AQA A-LEVEL CHEMISTRY · 7405

CHEMISTRY



EXAM QUESTION PACK

3.3.4 ALKENES

SCORE	PERCENTAGE
/243	%

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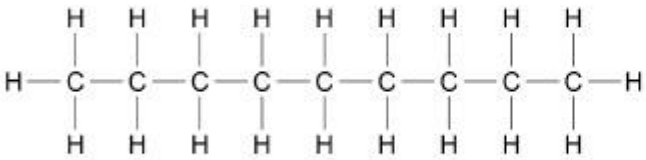
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Q1.

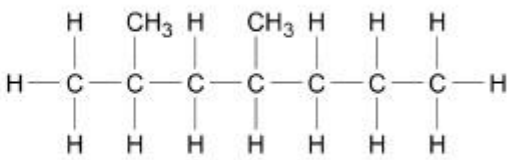
The alkanes nonane and 2,4-dimethylheptane are structural isomers with the molecular formula C_9H_{20}
They are found in crude oil and can be separated by fractional distillation.
Both can be used in fuels or cracked to form other products.

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.

_____

_____

_____

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_____

_____

(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)

Q2.

Which statement is correct about poly(chloroethene)?

A It has the empirical formula CHCl ⬭

B It decolourises bromine water. ⬭

C Its brittleness is reduced by plasticisers. ⬭

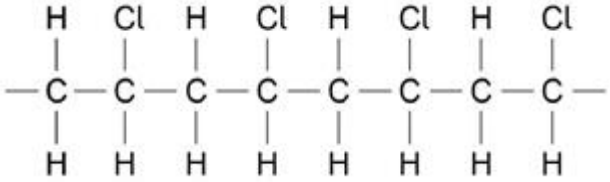
D Its polymer chain contains alternate single and double bonds. ⬭

(Total 1 mark)

Q3.

Chloroethene can be polymerised to form poly(chloroethene), commonly known as PVC. This polymer can be used to make pipes, window frames and electrical insulation. Plasticisers can be added to change the properties of PVC

A section of poly(chloroethene) is shown.



(a) Chloroethene has a melting point of −154 °C

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All types of PVC melt at temperatures over 100 °C

Explain why PVC melts at a higher temperature than chloroethene.

_____

_____

_____

_____

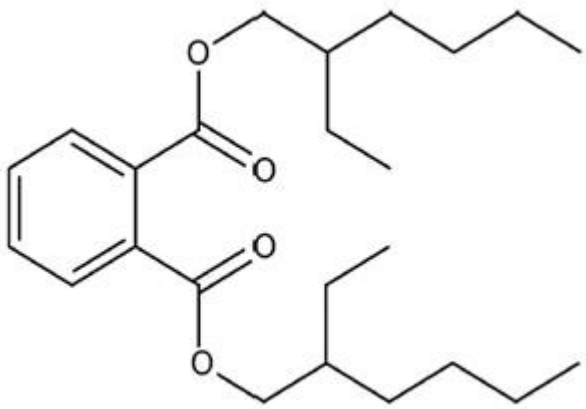
_____

_____

_____

(2)

(b) This structure shows a molecule that has been used as a plasticiser in PVC.



Deduce the number of hydrogen atoms in this molecule.

_____

(1)

(c) Use your understanding of the properties of PVC to explain whether you would expect to find a plasticiser in the PVC used to insulate electrical cables.

_____

_____

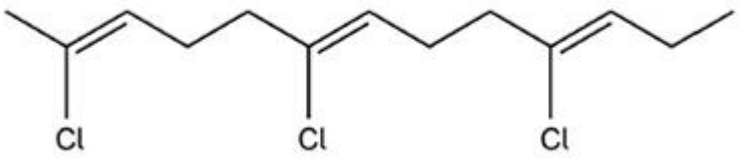
_____

_____

(1)

(d) A section of the polymer poly(chloroprene), a synthetic rubber, is shown.

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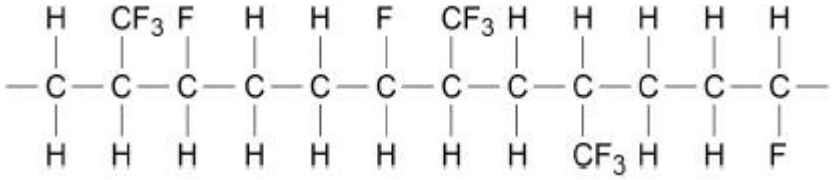
Draw the **displayed** formula for the repeating unit of poly(chloroprene).

(1)

(Total 5 marks)

Q4.

This structure shows a section of a polymer chain formed from the random polymerisation of two different monomers.



Which pair of monomers could produce this polymer?

A $CH_2=CHF$ and $CH_2=CHCF_3$ ⬭

B $CH_2=CH_2$ and $CHF=CHCF_3$ ⬭

C $CH_2=CH_2$ and $CH_2=CHCF_3$ ⬭

D $CH_2=CHF$ and $CHCF_3=CHF$ ⬭

(Total 1 mark)

Q5.

This question is about halogenoalkanes.

(a) Chlorine atoms are formed in the upper atmosphere when ultraviolet radiation causes C–Cl bonds in chlorofluorocarbons (CFCs) to break.

Write **two** equations to show how chlorine atoms catalyse the decomposition of ozone.

1. _____

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_____

2. _____

_____

(2)

(b) Chloroethane reacts with potassium hydroxide in the presence of propan-1-ol to form ethene.

State the role of potassium hydroxide and the role of propan-1-ol in the reaction.

Role of potassium hydroxide _____

Role of propan-1-ol _____

(2)

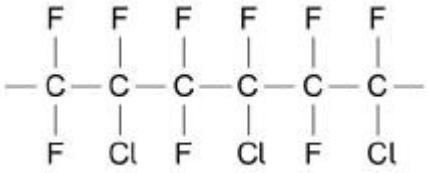
(c) Name and outline a mechanism for the reaction in part **(b)** between chloroethane and potassium hydroxide to produce ethene.

Name of mechanism _____

Mechanism

(4)

(d) The structure of polymer **A** is shown.



Draw the structure of the monomer used to form polymer **A**.

(1)

(e) Chemical analysis shows that a chlorofluoroalkane, **B**, contains by mass 51.6% fluorine, 32.1% chlorine and no hydrogen.

Chlorine exists as two isotopes, ^{35}Cl and $3^{37}Cl$, in the ratio 3:1
Fluorine only exists as one isotope, ^{19}F.

A mass spectrum of **B** is obtained using electron impact ionisation. The mass spectrum shows three molecular ion peaks at *m/z* = 220, 222 and 224.

Determine the formula of each of the three molecular ions of **B**.

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Predict and explain the ratio of the relative abundancies of each of the three molecular ion peaks at *m/z* = 220, 222 and 224.

To gain full marks you must show all your working.

(6)
(Total 15 marks)

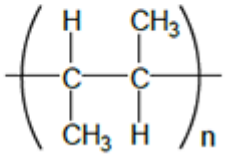
Q6.

Dodecane ($C_{12}H_{26}$) is a hydrocarbon found in the naphtha fraction of crude oil. Dodecane can be used as a starting material to produce a wide variety of useful products. The scheme below shows how one such product, polymer **Y**, can be produced from dodecane.

Reaction **1**

$C_{12}H_{26} \longrightarrow C_2H_4 + C_4H_8 + \mathbf{X}$

Reaction **2**

$nC_4H_8 \rightleftharpoons$ 

Polymer **Y**

(a) Name the homologous series that both C_2H_4 and C_4H_8 belong to.
Draw a functional group isomer of C_4H_8 that does **not** belong to this homologous series.

Name _____

Functional group isomer

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(2)

(b) Identify compound **X**.

_____

(1)

(c) Name polymer **Y**.

_____

(1)

(d) Reaction **1** is an example of thermal cracking and is carried out at a temperature of 750 °C.

State **one other** reaction condition needed.

_____

(1)

(e) Reaction **2** is exothermic. A typical compromise temperature of 200 °C is used industrially for this reaction.

Explain the effect of a change of temperature on both the position of equilibrium and the rate of reaction, and justify why a compromise temperature is used industrially.

_____

_____

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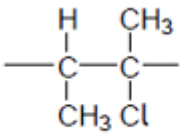
(6)

(Total 11 marks)

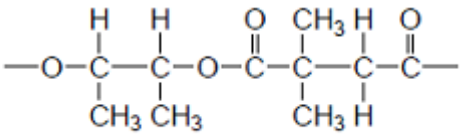
Q7.

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Repeating units of two polymers, **P** and **Q**, are shown in the figure below.



P



Q

(a) Draw the structure of the monomer used to form polymer **P**.
Name the type of polymerisation involved.

Monomer

Type of polymerisation

_____

(2)

(b) Draw the structures of **two** compounds that react together to form polymer **Q**.

Structure of compound 1

Structure of compound 2

(2)

(c) Suggest an environmental advantage of polymer **Q** over polymer **P**.
Justify your answer.

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Advantage _____

Justification _____

_____

_____

_____

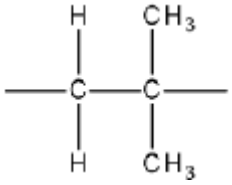
_____

(3)

(Total 7 marks)

Q8.

The repeating unit of a polymer is



Which of the following molecules would form a polymer containing this repeating unit?

A But-1-ene ⬭

B *E*-but-2-ene ⬭

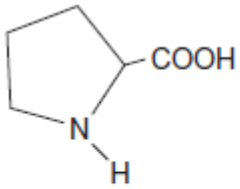
C *Z*-but-2-ene ⬭

D Methylpropene ⬭

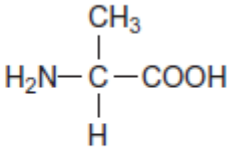
(Total 1 mark)

Q9.

(a) The structures and common names of two amino acids are shown.



proline



alanine

(i) Draw the structure of the zwitterion of proline.

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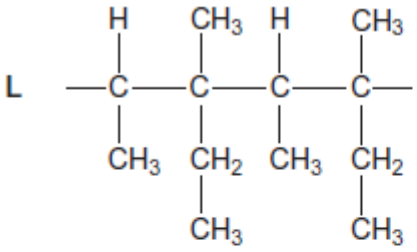
(1)

(ii) Draw the structure of the tripeptide formed when a proline molecule bonds to two alanine molecules, one on each side.

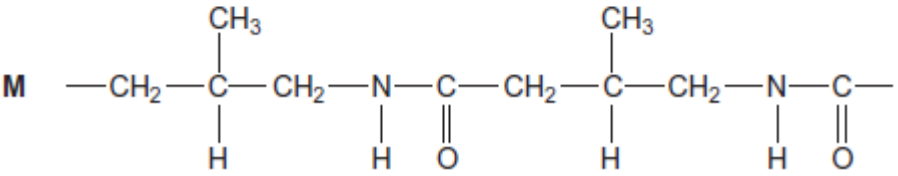
(2)

(b) Sections of two polymers, **L** and **M**, are shown.

L



M



(i) Give the IUPAC name of a monomer that forms polymer **L**.

_____

(1)

(ii) Give the IUPAC name of the monomer that forms polymer **M**.

_____

(1)

(iii) Draw the section of a polymer made from a dicarboxylic acid and a diamine that is isomeric with the section of polymer **M** shown.

(1)

(vi) Explain why polymer **L** is non-biodegradable.

_____

_____

_____

(1)

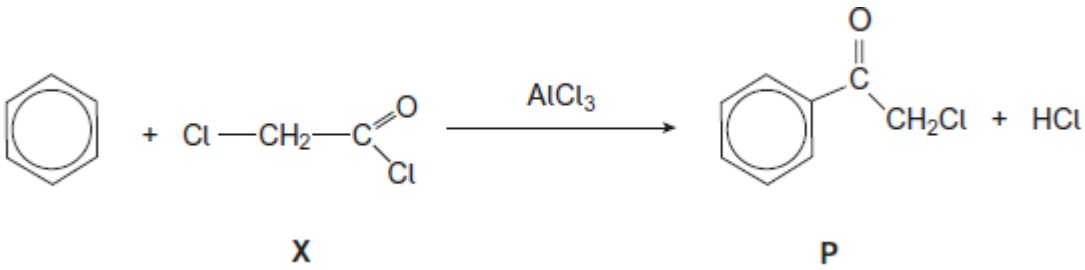
(Total 7 marks)

Q10.

Compound **X** ($ClCH_2COCl$) is used as a reagent in organic synthesis.

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(a) One important reaction of **X** is in the preparation of compound **P** as shown.



X **P**

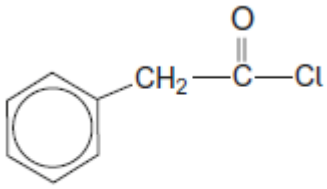
(i) Draw the structure of the electrophile formed by the reaction of **X** with $AlCl_3$.

(1)

(ii) Outline the mechanism for the reaction of the electrophile from part **(a)(i)** with benzene in the preparation of **P**.

(3)

(b) Compound **Q** is an alternative product that could be formed when **X** reacts with benzene.



Q

Describe how you could distinguish between **P** and **Q** by a test-tube reaction. Give the reagent used and the observation with each compound.

Reagent _____

Observation with **P** _____

Observation with **Q** _____

(3)

(c) **X** is also used to make the compound $HOCH_2COOH$. This compound is polymerised to form the polymer known as PGA. PGA is used in surgical sutures (stitches).

(i) Draw the repeating unit of PGA.

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(1)

(ii) Production of PGA occurs via a cyclic compound. Two $HOCH_2COOH$ molecules react together to form the cyclic compound and two molecules of water.

Draw the structure of this cyclic compound.

(1)

(d) Poly(propene) is also used in surgical sutures.

(i) Draw the repeating unit of poly(propene).

(1)

(ii) Suggest an advantage of surgical sutures made from PGA rather than from poly(propene).
Explain your answer.

_____

_____

_____

_____

(2)

(Total 12 marks)

Q11.

The carbonyl compound CH_3CH_2CHO reacts very slowly with HCN

(a) Name and outline a mechanism for the reaction of CH_3CH_2CHO with HCN

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Name of mechanism _____

Mechanism

(5)

(b) The reaction in part (a) produces a pair of enantiomers.

(i) Draw the structure of each enantiomer to show how they are related to each other.

(2)

(ii) State and explain how you could distinguish between the two enantiomers.

_____

_____

_____

_____

(2)

(c) Give the IUPAC name of the product of the reaction in part (a).

_____

(1)

(d) In practice, KCN rather than HCN is added to the carbonyl compound.

Given that K_a for HCN = 4.0×10^{-10} mol dm^{-3}, suggest why the reaction with HCN is very slow.

_____

_____

_____

_____

(2)

(e) Acrylic fibres are used as a substitute for wool. Acrylics are copolymers of

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acrylonitrile with other compounds.

Acrylonitrile is the common name for the following compound.

$$H_2C = CH - C \equiv N$$

(i) Acrylonitrile can be formed from propene.

Write an equation for the reaction of propene with ammonia and oxygen to form acrylonitrile and one other product.

_____

(1)

(ii) The term copolymer is used to describe the product obtained when two or more different monomers form a polymer.

Draw the repeating unit of the acrylic copolymer that contains 75% acrylonitrile monomer and 25% chloroethene monomer.

(1)

(iii) Name the type of polymerisation involved in part (ii)

_____

(1)

(Total 15 marks)

Q12.

Lactic acid, $CH_3CH(OH)COOH$, is formed in the human body during metabolism and exercise. This acid is also formed by the fermentation of carbohydrates such as sucrose, $C_{12}H_{22}O_{11}$.

(a) (i) Give the IUPAC name for lactic acid.

_____

(1)

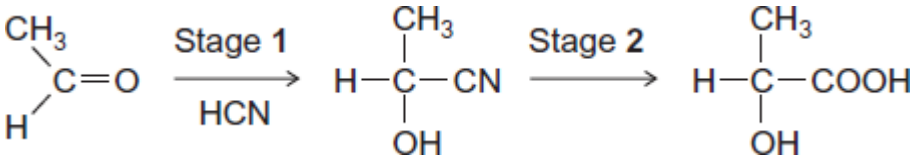
(ii) Write an equation for the formation of lactic acid from sucrose and water.

_____

(1)

(b) A molecule of lactic acid contains an asymmetric carbon atom.
The lactic acid in the body occurs as a single enantiomer.
A racemic mixture (racemate) of lactic acid can be formed in the following two-stage synthesis.

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(i) Name and outline a mechanism for Stage **1**.

Name of mechanism _____

Mechanism

(5)

(ii) Give the meaning of the term *racemic mixture (racemate)*.

_____

_____

_____

(1)

(iii) Explain how you could distinguish between a racemic mixture (racemate) of lactic acid and one of the enantiomers of lactic acid.

_____

_____

_____

_____

(2)

(c) A mixture of lactic acid and its salt sodium lactate is used as an acidity regulator in some foods. An acidity regulator makes sure that there is little variation in the pH of food.

(i) Write an equation for the reaction of lactic acid with sodium hydroxide.

_____

(1)

(ii) The acid dissociation constant K_a for lactic acid has the value 1.38×10^{-4} mol dm^{-3} at 298 K.

Calculate the pH of an equimolar solution of lactic acid and sodium lactate.

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_____

_____

_____

_____

(2)

(iii) Suggest an alternative name for the term *acidity regulator*.
Explain how a mixture of lactic acid and sodium lactate can act as a regulator when natural processes increase the acidity in some foods.

Name _____

Explanation _____

_____

_____

_____

(3)

(d)



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The cup shown is made from PLA, poly(lactic acid).
PLA is the condensation polymer formed from lactic acid.

The polymer is described as 100% biodegradable and 100% compostable.

Compostable material breaks down slowly in contact with the moist air in a garden bin. This produces compost that can be used to improve soil.

The manufacturers stress that PLA cups differ from traditional plastic cups that are neither biodegradable nor compostable.

(i) Draw a section of PLA that shows **two** repeating units.

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(2)

(ii) Name the type of condensation polymer in PLA.

_____

(1)

(iii) An intermediate in the production of PLA is a cyclic compound ($C_6H_8O_4$) that is formed from two PLA molecules.

Draw the structure of this cyclic compound.

(1)

(iv) Traditional non-biodegradable plastic cups can be made from poly(phenylethene), commonly known as *polystyrene*.

Draw the repeating unit of poly(phenylethene).

(1)

(v) The manufacturers of PLA claim that the material will break down to compost in just 12 weeks.

Suggest **one** reason why PLA in landfill may take longer than 12 weeks to break down.

_____

_____

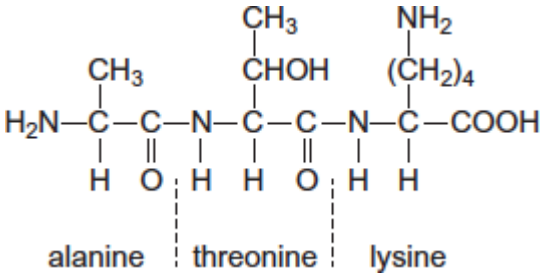
(1)

(Total 22 marks)

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Q13.

(a) The tripeptide shown is formed from the amino acids alanine, threonine and lysine.



(i) Draw a separate circle around **each** of the asymmetric carbon atoms in the tripeptide.

(1)

(ii) Draw the zwitterion of alanine.

(1)

(iii) Give the IUPAC name of threonine.

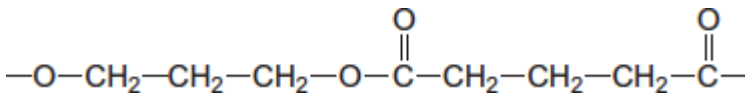
_____

(1)

(iv) Draw the species formed by lysine at low pH.

(1)

(b) The repeating unit shown represents a polyester.



(i) Name this type of polymer.

_____

(1)

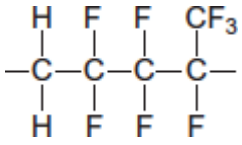
(ii) Give the IUPAC name for the alcohol used to prepare this polyester.

_____

(1)

(c) The repeating unit shown represents a polyalkene co-polymer. This co-polymer is made from two different alkene monomers.

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(i) Name the type of polymerisation occurring in the formation of this co-polymer.

_____

(1)

(ii) Draw the structure of each alkene monomer.

Alkene monomer 1 Alkene monomer 2

(2)

(d) One of the three compounds shown in parts (a), (b) and (c) cannot be broken down by hydrolysis.

Write the letter **(a)**, **(b)** or **(c)** to identify this compound and explain why hydrolysis of this compound does **not** occur.

Compound _____

Explanation _____

_____

_____

(2)

(Total 11 marks)

Q14.

The amide or peptide link is found in synthetic polyamides and also in naturally occurring proteins.

(a) (i) Draw the repeating unit of the polyamide formed by the reaction of propanedioic acid with hexane-1,6-diamine.

(2)

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(ii) In terms of the intermolecular forces between the polymer chains, explain why polyamides can be made into fibres suitable for use in sewing and weaving, whereas polyalkenes usually produce fibres that are too weak for this purpose.

_____

_____

_____

_____

_____

_____

(3)

(b) (i) Name and outline a mechanism for the reaction of CH_3CH_2COCl with CH_3NH_2

Name of mechanism _____

Mechanism

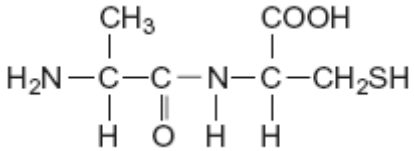
(5)

(ii) Give the name of the product containing an amide linkage that is formed in the reaction in part (b) (i).

_____

(1)

(c) The dipeptide shown below is formed from two different amino acids.



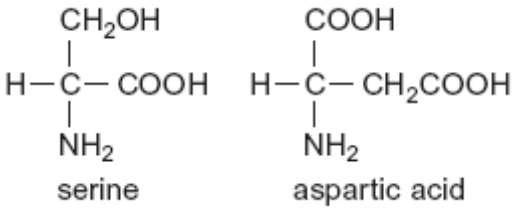
Draw the structure of the alternative dipeptide that could be formed by these two

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amino acids.

(1)

(d) The amino acids serine and aspartic acid are shown below.



(i) Give the IUPAC name of serine.

_____

(1)

(ii) Draw the structure of the species formed when aspartic acid reacts with aqueous sodium hydroxide.

(1)

(iii) Draw the structure of the species formed when serine reacts with dilute hydrochloric acid.

(1)

(iv) Draw the structure of the species formed when serine reacts with an excess of bromomethane.

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(1)

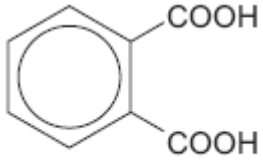
(Total 16 marks)

Q15.

Items softened with plasticisers have become an essential part of our modern society.

Compound **S**, shown below, is commonly known as phthalic acid.

Esters of phthalic acid are called phthalates and are used as plasticisers to soften polymers such as PVC, poly(chloroethene).



S

(a) Give the IUPAC name for phthalic acid.

_____

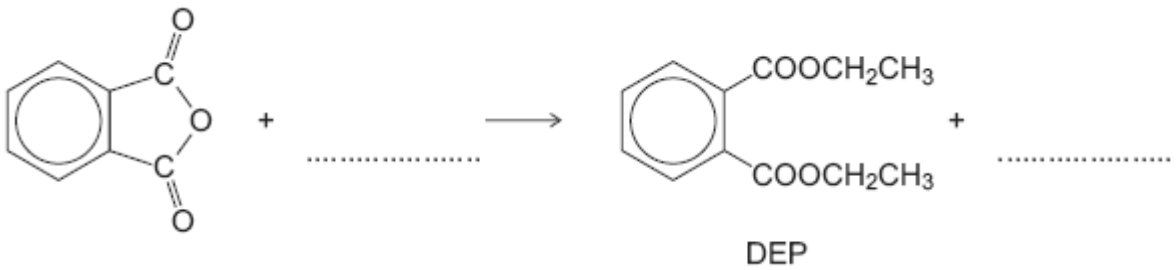
(1)

(b) Draw the displayed formula of the repeating unit of poly(chloroethene).

(1)

(c) The ester diethyl phthalate (DEP) is used in food packaging and in cosmetics.

(i) Complete the following equation showing the formation of DEP from phthalic anhydride.



DEP

(2)

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(ii) Deduce the number of peaks in the ^{13}C n.m.r. spectrum of DEP.

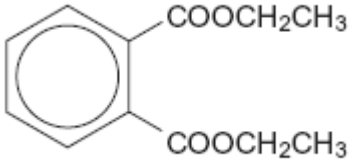
_____

(1)

(iii) One of the peaks in the ^{13}C n.m.r. spectrum of DEP is at δ = 62 ppm.

Table 3 on the Data Sheet can be used to identify a type of carbon atom responsible for this peak.

Draw a circle around **one** carbon atom of this type in the structure below.



(1)

(d) The mass spectrum of DEP includes major peaks at *m/z* = 222 (the molecular ion) and at *m/z* = 177

Write an equation to show the fragmentation of the molecular ion to form the fragment that causes the peak at *m/z* = 177

_____

(2)

(e) Because of their many uses, phthalates have been tested for possible adverse effects to humans and to the environment.

An organisation that represents the manufacturers of plasticisers asserts that experimental evidence and research findings show that phthalates do not pose a risk to human health because they biodegrade in a short time scale.

According to the organization's research, phthalates do not represent a risk for humans or for the environment and they are biodegradable.

(i) Hydrolysis of DEP in an excess of water was found to follow first order kinetics.

Write a rate equation for this hydrolysis reaction using DEP to represent the ester.

_____

(1)

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(ii) Suggest what needs to be done so that the public could feel confident that the research discussed above is reliable.

_____

_____

_____

_____

_____

(2)

(Total 11 marks)

Q16.

(a) Name compound **Y**, $HOCH_2CH_2COOH$

_____

(1)

(b) Under suitable conditions, molecules of **Y** can react with each other to form a polymer.

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

(1)

(ii) Name the type of polymerisation involved.

_____

(1)

(c) When **Y** is heated, an elimination reaction occurs in which one molecule of **Y** loses one molecule of water. The organic product formed by this reaction has an absorption at 1637 cm^{-1} in its infrared spectrum.

(i) Identify the bond that causes the absorption at 1637 cm^{-1} in its infrared spectrum.

_____

(1)

(ii) Write the displayed formula for the organic product of this elimination reaction.

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(1)

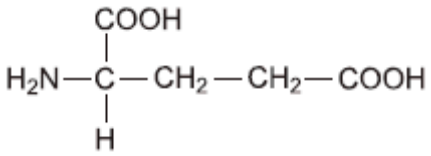
(iii) The organic product from part (ii) can also be polymerised.
Draw the repeating unit of the polymer formed from this organic product.

(1)

(d) At room temperature, 2-aminobutanoic acid exists as a solid.
Draw the structure of the species present in the solid form.

(1)

(e) The amino acid, glutamic acid, is shown below.



Draw the structure of the organic species formed when glutamic acid reacts with each of the following.

(i) an excess of sodium hydroxide

(1)

(ii) an excess of methanol in the presence of concentrated sulfuric acid

(1)

(iii) ethanoyl chloride

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(1)

(f) A tripeptide was heated with hydrochloric acid and a mixture of amino acids was formed. This mixture was separated by column chromatography.
Outline briefly why chromatography is able to separate a mixture of compounds.
Practical details are **not** required.

_____

_____

_____

_____

_____

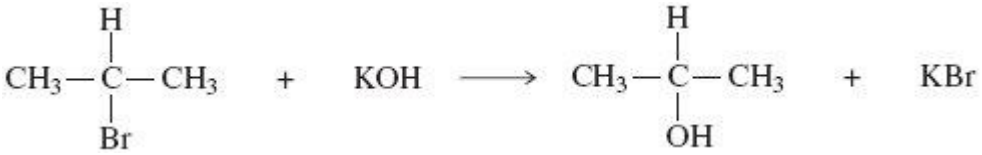
_____

(3)

(Total 13 marks)

Q17.

(a) Consider the following reaction.



(i) Name and outline a mechanism for this reaction.

Name of mechanism _____

Mechanism

(3)

(ii) Name the haloalkane in this reaction.

_____

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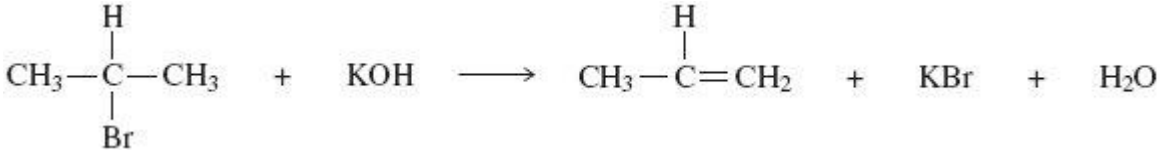
(1)

(iii) Identify the characteristic of the haloalkane molecule that enables it to undergo this type of reaction.

_____

(1)

(b) An alternative reaction can occur between this haloalkane and potassium hydroxide as shown by the following equation.



Name and outline a mechanism for this reaction.

Name of mechanism _____

Mechanism

(4)

(c) Give **one** condition needed to favour the reaction shown in part (b) rather than that shown in part (a).

_____

(1)

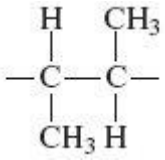
(d) Alkenes can be polymerised to produce poly(alkenes).

(i) State the type of polymerisation that alkenes undergo.

_____

(1)

(ii) Name the alkene that gives a polymer with the repeating unit shown below.



Name of alkene _____

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(1)

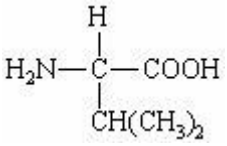
(Total 12 marks)

Q18.

Fibres are made from natural and from synthetic polymers. Both types of polymer have advantages and disadvantages.

(a) Amino acids are the building blocks of naturally-occurring polymers called proteins.

Consider the following amino acid.



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

(ii) Use your understanding of amino acid chemistry to deduce the structure of the dipeptide formed from two molecules of this amino acid and illustrate your answer with a sketch showing the structure of the dipeptide.

(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) Alkenes are the building blocks of synthetic addition polymers.

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

(i) Draw the repeating unit of the polymer.

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(ii) Draw the structure of an isomer of **G** which shows *E*-*Z* isomerism.

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

(3)

(c) Draw the repeating unit of the polymer formed by the reaction between butanedioic acid and hexane-1,6-diamine.

(2)

(d) Two plastic objects were manufactured, one from the polyalkene represented by the repeating unit in part (b)(i) and the other from the polyamide represented by the repeating unit in part (c).

After use it was suggested that both objects be disposed of as landfill.

(i) Describe an experiment in which you could compare the biodegradability of these two objects.

_____

_____

_____

_____

_____

_____

_____

(3)

(ii) Describe an advantage or a disadvantage of a different method of disposal of such objects compared with landfill.

_____

_____

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_____

_____

_____

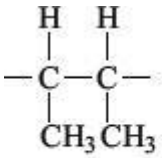
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(3)

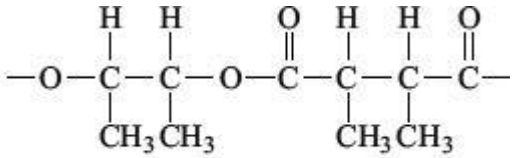
(Total 14 marks)

Q19.

(a) The repeating units of two polymers, **P** and **Q**, are shown below.



P



Q

(i) Draw the structure of the monomer used to form polymer **P**. Name the type of polymerisation involved.

Structure of monomer

Type of polymerisation _____

(ii) Draw the structures of **two** compounds which react together to form polymer **Q**. Name these **two** compounds and name the type of polymerisation involved.

Structure of compound 1

Name of compound 1 _____

Structure of compound 2

Name of compound 2 _____

Type of polymerisation _____

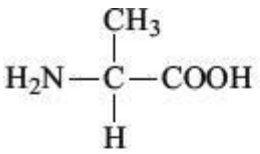
(iii) Identify a compound which, in aqueous solution, will break down polymer **Q** but not polymer **P**.

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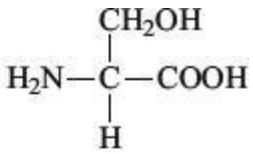
_____

(8)

(b) Draw the structures of the **two** dipeptides which can form when one of the amino acids shown below reacts with the other.



Structure 1



Structure 2

(2)

(c) Propylamine, $CH_3CH_2CH_2NH_2$, can be formed either by nucleophilic substitution or by reduction.

(i) Draw the structure of a compound which can undergo nucleophilic substitution to form propylamine.

(ii) Draw the structure of the nitrile which can be reduced to form propylamine.

(iii) State and explain which of the two routes to propylamine, by nucleophilic substitution or by reduction, gives the less pure product. Draw the structure of a compound formed as an impurity.

Route giving the less pure product _____

Explanation _____

_____

Structure of an impurity

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(5)

(Total 15 marks)

Q20.

Glucose can be used as a source of ethanol. Ethanol can be burned as a fuel or can be converted into ethene.

$C_6H_{12}O_6 \rightarrow CH_3CH_2OH \rightarrow H_2C=CH_2$

glucose ethanol ethene

(a) Name the types of reaction illustrated by the two reactions above.

Glucose to ethanol _____

Ethanol to ethene _____

(2)

(b) (i) State what must be added to an aqueous solution of glucose so that ethanol is formed.

_____

(ii) Identify a suitable catalyst for the conversion of ethanol into ethene.

_____

(2)

(c) (i) State the class of alcohols to which ethanol belongs.

_____

(ii) Give **one** advantage of using ethanol as a fuel compared with using a petroleum fraction.

_____

(2)

(d) Most of the ethene used by industry is produced when ethane is heated to 900°C in the absence of air. Write an equation for this reaction.

_____

(1)

(e) Name the type of polymerisation which occurs when ethene is converted into poly(ethene).

_____

(1)

(Total 8 marks)

Q21.

Tetrafluoroethene, C_2F_4, is obtained from chlorodifluoromethane, $CHClF_2$, according to the equation:

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$2CHClF_2(g) \rightleftharpoons C_2F_4(g) + 2HCl(g)$ $\Delta H^{o} = +128 kJ\ mol^{-1}$

(a) A 1.0 mol sample of $CHClF_2$ is placed in a container of volume 18.5 dm^3 and heated.

When equilibrium is reached, the mixture contains 0.20 mol of $CHClF_2$

(i) Calculate the number of moles of C_2F_4 and the number of moles of HCl present at equilibrium.

Number of moles of C_2F_4 _____

Number of moles of HCl _____

(ii) Write an expression for K_c for the equilibrium.

_____

(iii) Calculate a value for K_c and give its units.

Calculation _____

_____

_____

_____

Units _____

(6)

(b) (i) State how the temperature should be changed at constant pressure to increase the equilibrium yield of C_2F_4

_____

(ii) State how the total pressure should be changed at constant temperature to increase the equilibrium yield of C_2F_4

_____

(2)

(c) C_2F_4 is used to manufacture the polymer polytetrafluoroethene, PTFE. Name the type of polymerisation involved in the formation of PTFE.

_____

(1)

(Total 9 marks)

Q22.

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(a) The compound $H_2C=CHCN$ is used in the formation of acrylic polymers.

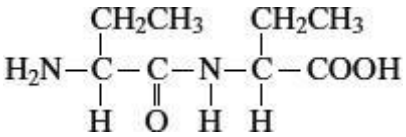
(i) Draw the repeating unit of the polymer formed from this compound.

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

_____

(2)

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



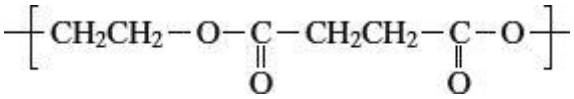
(i) Name this amino acid.

_____

(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.

_____

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

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Structure _____

Name _____

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

_____

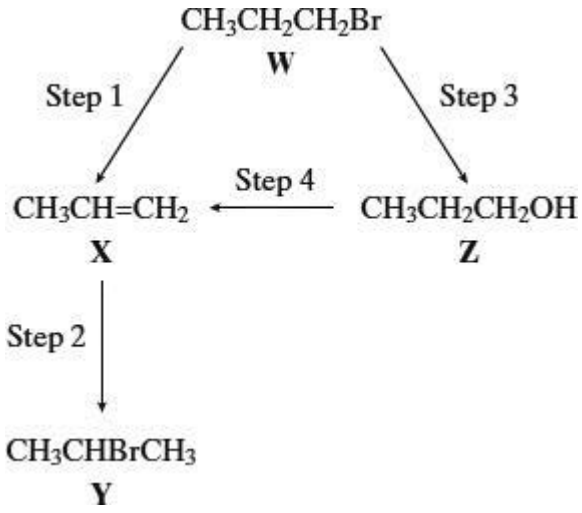
_____

(4)

(Total 8 marks)

Q23.

For this question refer to the reaction scheme below.



Which one of the following statements is **not** correct?

A Reaction of **W** with sodium cyanide followed by hydrolysis of the resulting product gives propanoic acid.

B Mild oxidation of **Z** produces a compound that reacts with Tollens' reagent, forming a silver mirror.

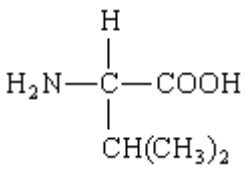
C **Z** reacts with ethanoic acid to produce the ester propyl ethanoate.

D **W** undergoes addition polymerisation to form poly(propene).

(Total 1 mark)

Q24.

(a) Consider the following amino acid.



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(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.

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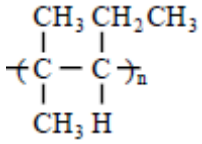
(iii) Draw the structure of an isomer of **G** which does not react with bromine water.

(4)

(Total 7 marks)

Q25.

The correct name for the alkene monomer which forms the polymer shown below is



A 2-methyl-3-ethylpropene

B 2-methylpent-2-ene

C 2-methylpent-3-ene

D 4-methylpent-2-ene

(Total 1 mark)

Q26.

Propene reacts with bromine by a mechanism known as electrophilic addition.

(a) Explain what is meant by the term *electrophile* and by the term *addition*.

Electrophile _____

_____

Addition _____

_____

(2)

(b) Explain why bromine, a non-polar molecule, is able to react with propene.

_____

_____

_____

(2)

(c) Outline the mechanism for the electrophilic addition of bromine to propene. Give the

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name of the product formed.

Mechanism

Name of product _____

(5)

(d) The polymerisation of propene to form poly(propene) is an important industrial process.

Name the type of polymerisation involved.

_____

(1)

(Total 10 marks)

Q27.

Which one of the following does **not** contain any delocalised electrons?

A poly(propene)

B benzene

C graphite

D sodium

(Total 1 mark)

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