

# **AQA A2 CHEMISTRY**

## **TOPIC 4.8 AMINO ACIDS**

## **TOPIC 4.9 POLYMERS**

### **BOOKLET OF PAST EXAMINATION QUESTIONS**

1. (a) Write an equation for the formation of ethyl ethanoate from ethanoyl chloride and ethanol. Name and outline the mechanism for the reaction taking place.

*Equation* .....

*Name of mechanism* .....

*Mechanism*

(6)

- (b) Explain why dilute sodium hydroxide will cause holes to appear in clothing made from polymers such as Terylene but a poly(phenylethene) container can be used to store sodium hydroxide.

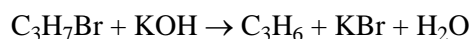
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(2)

(Total 8 marks)

2. (a) Classify the following reaction.



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(1)

- (b) How do the physical properties of the alkene homologous series change as the chain length increases?

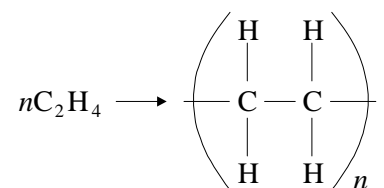
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(2)

- (c) For the reaction shown in the equation:



- (i) give the name of this process:

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(2)

- (d) Most ethanol used in the chemical industry is manufactured by reacting together water and ethene.

- (i) Write a balanced equation for this reaction.

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(1)

- (ii) Outline the reaction conditions for this reaction.

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(3)

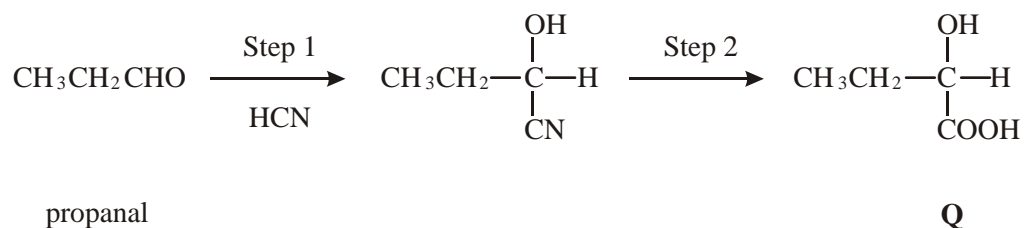
- (iii) Classify this reaction, indicating the type of initial attack on the ethene.

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(2)

(Total 11 marks)

3. Consider the reaction sequence shown below.



- (a) Name and outline a mechanism for the reaction in Step 1.

*Name of mechanism* .....

*Mechanism*

(5)

- (b) (i) Name compound **Q** formed in Step 2.

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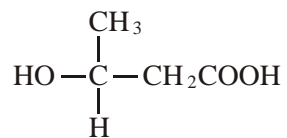
- (ii) Two stereoisomers are formed by the dehydration of **Q**. Give the structures of these two isomers and name the type of stereoisomerism shown.

*Structures of isomers*

*Type of stereoisomerism* .....

(4)

- (c) An isomer of **Q** which has the structure shown below is polymerised to form the biodegradable polymer known as PHB.



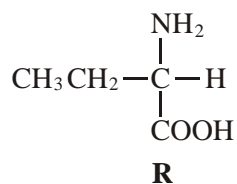
- (i) Draw the repeating unit of the polymer PHB.

- (ii) Suggest a reason why the polymer is biodegradable.

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 .....

(2)

- (d) The amino acid **R** is shown below.



- (i) Draw the structure of the zwitterion formed by **R**.

- (ii) Draw the structure of the major organic product formed when an excess of **R** is reacted with bromomethane.

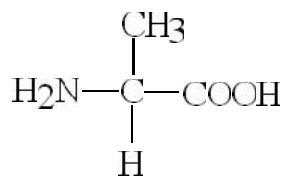
- (iii) Name the mechanism of the reaction which results in the formation of the product given in part (ii).

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(3)

(Total 14 marks)

4. The amino acid *alanine* is shown below.



*alanine*

- (a) A sample of alanine is dissolved in water.
- (i) Draw the structure of the main alanine species present in this aqueous solution and give the name of this type of species.

*Structure*

*Type of species* .....

- (ii) Draw the structure of the alanine species formed when an excess of hydrochloric acid is added to the solution.

(3)

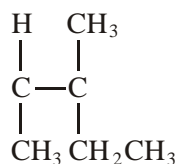
- (b) Alanine molecules may be reacted together to form a polypeptide. Give the repeating unit of this polypeptide and name the type of polymerisation involved in its formation.

*Repeating unit*

*Type of polymerisation* .....

(2)

- (c) The repeating unit of a polyalkene is shown below.



Give the name of the alkene which is used to form this polymer.

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(1)

(Total 6 marks)

5. (a) The compound  $\text{H}_2\text{C}=\text{CHCN}$  is used in the formation of acrylic polymers.

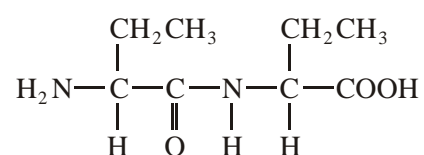
(i) Draw the repeating unit of the polymer formed from this compound.

(ii) Name the type of polymerisation involved in the formation of this polymer.

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(2)

(b) When the dipeptide shown below is heated under acidic conditions, a single amino acid is produced.



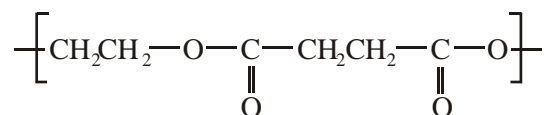
(i) Name this amino acid.

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(ii) Draw the structure of the amino acid species present in the acidic solution.

(2)

- (c) The repeating unit of a polyester is shown below.



- (i) Deduce the empirical formula of the repeating unit of this polyester.

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- (ii) Draw the structure of the acid which could be used in the preparation of this polyester and give the name of this acid.

*Structure* .....

*Name* .....

- (iii) Give **one** reason why the polyester is biodegradable.

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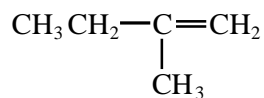
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(4)

(Total 8 marks)



6. (a) The hydrocarbon **M** has the structure shown below.



- (i) Name hydrocarbon **M**.

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- (ii) Draw the repeating unit of the polymer which can be formed from **M**. State the type of polymerisation occurring in this reaction.

*Repeating unit*

*Type of polymerisation* .....

- (iii) The reaction between **M** and benzene in the presence of HCl and AlCl<sub>3</sub> is similar to the reaction between ethene and benzene under the same conditions. Name the type of mechanism involved and draw the structure of the major product formed in the reaction between **M** and benzene.

*Name of mechanism* .....

*Major product*

- (iv) Draw a structural isomer of **M** which shows geometrical isomerism.

(6)

- (b) Draw the repeating unit of the polymer formed by the reaction between butanedioic acid and hexane-1,6-diamine. State the type of polymerisation occurring in this reaction and give a name for the linkage between the monomer units in this polymer.

*Repeating unit*

*Type of polymerisation* .....

*Name of linkage* .....

(4)

(Total 10 marks)

7. (a) "Terylene" is a condensation polymer that can be formed from benzene-1,4-dicarboxylic acid and ethane-1,2-diol. Draw graphical formulae to represent:

(i) benzene-1,4-dicarboxylic acid;

(1)

(ii) ethane-1,2-diol;

(1)

(iii) the polymer "Terylene".

(2)

- (b) Give the name of the type of condensation polymer of which "Terylene" is an example.

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(1)

- (c) Outline the difference between the formation of an addition polymer and a condensation polymer.

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(2)

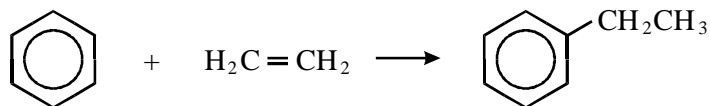
- (d) Give the name of **one** addition polymer.

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(1)

(Total 8 marks)

8. Ethylbenzene is made by the reaction shown below.



- (a) Identify two other substances required as catalysts in this preparation.

*Substance 1* .....

*Substance 2* .....

(2)

- (b) Write an equation for the reaction of these two substances with ethene to form the reactive intermediate involved in the formation of ethylbenzene.

.....

(1)

- (c) Name and outline a mechanism for the reaction between this reactive intermediate and benzene.

*Name of mechanism* .....

*Mechanism*

(4)

- (d) Draw the structure of the product formed in a similar reaction between benzene and cyclohexene.

(1)

- (e) Ethylbenzene is used to make phenylethene which can be polymerised to form poly(phenylethene). Name this type of polymerisation and draw the structure of the repeating unit in the polymer.

*Type of polymerisation* .....

*Repeating unit* .....

(2)

(Total 10 marks)

9. (a) Synthetic polyamides are produced by the reaction of dicarboxylic acids with compounds such as  $\text{H}_2\text{N}(\text{CH}_2)_6\text{NH}_2$

(i) Name the compound  $\text{H}_2\text{N}(\text{CH}_2)_6\text{NH}_2$

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(ii) Give the repeating unit in the polyamide nylon 6,6.

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(2)

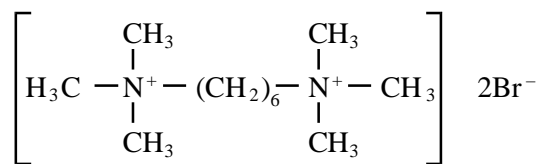
- (b) Synthetic polyamides have structures similar to those found in proteins.

(i) Draw the structure of 2-aminopropanoic acid.

(ii) Draw the organic product formed by the condensation of two molecules of 2-aminopropanoic acid.

(2)

- (c) Compounds like  $\text{H}_2\text{N}(\text{CH}_2)_6\text{NH}_2$  are also used to make ionic compounds such as **X**, shown below.



Compound **X**

- (i) **X** belongs to the same type of compound as  $(\text{CH}_3)_4\text{N}^+\text{Br}^-$   
Name this **type** of compound.

.....

- (ii) State a reagent which could produce **X** from  $\text{H}_2\text{N}(\text{CH}_2)_6\text{NH}_2$  and give a necessary condition to ensure that **X** is the major product.

*Reagent* .....

*Condition* .....

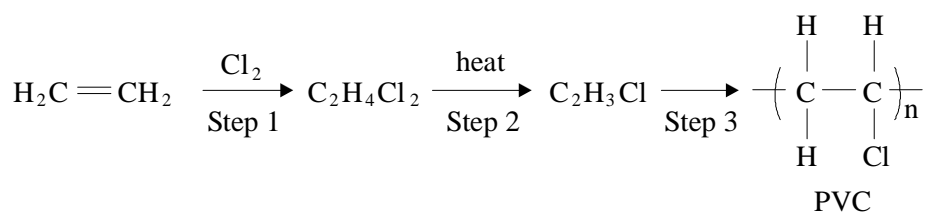
- (iii) Name the mechanism involved in this reaction to form **X**.

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(4)

(Total 8 marks)

10. The polymer poly(chloroethene), commonly known as poly(vinyl chloride) or PVC, can be produced as follows:



- (a) Using your knowledge of the reaction between bromine and ethene, name and outline a mechanism for Step 1.

*Name of mechanism* .....

*Mechanism*

(5)

- (b) Write an equation for Step 2 showing clearly the structure of the organic product.

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(1)

- (c) Plasticisers are often incorporated into polymers such as PVC. Name a type of compound used as a plasticiser.

.....

(1)

- (d) (i) Draw the structure of the organic product of the reaction of  $C_2H_4Cl_2$  with an excess of warm aqueous sodium hydroxide.

- (ii) Suggest why  $C_2H_3Cl$ , the organic product of Step 2, does not react with warm aqueous sodium hydroxide.

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(3)

(Total 10 marks)

11. This question concerns the chemistry of ethene and compounds derived from it. Consider the following statements and then answer the questions below.

- Ethene may be polymerised to form poly(ethene).
- Treatment of ethene with bromine gives a compound **C**.
- Compound **C** may be converted in the laboratory into a compound **D**, which has a percentage composition by mass of: C 38.71%; H 9.68%; O 51.61%. The relative molecular mass,  $M_r$ , of **D** is 62.

- (a) (i) Explain what is meant by the term *polymerisation*.

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(2)

- (ii) Write an equation to represent the polymerisation of ethene.

.....

(1)

- (b) Give the name of compound **C**.

.....

(1)

- (c) Give the name of the mechanism of the reaction between ethene and bromine. Draw the mechanism for this reaction.

*Name of the mechanism.*

.....

*Mechanism*

(4)

- (d) (i) Use the analytical data provided at the start of the question to deduce the molecular formula of compound **D**.

(3)

- (ii) Give the reagent(s) and condition(s) for the conversion of **C** into **D**.

*Reagent(s)* .....

*Condition(s)* .....

(2)

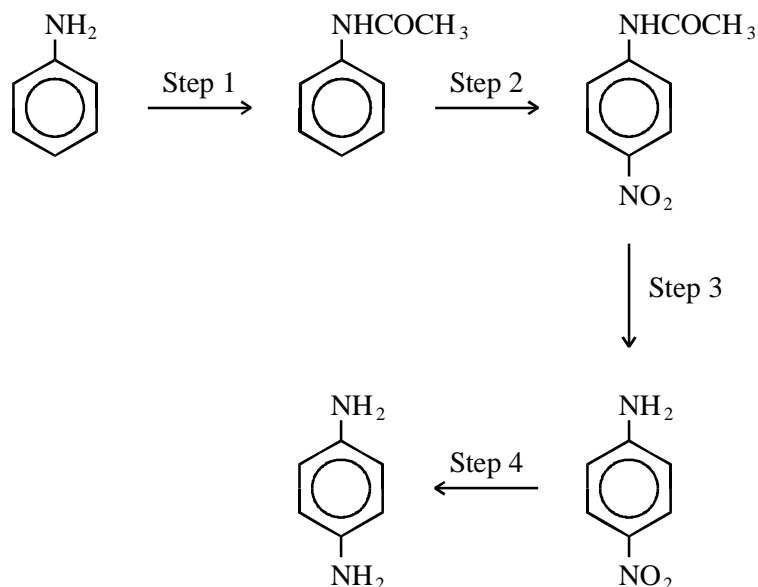
- (iii) Write an equation for the conversion of **C** into **D**.

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(2)

(Total 15 marks)

12. A possible synthesis of 1,4-diaminobenzene is shown below.



- (a) Identify a suitable reagent or combination of reagents for Step 1. Name and outline a mechanism for the reaction. (6)
- (b) Identify a suitable reagent or combination of reagents for Step 2. Name and outline a mechanism for the reaction. (6)
- (c) Identify a suitable reagent or combination of reagents for Step 4. Draw the repeating unit of the polymer formed by reaction of 1,4-diaminobenzene with pentanedioic acid. (3)

(Total 15 marks)