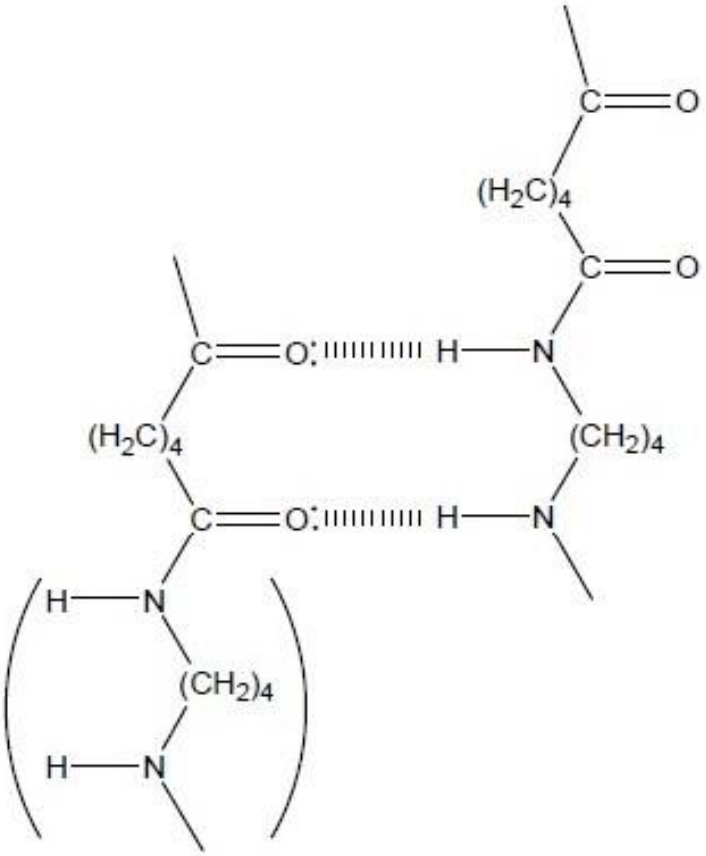
2

(e) M1 $x = 5$

M2 $y = 9$

2

(f)



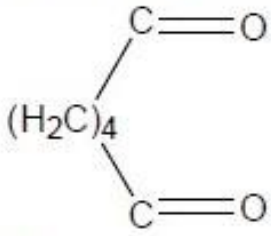
Structure shown on the left of the given structure.

The correct answer is the same irrespective of whether it's drawn on the left or right of the polymer section.

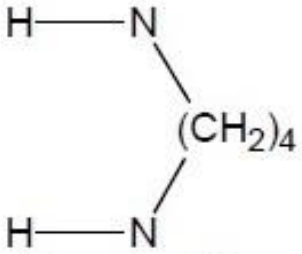
Deduct a mark(s) for error(s)/omission(s)

Must have the following:

- *Minimum correct structure*



Or



- *Lp on O or N*
- *2 Linear dashed lines from O or N to H*

Allow alternative connection below