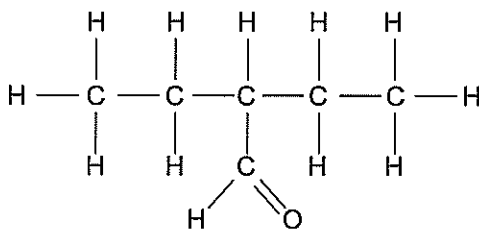


2016

18. What is the IUPAC name of the following compound?



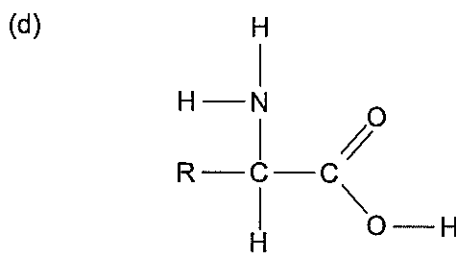
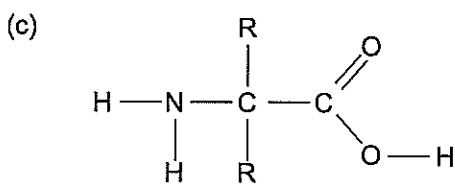
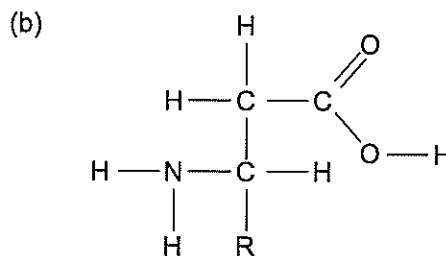
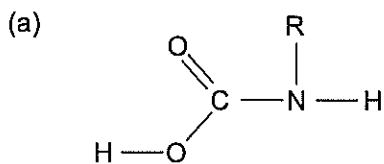
- (a) 3-methylpentan-3-al
- (b) 2-ethylbutanal
- (c) 2,2-diethylethanal
- (d) 2-methylbutanal

9

CHEMISTRY

2016

21. Which of the following **best** represents the generalised structure of α -amino acids?
(Note: R represents a side chain.)



2016

19. Below is a table of reactions involving organic compounds.

Reaction	Product
ethene + hydrogen	1
ethanal + permanganate ion	2
ethanol + acetic (ethanoic) acid	3
acetic (ethanoic) acid + sodium carbonate	4

Which row of the table below identifies a product of each reaction correctly?

	Product 1	Product 2	Product 3	Product 4
(a)	an alkane	a carboxylic acid	an aldehyde	an ester
(b)	an alkene	a carboxylic acid	an ester	carbon dioxide
(c)	an alkane	carbon dioxide	an aldehyde	a carboxylic acid
(d)	an alkane	a carboxylic acid	an ester	carbon dioxide

2016

20. Which of the following compounds could be used to produce a polymer?

- I CH_2CHCH_3
 II $\text{HOOCCH}_2\text{COOH}$
 III CH_2CHOH
 IV HOCH_2CH_3
 V $\text{H}_2\text{NCH}_2\text{NH}_2$

- (a) I, II, V
 (b) I, II, IV
 (c) I, II, III, V
 (d) II, III, IV, V

(9 marks)

Write observations for the changes occurring when the substances below are mixed. In your answers include the appearance of the reactants and any product(s) that form.

- (a) (i) methanol, pentanoic acid and sulfuric acid (2 marks)

- (ii) powdered magnesium carbonate and excess methanoic acid (2 marks)

- (iii) acidified potassium permanganate solution and excess propan-2-ol (2 marks)

- (b) Name the organic product and write the equation for the reaction when pentanal is added to a solution containing acidified sodium dichromate. (3 marks)

Organic product: _____

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Addition and condensation polymers are used in industry to produce a vast range of plastics.

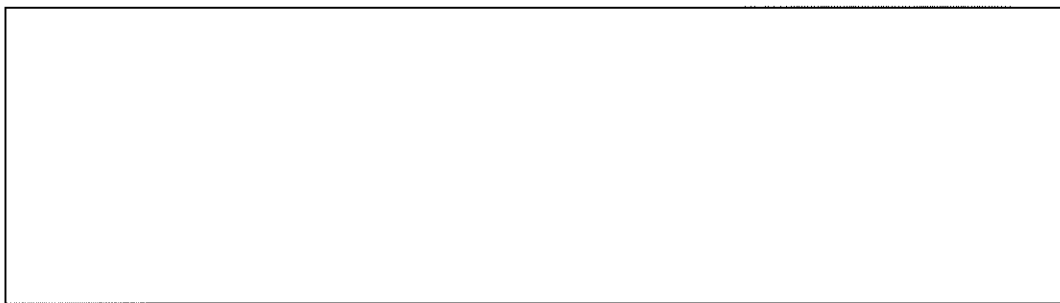
Select **one** addition polymer you have studied and use it to complete parts (a) to (c).

- (a) Draw and name the structure of the monomer used to produce this polymer. (2 marks)



Name: _____

- (b) Draw and name the polymer, including at least **three** repeating units. (2 marks)



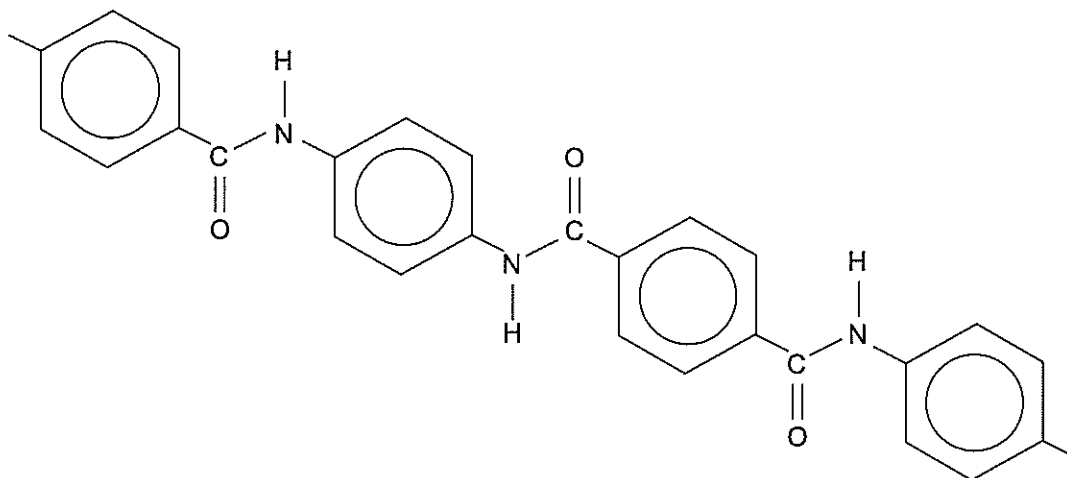
Name: _____

- (c) State **one** use for this polymer, making reference to its relevant property/ies. (2 marks)

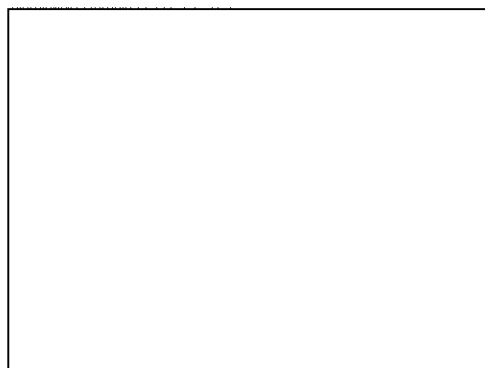
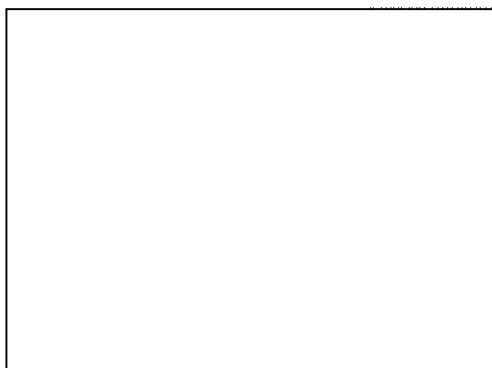
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Kevlar is a condensation polymer utilised for its high strength. A section of the Kevlar polymer is drawn below.



- (d) Draw the **two** monomers from which Kevlar is derived. (2 marks)



Kevlar's high strength can be attributed in part to the hydrogen bonding that occurs between neighbouring chains. This is similar to a secondary structure of proteins.

- (e) To what secondary structure of proteins does this refer? (1 mark)

2016

19

CHEMISTRY

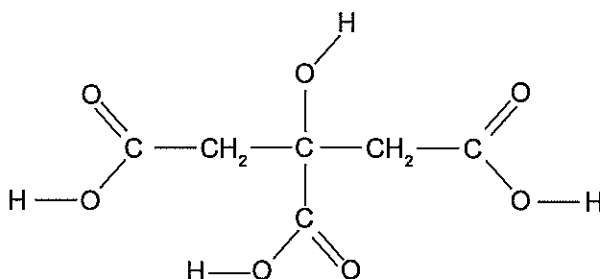
Question 33

(5 marks)

Citric acid, $C_6H_8O_7(aq)$, is a triprotic acid which reacts readily with solid sodium hydroxide, $NaOH(s)$.

- (a) Write a balanced chemical equation for this reaction, showing all state symbols. (2 marks)

The structure of $C_6H_8O_7$ is shown below.



- (b) In the spaces below, complete the structures, showing **each** successive ionisation of the acidic hydrogen atoms. (3 marks)

H ⁺ removed	Structure
First	$ \begin{array}{c} C - CH_2 - C - CH_2 - C \\ \\ C \end{array} $
Second	$ \begin{array}{c} C - CH_2 - C - CH_2 - C \\ \\ C \end{array} $
Third	$ \begin{array}{c} C - CH_2 - C - CH_2 - C \\ \\ C \end{array} $

See next page

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2016

21

CHEMISTRY

Question 35

(9 marks)

For each of the three organic compounds identified in the table below:

- use a structural formula to show the arrangement of **all** the atoms and **all** the bonds
- state **all** the intermolecular forces that exist between its molecules.

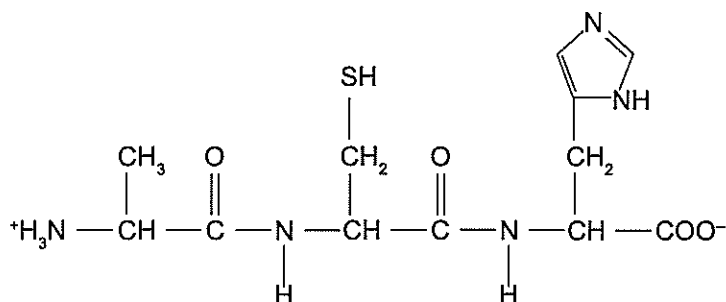
Organic compound	Full structural formula	All intermolecular forces
hexan-3-one		
1,1-difluoroethane		
butanamide		

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See next page

Condensation reactions will take place between different α -amino acids and results in them being joined by peptide bonds. Structures produced by two α -amino acids are called dipeptides, while those produced by three are called tripeptides.

(a) Below is the structure of a particular tripeptide.



(i) Circle the peptide bonds on the structure. (2 marks)

(ii) Name the **three** α -amino acids that reacted to form this tripeptide. (3 marks)

One: _____

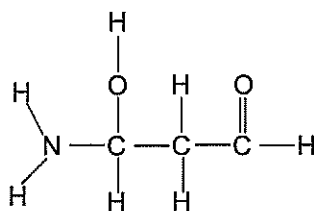
Two: _____

Three: _____

(b) Using the symbols (abbreviations) for these three α -amino acids, give **one** other polypeptide that can be formed from them. (1 mark)

Alanine is one of the simplest examples of the twenty α -amino acids found in the human body. The structure below is an isomer of alanine.

- (c) Circle and name each of the **three** functional groups on the isomer of alanine drawn below. (3 marks)



- (d) Draw a different isomer of alanine, showing clearly **all** atoms and **all** bonds. (2 marks)

Isomer of alanine structure

See next page

Pentane, pentanal and pentanoic acid all contain the same number of carbon atoms but display different physical properties. Their boiling points are given in the table below.

Organic compound	Boiling point (°C)
pentane	36.1
pentanal	102
pentanoic acid	186

Account for the difference in boiling points of the three compounds.

End of Section Two

See next page

2017

14. Which of the following are isomers of $C_5H_8O_2$?

- i $CH_3CH_2COCH_2CHO$
- ii $CH_3CH_2CH_2CH_2COOH$
- iii $CH_3COCH(CH_3)CHO$
- iv $CH_2CHCH_2CH_2COOH$

- (a) i and ii only
- (b) i, ii and iv only
- (c) i, iii and iv only
- (d) ii, iii and iv only

7

CHEMISTRY

2017

15. Which one of the following is the dominant form of glycine in basic solution?

- (a) $NH_2 - CH_2 - COOH$
- (b) $NH_2 - CH_2 - COO^-$
- (c) $NH_3^+ - CH_2 - COO^-$
- (d) $NH_3^+ - CH_2 - COOH$

2017

16. A chemist attempts to identify a pungent, colourless liquid by conducting several experiments. The results are shown in the table below:

Experiment	Observations
add acidified potassium dichromate solution	orange solution turns green
a lighted taper held above the liquid	flame and heat produced
add sodium metal	metal reacts and colourless, odourless gas evolved
add acidified, concentrated acetic (ethanoic) acid	fruity odour produced

Using this information, identify the functional group present in the liquid.

- (a) ketone
- (b) alcohol
- (c) amine
- (d) carboxylic acid

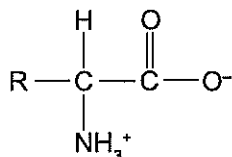
2017

17. The amino acid sequence of a protein is referred to as its

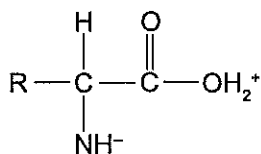
- (a) primary structure.
- (b) secondary structure.
- (c) tertiary structure.
- (d) parent chain.

19. Which one of the following structures represents a zwitterion?

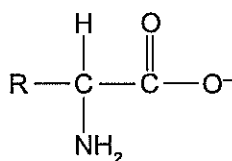
(a)



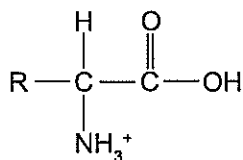
(b)



(c)



(d)



2017

20. The function of a protein is linked closely to

- (a) its method of production.
- (b) the nature of its intermolecular forces.
- (c) the number of atoms bonded to it.
- (d) its structure.

Ethanol and methanol are completely miscible (soluble) in water.

- (a) By referring to any intermolecular forces present, describe the dissolving process as ethanol is added to water. (3 marks)

- (b) Explain what happens to the solubility of alcohols in water as the hydrocarbon chain length increases. (3 marks)

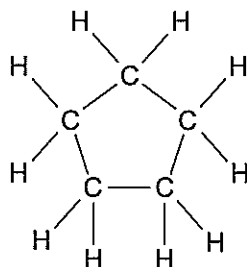
- (c) For each of the following substances, list **all** force/s of attraction formed between the solute and solvent when each substance dissolves in water. (3 marks)

Substance	Force/s of attraction with water
Propanal	
Methanoic acid	
Sodium chloride	

See next page

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There are a number of different isomers with the molecular formula of C_5H_{10} . These include chain isomers and cyclic isomers such as cyclopentane, which is shown here.



- (a) Draw **one** chain isomer for C_5H_{10} that satisfies each of the following types. For each isomer, show **all** atoms and **all** bonds. (2 marks)

Type	Diagram
Trans isomer	
Cis isomer	

Chemical tests (adding reagent/s) can be used to distinguish between **chain** and **cyclic** isomers in this question.

- (b) In the table below suggest a distinguishing test by stating the reagent/s used and the observations expected for any reaction with each isomer. (3 marks)

Reagent/s		
	Cis/trans chain isomer	Cyclic isomer
Observations		

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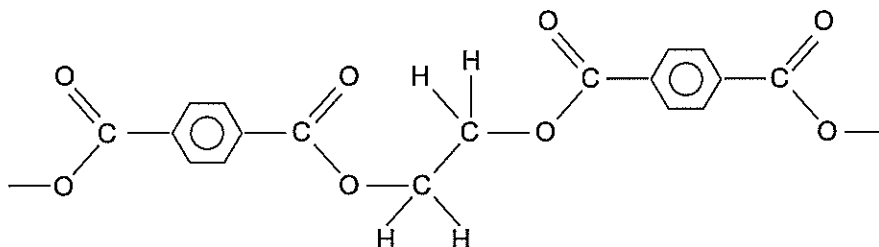
End of Section Two

See next page

2017

Question 36 (continued)

Pure antimony(III) oxide is used as a catalyst in the production of polyethylene terephthalate (PET).



A section of a PET polymer

- (c) Draw the monomers required to produce this polymer. (4 marks)

--	--

- (d) State **one** common use for PET and state **two** properties that enable it to be used for this purpose. (3 marks)

Use: _____

Properties:

One: _____

Two: _____

See next page

PET is produced through condensation polymerisation; another type of polymer is produced through addition polymerisation. Each of these types of polymerisation uses different types of monomers.

- (e) Distinguish between the types of monomers used for each type of polymerisation. (2 marks)

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See next page

Empirical formula

A third, 1.05 g sample of caffeine was converted to the gaseous phase. Measurement showed that 100.0 mL of the gas exerted 370 kPa pressure at a temperature of 550 °C.

- (b) Calculate the molar mass of caffeine. (2 marks)

- (c) From your answers to part (a) and part (b), determine the molecular formula of caffeine, showing clearly how this was determined. (2 marks)

See next page

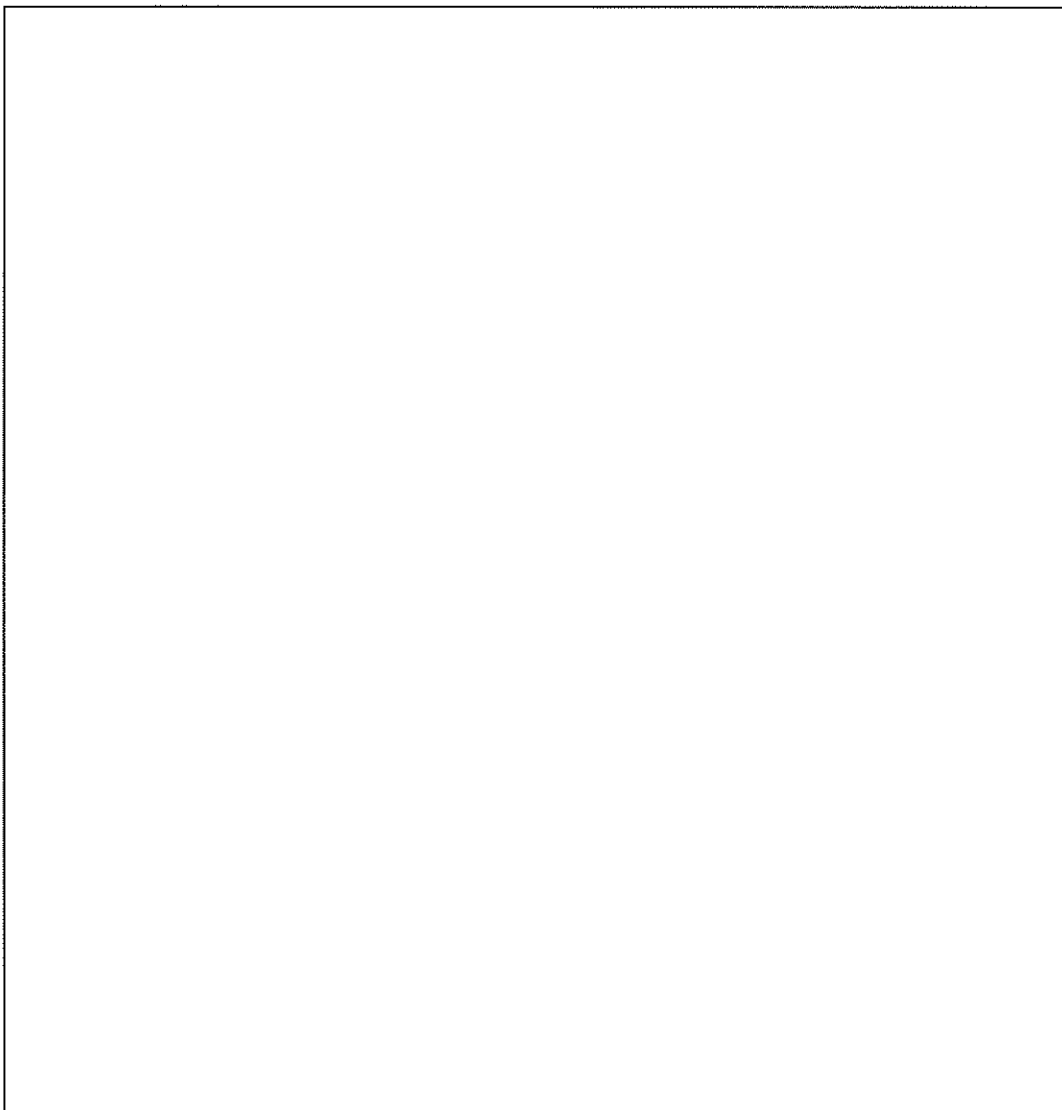
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The properties of human hair can be attributed to it being composed almost entirely of the strong fibrous protein, keratin.

Structure of keratin:

- Keratin is a polypeptide and consists of a repeating pattern of amino acids.
- Common amino acids in keratin, in order from most to least abundant, are: cysteine (17.5%), serine, glutamic acid, threonine, glycine, leucine, valine, arginine, aspartic acid and alanine (4.8%).

- (a) Draw a section of the polypeptide that is composed of the **three** most abundant amino acids found in keratin. (4 marks)



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- (b) With reference to the structure drawn in part (a), state **three** types of attractive forces/bonding other than dispersion forces, that can occur **between** neighbouring keratin polypeptide chains. (3 marks)

One: _____

Two: _____

Three: _____

- (c) Describe the α -helix structure of keratin. (2 marks)

One of the physical properties of hair is its capacity to absorb water, increasing a strand's diameter by roughly 20%.

- (d) State why hair can absorb water. (1 mark)

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2017

Question 40 (continued)

Keratin is often chemically analysed for cysteine, due to its effect on the strength of hair. One method of determining the proportion of cysteine is titration with bromide in an acidic solution. Under these conditions, the cysteine is oxidised to cystine and then to cysteic acid.

Two cysteine molecules joined together by a disulfide bond is called cystine.

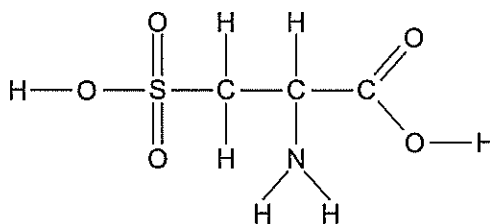
(e) Draw the structure of cystine.

(2 marks)



(f) On the structural formula of cysteic acid drawn below, circle and label any functional groups as acidic or basic.

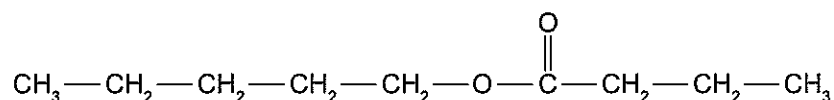
(3 marks)



End of questions

2018

4. The compound with the structural formula shown below smells like apricots:



Which of the following is true for this compound?

	Name of compound	Organic reactants required to synthesise this compound
(a)	pentyl butanoate	pentanol and butanoic acid
(b)	butyl pentanoate	butanol and pentanoic acid
(c)	pentyl butanoate	butanol and pentanoic acid
(d)	butyl pentanoate	pentanol and butanoic acid

2018

9. Which of the following statements about the Protein Databank (PDB) is/are correct?

- (i) The PDB allows users to select a protein and then view its structure.
 (ii) The PDB is updated regularly and access by scientists worldwide is free.
 (iii) The PDB is a worldwide repository of information on all chemical substances listed in chronological order of discovery.
- (a) i only
 (b) iii only
 (c) i and ii only
 (d) ii and iii only

2018

10. Which of the following is **not** a use of polytetrafluorethene?

- (a) windscreen wiper blades
 (b) parachute canopies
 (c) fabric and carpet protection
 (d) cookware coating

2018

11. Which of the following molecules is capable of demonstrating cis-trans isomerisation?

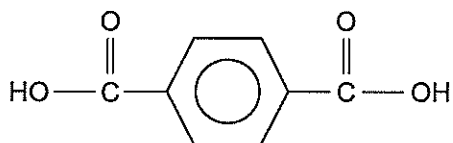
- (a) $\text{CH}_2\text{CHCHBrCH}_3$
 (b) $\text{CH}_3\text{CHCHCH}_3$
 (c) $\text{CBr}_2\text{CHCH}_2\text{CH}_2\text{Br}$
 (d) $\text{CH}_2\text{BrCBr}_2\text{CH}_2\text{CH}_3$

2018

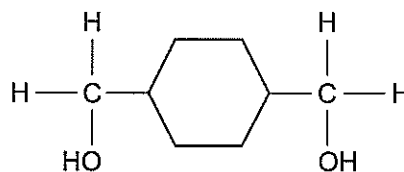
17. Proteins can contain α -helices and/or β -pleated sheets. The intermolecular forces holding these structures in their shapes are

- (a) dispersion forces.
 (b) dipole-dipole forces.
 (c) hydrogen bonds.
 (d) ion-dipole attractions.

Polycyclohexanedimethyl terephthalate glycol, (PCTG), is a strong, chemically-resistant polymer that is food-safe. The monomers needed to synthesise PCTG are terephthalic acid and 1,4-cyclohexanedimethanol, as shown below.



terephthalic acid

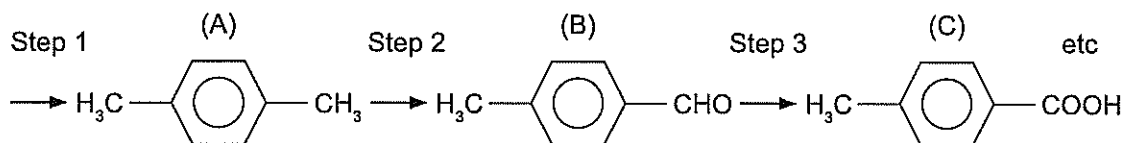


1,4-cyclohexanedimethanol

- (a) In the space below, draw the structural formula of PCTG, showing **two** repeating units. (2 marks)

- (b) State the name or give the formula of the by-product of this polymerisation process. (1 mark)

The following flow diagram shows some of the steps needed to synthesise terephthalic acid.



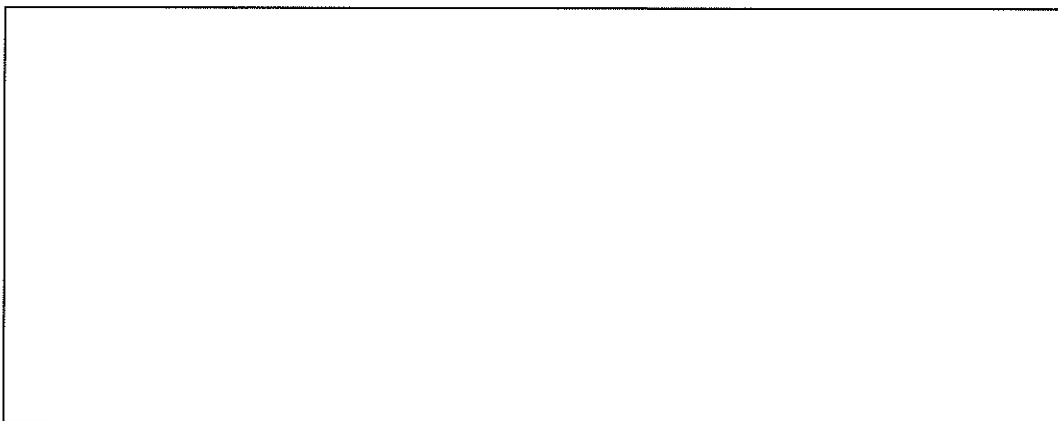
- (c) Name **two** reagents that could be used to synthesise (C) from (B) in Step 3. (2 marks)

One: _____

Two: _____

(d) Write a balanced half-equation to show (B) reacting to form (C).

(2 marks)



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See next page

Consider the compounds and their properties listed in the table below.

Compound	Boiling point (°C)	Solubility in water (g L ⁻¹)
Butane C ₄ H ₁₀	-0.5	0.061
Butan-1-ol C ₄ H ₁₀ O	117	73.0
Butanone C ₄ H ₈ O	79.6	27.5

- (a) Given that the molecular formulas indicate that the compounds contain the same number of carbon atoms and differ only in the number of one or two hydrogen or oxygen atoms, propose an hypothesis for why there is a variation in the boiling points of these compounds. (2 marks)

2018

Question 33 (continued)

Butanoic acid, $C_4H_8O_2$, is another organic compound that contains four carbon atoms in each molecule and, like butan-1-ol, it is a colourless liquid.

- (c) Complete the table below to describe a chemical test that could be used to distinguish between butan-1-ol and butanoic acid by stating the reagent/s used and the distinguishing observations. (3 marks)

Reagent/s used		
Substance being tested	Butan-1-ol	Butanoic acid
Observations		

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2018

27

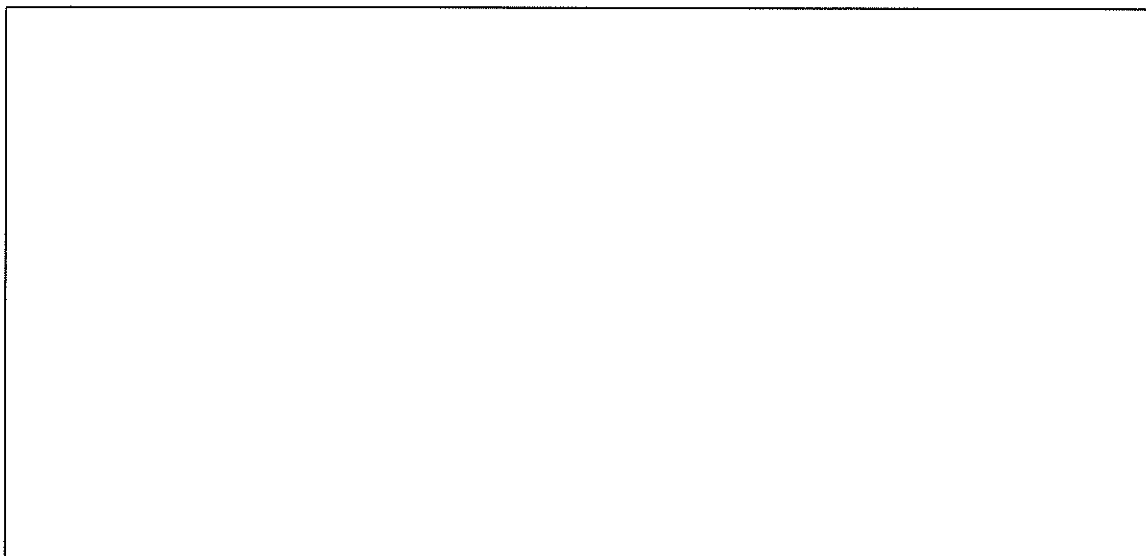
CHEMISTRY

Question 34

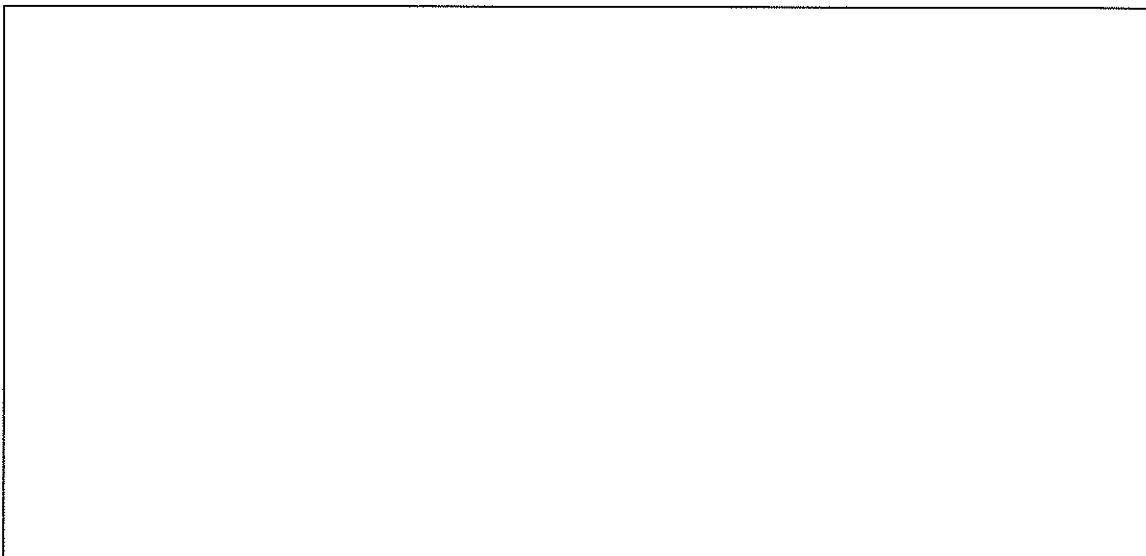
(6 marks)

For the molecular formula $C_6H_{12}O$ draw **two** different structural isomers, one which can be readily oxidised by acidified dichromate solution and one which cannot be readily oxidised by acidified dichromate solution. Show all atoms.

Isomer that **can** be readily oxidised by acidified dichromate solution.



Isomer that **cannot** be readily oxidised by acidified dichromate solution.



End of Section Two

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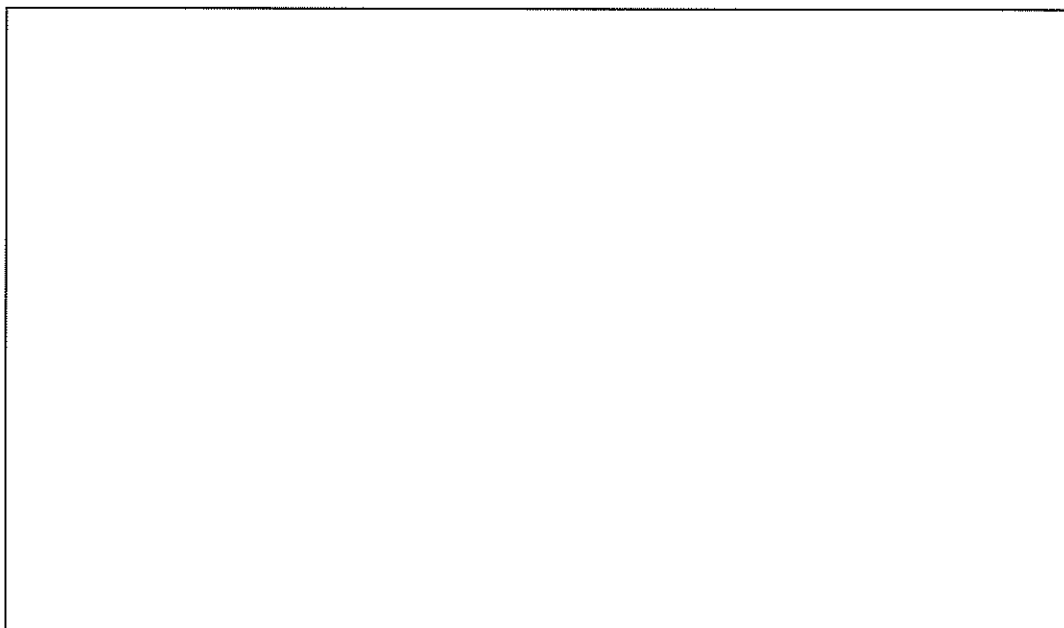
(14 marks)

The Atlantic longfin inshore squid is able to blend into its surroundings and seemingly disappear. It does this by reflecting light using specialised cells. The squid tunes and adapts the reflection of light from these cells by using a class of proteins called reflectins.

The amino acid sequences of some reflectins from this squid have been characterised. A small sequence from one of the reflectins is shown below.



- (a) Draw the full structural formula of this section of the reflectin. Show all hydrogen atoms. (3 marks)



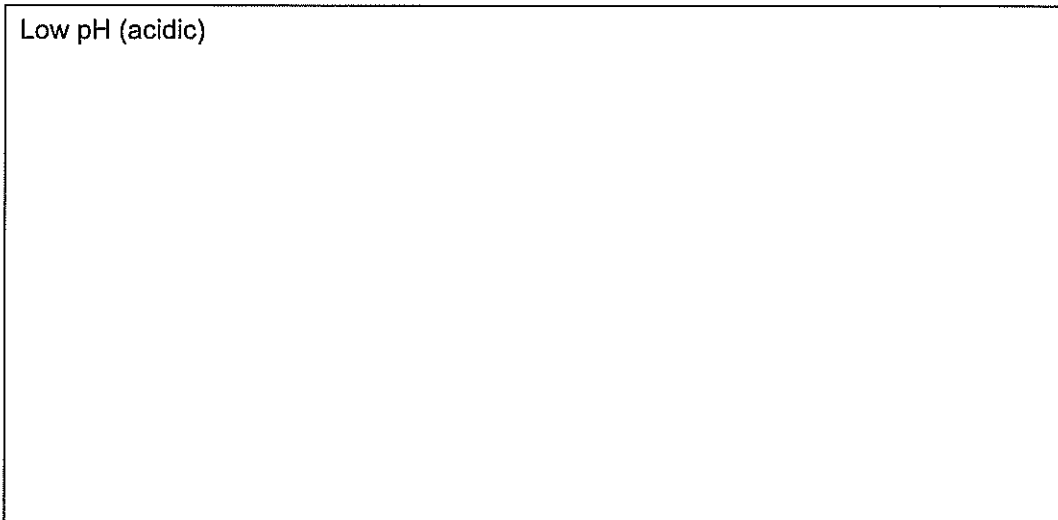
- (b) Circle **one** peptide bond in the structure that you drew in part (a). (1 mark)

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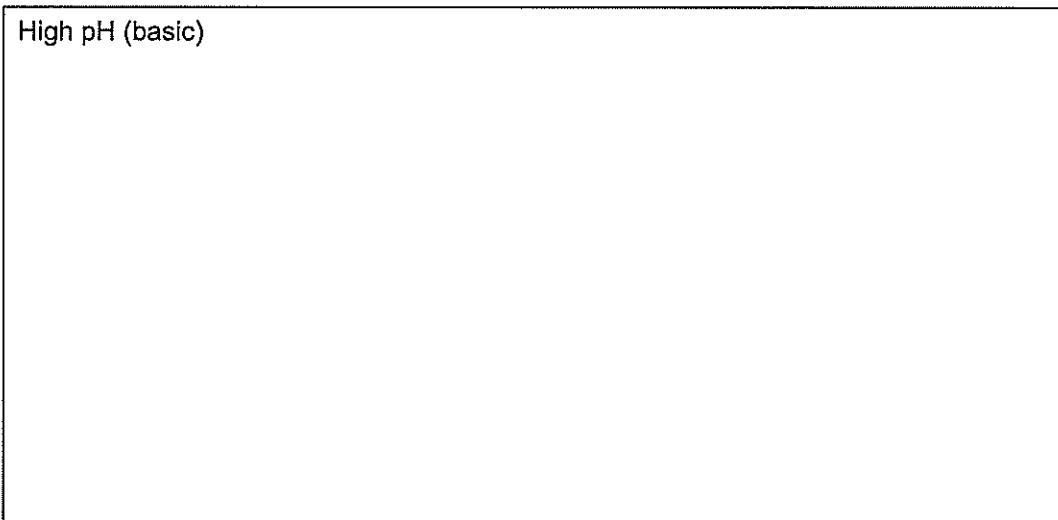
The amino acid leucine is also found in reflectin.

- (c) Draw the full structural formula of leucine, Leu, in each of the conditions specified below. Show all hydrogen atoms. (4 marks)

Low pH (acidic)



High pH (basic)



- (d) Explain why the structure of Leu is pH dependent. (3 marks)

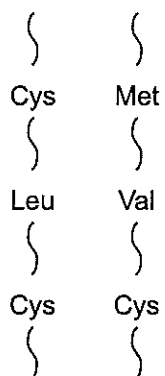
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2018

Question 39 (continued)

Consider the following amino acids found on neighbouring protein chains as they come into proximity to each other.



- (e) Identify the pair **most** strongly attracted to each other. Justify your choice. (3 marks)

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2019

9. Which one of the following is an alpha amino acid?

(a) $\begin{array}{c} \text{H} - \text{Se} - \text{CH} - \text{COOH} \\ \\ \text{NH}_2 \end{array}$	(b) $\begin{array}{c} \text{OH} \\ \\ \text{H}_2\text{N} - \text{CH} - \text{CH}_2 - \text{COOH} \end{array}$
(c) $\begin{array}{c} \text{H}_2\text{N} - \text{CH}_2 - \text{CH}_2 - \text{COOH} \\ \\ \text{CH} - \text{COOH} \end{array}$	(d) $\begin{array}{c} \text{O} \\ \\ \text{H}_2\text{N} - \text{C} - \text{NH}_2 \\ \\ \text{Se} - \text{CH}_2 - \text{COOH} \end{array}$

3E CUT OFF

CHEMISTRY

8

2019

14. Which one of the following properties exhibited by octanol is **not** related to the dispersion forces between the molecules?

- (a) combustibility
- (b) melting point
- (c) solubility in octane
- (d) solubility in water

2019

15. Which one of the following compounds will **not** exhibit geometric (cis-trans) isomerism?

- (a) 1,2-difluoro-1-butene
- (b) 1,1-difluoro-1-butene
- (c) 1,2-difluoro-2-butene
- (d) 1,4-difluoro-2-butene

2019

18. Which one of the following could **not** be a product when propan-1-ol is oxidised?

- (a) CO_2
- (b) $\text{CH}_3\text{CH}_2\text{CHO}$
- (c) $\text{CH}_3\text{CH}_2\text{COOH}$
- (d) CH_3COCH_3

See next page

2019

22. Between which of the following pairs of substances can dispersion forces exist?

- (i) CH_3Cl and H_2O
 - (ii) $\text{CH}_3\text{CH}_2\text{CHO}$ and HBr
 - (iii) $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3$ and $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_3$
 - (iv) $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$ and NH_3
- (a) i and ii only
 - (b) i, ii and iii only
 - (c) iii only
 - (d) i, ii, iii and iv

2019

23. Which one of the following is an isomer of pentanoic acid?

- (a) $\text{CH}_3\text{CHCH}_2\text{OCH}_2\text{CHO}$
- (b) $\text{CH}_2\text{CHCH}_2\text{OCH}_2\text{CH}_2\text{OH}$
- (c) $\text{OHCCH}_2\text{CH}_2\text{CH}_2\text{CHO}$
- (d) $\text{CH}_3\text{CHCHCH}_2\text{COOH}$

2019

25. How many isomers does the compound $\text{C}_2\text{H}_3\text{Br}_3$ have?

- (a) 1
- (b) 2
- (c) 3
- (d) 4

End of Section One

See next page

Organic molecules have a hydrocarbon skeleton and can contain functional groups that are responsible for the molecules' characteristic chemical properties.

Complete the following tables by

- (i) writing the structural formula of each compound listed
- (ii) writing the structural formula of the organic product from the reaction
- (iii) naming the organic product from the reaction.

When writing the structural formula, show the bonds between carbon atoms and within any functional group e.g. $\text{CH}_3\text{—CH}_2\text{—}\overset{\text{O}}{\underset{\parallel}{\text{C}}}\text{—CH}_3$

Name of compound		Structural formula of compound
pent-2-ene		
Reacts with $\text{Br}_2(\text{aq})$	Structural formula of organic product	
	Name of organic product	

DO NOT WRITE IN THIS AREA AS IT WILL BE CUT OFF

Name of compound		Structural formula of compound
ethanal		
Reacts with $\text{KMnO}_4(\text{aq}) / \text{H}^+(\text{aq})$	Structural formula of organic product	
	Name of organic product	

Name of compound		Structural formula of compound
butanoic acid		
Reacts with $\text{Na}_2\text{CO}_3(\text{aq})$	Structural formula of organic product	
	Name of organic product	

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See next page

Polymethyl methacrylate and polycarbonate are two polymers that are used as alternatives to glass. Polymethyl methacrylate is more commonly known as Perspex or plexiglass and is an addition polymer, while polycarbonate is a type of condensation polymer.

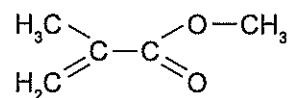
Both polymers are transparent to visible light and have other properties as listed below.

Polymethyl methacrylate	Polycarbonate
lightweight	moderate chemical resistance
moderate UV resistance	high heat resistance
low impact strength	high impact strength
low chemical resistance	low scratch resistance
low heat resistance	low UV resistance

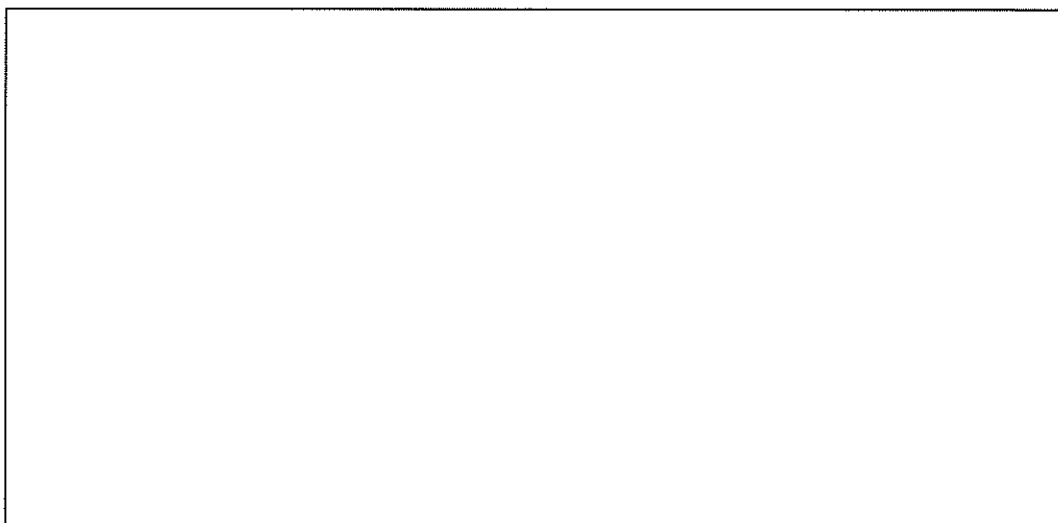
- (a) For the following uses as an alternative to glass, identify which polymer would be the more appropriate. Justify your choice of polymer by comparing the effect of **two** relevant properties as listed for both polymers. (4 marks)

Use	Choice of polymer	Justification
Skylight		
Safety glasses		

The monomer, methyl methacrylate, can be formed from the esterification of methanol and methacrylic acid (2-methylprop-2-enoic acid). The structural formula of methyl methacrylate is shown below.

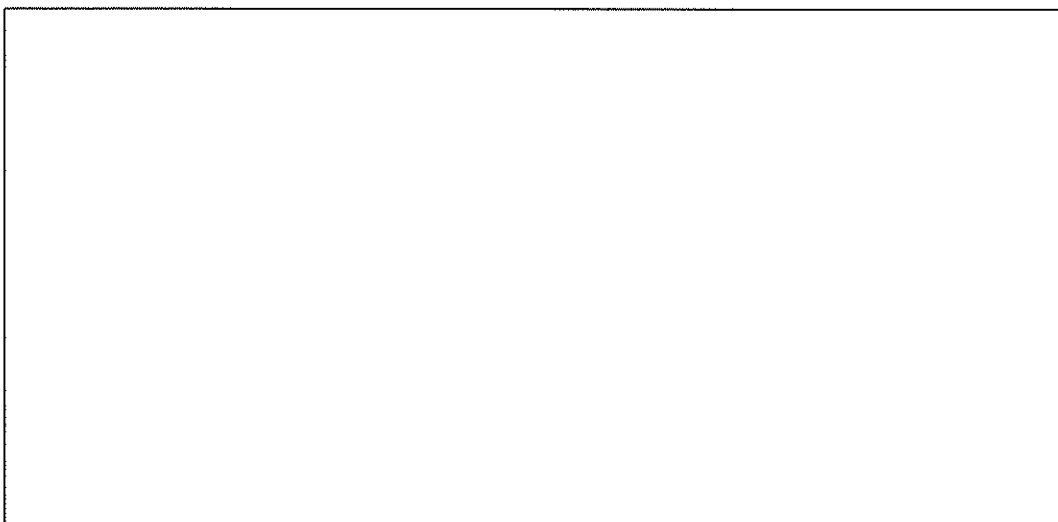


- (b) Write a balanced equation for the esterification of methanol and methacrylic acid. Show the full structural formula of each species in the equation. (4 marks)



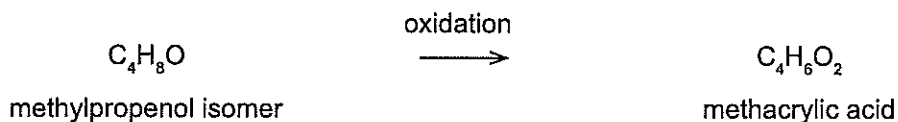
Methyl methacrylate can undergo addition polymerisation to form polymethyl methacrylate.

- (c) Draw a section of a polymethyl methacrylate showing **all** atoms and at least **three** repeating units of the monomer. (3 marks)



2019
Question 38 (continued)

One method for the production of methacrylic acid is by the following oxidation.



- (d) Suggest an assumption that **must** be made regarding the mole ratios of product to reactant for this reaction and then determine the mass of the methylpropenol isomer required to produce 1.50 tonne of methacrylic acid if the efficiency of this oxidation is 65%. (Note: 1 tonne = 1000 kg.) (5 marks)

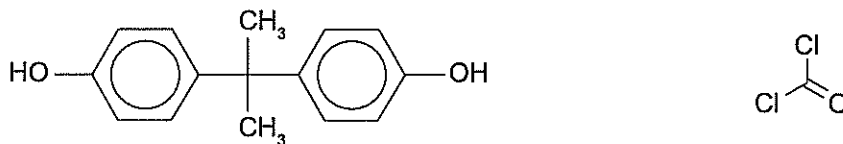
Assumption: _____

Calculation: _____

See next page

Polycarbonates are condensation-type polymers for which the by-product is hydrogen chloride instead of water.

The two monomers for polycarbonate are shown below.



- (e) Why is polymethyl methacrylate classified as an addition polymer, while polycarbonate is classified as a condensation polymer? (2 marks)

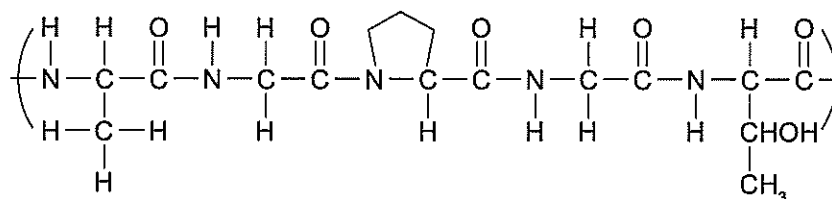
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Question 41

(12 marks)

When insects touch a spider's web they become stuck and therefore, easy prey for the spider. The insects become stuck because the web is coated with a glue-like substance produced by the spider. The 'spider glue' consists of water, proteins, ionic salts and polar carbon compounds.

The structural formula given below shows a small section of a spider glue protein.



- (a) List the names of the amino acids in the order in which they were drawn in the section of the protein given above. Do **not** use abbreviations. (3 marks)

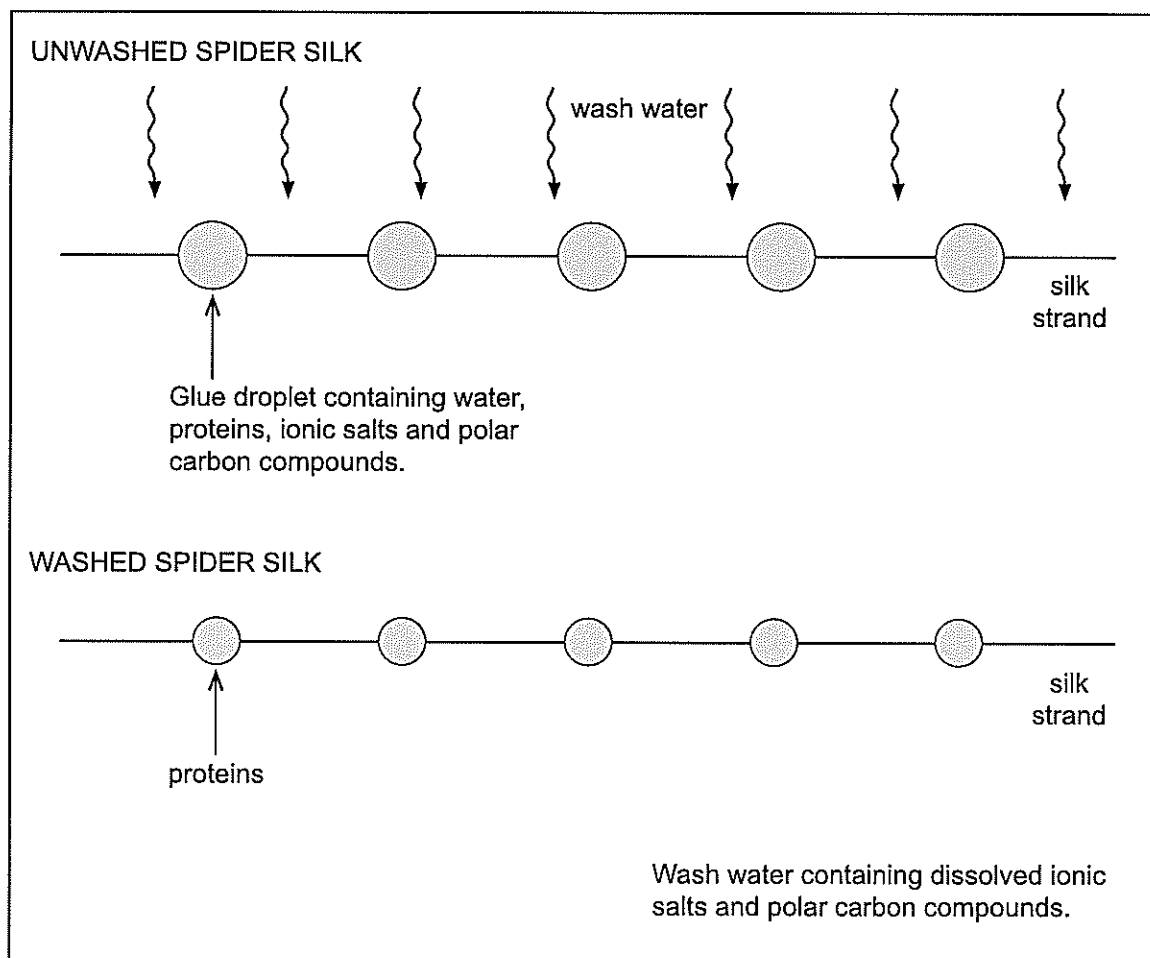
- (b) Circle **one** peptide bond in the above structure. (1 mark)

2019

Question 41 (continued)

- (c) What is the difference between the primary structure and the secondary structure of a protein? (2 marks)

When spider glue is washed with water, the ionic salts and polar carbon compounds dissolve. The proteins do not dissolve and remain on the silk strand. The following diagram shows what happens.



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See next page

2020

4.

The number of possible isomers of $C_2H_2F_2$ is

- (a) 1
- (b) 2
- (c) 3
- (d) 4

2020

13.

Which of the following alcohols would you expect to have the highest boiling point?

- (a) pentan-1-ol
- (b) pentan-2-ol
- (c) pentan-3-ol
- (d) 2-methylbutan-2-ol

2020

14.

The Protein Data Bank contains information relating to the structures of proteins. The structure of a protein is important because it is related closely to its

- (a) equilibrium constant.
- (b) bonding capacity.
- (c) nutritional value.
- (d) function.

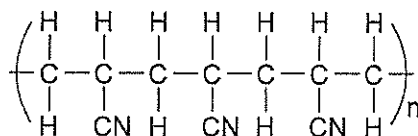
CHEMISTRY

10

2020

21.

Polyacrylonitrile fibres can be used to make blankets and carpets. The structural formula of a segment of this polymer is shown below.



The structural formula of the monomer used to make polyacrylonitrile is:

- | | |
|-----|---|
| (a) | $\begin{array}{c} \text{H} & & \text{H} \\ & & \\ \text{H}-\text{C} & = & \text{C}-\text{C}-\text{H} \\ & & & \\ & & \text{CN} & \text{H} \end{array}$ |
| (b) | $\begin{array}{c} \text{H} & \text{H} & \text{H} \\ & & \\ \text{H}-\text{C} & -\text{C} & -\text{C}-\text{H} \\ & & \\ \text{CN} & \text{H} & \text{CN} \end{array}$ |
| (c) | $\begin{array}{c} \text{H} & \text{H} \\ & \\ \text{H}-\text{C} & = & \text{C}-\text{CN} \end{array}$ |
| (d) | $\begin{array}{c} \text{H} & \text{H} \\ & \\ \text{H}-\text{C} & -\text{C}-\text{CN} \\ & \\ \text{H} & \text{H} \end{array}$ |

2020

10. Which of these statements regarding organic molecules are correct?

- (i) Organic molecules have hydrocarbon skeletons.
 (ii) Functional groups consist of groups of atoms or a particular type of bond.
 (iii) Functional groups influence the chemical properties of organic molecules.
 (iv) Functional groups influence the physical properties of organic molecules.
- (a) i and iii only
 (b) ii and iv only
 (c) i, ii and iii only
 (d) i, ii, iii and iv

2020

11. Which of the following pairs of molecules can form peptide bonds with each other?

(i)	$\begin{array}{cccc} \text{H} & \text{H} & \text{H} & \text{H} \\ & & & \\ \text{HO}-\text{C} & -\text{C} & -\text{C} & -\text{C}-\text{OH} \\ & & & \\ \text{H} & \text{H} & \text{H} & \text{H} \end{array}$ <p>butan-1,4-diol</p>	$\begin{array}{cccc} \text{H} & \text{H} & \text{H} & \text{H} \\ & & & \\ \text{H}_2\text{N}-\text{C} & -\text{C} & -\text{C} & -\text{C}-\text{NH}_2 \\ & & & \\ \text{H} & \text{H} & \text{H} & \text{H} \end{array}$ <p>butan-1,4-diamine</p>
(ii)	$\begin{array}{c} \text{CH}_2-\text{C}_6\text{H}_4-\text{OH} \\ \\ \text{H}_2\text{N}-\text{CH}-\text{COOH} \end{array}$ <p>tyrosine</p>	$\begin{array}{c} \text{CH}_2-\text{C}_6\text{H}_4-\text{OH} \\ \\ \text{H}_2\text{N}-\text{CH}-\text{COOH} \end{array}$ <p>tyrosine</p>
(iii)	$\begin{array}{c} \text{CH}_3-\text{CH}-\text{CH}_3 \\ \\ \text{H}_2\text{N}-\text{CH}-\text{COOH} \end{array}$ <p>valine</p>	$\begin{array}{c} \text{CH}_2-\text{C}_6\text{H}_5 \\ \\ \text{H}_2\text{N}-\text{CH}-\text{COOH} \end{array}$ <p>phenylalanine</p>
(iv)	$\begin{array}{ccc} \text{H} & \text{H} & \\ & & \\ \text{H}-\text{C} & -\text{C} & -\text{O}-\text{H} \\ & & \\ \text{H} & \text{H} & \end{array}$ <p>ethanol</p>	$\begin{array}{ccc} \text{H} & \text{H} & \text{O} \\ & & // \\ \text{H}-\text{C} & -\text{C} & -\text{C} \\ & & \backslash \\ \text{H} & \text{H} & \text{O}-\text{H} \end{array}$ <p>butanoic acid</p>

- (a) i and iv only
 (b) ii and iii only
 (c) i, ii and iii only
 (d) i, ii, iii and iv

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Section Two: Short answer

35% (76 Marks)

This section has nine questions. Answer **all** questions. Write your answers in the spaces provided.

Supplementary pages for planning/continuing your answers to questions are provided at the end of this Question/Answer booklet. If you use these pages to continue an answer, indicate at the original answer where the answer is continued, i.e. give the page number.

Suggested working time: 60 minutes.

2020

Question 26

(4 marks)

Complete this table by giving the IUPAC name or full structural formula of the indicated organic compounds. All hydrogen atoms must be shown.

Full structural formula	IUPAC name
$ \begin{array}{ccccccc} & \text{H} & \text{H} & \text{H} & \text{H} & & \text{H} \\ & & & & & & / \\ \text{H} & - \text{C} & - \text{C} & - \text{C} & - \text{C} & - \text{C} & - \text{N} \\ & & & & & & \backslash \\ & \text{H} & \text{H} & \text{H} & \text{H} & \text{O} & \text{H} \end{array} $	
$ \begin{array}{ccc} \text{H}_3\text{C} & & \text{CH}_3 \\ & \diagdown & / \\ & \text{C} = \text{C} & \\ & / & \diagdown \\ \text{H}_3\text{C} & & \text{CH}_3 \end{array} $	
	heptan-2-amine
	hexan-3-one

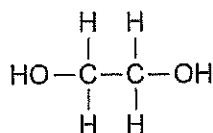
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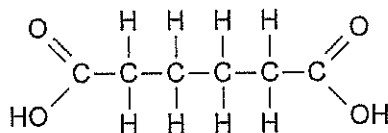
2020
Question 28

(5 marks)

Poly(ethylene adipate) is an inexpensive, biodegradable polymer. It is formed when ethylene glycol and adipic acid react. The structural formulae of these two monomers are shown below.



ethylene glycol

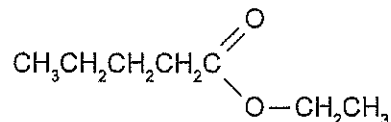


adipic acid

- (a) Draw the structural formula of poly(ethylene adipate). Show two repeating units. (2 marks)

- (b) Classify poly(ethylene adipate) according to the:
- (i) functional group or groups present in its structure. (1 mark)
- _____
- (ii) type of reaction resulting in its formation. (1 mark)
- _____
- (c) Identify a different type of reaction that results in the formation of a polymer. (1 mark)
- _____

A chemist wanted to add a fruity fragrance to an air freshener that he was developing. A colleague suggested the compound ethyl pentanoate which has an apple-like fragrance. The structure for ethyl pentanoate is shown below.



The chemist wanted to check the fragrance of this compound to make sure that it was suitable but there was no ethyl pentanoate in the chemist's laboratory. The only organic substances that the chemist had were a:

- commercial gas cylinder containing ethene
- bottle of pentan-2-one
- bottle of pentan-1-ol
- bottle of pentanal.

Ethyl pentanoate can be synthesised from one or more of the organic substances in the above list in **three** steps.

Describe the steps that will allow the chemist to synthesise ethyl pentanoate. Include balanced equations for all reactions that occur, using molecular formulae for organic compounds. Any inorganic compounds deemed necessary can be used in the procedure. It is not necessary to specify how the products of a particular reaction will be isolated before use in another reaction.

Step One: _____

See next page

Step Two: _____

Step Three: _____

Section Three: Extended answer

40% (88 Marks)

This section contains six questions. You must answer all questions. Write your answers in the spaces provided.

Where questions require an explanation and/or description, marks are awarded for the relevant chemical content and also for coherence and clarity of expression. Lists or dot points are unlikely to gain full marks.

Final answers to calculations should be expressed to the appropriate number of significant figures and include appropriate units where applicable.

Supplementary pages for planning/continuing your answers to questions are provided at the end of this Question/Answer booklet. If you use these pages to continue an answer, indicate at the end of the original answer where the answer is continued, i.e. give the page number.

Suggested working time: 70 minutes.

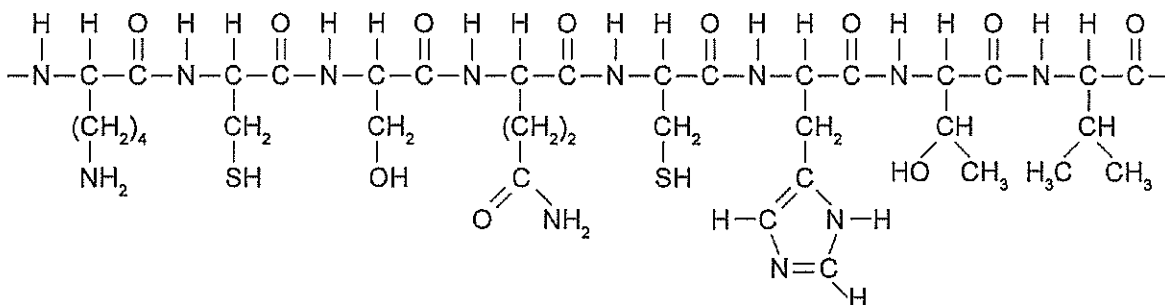
2020
Question 35

(11 marks)

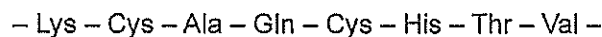
Cytochrome C is a protein found in the cells of many organisms. A biochemist analysed the Cytochrome C from a human and a grey whale to establish their respective α -amino acid sequences.

- (a) What protein structure level does the α -amino acid sequence represent? (1 mark)

The structural formula of a small segment of human Cytochrome C, as written by the biochemist in her notebook, is shown below.



The biochemist wrote the sequence of α -amino acids in the corresponding grey whale Cytochrome C segment in an abbreviated form:



2020

Question 35 (continued)

- (b) Identify **one** similarity and **one** difference between the given α -amino acid sequences of human and grey whale Cytochrome C. (2 marks)

Similarity: _____

Difference: _____

The biochemist examined the overall three-dimensional folded shape of grey whale Cytochrome C. The biochemist did this by identifying the predominant types of interactions occurring between the side chains of α -amino acids located near each other in grey whale Cytochrome C. Three of the α -amino acid pairs considered by the biochemist are shown in the following table.

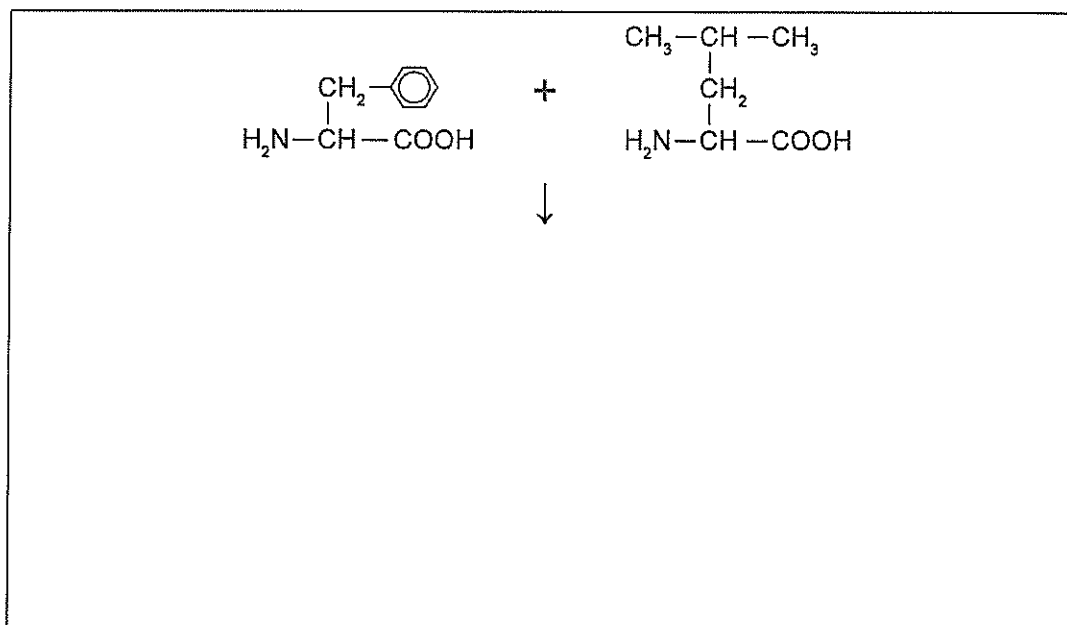
- (c) Complete the following table by identifying the predominant side chain interaction for each α -amino acid pair. (3 marks)

α -Amino acid pairs	Predominant side chain interaction
Ala and Val	
Gln and His	
Cys and Cys	

- (d) The biochemist found that both human and grey whale Cytochrome C contain several alpha helices but no beta-pleated sheets. What protein structure level do alpha helices and beta-pleated sheets represent? (1 mark)

Further analysis of human Cytochrome C showed that there was a segment where two other α -amino acids (phenylalanine and leucine) were adjacent to each other. The biochemist obtained pure samples of each of these amino acids and set up an experiment to facilitate their reaction with each other.

- (e) Write a balanced equation, using condensed structural formulae, for a reaction that occurs between phenylalanine and leucine. (2 marks)



- (f) The biochemist decided to examine how the structure of leucine changes with solution pH. Complete the following table by drawing the structural formula of leucine at the indicated pH. (2 marks)

Structural formula of leucine	pH
	acidic
	alkaline

2020

Question 38 (continued)

When another 5.00 g sample was vaporised it was found to occupy a total volume of 637 mL at 150 kPa and 40 °C.

- (b) Determine the molecular formula of the compound. (4 marks)

See next page

2021

2. Chlorine gas is bubbled for several minutes through a sample of pent-1-ene. Which of the following statements identifies the type of reaction that occurs and the colour of the solution in the flask after the reaction is complete, assuming the chlorine gas is the limiting reagent?

	Type of reaction	Solution colour after complete reaction
(a)	substitution	colourless
(b)	addition	colourless
(c)	addition	green
(d)	substitution	green

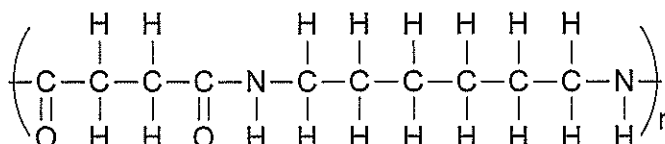
2021

4. Which of the following characteristics influence how a particular polymer might be used?

- (i) The amount of cross-linking between the hydrogen atoms in the polymer.
 (ii) The length of the carbon chains in the polymer.
 (iii) The functional groups present in the monomer used to synthesise the polymer.
 (iv) The melting point of the polymer.
- (a) ii, iii and iv only
 (b) i and ii only
 (c) ii and iii only
 (d) i, ii and iv only

2021

5. Nylon 46 is a polymer that can withstand very large forces without breaking. Its structural formula is shown below.



The intermolecular forces contributing the most to the strength of Nylon 46 is/are

- (a) covalent network bonding.
 (b) dispersion forces.
 (c) hydrogen bonding.
 (d) dipole-dipole forces.

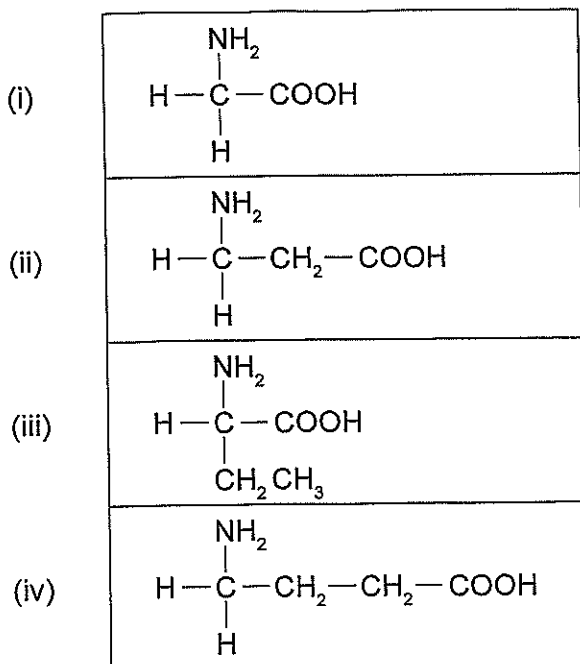
2021

19. In which of the following reactions would there be no visible reaction at 25 °C?

- (a) A solid iron strip is placed in a solution of 1.00 mol L⁻¹ copper(II) sulfate.
 (b) Bromine water and 2,3-dimethylbut-2-ene are shaken together.
 (c) Chlorine gas is bubbled through a solution of 1.00 mol L⁻¹ potassium iodide.
 (d) 1.00 mol L⁻¹ potassium dichromate and 1.00 mol L⁻¹ acetic acid are mixed together.

2021
11.

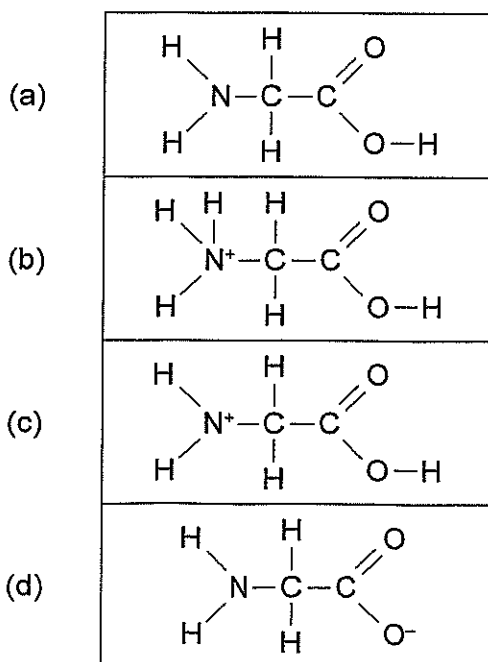
Which of the following shows an α -amino acid?



- (a) i and iii only
 (b) i only
 (c) ii, iii and iv only
 (d) i, ii, iii and iv

2021
7.

Which of the following structures represents glycine in acidic conditions?



2021
16.

Two isomeric forms of a saturated hydrocarbon

- (a) contain different types of atoms.
 (b) have the same structural formula.
 (c) have the same molecular formula.
 (d) react vigorously with one another.

Section Two: Short answer

35% (76 Marks)

This section has **eight** questions. Answer **all** questions. Write your answers in the spaces provided.

Supplementary pages for planning/continuing your answers to questions are provided at the end of this Question/Answer booklet. If you use these pages to continue an answer, indicate at the original answer where the answer is continued, i.e. give the page number.

Suggested working time: 60 minutes.

2021

Question 26

(8 marks)

A student was given the task of naming and/or drawing the structural formula of some organic compounds. The student, however, made some errors.

- (a) For each of the following organic compounds, state why the name given by the student is incorrect and rename it using IUPAC nomenclature. (4 marks)

Structural formula and name given by student	Reason for name being incorrect	IUPAC name
$ \begin{array}{cccccc} & \text{H} & \text{H} & \text{H} & \text{O} & \text{H} \\ & & & & & \\ \text{H} & -\text{C} & -\text{C} & -\text{C} & -\text{C} & -\text{C}-\text{H} \\ & & & & & \\ & \text{H} & \text{H} & \text{H} & & \text{H} \end{array} $ <p>pentan-4-one</p>		
$ \begin{array}{cccc} & \text{H} & \text{H} & \text{O} \\ & & & \\ \text{H} & -\text{C} & -\text{C} & -\text{C}-\text{NH}_2 \\ & & & \\ & \text{H} & \text{H} & \end{array} $ <p>1-aminopropanone</p>		

- (b) Circle an error in each structural formula and state the reason why it is an error. (4 marks)

Student's structural formula	Reason
$ \begin{array}{cccc} & \text{H} & \text{H} & \text{H} & \text{H} \\ & & & & \\ \text{H} & -\text{C} & -\text{C} & =\text{C} & -\text{C}-\text{H} \\ & & & & \\ & \text{H} & \text{H} & & \text{H} \end{array} $	
$ \begin{array}{cccc} & \text{H} & \text{H} & \text{H} \\ & & & \\ \text{H} & -\text{C} & -\text{C} & -\text{C}-\text{O} \\ & & & \\ & \text{H} & \text{H} & \text{H} \end{array} $	

Alcohols exhibit a variety of different chemical properties. For example, some alcohols react with acidified permanganate ions while others do not.

- (a) The alcohols in the following table were each heated with excess acidified potassium permanganate solution. Name all organic products formed **during** this process. If there is no reaction, indicate this by writing 'no reaction'. (4 marks)

Name of alcohol	Name(s) of organic compound(s) formed
2-methylpentan-2-ol	
pentan-1-ol	
pentan-2-ol	

- (b) Write a balanced overall ionic equation showing the formation of **one** of the organic compounds named in part (a). Only the alcohols listed in the table and acidified potassium permanganate solution can be used. Show your working. (4 marks)

2021 Q27

(c) The same type of reaction occurs if alcohols are mixed with acidified potassium dichromate solution.

(i) Name this type of reaction. (1 mark)

(ii) State how the reaction observations are different when limited acidified potassium dichromate solution is used instead of limited acidified potassium permanganate solution. (2 marks)

Ethanol (C_2H_5OH) dissolves readily in water, while decan-1-ol ($C_{10}H_{21}OH$) has very limited solubility. Explain, with the aid of labelled diagrams, why ethanol is able to dissolve in water and decan-1-ol is not.

End of Section Two

Section Three: Extended answer

40% (90 Marks)

This section contains six questions. You must answer all questions. Write your answers in the spaces provided.

Where questions require an explanation and/or description, marks are awarded for the relevant chemical content and also for coherence and clarity of expression. Lists or dot points are unlikely to gain full marks.

Final answers to calculations should be expressed to the appropriate number of significant figures and include appropriate units where applicable.

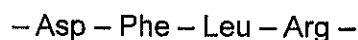
Supplementary pages for planning/continuing your answers to questions are provided at the end of this Question/Answer booklet. If you use these pages to continue an answer, indicate at the original answer where the answer is continued, i.e. give the page number.

Suggested working time: 70 minutes.

2021
Question 34

(13 marks)

Keratin 86 is a protein found in human fingernails. A small section of the amino acid sequence of Keratin 86 is shown below:



- (a) Draw the full structural formula of this small section of Keratin 86. (3 marks)

The amino acid chains in Keratin 86 form α -helices, with two α -helices twisting around each other to form what is called a 'coiled coil' that is held together by disulfide bridges.

- (b) Circle the protein structural level represented by an α -helix. (1 mark)

primary

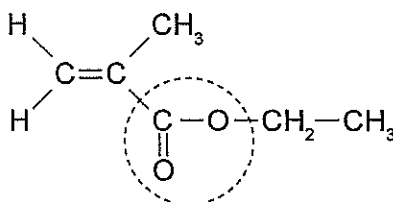
secondary

tertiary

2021
Question 34 (continued)

- (c) What does the presence of disulfide bridges indicate about the primary structure of Keratin 86? (1 mark)

Synthetic fingernails are a popular fashion accessory. They are made in industrial laboratories from polymers. A monomer that can be used to make a polymer suitable for synthetic fingernails is shown below.



- (d) Name the circled functional group in this monomer. (1 mark)
-
- (e) Give the IUPAC name of the alcohol needed to make this monomer. (1 mark)
-
- (f) Draw **three** repeating units of the polymer made from this monomer. (2 marks)

The protein which makes natural fingernails, Keratin 86, is also a polymer.

- (g) What type of polymerisation reaction produces Keratin 86 and what type produces synthetic fingernails? (2 marks)

Polymer	Type of polymerisation reaction
Keratin 86	
Synthetic fingernail polymer	

- (h) State **two** differences between the polymerisation reaction types identified in part (g). (2 marks)

One: _____

Two: _____

- (b) Another 2.30 g sample of glycoluril was vapourised at 242.0 kPa and 865.0 °C. The total volume of the resulting gas was 633.0 mL. Determine the molecular formula of glycoluril.
(5 marks)
