

PROSPERITY ACADEMY

A2 CHEMISTRY 9701

Crash Course

RUHAB IQBAL

POLYMERISATION

COMPLETE NOTES



0331 - 2863334



**ruhab.prosperityacademics
@gmail.com**



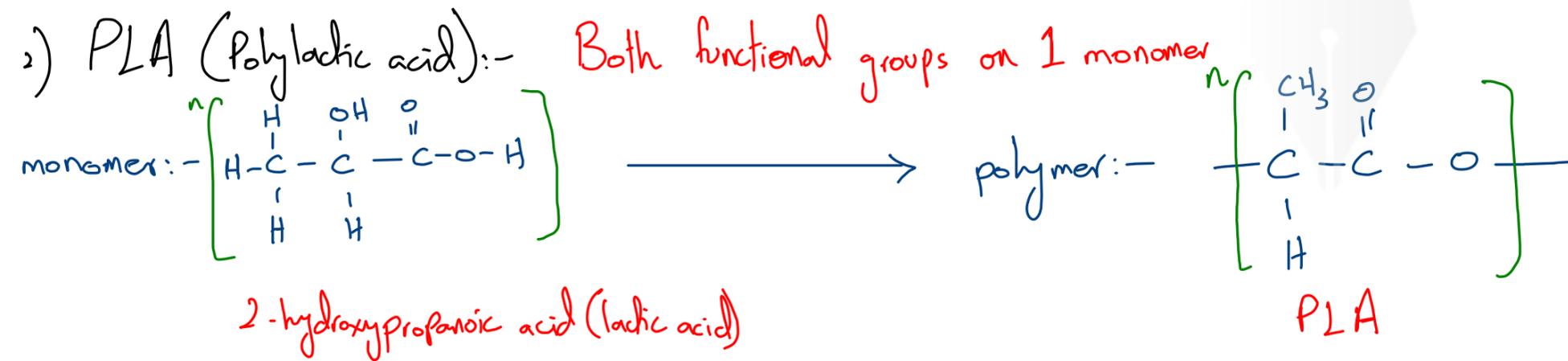
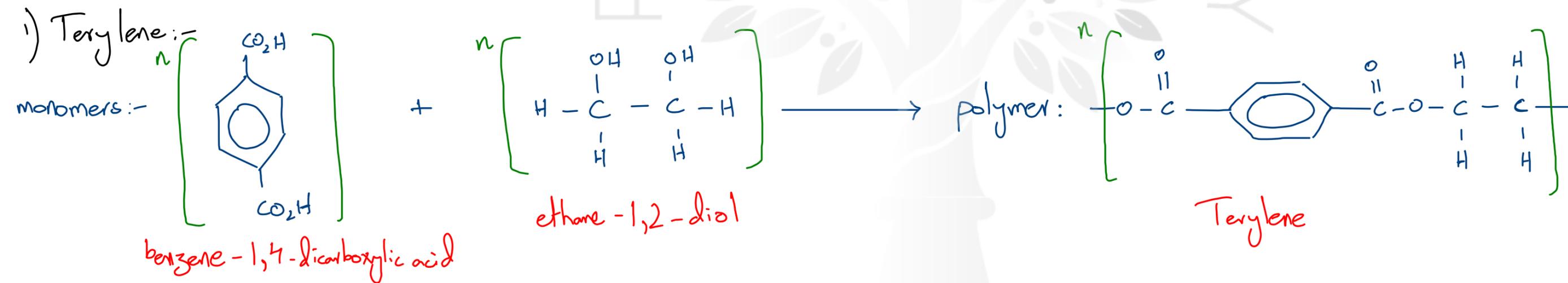
Condensation Polymerization:-

Condensation polymerization is when 2 or more monomers join together with the release of a small molecule like HCl or H₂O.

The 2 main types of condensation polymers are:-

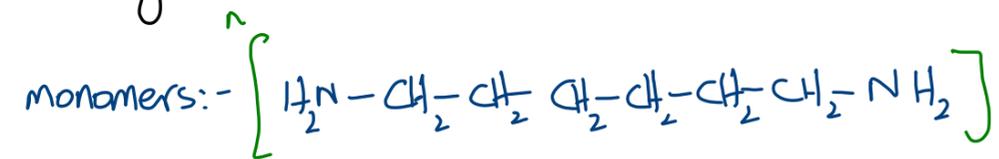
- 1) Polyesters (contain $-\overset{\text{O}}{\parallel}{\text{C}}-\text{O}-$ bond) e.g. Terylene and Polylactic acid (PLA)
- 2) Polyamides (contain $-\overset{\text{O}}{\parallel}{\text{C}}-\underset{\text{H}}{\text{N}}-$ bond) e.g. Nylon and Kevlar

Polyesters:- Require monomer with 2 alcohol group and another monomer with 2 carboxylic or acyl chloride groups.

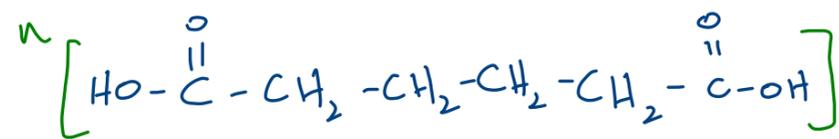


Polyamides:- Require monomer with 2 amine groups and 2 carboxylic or acyl chloride groups.

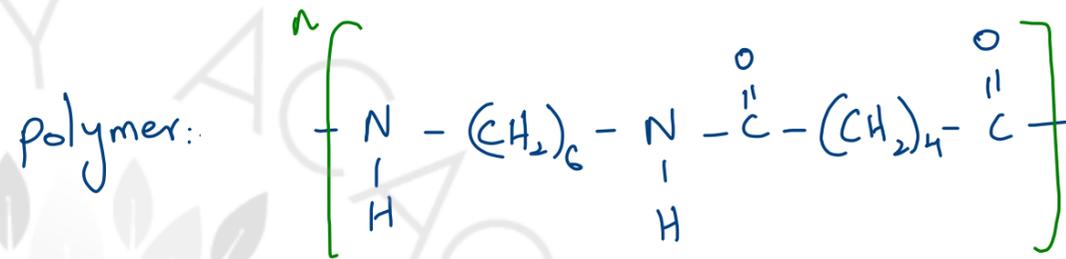
1) Nylon



1,6-diamino hexane

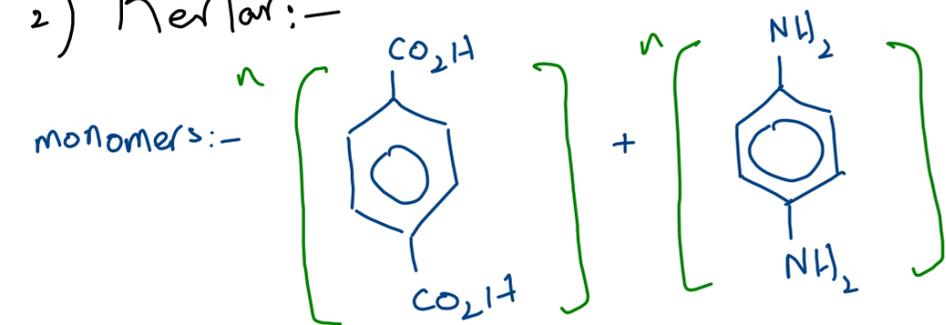


hexane-1,6-dioic acid



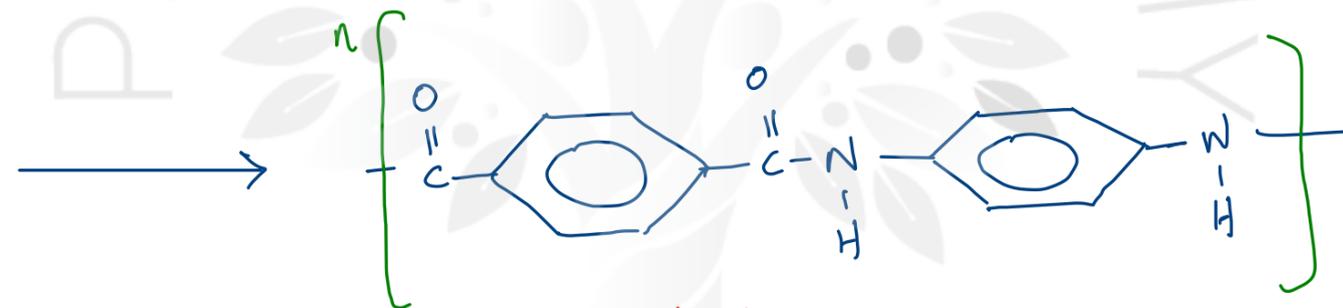
Nylon

2) Kevlar:-



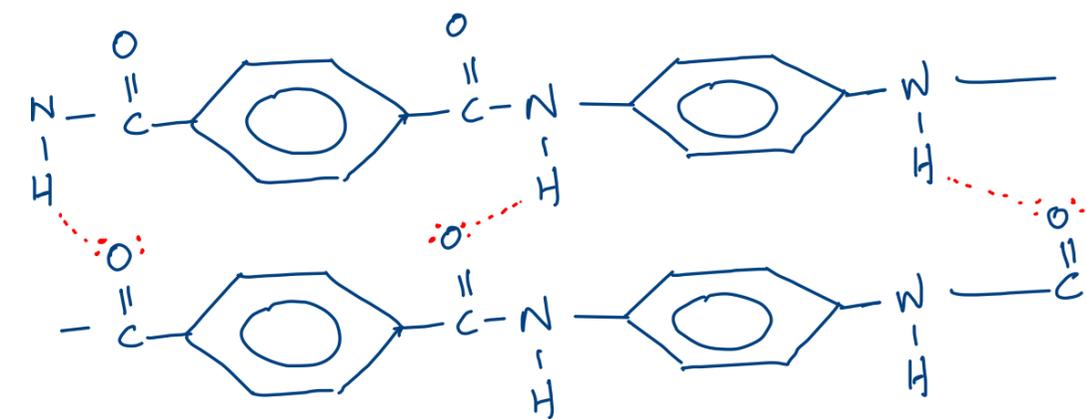
benzene-1,4-dicarboxylic acid

1,4-diaminobenzene



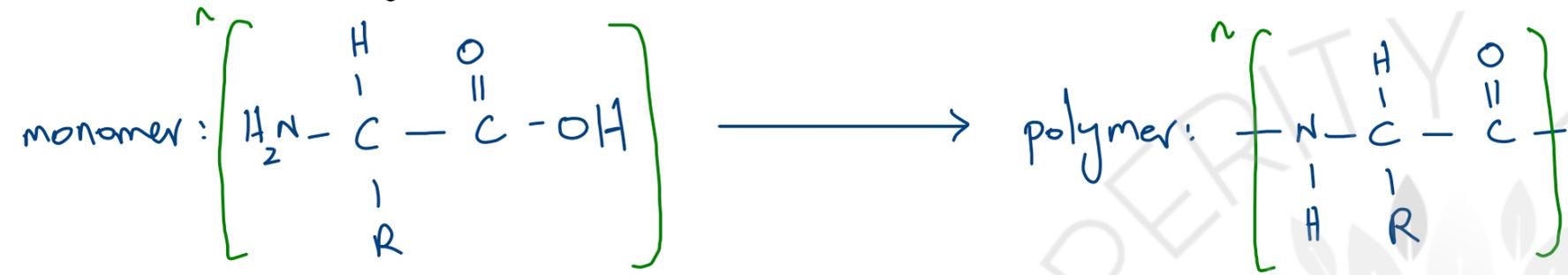
Kevlar

- The oxygens can hydrogen bond to hydrogens bonded to the nitrogens:-



- This gives Kevlar its low density as the structure is very spaced
- The many hydrogen bonds give it its strength
- Used in bullet proof and fire protective clothing

3) Amino carboxylic acid:- Both functional groups on 1 monomer



- Condensation polymers are biodegradable

↳ hydrolyse with dil. H_2SO_4 or dil. NaOH + heat

- Addition polymers are non biodegradable

- Some polymer chains are designed to have $\text{C}=\text{O}$ bonds. When these molecules absorb U.V light, the bonds around the $\text{C}=\text{O}$ can get weak and break. These are photodegradable polymers.

9 (a) (i) Name an example of a synthetic polyester and a synthetic polyamide.

polyester Terylene
 polyamide Nylon [1]

(ii) Polyesters and polyamides are formed by condensation reactions.

Name a molecule which is commonly eliminated in such reactions.
Water [1]

(b) (i) The table shows the repeat units of a number of polymers. Place a tick (✓) against the ones which are biodegradable.

polymer	repeat unit	biodegradable
A		✓
B		✓
C		
D		✓

(ii) Draw the structures of two monomers used to form polymer B.



(c) A section of polypeptide was hydrolysed and the following amino acids identified.

amino acid	formula
T	$\text{CH}_3\text{CH}(\text{NH}_2)\text{CO}_2\text{H}$
U	$\text{C}_6\text{H}_5\text{CH}_2\text{CH}(\text{NH}_2)\text{CO}_2\text{H}$
V	$\text{H}_2\text{N}(\text{CH}_2)_4\text{CH}(\text{NH}_2)\text{CO}_2\text{H}$

(i) Which of the amino acids T, U or V has the highest pH in aqueous solution? Explain why.

amino acid V
It has 2 amine groups and can accept 2 H⁺ making it a stronger base and hence higher pH. [1]

(ii) State how many different dipeptides could be formed from a reaction mixture consisting of amino acids T and U.

4 (TT, TU, UT, UU) [1]

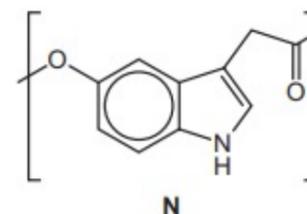
(iii) Polypeptides contain a high proportion of carbon and hydrogen in their structures, yet many are soluble in water.

By referring to the structure of a polypeptide, explain why.

They are soluble as they can form hydrogen bonds. Some hydrogens are directly bonded to electronegative elements like N and O and so a hydrogen bond can be formed when N or O use their lone pairs to attract this hydrogen. [2]

[Total: 10]

(d) Compound M can be polymerised under certain conditions to form polymer N, shown.



[2]

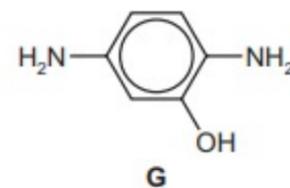
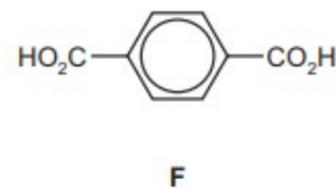
Polymer N is biodegradable, unlike polyethene which is not.

Explain why N is biodegradable.

It contains an ester bond which can be hydrolysed. [1]

[Total: 16]

- 5 (a) Polyhydroxyamide is a fire-resistant polyamide which is formed from the two monomers, **F** and **G**.

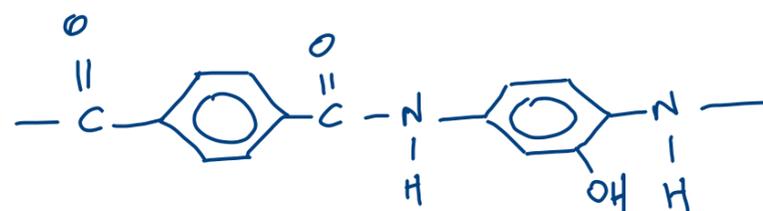


- (i) Predict the number of peaks that will be seen in the carbon-13 NMR spectra of **F** and **G**.

	number of peaks
F	
G	

[2]

- (ii) Draw the repeat unit of polyhydroxyamide. The amide bond should be shown displayed.



[2]

- (b) When poly(ethene) is formed from ethene, many bonds are broken and formed.

Place **one tick** (✓) in **each row** of the table to indicate the types of bonds broken and formed in this process.

	σ -bonds only	π -bonds only	both σ - and π -bonds
bonds broken		✓	
bonds formed	✓		

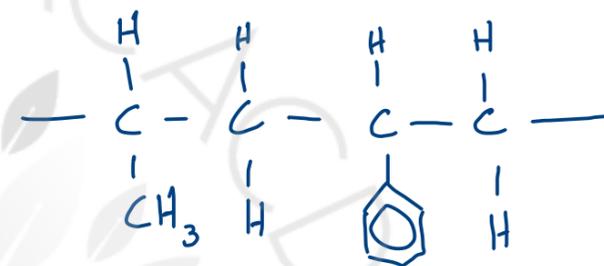
[2]

- (c) Addition polymers can be classified into two types.

- homopolymer - a polymer made up of the same monomer unit
- copolymer - a polymer made up of two or more different monomer units

The reaction of propene, $\text{CH}_3\text{CH}=\text{CH}_2$, with phenylethene, $\text{C}_6\text{H}_5\text{CH}=\text{CH}_2$, gives a copolymer.

Draw a length of the chain of this copolymer that contains one molecule of **each** monomer.



[2]

- (d) (i) Polyalkenes biodegrade very slowly.

Explain why by referring to the structures of the polymers.

C-C σ bonds are non polar so cannot be hydrolysed.

[1]

- (ii) Some polymers will degrade in the environment.

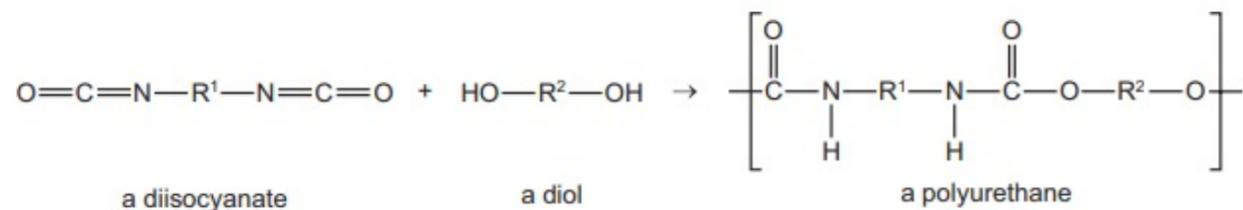
Describe **two** processes by which this occurs.

1 Hydrolysis using acid/base
2 breakdown by UV light

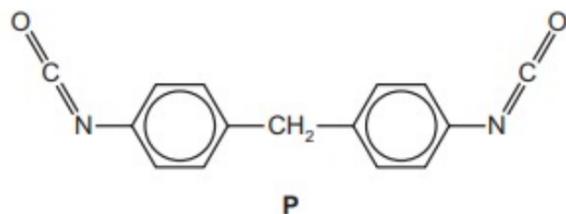
[2]

[Total: 11]

- 7 (a) Polyurethanes are polymers made by the reaction of a diisocyanate with a diol as shown. R¹ and R² are hydrocarbon groups.



Lycra[®] is a polyurethane formed from the diisocyanate **P** and HOCH₂CH₂OH.

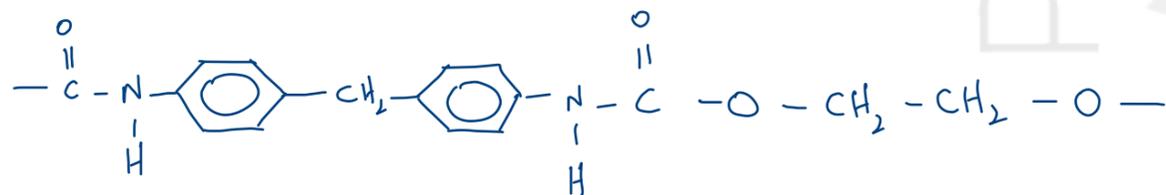


- (i) Give the molecular formula for **P**.

C₁₅H₁₀N₂O₂

[1]

- (ii) Draw the repeat unit of Lycra[®].



[2]

- (iii) Fibres of Lycra[®] are strong due to the intermolecular forces between the polymer chains.

Complete the table to identify two intermolecular forces responsible for this property and the group(s) involved.

intermolecular force	group(s) involved
hydrogen bonding	N-H and C=O
temporary dipoles	benzene rings

[2]

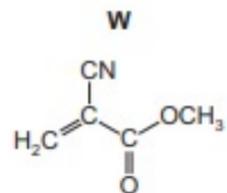
- (b) Name one example of each of the following types of polymer.

type of polymer	example
synthetic polyamide	Kevlar
synthetic polyester	Terylene
conducting polymer	
non-solvent based adhesive	

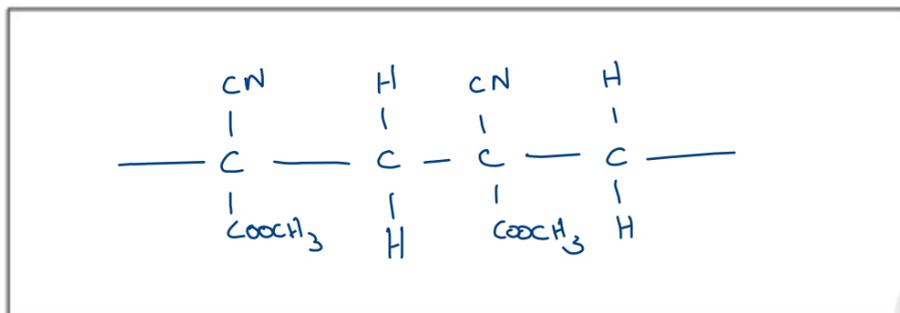
[3]

- 5 (a) Methyl 2-cyanoprop-2-enoate, **W**, is the major component of *Super Glue*, a rapid-setting adhesive.

As the adhesive sets, the monomer **W** polymerises.



- (i) Draw a section of the polymer showing **two** repeat units.



[2]

- (ii) Name the type of polymerisation occurring.

Addition

[1]

- (iii) Suggest **two** types of intermolecular force that could occur between the *Super Glue* polymer and the objects glued together. For each type of intermolecular force, refer to the atoms/groups in the *Super Glue* polymer involved in the attraction.

type of intermolecular force	atoms/groups in the <i>Super Glue</i> polymer
temporary dipoles	CH ₃ , CH ₂ , CN
permanent dipoles	C=O, CN

[2]