A-Level Chemistry

Addition Polymers

Question Paper

Time available: 50 minutes
Marks available: 43 marks

1. This question is about poly(chloroethene), commonly known as PVC.

(a) Give an equation, showing structural formulas, for the conversion of chloroethene into poly(chloroethene).

(3)

(b) State what you would observe if bromine water was added to poly(chloroethene). Explain this observation.

Observation _____

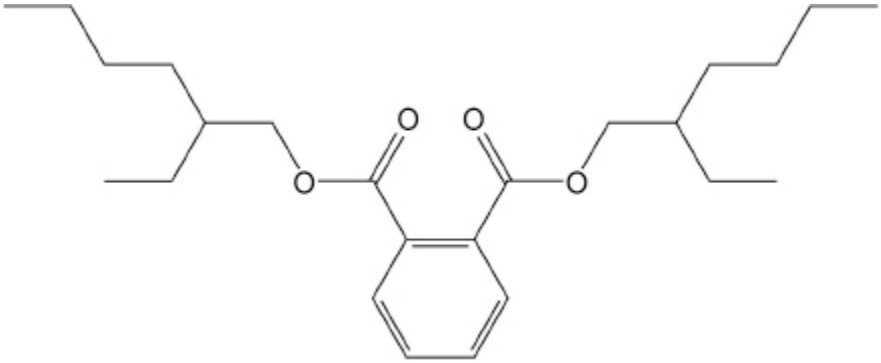
Explanation _____

_____

_____

(2)

(c) Plasticisers are often added during the manufacture of PVC. The structure of the plasticiser DEHP is shown.



Deduce the molecular formula of DEHP and state why a plasticiser is added to PVC.

Molecular formula _____

Why a plasticiser is added _____

_____

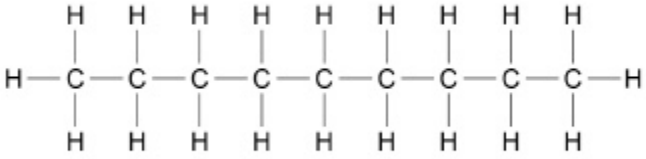
_____

(2)

(Total 7 marks)

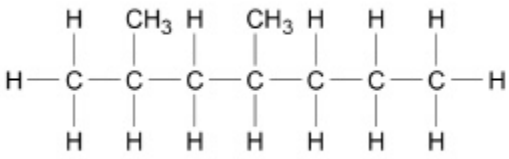
2. The alkanes nonane and 2,4-dimethylheptane are structural isomers with the molecular formula C_9H_{20}
They are found in crude oil and can be separated by fractional distillation.
Both can be used in fuels or cracked to form other products.

nonane



boiling point 151 °C

2,4-dimethylheptane



boiling point 134 °C

(a) State the general formula of an alkane containing n carbon atoms.
Deduce an expression for the relative molecular mass (M_r) of an alkane in terms of n.

General formula _____

Expression _____

(2)

(b) Explain why nonane has a higher boiling point than 2,4-dimethylheptane.

_____

_____

_____

_____

_____

_____

(2)

(c) Give an equation for the complete combustion of nonane.

_____

(1)

(d) Nonane is often found in fuel for jet engines. Combustion in jet engines produces pollutants including nitrogen monoxide (NO).

Explain how this nitrogen monoxide is formed.

_____

_____

_____

_____

_____

(2)

(e) Nonane can be cracked to form large quantities of propene.

Name the type of cracking used.

_____

(1)

(f) The main use of propene, formed from cracking, is to make poly(propene).

Draw the repeating unit of poly(propene).

(1)

(Total 9 marks)

3. Ethanal reacts with potassium cyanide, followed by dilute acid, to form 2-hydroxypropanenitrile.

(a) Name the mechanism for the reaction between potassium cyanide and ethanal.

_____

(1)

(b) The 2-hydroxypropanenitrile formed by the reaction in part **(a)** is a mixture of equal amounts of two isomers.

State the name of this type of mixture.

Explain how the structure of ethanal leads to the formation of two isomers.

Draw 3D representations of the two isomers to show the relationship between them.

Name _____

Explanation _____

_____

_____

_____

_____

_____

3D representations

(5)

(c) 2-Hydroxypropanenitrile can be used in the synthesis of the monomer, acrylonitrile, CH_2=CHCN

Suggest a suitable reagent and conditions for the conversion of 2-hydroxypropanenitrile into acrylonitrile.

Reagent _____

Conditions _____

(2)

(d) Draw a section of the polymer polyacrylonitrile, showing three repeating units.

(1)

(Total 9 marks)

4. This question is about 2-methylbut-1-ene.

(a) Name the mechanism for the reaction of 2-methylbut-1-ene with concentrated sulfuric acid.

Outline the mechanism for this reaction to form the major product.

Name of mechanism _____

Outline of mechanism to form major product

(5)

(b) Draw the structure of the minor product formed in the reaction in part (a)

Explain why this is the minor product.

Structure of minor product

Explanation _____

_____

_____

_____

(3)

(c) Draw the skeletal formula of a functional group isomer of 2-methylbut-1-ene.

(1)

(d) 2-methylbut-1-ene can form a polymer.

State the type of polymerisation.

Draw the repeating unit for the polymer formed.

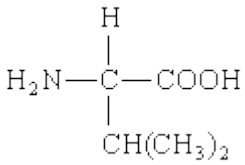
Type of polymerisation _____

Repeating unit

(2)

(Total 11 marks)

5. (a) Consider the following amino acid.



(i) Draw the structure of the amino acid species present in a solution at pH 12.

(ii) Draw the structure of the dipeptide formed from two molecules of this amino acid.

(iii) Protein chains are often arranged in the shape of a helix. Name the type of interaction that is responsible for holding the protein chain in this shape.

_____

(3)

(b) Consider the hydrocarbon **G**, $(CH_3)_2C=CHCH_3$, which can be polymerised.

(i) Name the type of polymerisation involved and draw the repeating unit of the polymer.

Type of polymerisation _____

Repeating unit

(ii) Draw the structure of an isomer of **G** which shows geometrical isomerism.

(iii) Draw the structure of an isomer of **G** which does not react with bromine water.

(4)
(Total 7 marks)