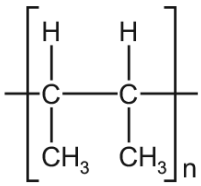
01. 0620_m21_qp_42 Q: 6

Polymers are large molecules built up from small molecules.

(a) State the name given to the small molecules from which polymers are made.

..... [1]

(b) The formula of a polymer is shown.



(i) Draw the structure of the small molecule from which this polymer is made. Show all of the atoms and all of the bonds.

[2]

(ii) State the type of polymerisation used to make this polymer.

..... [1]

(c) Three amino acids are shown. They combine to form part of a natural polymer.

(i) Name the type of natural polymer formed when amino acids combine.

..... [1]

(ii) Complete the diagram to show part of the structure of the natural polymer that forms when these three amino acids combine. Show all of the bonds in the linkages.

[3]

(iii) Name the type of chemical reaction that takes place when this natural polymer is converted back to amino acids.

..... [1]

[Total: 9]

02. 0620_s21_qp_41 Q: 1

Give the name of the process that is used:

(a) to produce ammonia from nitrogen

..... [1]

(b) to separate nitrogen from liquid air

..... [1]

(c) to produce bromine from molten lead(II) bromide

..... [1]

(d) to separate an undissolved solid from an aqueous solution

..... [1]

(e) to produce amino acids from proteins

..... [1]

(f) to separate a mixture of amino acids.

..... [1]

[Total: 6]

03. 0620_s21_qp_42 Q: 6

Molecules **A** and **B** can form condensation polymers.

(a) Each molecule has two identical functional groups.

(i) Name the functional group in **B**.

..... [1]

(ii) Draw the part of the structure of the synthetic polymer that would form when two molecules of **A** and two molecules of **B** combine. Show all of the bonds in the linkages.

[3]

(iii) Name the other product formed when molecules of **A** and **B** undergo polymerisation.

..... [1]

(b) Molecule **A** is a simple sugar unit which can be made by hydrolysis of complex carbohydrates.

(i) Draw part of the complex carbohydrate that could be hydrolysed to make molecules of **A**.

Include **one** linkage and show all of the bonds in the linkage.

[1]

(ii) State **two** sets of conditions which could be used to hydrolyse the complex carbohydrate to form **A**.

1 .....

2 .....

[2]

(iii) Name the technique used to identify the individual sugar units made by the hydrolysis of a complex carbohydrate.

..... [1]

(c) Ethanol can be made from the simple sugar glucose, $C_6H_{12}O_6$.

(i) State the name of this process.

..... [1]

(ii) Complete the chemical equation for this reaction.

$C_6H_{12}O_6 \rightarrow$ [2]

[Total: 12]

---

04. 0620_s21_qp_43 Q: 1

Give the name of the process that is used:

(a) to produce large molecules from monomers

..... [1]

(b) to separate oxygen from liquid air

..... [1]

(c) to make ethanol from glucose

..... [1]

(d) to separate water from aqueous sodium chloride

..... [1]

(e) to produce aluminium from aluminium oxide in molten cryolite

..... [1]

(f) to separate the products of hydrolysis of long chain carbohydrates

..... [1]

(g) to separate an aqueous solution from an undissolved solid.

..... [1]

[Total: 7]

---

05. 0620_w21_qp_43 Q: 7

(a) Ethanol is a member of the homologous series of alcohols.

Give **two** characteristics of members of a homologous series.

1 .....

2 .....
[2]

(b) Ethanol can be manufactured from ethene.

Ethene can be made from long chain hydrocarbons such as decane, $C_{10}H_{22}$.

Ethene is then converted into ethanol.

(i) Name the process used to obtain ethene from long chain hydrocarbons such as decane, $C_{10}H_{22}$.

..... [1]

(ii) Complete the chemical equation to show the formation of ethene from decane, $C_{10}H_{22}$.

$$C_{10}H_{22} \rightarrow C_4H_8 + \text{.....} + \text{.....}$$ [2]

(iii) Write the chemical equation for the conversion of ethene into ethanol.

..... [1]

(iv) Name the type of reaction occurring when ethene is converted into ethanol.

..... [1]

(v) Give **one** condition for the reaction in which ethene is converted into ethanol.

..... [1]

(c) Ethanol can also be produced by fermentation of carbohydrates such as glucose.

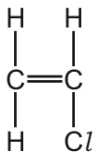
Give **two** advantages of manufacturing ethanol by fermentation compared to manufacturing ethanol from ethene.

1 .....

2 .....
[2]

(d) (i) Under certain conditions ethene can react with chlorine to produce chloroethene.

The structure of chloroethene is shown.



The equation for the chemical reaction is shown.

$$C_2H_4 + Cl_2 \rightarrow C_2H_3Cl + HCl$$

State the type of chemical reaction between ethene and chlorine that this equation shows.

..... [1]

(ii) Chloroethene monomers can be converted into a polymer called poly(chloroethene).

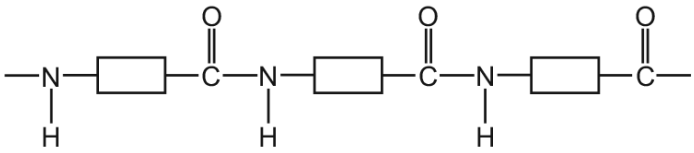
State the type of polymerisation that produces poly(chloroethene) from chloroethene.

..... [1]

(iii) Draw a section of the poly(chloroethene) molecule made from **two** monomer molecules.

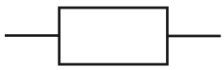
[2]

(e) The structure of part of a polymer is shown.



This polymer is made from one type of monomer only.

Complete the diagram to show the structure of the monomer used to produce this polymer. Show all of the atoms and all of the bonds in the functional groups.



[2]

[Total: 16]

06. 0620_m20_qp_42 Q: 5

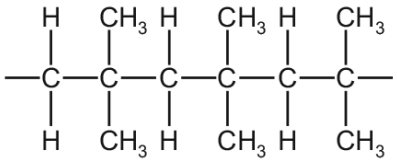
There are two types of polymers.

(a) Addition polymers are made from many identical small units.

(i) What is the term used to describe these small units?

..... [1]

(ii) A section of an addition polymer is shown.



Draw the structure of the small unit used to make this addition polymer.

Show all of the atoms and all of the bonds.

[2]

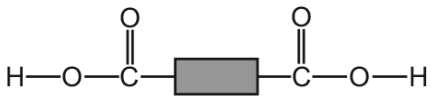
(b) Polyamides are condensation polymers.

What does the term *condensation* mean when used to describe this type of polymer?

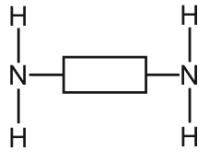
..... [1]

(c) A polyamide can be made from two different molecules.

A simplified structure of octanedioic acid is shown.



A simplified structure of 1,6-diaminohexane is shown.



(i) Complete the diagram to show a section of polyamide manufactured from octanedioic acid and 1,6-diaminohexane. Include all of the atoms and all of the bonds in the linkages.

[3]

(ii) State the name of a synthetic polyamide.

..... [1]

[Total: 8]

07. 0620_p20_qp_40 Q: 9

There are two types of polymerisation, addition and condensation.

(a) Explain the difference between these two types of polymerisation.

.....

.....

..... [2]

(b) Some plastics, formed by polymerisation, are non-biodegradable.

Describe **two** pollution problems that are caused by non-biodegradable plastics.

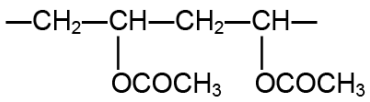
.....

.....

.....

..... [2]

(c) The polymer known as PVA is used in paints and adhesives. Its structural formula is shown below.



Deduce the structural formula of its monomer.

[1]

(d) A condensation polymer can be made from the following monomers.

$HOOC(CH_2)_4COOH$ and $H_2N(CH_2)_6NH_2$

Draw the structural formula of this polymer.

[3]

[Total: 8]

08. 0620_s20_qp_42 Q: 6

(a) Propane reacts with chlorine in a photochemical reaction as shown.

$$C_3H_8 + Cl_2 \rightarrow C_3H_7Cl + HCl$$

(i) What type of reaction is this?

..... [1]

(ii) What condition is needed for this photochemical reaction to occur?

..... [1]

(iii) Draw **two** structural isomers of compounds with the formula C_3H_7Cl.
Show all of the atoms and all of the bonds.

[2]

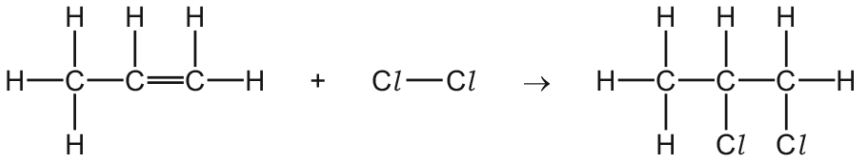
(b) Propene reacts with chlorine in an addition reaction as shown.

$$C_3H_6 + Cl_2 \rightarrow C_3H_6Cl_2$$

(i) State why this is an addition reaction.

..... [1]

(ii) The structures of the reactants and products of this reaction are shown.



Some bond energies are shown in the table.

bond	bond energy in kJ/mol
C–C	347
C=C	612
C–H	413
C–C*l*	339
C*l*–C*l*	242

Calculate the energy change for the reaction between propene and chlorine using the following steps.

- Calculate the energy needed to break the bonds.

..... kJ

- Calculate the energy released when bonds are formed.

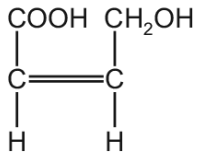
..... kJ

- Calculate the energy change for the reaction between propene and chlorine.

..... kJ/mol
[3]

(c) There are three functional groups in compound **A**.

compound **A**



(i) Name the homologous series of compounds that contains the following structures.

C=C .....

–OH .....

–COOH .....

[3]

(ii) What would you observe when compound **A** is added to:

aqueous bromine .....

aqueous sodium carbonate? .....

[2]

(d) Compound **A** can be used as a single monomer to produce two different polymers.

(i) Draw **one** repeat unit of the addition polymer formed from compound **A**.

[2]

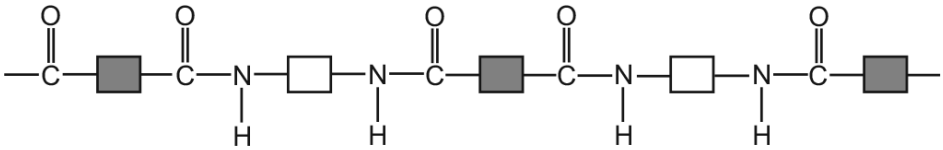
(ii) What type of condensation polymer is formed from compound **A**?

..... [1]

[Total: 16]

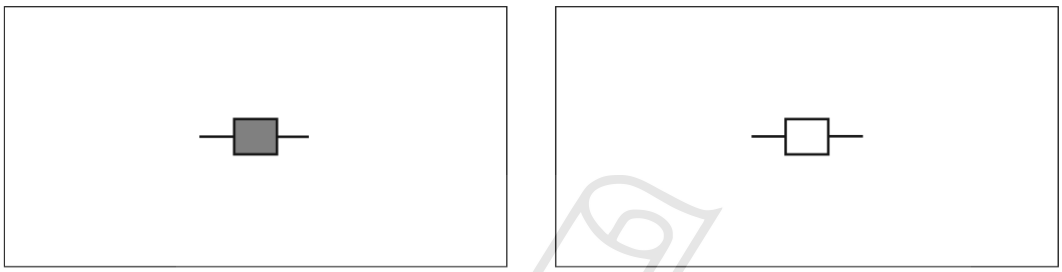
09. 0620_s20_qp_43 Q: 8

(a) Part of the synthetic polymer, nylon, is shown in the diagram.



(i) Circle **one** amide linkage **on the diagram**. [1]

(ii) Complete the structures of the **two** monomers that react to form nylon.



[2]

(iii) Name the other product formed when nylon is produced.

..... [1]

(b) Items made from nylon are often disposed of by burying them in the ground. This is called landfill.

Why is the disposal of nylon using landfill a problem?

.....

..... [1]

(c) Give the name of a natural polymer.

..... [1]

[Total: 6]

10. 0620_w20_qp_42 Q: 5

This question is about alcohols, carboxylic acids and esters.

(a) Ethanol will react with hot aqueous potassium manganate(VII) to form ethanoic acid.

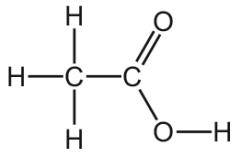
(i) State the other condition needed for this reaction to take place.

..... [1]

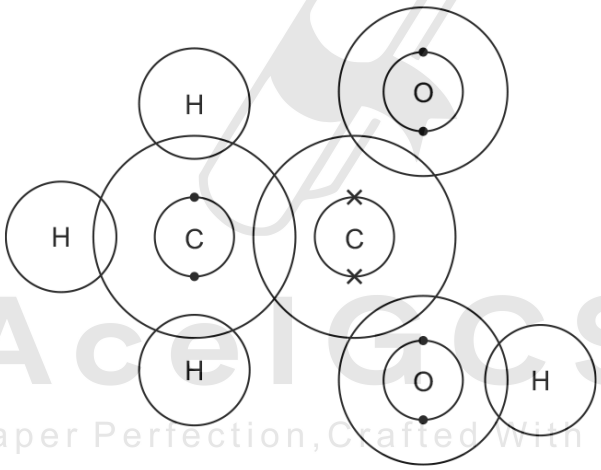
(ii) State the type of chemical change that happens to the ethanol during this reaction.

..... [1]

(iii) The structure of ethanoic acid is shown.



Complete the dot-and-cross diagram to show the electron arrangement in a molecule of ethanoic acid.



[3]

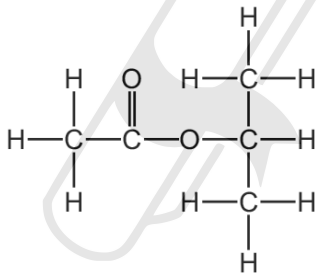
(b) Ethanoic acid is a weak acid and hydrochloric acid is a strong acid.

Complete the table to show the similarities and differences in the properties of samples of these two acids of equal concentration.

	dilute ethanoic acid	dilute hydrochloric acid
extent of dissociation		
colour after adding universal indicator solution		
observation when magnesium ribbon is added		

[6]

(c) Ethanoic acid will react with an alcohol to form the ester shown.



(i) Name the **other** product formed when ethanoic acid reacts with an alcohol to make this ester.

..... [1]

(ii) Give **one** condition needed when ethanoic acid reacts with the alcohol to make this ester.

..... [1]

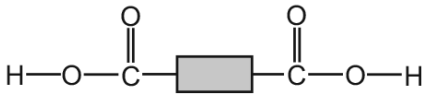
(iii) Draw the structure of the alcohol which was added to ethanoic acid to make this ester. Show all of the atoms and all of the bonds.

[2]

(d) Polyesters can be manufactured from carboxylic acids and alcohols.

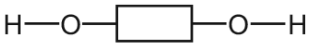
Hexanedioic acid has the structure: $HOOC–CH_2–CH_2–CH_2–CH_2–COOH$.

This structure can be simplified as shown.



Ethanediol has the structure: $HO–CH_2–CH_2–OH$.

This structure can be simplified as shown.



The functional groups are found at the end of each molecule.

(i) State what is meant by the term *functional group*.

..... [1]

(ii) Determine the empirical formula of hexanedioic acid.

..... [1]

(iii) Calculate the percentage by mass of oxygen present in ethanediol.

Give your answer to the nearest whole number.

..... % [2]

(iv) Complete the diagram to show a section of polyester manufactured from hexanedioic acid and ethanediol. Include all of the atoms and all of the bonds in the linkages.

[2]

(v) State the name of a polyester.

..... [1]

[Total: 22]

11. 0620_w20_qp_43 Q: 6

(a) A carboxylic acid and an ester are structural isomers.

(i) State the meaning of the term *structural isomers*.

.....

.....

..... [2]

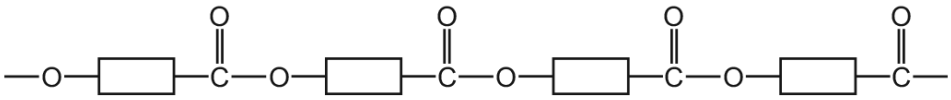
(ii) Draw the structures of the carboxylic acid and the ester which both contain two carbon atoms.
Show all of the atoms and all of the bonds.

Name the carboxylic acid and the ester.

carboxylic acid	ester
name	name .....

[4]

(b) Part of a polyester chain is shown. This polyester is made from one monomer.

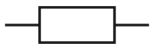


(i) **On the diagram** draw a ring around one unit of the polymer that is repeated. [1]

(ii) Name the type of polymerisation that produces polyesters.

..... [1]

(iii) Complete the diagram to show the structure of the monomer used to produce this polyester.
Show all of the atoms and all of the bonds in the functional groups.



[2]

(c) A polyamide is made from the two monomers shown.

Complete the diagram to show a section of the polyamide made from the two monomers.
Show all of the atoms and all of the bonds in the linkages.

[2]

(d) Naturally occurring polyamides are constituents of food.

(i) State the name given to naturally occurring polyamides.

..... [1]

(ii) Name the monomers which form naturally occurring polyamides.

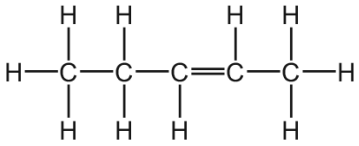
..... [1]

[Total: 14]

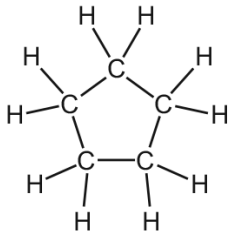
12. 0620_s19_qp_43 Q: 6

(a) Two hydrocarbons have the structures shown.

hydrocarbon **A**



hydrocarbon **B**



(i) Why are these **two** compounds *hydrocarbons*?

.....

..... [2]

(ii) Hydrocarbon **B** reacts in the same way as a typical alkane.

Describe a chemical test to tell the difference between hydrocarbon **A** and hydrocarbon **B**.

State the name of the reagent you would use and the result you would obtain with hydrocarbon **A** and hydrocarbon **B**.

reagent .....

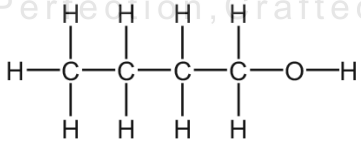
result with hydrocarbon **A** .....

result with hydrocarbon **B** .....

[3]

(b) Alkenes react with steam to form alcohols.
Compound **C** is an alcohol.

compound **C**



Draw the structure of the alkene which could be reacted with steam to make compound **C**.
Show all of the atoms and all of the bonds.

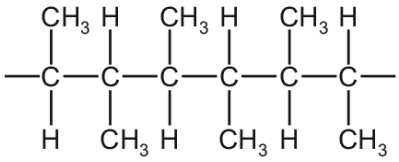
[1]

(c) Alkenes can form polymers.

(i) What type of polymerisation occurs when alkenes form polymers?

..... [1]

(ii) Part of the structure of a polymer is shown.

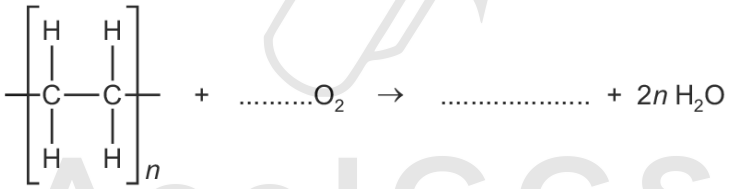


Draw the structure of the alkene from which this polymer can be made. Show all of the atoms and all of the bonds.

[1]

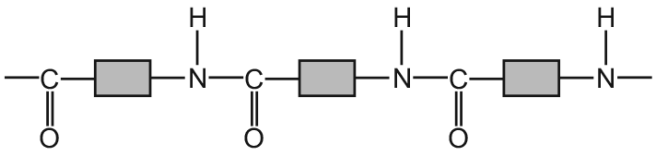
(iii) Polymers can undergo incomplete combustion to form carbon monoxide.

Complete the chemical equation for the incomplete combustion of poly(ethene). The only carbon-containing product is carbon monoxide.



[2]

(d) Part of the structure of a polyamide is shown.



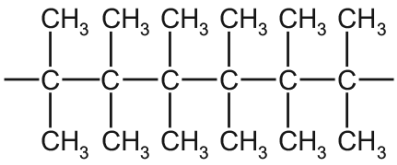
This polyamide is formed from identical monomers. Complete the diagram to show the structure of **one** monomer. Show all of the atoms and all of the bonds.

[2]

[Total: 12]

13. 0620_w19_qp_41 Q: 5

(a) Part of the structure of synthetic polymer **A** is shown.



(i) What type of synthetic polymer is **A**?

..... [1]

(ii) Deduce the empirical formula of polymer **A**.

..... [1]

(iii) Draw the structure of the monomer from which polymer **A** is made.

[2]

(b) The formula C_4H_{10} represents two different structural isomers.

(i) What is meant by the term *structural isomers*?

.....

.....

..... [2]

(ii) Draw the structures of **two** structural isomers with the formula C_4H_{10}.
Show all of the atoms and all of the bonds.

[2]

(iii) All structural isomers of C_4H_{10} are flammable.

Write a chemical equation for the **incomplete** combustion of C_4H_{10}.

..... [2]

[Total: 10]

14. 0620_w19_qp_42 Q: 2

The gases Ar, CO_2, N_2 and O_2 are in clean, dry air.

CO, NO, NO_2 and SO_2 are gases commonly found in polluted air.

(a) What percentage of clean, dry air is N_2?

Give your answer to the nearest whole number.

..... % [1]

(b) Name the process used to separate O_2 from clean, dry air.

..... [2]

(c) State **one** major adverse effect of the pollutant SO_2.

..... [1]

(d) NO and NO_2 are produced in car engines.

Describe how oxides of nitrogen form in a car engine.

.....

.....

..... [2]

(e) Many cars have catalytic converters in their exhaust systems. In a catalytic converter, most of the CO and NO formed in a car engine is changed into less harmful products.

Identify these products and state the metal catalyst used.

products .....

catalyst .....
[3]

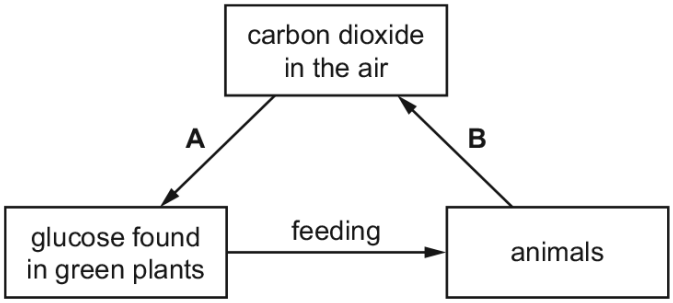
(f) CO is formed from the incomplete combustion of fossil fuels such as methane.

Write a chemical equation to show the incomplete combustion of methane.

..... [2]

(g) The CO_2 in air is part of the carbon cycle.

The scheme shows a simple representation of part of the carbon cycle.



(i) State the scientific terms for each of process **A** and process **B**.

A .....

B .....

[2]

(ii) Plants convert glucose into complex carbohydrates.

A unit of glucose can be represented as HO—▭—OH.

Complete the diagram to show the complex carbohydrate formed from **three** units of glucose. Show all of the atoms and all of the bonds in the linkages.

[2]

(iii) Complex carbohydrates break down to form simple sugars.

State **two** ways that complex carbohydrates can be broken down into simple sugars.

1 .....

2 .....

[2]

(iv) Name a suitable technique for separating and identifying the individual sugars formed when complex carbohydrates are broken down.

..... [1]

[Total: 18]

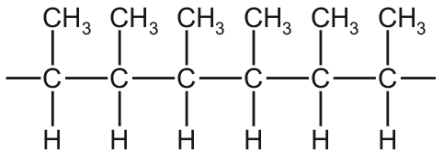
15. 0620_w19_qp_43 Q: 7

Addition polymerisation and condensation polymerisation are two types of polymerisation.

(a) Which functional group is present in all the monomers which are used to make addition polymers?

..... [1]

(b) Part of an addition polymer is shown.



(i) How many monomer units are needed to make the part of the addition polymer shown?

..... [1]

(ii) Draw the structure of the monomer that is used to make this addition polymer. Show all of the atoms and all of the bonds.

Name the monomer.

name .....
[2]

(iii) State the empirical formula of:

the monomer .....

the polymer. .....
[2]

(c) Complex carbohydrates are natural condensation polymers. They can be broken down into colourless monomers which can then be separated and identified.

X is a complex carbohydrate.

Starting with a sample of **X**, describe how to produce, separate, detect and identify the monomers which make it up.

Your answer should include:
- the name of the process used to break down **X** into its monomers
- **two** types of substance that can be used to break down **X**
- the name of the process used to **separate** the monomers
- the method used to **detect** the monomers after they have been separated
- the method used to **identify** the monomers after they have been separated and detected.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [6]

(d) Synthetic polyamides are condensation polymers.

(i) Name a synthetic polyamide.

..... [1]

(ii) Synthetic polyamides can be made by reacting carboxylic acids with amines.

Name the other substance that is produced in this reaction.

..... [1]

[Total: 14]

16. 0620_m18_qp_42 Q: 4

Ammonia is an important chemical.

(a) Ammonia is a base.

(i) In chemistry, what is meant by the term *base*?

.....

..... [1]

(ii) Write a word equation to show ammonia behaving as a base.

.....

..... [2]

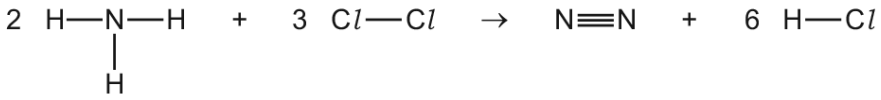
(b) Ammonia reacts with chlorine. The chemical equation is shown.

$$2NH_3(g) + 3Cl_2(g) \rightarrow N_2(g) + 6HCl(g)$$

(i) Calculate the volume of chlorine, measured at room temperature and pressure, needed to react completely with 0.68 g of ammonia.

volume of chlorine = ... cm^3 [3]

(ii) The chemical equation can be represented as shown.



Use the bond energies in the table to determine the energy change, ΔH, for the reaction between ammonia and chlorine.

bond	bond energy in kJ / mol
N–H	390
C*l*–C*l*	240
N≡N	945
H–C*l*	430

- energy needed to break bonds

..... kJ

- energy released when bonds are formed

..... kJ

- energy change, ΔH, for the reaction between ammonia and chlorine

..... kJ
[3]

(iii) Is the reaction endothermic or exothermic? Explain your answer.

.....

..... [1]

(c) Ammonia reacts with oxygen at high temperatures in the presence of a suitable catalyst to form nitric oxide, NO.

$$4NH_3(g) + 5O_2(g) \rightarrow 4NO(g) + 6H_2O(g)$$

(i) Explain how this chemical equation shows ammonia acting as a reducing agent.

.....

..... [1]

(ii) Suggest a suitable catalyst for the reaction from the list of metals. Give a reason for your answer.

aluminium **calcium** **platinum** **potassium** **sodium**

suitable catalyst .....

reason .....
[2]

[Total: 13]

17. 0620_m18_qp_42 Q: 5

Alcohols are a 'family' of organic molecules which have the same general formula.

(a) What is the name given to any 'family' of organic molecules which have the same general formula and similar chemical properties?

..... [1]

(b) Give the general formula of alcohols.

..... [1]

(c) Propan-1-ol can be made from propene.

(i) Name the reagent and give the conditions needed to convert propene into propan-1-ol.

reagent .....

conditions .....

[2]

(ii) Write a chemical equation for the complete combustion of propan-1-ol.

..... [2]

(d) A simple sugar can be represented as shown.

Simple sugars can be polymerised to make more complex carbohydrates.

(i) Complete the diagram to show part of a carbohydrate **polymer** made from the simple sugar shown.

[2]

(ii) Name the chemical process which occurs when a carbohydrate polymer is broken down into simple sugars.

..... [1]

(iii) What conditions are needed for this process to occur?

..... [1]

(e) Chromatography can be used to identify simple sugars in a mixture.

A student analysed a mixture of simple sugars by chromatography. All the simple sugars in the mixture were colourless.

(i) What is the name given to the type of substance used to identify the positions of the simple sugars on the chromatogram?

..... [1]

(ii) The student calculated the R_f value of a spot on the chromatogram.

Complete the expression for the R_f value of the spot.

R_f =

[1]

(iii) How could a student identify a simple sugar from its R_f value?

.....

..... [1]

(iv) Sometimes not all the substances in a mixture can be identified from the chromatogram produced.

Explain why this may happen.

..... [1]

[Total: 14]

18. 0620_s18_qp_41 Q: 6

The table shows the structures of four hydrocarbons.

P	Q	R	S
$CH_3–CH_3$	$CH_2=CH_2$	$CH_2=CH–CH_3$	$CH_2=CH–CH_2–CH_3$

(a) Why are compounds **P**, **Q**, **R** and **S** known as hydrocarbons?

.....

..... [2]

(b) Compound **P** is saturated.

What is meant by the term *saturated*?

.....

..... [1]

(c) Compound **P** undergoes a substitution reaction with chlorine.

(i) What is meant by the term *substitution reaction*?

.....

..... [1]

(ii) State a condition required for this reaction to occur.

..... [1]

(iii) Write a chemical equation for this reaction.

..... [2]

(d) Compound **R** undergoes an addition reaction with bromine.

(i) Why is this reaction an addition reaction?

..... [1]

(ii) A compound containing bromine is formed in this reaction.

Draw the structure of this compound. Show all of the atoms and all of the bonds.

[1]

(e) Draw the structure of an unbranched isomer of compound **S**. Show all of the atoms and all of the bonds. Name this unbranched isomer of compound **S**.

structure

name .....
[2]

(f) Compound **Q** undergoes polymerisation.

(i) Name the polymer formed.

..... [1]

(ii) Complete the chemical equation to show the polymerisation of compound **Q**.

$n\ CH_2{=}CH_2 \rightarrow$

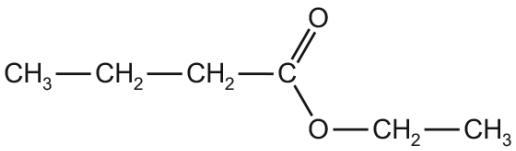
[2]

(g) Amino acids undergo polymerisation to form proteins. Part of a protein molecule with the linkages missing is shown.

Draw the linkages on the diagram. Show all of the atoms and all of the bonds.

[2]

(h) The structure shows an ester.



Write the word equation for a reaction which could be used to make this ester.

..... [3]

[Total: 19]

19. 0620_w18_qp_41 Q: 6

(a) Ethane, C_2H_6, is a member of the homologous series called alkanes.
Ethanol, C_2H_5OH, is a member of the homologous series called alcohols.

(i) Alkanes are hydrocarbons.

What is meant by the term *hydrocarbon*?

.....

..... [2]

(ii) All members of a homologous series can be represented by a general formula.

State the general formula of:

- alkanes .....
- alcohols .....

[2]

(iii) State **two** characteristics, other than having the same general formula, of members of a homologous series.

1 .....

.....

2 .....

.....

[2]

(b) Ethane can react with chlorine in a substitution reaction.

(i) State **one** essential reaction condition.

..... [1]

(ii) Draw the structure of the organic product formed by substitution of **one** of the hydrogen atoms in ethane with chlorine. Show all of the atoms and all of the bonds.

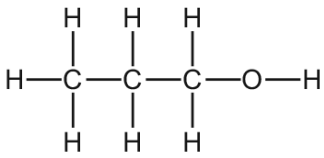
[1]

(iii) Name the product of the substitution reaction between ethane and chlorine that does **not** contain carbon.

..... [1]

(c) Propan-1-ol is an alcohol.

The structure of propan-1-ol is shown.

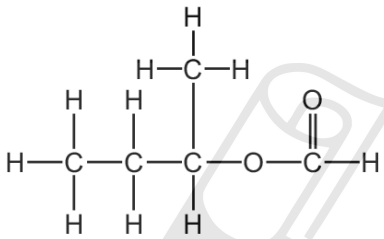


Propan-1-ol reacts with ethanoic acid to form an ester.

Give the name of the ester formed in this reaction.

..... [1]

(d) Ester **Y** has the structure shown.



ester **Y**

(i) Give the molecular formula of ester **Y**.

..... [1]

(ii) Draw the structures of the carboxylic acid and the alcohol used to make ester **Y**. Show all of the atoms and all of the bonds. Give the name of the carboxylic acid and the alcohol.

structure of the carboxylic acid

name of the carboxylic acid .....

structure of the alcohol

name of the alcohol .....

[4]

(e) Nylon is a polyamide.

Complete the diagram to show the structure of nylon. Show all of the atoms and all of the bonds present in the linkages.

[3]

[Total: 18]

---

20. 0620_w18_qp_42 Q: 5

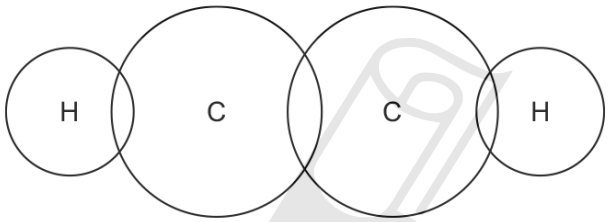
Alkynes are a homologous series of unsaturated hydrocarbons.
All members contain a C≡C triple bond.

(a) Complete the table showing information about the first **three** alkynes.

formula	C_2H_2	C_3H_4	
structure	H–C≡C–H	H–C≡C–CH_3	H–C≡C–CH_2–CH_3
name	ethyne		butyne

[2]

(b) Complete the dot-and-cross diagram to show the electron arrangement in a molecule of ethyne, H–C≡C–H. Show outer shell electrons only.



[2]

(c) Compounds in the same homologous series have the same general formula.

(i) Give **two** other characteristics of members of a homologous series.

1 .....

2 .....

[2]

(ii) Use the information in the table in **(a)** to deduce the general formula of alkynes.

..... [1]

(d) Alkynes are unsaturated.

Describe a test for unsaturation.

test .....

result .....

[2]

(e) **(i)** Name an oxidising agent which can be used to oxidise ethanol to ethanoic acid.

..... [2]

(ii) Draw the structure of ethanoic acid. Show all of the atoms and all of the bonds.

[1]

(f) Carboxylic acids can be converted into esters.

(i) The ester formed by reacting propanoic acid and methanol has the molecular formula $C_4H_8O_2$.

Name this ester and draw its structure. Show all of the atoms and all of the bonds.

name of the ester .....

structure of the ester

[2]

(ii) Name another ester with the molecular formula $C_4H_8O_2$.

..... [1]

(g) Polyesters are polymers.

(i) What type of polymerisation is used in the manufacture of polyesters?

..... [1]

(ii) Name a polyester.

..... [1]

[Total: 17]

21. 0620_w18_qp_43 Q: 6

(a) Ethanol can be manufactured by fermentation and by hydration.

(i) Describe these **two** processes of ethanol manufacture.

In each case you should:
- identify the reactants
- give the reaction conditions
- write a chemical equation for the reaction which produces ethanol.

fermentation .....

.....

.....

.....

.....

hydration .....

.....

.....

.....

.....

[6]

(ii) Give **two** advantages of ethanol manufacture by fermentation compared to by hydration.

1 .....

2 .....

[2]

(iii) State **two** major uses of ethanol.

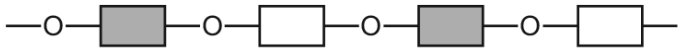
1 .....

2 .....

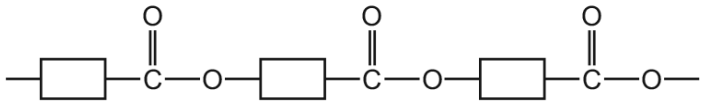
[2]

(b) The structures of some polymers are shown.

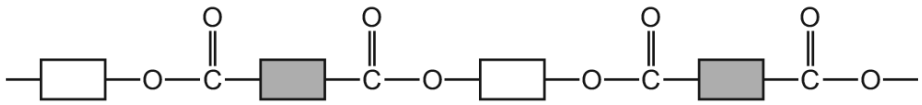
A



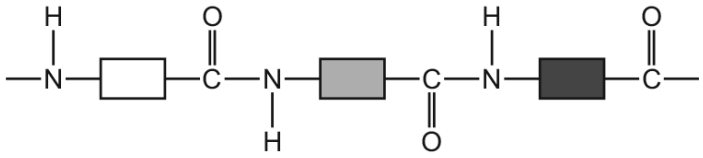
B



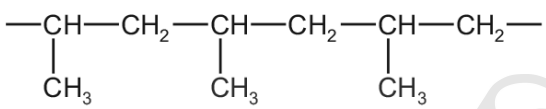
C



D



E



Answer the following questions about these polymers.
Each polymer may be used once, more than once or not at all.

State which polymer, **A**, **B**, **C**, **D** or **E**, represents:

(i) an addition polymer ..... [1]

(ii) a protein ..... [1]

(iii) a polyester made from only **one** monomer ..... [1]

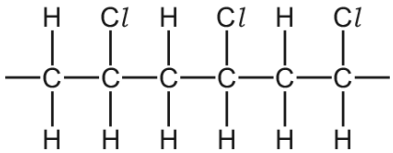
(iv) *Terylene* ..... [1]

(v) a complex carbohydrate. ..... [1]

[Total: 15]

22. 0620_m17_qp_42 Q: 7

(a) The diagram shows part of the structure of an addition polymer.



(i) Draw a circle around **one** repeat unit of the polymer. [1]

(ii) Draw the structure of the monomer from which this addition polymer is made.

[1]

(iii) Aqueous bromine is added to both the polymer and the monomer.

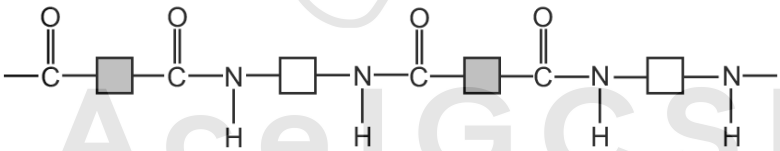
Describe what would be seen in each case.

with the polymer .....

with the monomer .....

[2]

(b) The diagram shows part of the structure of a condensation polymer.



(i) What type of condensation polymer is this?

..... [1]

(ii) On the diagram, draw a circle around **one** repeat unit of the polymer. [1]

(iii) Draw the structures of the **two** monomers from which the condensation polymer is made.

(c) Hydrolysis of a polymer gave a compound with the following composition by mass: C, 34.61%; H, 3.85%; O, 61.54%.

(i) Calculate the empirical formula of the compound.

empirical formula = ... [3]

(ii) What additional information is needed to calculate the molecular formula of the compound?

.....

..... [1]

[Total: 12]

---

23. 0620_s17_qp_42 Q: 6

(a) An homologous series is a 'family' of organic compounds whose names have the same ending.

(i) Name the homologous series for which the names of the organic compounds end in *-ene* and *-oic acid*.

-ene ..... [1]

-oic acid ..... [1]

(ii) State **two** characteristics of an homologous series.

.....

..... [2]

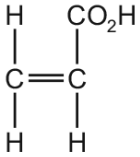
(b) Propan-1-ol is a member of the homologous series of alcohols. It reacts in the same way as ethanol with acidified potassium manganate(VII) and with carboxylic acids.

Name the **type** of compound that is formed when propan-1-ol is heated with

acidified potassium manganate(VII), ...

ethanoic acid and a suitable catalyst. .....
[2]

(c) The structure of prop-2-enoic (acrylic) acid is shown.



(i) What would you see if prop-2-enoic acid were added to

aqueous bromine, ...

a solution of sodium carbonate. .....

[2]

(ii) Prop-2-enoic acid can be polymerised to form poly(acrylic acid).

Suggest the type of polymerisation that occurs and draw **one** repeat unit of the polymer.

type of polymerisation .....

repeat unit

[3]

[Total: 11]

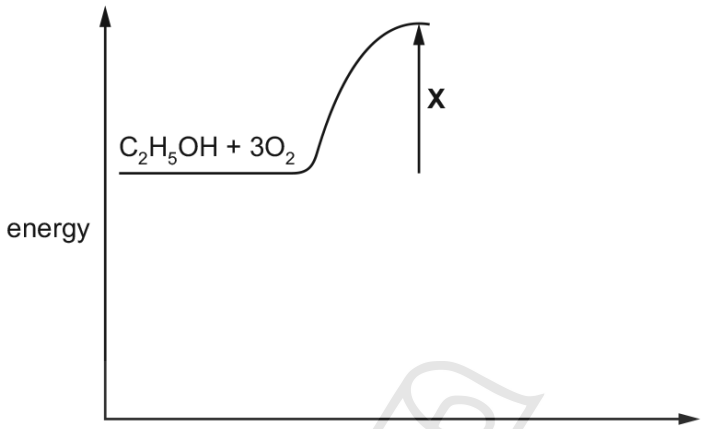
24. 0620_w17_qp_42 Q: 3

The chemical equation for the complete combustion of ethanol, C_2H_5OH, is shown.

$$C_2H_5OH + 3O_2 \rightarrow 2CO_2 + 3H_2O$$

The energy released when one mole of ethanol undergoes complete combustion is 1280 kJ.

Part of the energy level diagram for this reaction is shown.



(a) Complete the energy level diagram to show
- the products of the reaction,
- the overall energy change of the reaction.

[3]

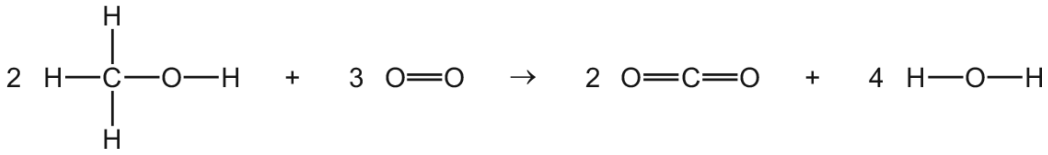
(b) What does **X** represent?

..... [1]

(c) The chemical equation for the complete combustion of methanol, CH_3OH, is shown.

$$2CH_3OH + 3O_2 \rightarrow 2CO_2 + 4H_2O$$

The equation can be represented as shown.



Use the bond energies in the table to determine the energy change, ΔH, for the complete combustion of **one** mole of methanol.

bond	bond energy in kJ / mol
C–H	410
C–O	360
O–H	460
O=O	500
C=O	805

- energy needed to break bonds

..... kJ

- energy released when bonds are formed

..... kJ

- energy change, ΔH, for the complete combustion of **one** mole of methanol

..... kJ / mol
[4]

(d) Dodecane is an alkane containing 12 carbon atoms. Ethanol can be manufactured from dodecane in a two-stage process.

In **stage 1**, each molecule of dodecane is converted into three molecules of ethene and one molecule of another hydrocarbon.

(i) Name the process which occurs in **stage 1**.

..... [1]

(ii) Write a chemical equation for the reaction which occurs in **stage 1**.

..... [2]

In **stage 2**, ethene reacts with steam to produce ethanol.

(iii) State **two** conditions needed for **stage 2**.

1 .....

2 .....
[2]

(iv) Name the type of reaction which occurs in **stage 2**.

..... [1]

(v) Suggest how to test the purity of the ethanol produced.

.....

..... [2]

(e) Ethanol can also be manufactured by the fermentation of glucose, $C_6H_{12}O_6$.

(i) State **two** conditions needed for the fermentation of glucose.

1 .....

2 .....

[2]

(ii) Complete the chemical equation for the fermentation of glucose.

$$C_6H_{12}O_6 \rightarrow \text{.....}C_2H_5OH + \text{.....}$$

[2]

(iii) One disadvantage of fermentation is that the maximum concentration of ethanol produced is about 15%.

Suggest why the concentration of ethanol produced by fermentation does **not** exceed 15%.

.....

..... [1]

(iv) Give **one** other disadvantage of manufacturing ethanol by fermentation.

..... [1]

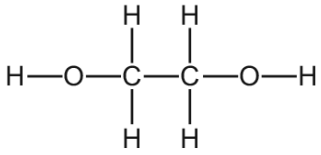
(v) Give **one** advantage, other than cost, of manufacturing ethanol by fermentation.

..... [1]

(vi) Suggest the name of a process to obtain ethanol from a mixture of ethanol and water.

..... [1]

(f) Ethane-1,2-diol has the following structure.



(i) Write the empirical formula of ethane-1,2-diol.

..... [1]

(ii) Ethane-1,2-diol can undergo condensation polymerisation but cannot undergo addition polymerisation.

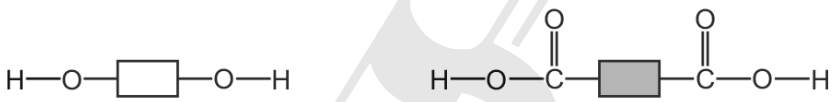
Explain why ethane-1,2-diol **cannot** undergo addition polymerisation.

.....

..... [1]

(iii) Ethane-1,2-diol undergoes condensation polymerisation with molecule **Y**.

The diagrams represent the structures of ethane-1,2-diol and molecule **Y**.



ethane-1,2-diol molecule **Y**

Draw the condensation polymer formed between ethane-1,2-diol and molecule **Y**.
Show **one** repeat unit. Show all of the atoms and all of the bonds in the linkage.

[3]

(iv) Name the type of condensation polymer formed between ethane-1,2-diol and molecule **Y**.

..... [1]

[Total: 30]

25. 0620_w17_qp_43 Q: 7

(a) Carbon and silicon are elements in Group IV of the Periodic Table.
Carbon dioxide from the air moves into green plants and is converted into carbohydrates.

(i) Name the process by which carbon dioxide molecules move through the air into green plants.

..... [1]

(ii) Explain why silicon(IV) oxide **cannot** move through the air in the same way that carbon dioxide can.

..... [1]

(iii) Name the process by which carbon dioxide is converted into glucose, $C_6H_{12}O_6$, in green plants. Give **two** conditions required for this process to occur. Write a chemical equation for the reaction which occurs.

name of process .....

condition 1 .....

condition 2 .....

chemical equation .....

[5]

(b) Starch is a natural polymer made from glucose.

(i) What type of polymerisation occurs when glucose is converted into starch?

..... [1]

(ii) What type of reaction occurs when starch is converted into glucose?

..... [1]

(iii) Starch can be represented as shown.

Complete the diagram below to represent the structure of the glucose monomer.

[1]

[Total: 10]

26. 0620_m16_qp_42 Q: 7

(a) Alkanes and alkenes are examples of hydrocarbons.

(i) What is meant by the term *hydrocarbon*?

.....

..... [1]

(ii) Give the general formula of straight-chain

alkanes, ...

alkenes. .....
[2]

(b) A compound X contains carbon, hydrogen and oxygen only.

X contains 54.54% of carbon by mass, 9.09% of hydrogen by mass and 36.37% of oxygen by mass.

(i) Calculate the empirical formula of compound X.

[2]

(ii) Compound X has a relative molecular mass of 88.

Deduce the molecular formula of compound X.

(c) An ester has the molecular formula $C_3H_6O_2$.

Name and give the structural formulae of **two** esters with the molecular formula $C_3H_6O_2$.

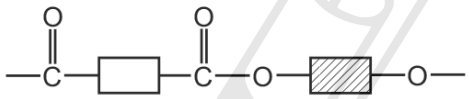
name of ester		
structural formula		

[4]

(d) Name the ester produced from the reaction of propanoic acid and methanol.

..... [1]

(e) A polyester is represented by the structure shown.



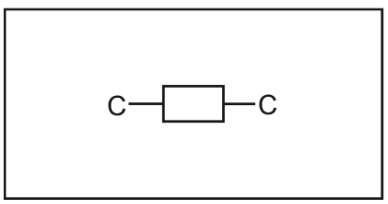
(i) What type of polymerisation is used for the production of polyesters?

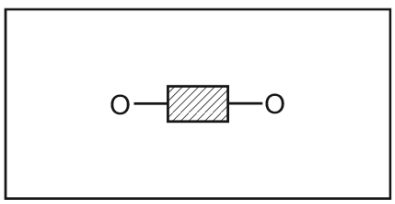
..... [1]

(ii) Which simple molecule is removed when the polyester is formed?

..... [1]

(iii) Complete the diagrams below to show the structures of the monomers used to produce the polyester. Show all atoms and bonds.





[2]

[Total: 16]

27. 0620_p16_qp_40 Q: 9

There are two types of polymerisation, addition and condensation.

(a) Explain the difference between these two types of polymerisation.

.....

.....

..... [2]

(b) Some plastics, formed by polymerisation, are non-biodegradable.

Describe **two** pollution problems that are caused by non-biodegradable plastics.

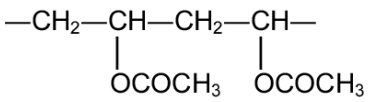
.....

.....

.....

..... [2]

(c) The polymer known as PVA is used in paints and adhesives. Its structural formula is shown below.



Deduce the structural formula of its monomer.

[1]

(d) A condensation polymer can be made from the following monomers.

$HOOC(CH_2)_4COOH$ and $H_2N(CH_2)_6NH_2$

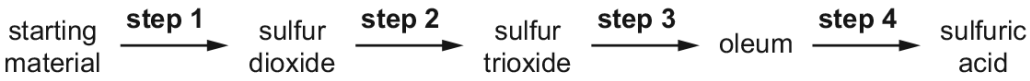
Draw the structural formula of this polymer.

[3]

[Total: 8]

28. 0620_s16_qp_41 Q: 5

Sulfuric acid is produced by the Contact process. The steps of the Contact process are shown.



(a) Sulfur is a common starting material for the Contact process.

Name a source of sulfur.

..... [1]

(b) Describe **step 2**, giving reaction conditions and a chemical equation. Reference to reaction rate and yield is not required.

.....

.....

.....

.....

.....

.....

..... [5]

(c) **Step 3** involves adding sulfur trioxide to concentrated sulfuric acid to form oleum.

Complete the chemical equation for this reaction.

$H_2SO_4 + SO_3 \rightarrow$ .....

[1]

(d) Dilute sulfuric acid is a typical acid.

A student adds excess dilute sulfuric acid to a sample of solid copper(II) carbonate in a test-tube.

(i) Give **three** observations the student would make.

.....

.....

..... [2]

(ii) Give the **names** of all products formed.

.....

..... [1]

(e) Concentrated sulfuric acid has different properties to dilute sulfuric acid.

When concentrated sulfuric acid is added to glucose, $C_6H_{12}O_6$, steam is given off and a black solid is formed.

(i) Name the black solid.

..... [1]

(ii) What type of reaction has occurred?

..... [1]

[Total: 12]

29. 0620_s16_qp_41 Q: 6

Petroleum is a source of many important chemicals.

(a) Name **two** industrial processes which must take place to produce alkenes from petroleum.

.....

..... [2]

(b) Ethene, $CH_2=CH_2$, and propene, $CH_2=CHCH_3$, can both be converted into polymers.

(i) What type of polymerisation takes place when ethene forms a polymer?

..... [1]

(ii) What is the empirical formula of the polymer formed from ethene?

..... [1]

(iii) Propene has the structural formula $CH_2=CHCH_3$.

Draw **two** repeat units of the polymer made from propene.

[2]

(c) Ethene will react with steam to form ethanol.

Propene will react with steam to form two isomers, both of which are alcohols.

Suggest the structures of these alcohols.

(d) Esters are organic chemicals noted for their characteristic smells. Ethanoic acid and methanol will react to form an ester.

(i) Name the catalyst needed to form an ester from ethanoic acid and methanol.

..... [1]

(ii) Name the ester formed when ethanoic acid reacts with methanol.

..... [1]

(iii) Draw the structure of the ester formed when ethanoic acid reacts with methanol. Show all bonds.

[2]

(iv) Give the name of a polyester.

..... [1]

[Total: 13]

30. 0620_s16_qp_42 Q: 5

(a) Hydrocarbons are compounds which contain hydrogen and carbon only.

- 10 cm^3 of a gaseous hydrocarbon, C_xH_y, are burned in 100 cm^3 of oxygen, which is an excess of oxygen.
- After cooling to room temperature and pressure, there is 25 cm^3 of unreacted oxygen, 50 cm^3 of carbon dioxide and some liquid water.

All volumes are measured under the same conditions of temperature and pressure.

(i) What is meant by an *excess* of oxygen?

..... [1]

(ii) What was the volume of oxygen that reacted with the hydrocarbon?

..... [1]

(iii) Complete the table below to express the smallest whole number ratio of

volume of hydrocarbon reacted : volume of oxygen reacted : volume of carbon dioxide produced

	volume of hydrocarbon reacted	volume of oxygen reacted	volume of carbon dioxide produced
smallest whole number ratio of volumes			

[1]

(iv) Use your answer to **(a)(iii)** to find the mole ratio in the equation below. Complete the equation and deduce the formula of the hydrocarbon.

.....C_xH_y(g) + ...O_2(g) → .....CO_2(g) + ...H_2O(l)

formula of hydrocarbon = ...

[2]

(b) Cracking is used to convert long chain alkanes into shorter chain alkanes and alkenes. Alkenes are unsaturated compounds.

Decane, $C_{10}H_{22}$, can be cracked to give propene and one other product.

(i) Complete the chemical equation.

$$C_{10}H_{22} \rightarrow C_3H_6 + \text{.....}$$

[1]

(ii) What is meant by the term *unsaturated*?

..... [1]

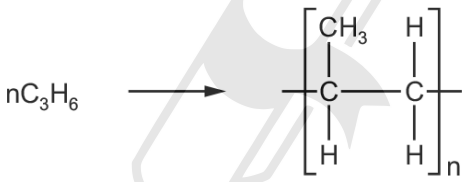
(iii) Describe a test to show that propene is an unsaturated compound.

test .....

result .....

[2]

(c) Propene can be polymerised. The only product is polypropene. The equation for the polymerisation is:



(i) Name the type of polymerisation that occurs.

..... [1]

(ii) Deduce the maximum mass of polypropene that could be produced from 1 kg of propene.

..... kg [1]

(iii) Give the empirical formula of

propene, ...

polypropene. .....

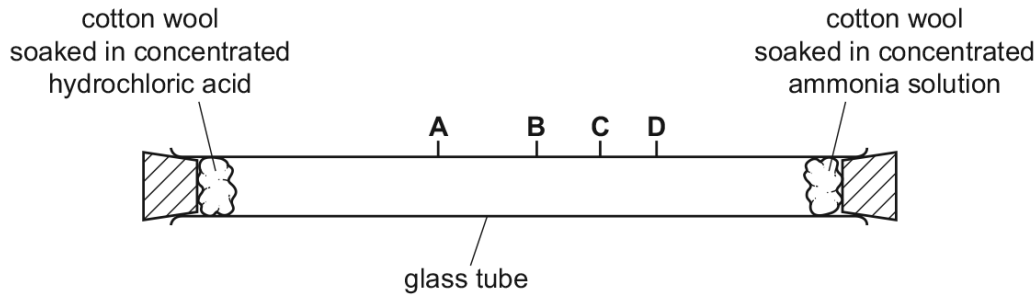
[2]

[Total: 13]

31. 0620_s16_qp_43 Q: 6

Concentrated ammonia solution gives off ammonia gas. Concentrated hydrochloric acid gives off hydrogen chloride gas. Ammonia, NH_3, and hydrogen chloride, HCl, are both colourless gases. Ammonia reacts with hydrogen chloride to make the white solid ammonium chloride.

Apparatus is set up as shown.



After ten minutes a white solid forms in the tube where the gases meet.

(a) (i) Write the chemical equation for the reaction of ammonia with hydrogen chloride.

..... [1]

(ii) Name the process by which the ammonia and hydrogen chloride gases move in the tube.

..... [1]

(iii) At which point, **A**, **B**, **C** or **D**, does the white solid form? Explain why the white solid forms at that point.

the solid forms at .....

explanation .....

.....

[3]

(iv) The experiment was repeated at a higher temperature.

Predict how the results of the experiment would be different. Explain your answer.

.....

.....

..... [3]

(b) Some of the white solid is removed from the tube and dissolved in water.

Describe how the white solid could be tested to show it contains,

(i) ammonium ions,

test .....

.....

result .....

.....

[3]

(ii) chloride ions.

test .....

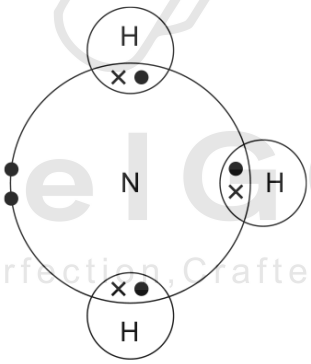
.....

result .....

.....

[3]

(c) The diagram shows the electron arrangement in a molecule of ammonia, showing only outer shell electrons.

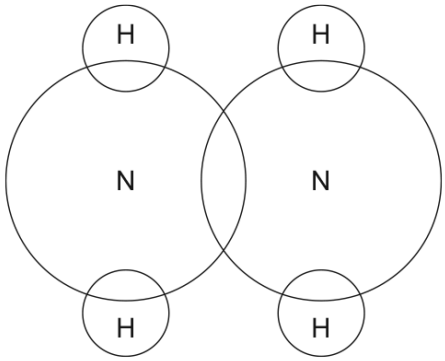


(i) State the type of bonding in ammonia.

..... [1]

(ii) Hydrazine, N_2H_4, is another compound of nitrogen and hydrogen.

Complete the diagram to show the electron arrangement in a molecule of hydrazine, showing only outer shell electrons.



[3]

(d) Nylon and proteins are both polymers containing nitrogen.

(i) Name the linkages found in the polymers of nylon and protein.

..... [1]

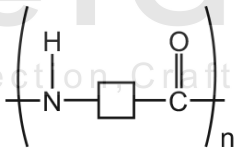
(ii) Describe **one** difference in the structures of nylon and protein.

..... [1]

(iii) What is the general name given to the products of hydrolysis of proteins?

..... [1]

(e) Suggest the structure of the monomer used to make the polymer shown.

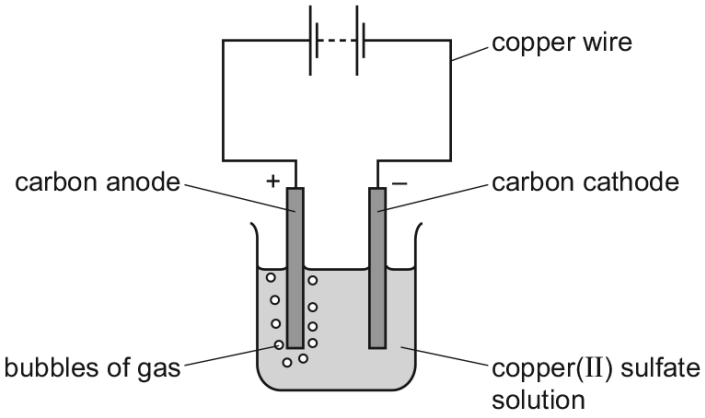


[1]

[Total: 22]

32. 0620_w16_qp_41 Q: 5

Copper(II) sulfate solution was electrolysed using the apparatus shown.



(a) A gas was formed at the anode.

Identify this gas and give the test for this gas.

gas .....

test .....

result of test .....

[3]

(b) During electrolysis, electricity passes through the copper(II) sulfate solution.

Solid copper(II) sulfate does not conduct electricity.

Explain **both** of these statements.

.....

.....

.....

.....

..... [3]

(c) The electrolysis was repeated using copper electrodes in place of carbon electrodes. The ionic half-equations for the reactions at the two electrodes are shown.

anode $Cu(s) \rightarrow Cu^{2+}(aq) + 2e^-$

cathode $Cu^{2+}(aq) + 2e^- \rightarrow Cu(s)$

(i) Which species is reduced during the electrolysis? Explain your answer.

.....

.....

..... [2]

(ii) The masses of the copper electrodes changed during the electrolysis.

State how **and** explain why the masses of the **two** copper electrodes changed.
Use the ionic half-equations to help you.

.....

.....

.....

.....

.....

.....

..... [3]

(iii) Explain why, during the electrolysis, the colour of the copper(II) sulfate solution does **not** change.

.....

.....

..... [1]

[Total: 12]

33. 0620_w16_qp_41 Q: 6

Nylon, *Terylene* and proteins are all polymers.

(a) What is a polymer?

.....

.....

..... [2]

(b) Proteins are natural polymers. Proteins are biodegradable.

(i) Name the type of linkage in proteins.

..... [1]

(ii) What is meant by the term *biodegradable*?

.....

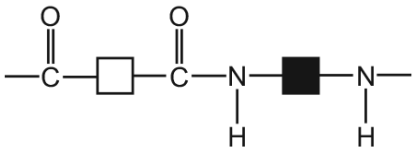
.....

..... [2]

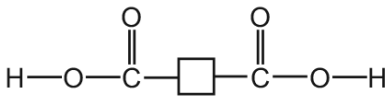
(iii) Name another natural polymer.

..... [1]

(c) Nylon and *Terylene* are synthetic polymers.
The repeat unit of nylon can be shown as



Terylene can be made from the monomers shown.



Draw a diagram to show the repeat unit of *Terylene*.

[3]

[Total: 9]

34. 0620_w16_qp_42 Q: 7

Proteins are a major constituent of food.

Proteins are polymers.

(a) What is a polymer?

.....

.....

..... [2]

(b) Proteins can be converted into amino acids.

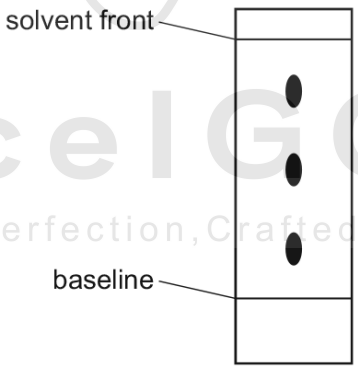
(i) Name the type of chemical reaction which occurs when proteins are converted into amino acids.

..... [1]

(ii) Suggest a condition needed to convert proteins into amino acids.

..... [1]

(c) A colourless mixture of amino acids was separated by chromatography.
Amino acid **X** has an R_f value of 0.8.
The chromatogram of the mixture after treatment with a locating agent is shown.



(i) How is an R_f value calculated?

R_f =

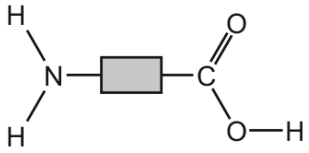
[1]

(ii) On the diagram put a ring around the spot caused by amino acid **X**. [1]

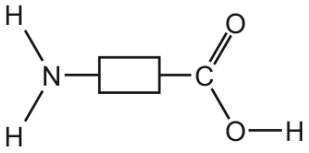
(d) When one molecule of an amino acid **A** combines with one molecule of another amino acid **B**, two different dipeptide molecules could be formed.

Draw the structures of the **two** different dipeptide molecules.
Show all of the atoms and all of the bonds in the linkages.

amino acid **A**



amino acid **B**



[3]

[Total: 12]

35. 0620_w16_qp_43 Q: 6

Synthetic polyamides are made by condensation polymerisation.

(a) (i) What is meant by the term *condensation polymerisation*?

.....

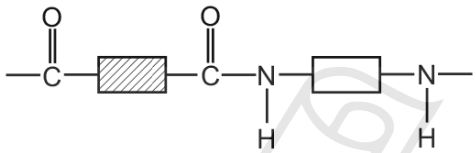
.....

..... [3]

(ii) Name another type of polymerisation.

..... [1]

(b) One repeat unit of a synthetic polyamide is represented by the following structure.



(i) Draw a ring around the amide link. [1]

(ii) Complete the diagrams to show the structures of the monomers used to produce the synthetic polyamide. Show all the missing atoms and bonds.

[2]

(iii) Name an example of a synthetic polyamide.

..... [1]

(c) Proteins and synthetic polyamides have similarities and differences.

(i) Name the type of compounds that are the monomers used to make up proteins.

..... [1]

(ii) Starting with a sample of protein, describe how to produce, separate, detect and identify the monomers which make it up.

Your answer should include

- the name of the process used to break down the protein into its monomers,
- the name of the process used to separate the monomers,
- the method used to detect the monomers after they have been separated,
- the method used to identify the monomers after they have been separated.

.....

.....

.....

.....

..... [4]

[Total: 13]

36. 0620_m15_qp_32 Q: 4

(a) A compound **X** contains 82.76% of carbon by mass and 17.24% of hydrogen by mass.

(i) Calculate the empirical formula of compound **X**.

[2]

(ii) Compound **X** has a relative molecular mass of 58.

Deduce the molecular formula of compound **X**.

[2]

(b) Alkenes are unsaturated hydrocarbons.

(i) State the general formula of alkenes.

..... [1]

(ii) State the empirical formula of alkenes.

..... [1]

(c) What is meant by the term *unsaturated hydrocarbon*?

unsaturated .....

.....

hydrocarbon .....

.....

[2]

(d) Describe a test that would distinguish between saturated and unsaturated hydrocarbons.

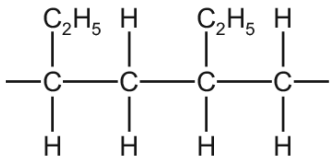
reagent .....

observation (saturated hydrocarbon) .....

observation (unsaturated hydrocarbon) .....

[3]

(e) Addition polymers can be made from alkenes. The diagram shows part of an addition polymer.



(i) Draw a circle on the diagram to show one repeat unit in this polymer. [1]

(ii) Give the structure and the name of the monomer used to make this polymer.

structure

name ..... [2]

(iii) Give the structure of an isomer of the alkene in **(e)(ii)**.

[1]

[Total: 15]

37. 0620_s15_qp_33 Q: 7

(a) Alkanes and alkenes are both hydrocarbons.

(i) How does the structure of alkenes differ from the structure of alkanes?

..... [1]

(ii) Is the straight-chain hydrocarbon $C_{22}H_{44}$ an alkane or an alkene? Explain your choice.

.....

..... [2]

(iii) Describe how you could distinguish between pentane and pentene.

test .....

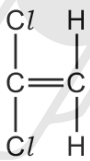
result with pentane .....

result with pentene .....

[3]

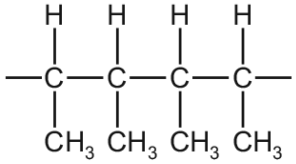
(b) Alkenes polymerise to form poly(alkenes).

(i) The alkene 1,1-dichloroethene has the structural formula given below.



Draw the structural formula of the polymer formed by the polymerisation of 1,1-dichloroethene.

(ii) The structural formula of a different polymer is given below.



Deduce the structural formula of the monomer used to form this polymer.

[2]

iii) There are two types of polymerisation - addition and condensation.

Explain the difference between them.

.....

.....

..... [2]

iv) There are two types of condensation polymer.

Give the name of **one** type of condensation polymer.

.....

..... [1]

[Total: 14]

38. 0620_w15_qp_31 Q: 4

(a) Synthetic polymers are disposed of in landfill sites and by burning.

(i) Describe **two** problems caused by the disposal of synthetic polymers in landfill sites.

.....

..... [2]

(ii) Describe **one** problem caused by burning synthetic polymers.

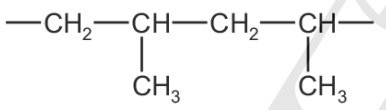
..... [1]

(b) State **two** uses of synthetic polymers.

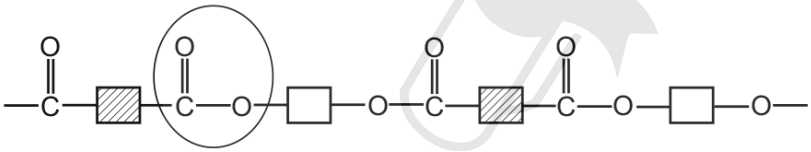
.....

..... [1]

(c) The structural formulae of two synthetic polymers are given below.



polymer **A**



polymer **B**

(i) Draw the structural formula of the monomer of polymer **A**.

[2]

(ii) Identify the functional group circled in polymer **B**.

..... [1]

(iii) Deduce the **two** types of organic compound which have reacted to form polymer **B**.

..... [2]

(d) Explain the difference between addition and condensation polymers. Classify **A** and **B** as either addition or condensation polymers.

.....

.....

.....

..... [3]

[Total: 12]

---

39. 0620_w15_qp_31 Q: 7

The rate of a photochemical reaction is affected by light.

(a) The decomposition of silver bromide is the basis of film photography. This is a redox reaction.

$$2AgBr \rightarrow 2Ag + Br_2$$
cream black

step 1 $2Br^- \rightarrow Br_2 + 2e^-$

step 2 $Ag^+ + e^- \rightarrow Ag$

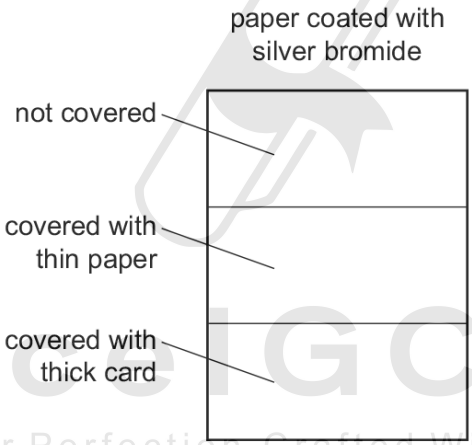
(i) Which step is reduction? Explain your answer.

..... [1]

(ii) Which ion is the oxidising agent? Explain your answer.

..... [1]

(b) A piece of white paper was coated with silver bromide and exposed to the light. Sections of the paper were covered as shown in the diagram.



Predict the appearance of the different sections of the paper after exposure to the light and the removal of the card. Explain your predictions.

.....

.....

.....

.....

.....

..... [4]

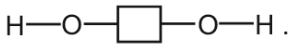
(c) Photosynthesis is another example of a photochemical reaction. Green plants can make simple carbohydrates, such as glucose. These can polymerise to make more complex carbohydrates, such as starch.

(i) Write a word equation for photosynthesis.

..... [2]

(ii) Name the substance which is responsible for the colour in green plants and is essential for photosynthesis.

..... [1]

(iii) The structural formula of glucose can be represented by  .

Draw part of the structural formula of starch which contains two glucose units.

[2]

(iv) Living organisms need carbohydrates for respiration.

What is meant by *respiration*?

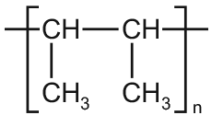
..... [1]

[Total: 12]

40. 0620_s14_qp_31 Q: 8

Polymers are made by the polymerisation of simple molecules called monomers.

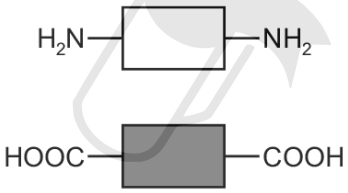
(a) (i) The structural formula of a polymer is given below.



This polymer is made by addition polymerisation. Draw the structural formula of its monomer.

[1]

(ii) The two monomers shown below form a nylon which is a condensation polymer.



Draw its structural formula showing one repeat unit of the polymer.

[3]

(iii) Name the natural macromolecule which contains the same linkage as nylon.

..... [1]

(iv) Explain the difference between addition polymerisation and condensation polymerisation.

.....

.....

..... [2]

(b) Many polymers are non-biodegradable.

(i) Explain the term *non-biodegradable*.

.....

..... [2]

(ii) State **three** problems caused by the disposal of non-biodegradable polymers.

.....

.....

..... [3]

(c) Storage tanks for cold water are now made from polymers because they are cheaper than metal tanks. Suggest **two** other advantages of making cold water tanks from polymers.

.....

..... [2]

[Total: 14]

41. 0620_s14_qp_33 Q: 3

(a) Biological catalysts produced by microbes cause food to deteriorate and decay.

(i) What is the name of these biological catalysts?

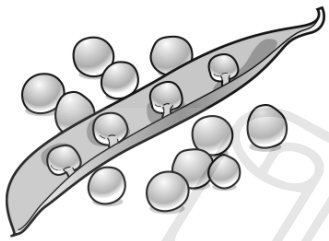
..... [1]

(ii) Freezing does not kill the microbes.
Suggest why freezing is still a very effective way of preserving food.

.....

..... [2]

(b) Pea seeds grow in pods on pea plants.



Freshly picked pea seeds contain a sugar. The sugar can form a polymer.
Give the structural formula of the polymer and name the other product of this polymerisation reaction.
You may represent the sugar by the formula:

structural formula of the polymer

other product ..... [3]

(c) Describe how the pea plant makes a sugar such as glucose.

.....

.....

.....

.....

..... [3]

[Total: 9]

---

42. 0620_w14_qp_32 Q: 5

(a) Glucose, sucrose and starch are all carbohydrates. Their formulae are:

glucose, $C_6H_{12}O_6$,
sucrose, $C_{12}H_{22}O_{11}$,
starch, $(C_6H_{10}O_5)_n$.

(i) Identify **two** common features in the formulae of these carbohydrates.

.....

..... [2]

(ii) Draw the structure of a complex carbohydrate, such as starch. The formula of glucose, can be represented by

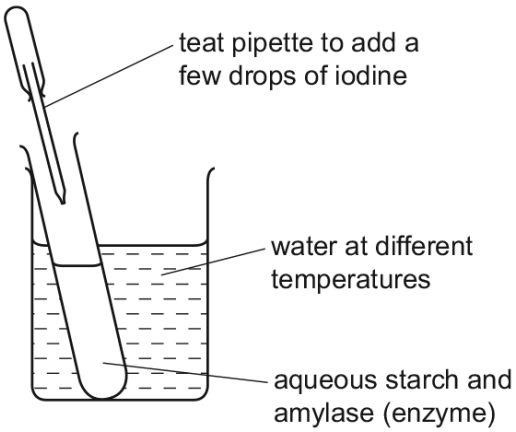
Include **three** glucose units in the structure.

[2]

(b) Starch hydrolyses to glucose in the presence of the enzyme, amylase.
What is meant by the term *enzyme*?

..... [2]

(c) The effect of temperature on this reaction can be studied by the experiment shown below.
Starch and iodine form a blue-black colour.
Glucose and iodine do not form a blue-black colour.



The experiment is set up as in the diagram and the time measured for the mixture to change from blue-black to colourless. The experiment is repeated at different temperatures.
Typical results of this experiment are given in the table below.

experiment	temperature / °C	time for blue-black colour to disappear / min
A	20	30
B	40	15
C	70	remained blue-black

(i) Put the experiments in order of reaction rate – slowest first and fastest last.

..... [2]

(ii) Explain why the reaction rates in experiments A and B are different.

.....

.....

.....

..... [3]

(iii) Suggest why the colour remains blue-black in experiment C.

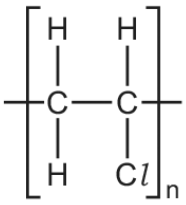
..... [1]

[Total: 12]

43. 0620_s13_qp_32 Q: 5

Many monomer molecules react together to form one molecule of a polymer. This reaction is called polymerisation.

(a) The structural formula of the polymer, poly(chloroethene), is given below. This polymer is also known as PVC.



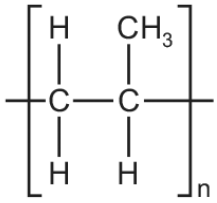
(i) A major use of PVC is insulation of electric cables. PVC is a poor conductor of electricity.
Suggest another property which makes it suitable for this use.

..... [1]

(ii) One way of disposing of waste PVC is by burning it. This method has the disadvantage that poisonous gases are formed.
Suggest **two** poisonous gases which could be formed by the combustion of PVC.

..... [2]

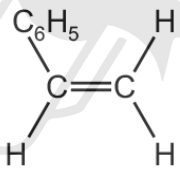
(b) (i) Deduce the structural formula of the monomer from that of the polymer.



structural formula of monomer

[1]

(ii) Deduce the structural formula of the polymer, poly(phenylethene), from the formula of its monomer, phenylethene.

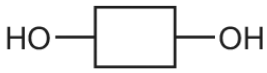


structural formula of polymer

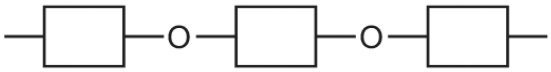
[2]

(c) The carbohydrate, glucose, polymerises to form the more complex carbohydrate starch.

If glucose is represented by



then the structural formula of starch is as drawn below.



How does the polymerisation of glucose differ from that of an alkene such as phenylethene?

.....

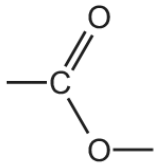
.....

..... [2]

[Total: 8]

44. 0620_s13_qp_32 Q: 7

The ester linkage showing all the bonds is drawn as



or more simply it can be written as –COO–.

(a) (i) Give the structural formula of the ester ethyl ethanoate.

[1]

(ii) Deduce the name of the ester formed from methanoic acid and butanol.

..... [1]

(b) (i) Which group of naturally occurring compounds contains the ester linkage?

..... [1]

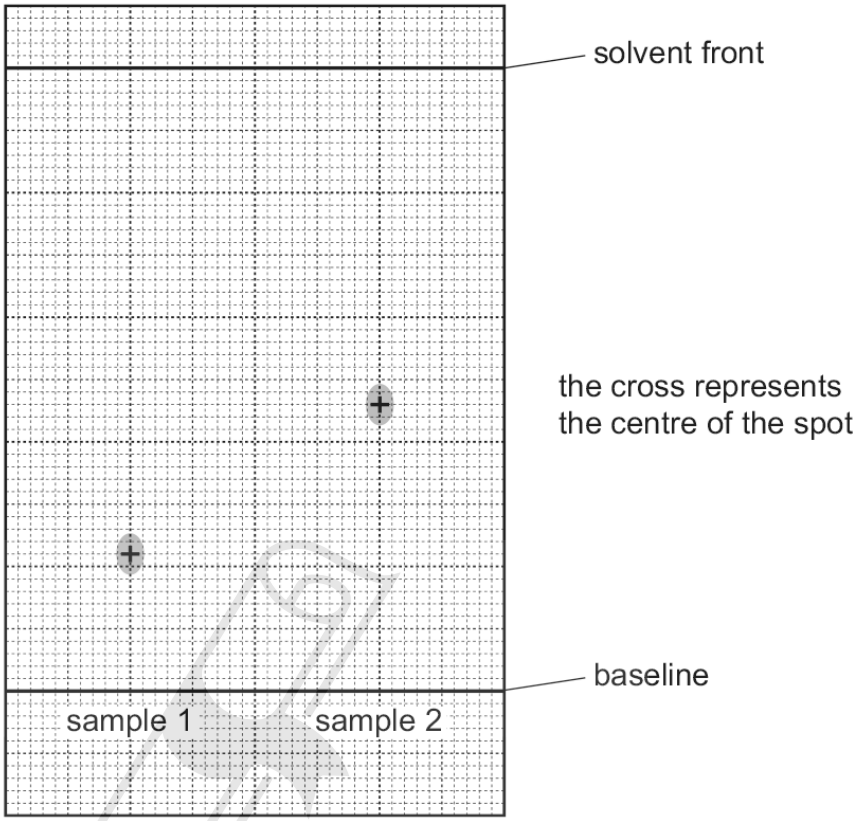
(ii) Draw the structural formula of the polyester formed from the following monomers.

$HOOCC_6H_4COOH$ and $HOCH_2CH_2OH$

You are advised to use the simpler form of the ester linkage.

[3]

(c) Esters can be used as solvents in chromatography. The following shows a chromatogram of plant acids.



An ester was used as the solvent and the chromatogram was sprayed with bromothymol blue.

(i) Suggest why it was necessary to spray the chromatogram.

.....

..... [2]

(ii) Explain what is meant by the R_f value of a sample.

.....

..... [1]

(iii) Calculate the R_f values of the two samples and use the data in the table to identify the plant acids.

plant acid	R_f value
tartaric acid	0.22
citric acid	0.30
oxalic acid	0.36
malic acid	0.46
succinic acid	0.60

sample 1 R_f = ... It is ..... acid.

sample 2 R_f = ... It is ..... acid. [2]

[Total: 11]

---

45. 0620_s13_qp_33 Q: 7

Alkanes and alkenes are both series of hydrocarbons.

(a) (i) Explain the term *hydrocarbon*.

.....

..... [1]

(ii) What is the difference between these two series of hydrocarbons?

.....

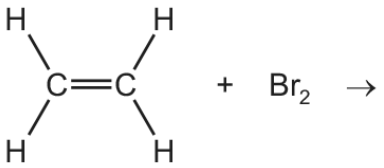
..... [2]

(b) Alkenes and simpler alkanes are made from long-chain alkanes by cracking. Complete the following equation for the cracking of the alkane $C_{20}H_{42}$.

$$C_{20}H_{42} \rightarrow 2C_4H_8 + 2C_2H_4 + ...$$ [1]

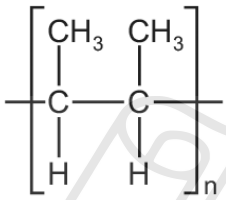
(c) Alkenes such as butene and ethene are more reactive than alkanes.
Alkenes are used in the petrochemical industry to make a range of products, which includes polymers and alcohols.

(i) Dibromoethane is used as a pesticide. Complete the equation for its preparation from ethene.



[1]

(ii) The structural formula of a poly(alkene) is given below.



Deduce the structural formula of its monomer.

[2]

(iii) How is butanol made from butene, $CH_3-CH_2-CH=CH_2$? Include an equation in your answer.

.....

..... [2]

(iv) Cracking changes alkanes into alkenes. How could an alkene be converted into an alkane? Include an equation in your answer.

.....

..... [2]

(d) 20 cm^3 of a hydrocarbon was burnt in 175 cm^3 of oxygen. After cooling, the volume of the remaining gases was 125 cm^3. The addition of aqueous sodium hydroxide removed carbon dioxide leaving 25 cm^3 of unreacted oxygen.

(i) volume of oxygen used = ... cm^3 [1]

(ii) volume of carbon dioxide formed = ... cm^3 [1]

(iii) Deduce the formula of the hydrocarbon and the balanced equation for the reaction.

.....

.....

.....

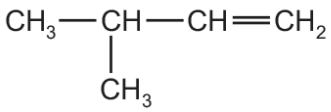
..... [2]

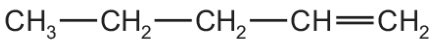
[Total: 15]

46. 0620_w13_qp_31 Q: 5

The alkenes are unsaturated hydrocarbons. They form a homologous series, the members of which have the same chemical properties.
They undergo addition reactions and are easily oxidised.

(a) The following hydrocarbons are isomers.





(i) Explain why these two hydrocarbons are isomers.

.....

..... [2]

(ii) Give the structural formula of another hydrocarbon which is isomeric with the above.

[1]

(b) Give the structural formula and name of each of the products of the following addition reactions.

(i) ethene and bromine

structural formula of product

name of product ..... [2]

(ii) propene and hydrogen

structural formula of product

name of product ..... [2]

(iii) but-1-ene and water

structural formula of product

name of product ..... [2]

(c) Alkenes can be oxidised to carboxylic acids.

(i) For example, propene, $CH_3-CH=CH_2$, would produce ethanoic acid, CH_3-COOH, and methanoic acid, $H-COOH$. Deduce the formulae of the alkenes which would form the following carboxylic acids when oxidised.

ethanoic acid and propanoic acid

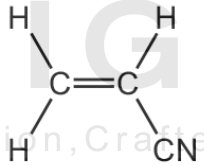
only ethanoic acid

[2]

(ii) Describe the colour change you would observe when an alkene is oxidised with acidified potassium manganate(VII).

..... [2]

(d) Alkenes polymerise to form addition polymers.
Draw the structural formula of poly(cyanoethene), include at least **two** monomer units.
The structural formula of the monomer, cyanoethene, is given below.



[3]

[Total: 16]

47. 0620_w13_qp_32 Q: 7

Plants can make complex molecules from simple starting materials, such as water, carbon dioxide and nitrates. Substances produced by plants include sugars, more complex carbohydrates, esters, proteins, vegetable oils and fats.

(a) (i) Describe how you could decide from its molecular formula whether a compound is a carbohydrate.

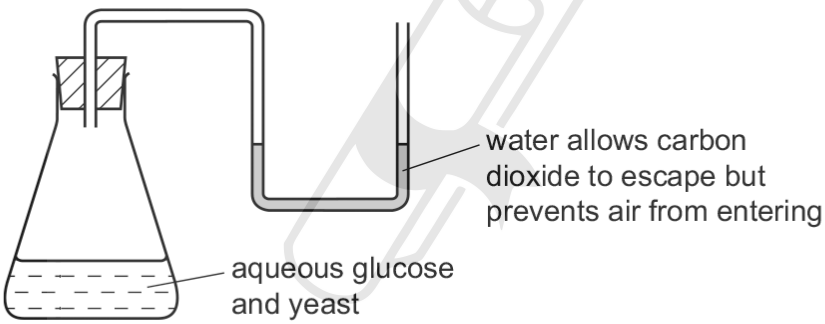
.....

..... [2]

(ii) Plants can change the sugar, glucose, into starch which is a more complex carbohydrate. What type of reaction is this?

..... [2]

(b) The fermentation of glucose can be carried out in the apparatus shown below. After a few days the reaction stops. A 12% aqueous solution of ethanol has been produced.



(i) The enzyme, zymase, catalyses the anaerobic respiration of the yeast. Explain the term *respiration*.

.....

..... [2]

(ii) Complete the equation.

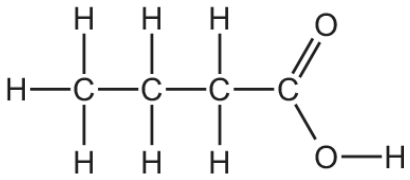
$C_6H_{12}O_6 \rightarrow$ ..... + ... [2]

glucose ethanol carbon dioxide

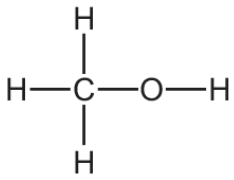
(iii) Why must air be kept out of the flask?

..... [1]

(c) The ester methyl butanoate is found in apples. It can be made from butanoic acid and methanol. Their structural formulae are given below.



butanoic acid

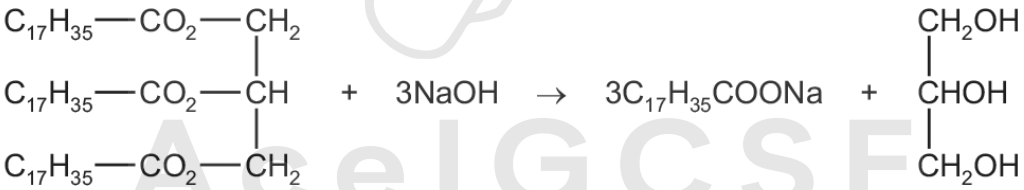


methanol

Use the information given above to deduce the structural formula of methyl butanoate showing all the bonds.

[2]

(d) The equation represents the hydrolysis of a naturally occurring ester.



(i) Which substance in the equation is an alcohol? Put a ring around this substance in the equation above. [1]

(ii) Is the alkyl group, $C_{17}H_{35}$, in this ester saturated or unsaturated? Give a reason for your choice.

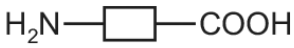
..... [1]

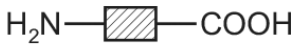
(iii) What type of compound is represented by the formula $C_{17}H_{35}COONa$?
What is the major use for compounds of this type?

type of compound .....

use ..... [2]

(e) Proteins are natural macromolecules. Draw the structural formula of a typical protein. Include three monomer units. You may represent amino acids by formulae of the type drawn below.





[3]

[Total: 18]

48. 0620_w13_qp_33 Q: 5

Domestic rubbish is disposed of in landfill sites. Rubbish could include the following items.

item of rubbish	approximate time for item to break down
newspaper	one month
cotton rag	six months
woollen glove	one year
aluminium container	up to 500 years
styrofoam cup	1000 years

(a) Explain why aluminium, a reactive metal, takes so long to corrode.

..... [1]

(b) Both paper and cotton are complex carbohydrates. They can be hydrolysed to simple sugars such as glucose.
The formula of glucose can be represented as:

Draw the structural formula of a complex carbohydrate, such as cotton.
Include at least **two** glucose units.

[2]

(c) Wool is a protein. It can be hydrolysed to a mixture of monomers by enzymes.

(i) What are enzymes?

.....

..... [2]

(ii) Name another substance which can hydrolyse proteins.

..... [1]

(iii) What type of compound are the monomers formed by the hydrolysis of proteins?

..... [1]

(iv) Which technique could be used to identify the individual monomers in the mixture?

..... [1]

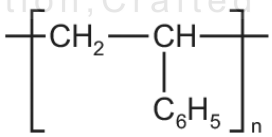
(v) Proteins contain the amide linkage. Name a synthetic macromolecule which contains the same linkage.

..... [1]

(d) **(i)** What is the scientific term used to describe polymers which do not break down in landfill sites?

..... [1]

(ii) Styrofoam is poly(phenylethene). It is an addition polymer. Its structural formula is given below. Deduce the structural formula of the monomer, phenylethene.



[1]

[Total: 11]

49. 0620_s12_qp_31 Q: 7

Plastics are polymers. They are formed from their monomers by polymerisation.

(a) Two methods for the disposal of waste plastics are

- burning
- recycling.

Describe one advantage **and** one disadvantage of each method.

burning .....

.....

.....

recycling .....

.....

..... [4]

(b) **(i)** There are two types of polymerisation reaction. Give their names and explain the differences between them.

.....

.....

.....

..... [4]

(ii) Give the structural formula of a polymer which is formed from two different monomers.

[2]

[Total: 10]

50. 0620_s12_qp_32 Q: 5

Islay is an island off the west coast of Scotland. The main industry on the island is making ethanol from barley.

Barley contains the complex carbohydrate, starch. Enzymes catalyse the hydrolysis of starch to a solution of glucose.

(a) (i) Draw the structure of the starch.
Glucose can be represented by HO—□—OH

[2]

(ii) Enzymes can catalyse the hydrolysis of starch. Name another catalyst for this reaction.

..... [1]

(iii) Both starch and glucose are carbohydrates. Name the elements found in all carbohydrates.

.....

..... [1]

(b) Yeast cells are added to the aqueous glucose. Fermentation produces a solution containing up to 10 % of ethanol.

(i) Complete the word equation for the fermentation of glucose.

glucose → ..... + ...

[1]

(ii) Explain why is it necessary to add yeast and suggest why the amount of yeast in the mixture increases.

.....

.....

..... [2]

(iii) Fermentation is carried out at 35 °C. For many reactions a higher temperature would give a faster reaction. Why is a higher temperature not used in this process?

.....

..... [2]

(c) The organic waste, the residue of the barley and yeast, is disposed of through a pipeline into the sea. In the future this waste will be converted into biogas by the anaerobic respiration of bacteria. Biogas, which is mainly methane, will supply most of the island's energy.

(i) Anaerobic means in the absence of oxygen. Suggest an explanation why oxygen must be absent.

..... [1]

(ii) The obvious advantage of converting the waste into methane is economic. Suggest **two** other advantages.

.....

..... [2]

[Total: 12]

51. 0620_s12_qp_32 Q: 7

The alkenes are unsaturated hydrocarbons. They form a homologous series, the members of which have similar chemical properties:

- easily oxidised
- addition reactions
- polymerisation
- combustion.

(a) All the alkenes have the same empirical formula.

(i) State their empirical formula.

..... [1]

(ii) Why is the empirical formula the same for all alkenes?

..... [1]

(b) Alkenes can be oxidised to carboxylic acids by boiling with aqueous potassium manganate(VII).

(i) Pent-2-ene, $CH_3–CH_2–CH=CH–CH_3$, oxidises to $CH_3–CH_2–COOH$ and CH_3COOH. Name these two acids.

$CH_3–CH_2–COOH$ .....

CH_3COOH ..... [2]

(ii) Most alkenes oxidise to two carboxylic acids. Deduce the formula of an alkene which forms only one carboxylic acid.

[1]

(c) Complete the following equations for the addition reactions of propene.

(i) $CH_3–CH=CH_2 + Br_2 \rightarrow$ ..... [1]

(ii) $CH_3–CH=CH_2 + H_2O \rightarrow$ ..... [1]

(d) Draw the structural formula of poly(propene)

[2]

(e) 0.01 moles of an alkene needed 2.4 g of oxygen for complete combustion. 2.2 g of carbon dioxide were formed. Determine the following mole ratio.

moles of alkene : moles of O_2 : moles of CO_2

From this ratio determine the formula of the alkene.

..... [3]

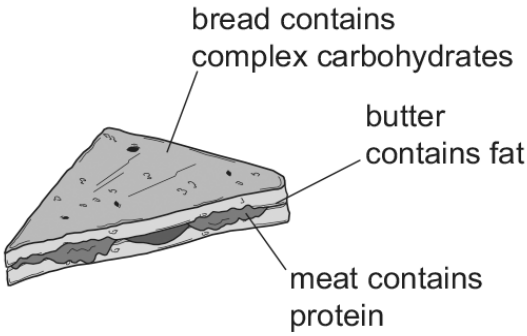
Write an equation for the complete combustion of this alkene.

..... [1]

[Total: 13]

52. 0620_w12_qp_31 Q: 6

A sandwich contains three of the main constituents of food.



(a) (i) These constituents of food can be hydrolysed by boiling with acid or alkali. Complete the table.

constituent of food	product of hydrolysis
protein	
fat	
complex carbohydrate	

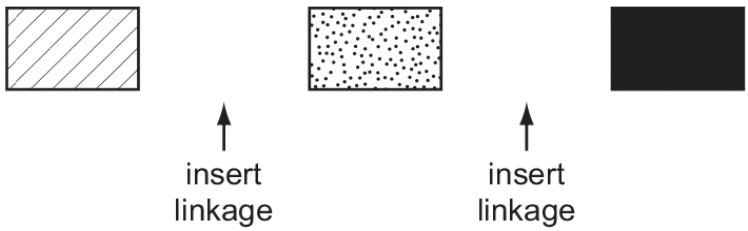
[3]

(ii) What type of synthetic polymer contains the same linkage as

fats, ...

proteins? ..... [2]

(b) An incomplete structural formula of a protein is given below. Complete this diagram by inserting the linkages.



[2]

(c) Butter contains mainly saturated fats. Fats based on vegetable oils, such as olive oil, contain mainly unsaturated fats.

A small amount of fat was dissolved in an organic solvent.
Describe how you could determine if the fat was saturated or unsaturated.

.....

.....

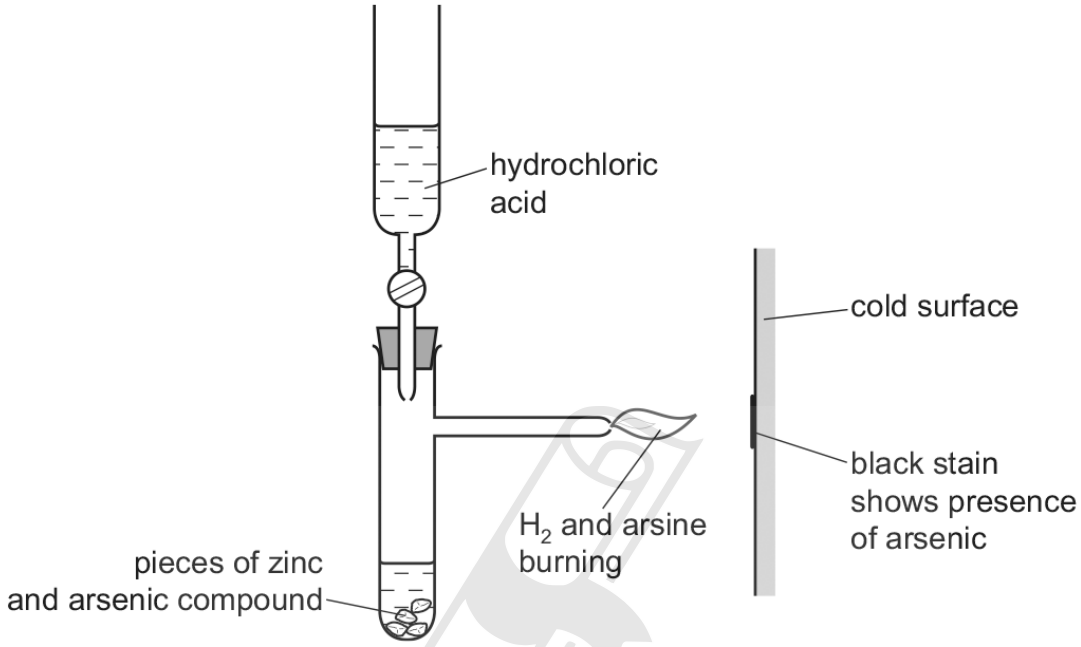
..... [3]

[Total: 10]

53. 0620_w12_qp_33 Q: 6

Until recently, arsenic poisoning, either deliberate or accidental, has been a frequent cause of death. The symptoms of arsenic poisoning are identical with those of a common illness, cholera. A reliable test was needed to prove the presence of arsenic in a body.

(a) In 1840, Marsh devised a reliable test for arsenic.



Hydrogen is formed in this reaction. Any arsenic compound reacts with this hydrogen to form arsine which is arsenic hydride, AsH_3.
The mixture of hydrogen and arsine is burnt at the jet and arsenic forms as a black stain on the glass.

(i) Write an equation for the reaction which forms hydrogen.

..... [2]

(ii) Draw a diagram which shows the arrangement of the outer (valency) electrons in one molecule of the covalent compound arsine.
The electron distribution of arsenic is 2 + 8 + 18 + 5.

Use x to represent an electron from an arsenic atom.
Use o to represent an electron from a hydrogen atom.

[2]

(b) Another hydride of arsenic has the composition below.

arsenic 97.4 % hydrogen 2.6 %

(i) Calculate the empirical formula of this hydride **from the above data**. Show your working.

.....

.....[2]

(ii) The mass of one mole of this hydride is 154 g. What is its molecular formula?

..... [1]

(iii) Deduce the structural formula of this hydride.

[1]

(c) Hair is a natural protein. Hair absorbs arsenic from the body. Analysis of the hair provides a measurement of a person's exposure to arsenic. To release the absorbed arsenic for analysis, the protein has to be hydrolysed.

(i) What is the name of the linkage in proteins?

..... [1]

(ii) Name a reagent which can be used to hydrolyse proteins.

..... [1]

(iii) What type of compound is formed by the hydrolysis of proteins?

..... [1]

(d) In the 19th Century, a bright green pigment, copper(II) arsenate(V) was used to kill rats and insects. In damp conditions, micro-organisms can act on this compound to produce the very poisonous gas, arsine.

(i) Suggest a reason why it is necessary to include the oxidation states in the name of the compound.

.....

..... [1]

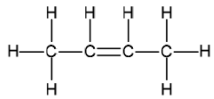
(ii) The formula for the arsenate(V) ion is AsO_4^{3-}. Complete the ionic equation for the formation of copper(II) arsenate(V).

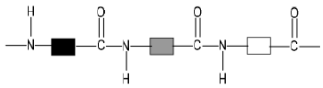
.....Cu^{2+} + ...AsO_4^{3-} → .....

[2]

[Total: 14]

01. 0620_m21_ms_42 Q: 6

Question	Answer	Marks
(a)	monomers	1
(b)(i)	any **hydrocarbon** with one C=C bond (with both C atoms having 4 bonds) (1) structure of but-2-ene (1) 	2
(b)(ii)	addition	1

Question	Answer	Marks
(c)(i)	protein	1
(c)(ii)	 any correct amide link between any two blocks showing all atoms and all bonds (1) identical orientation of both inter-block amide links including terminal groups with correct orientation (if shown) (1) continuation bonds on polymer (1)	3
(c)(iii)	hydrolysis (1)	1

02. 0620_s21_ms_41 Q: 1

Question	Answer	Marks
(a)	Haber (process)	1
(b)	fractional distillation	1
(c)	electrolysis	1
(d)	filtration	1
(e)	hydrolysis	1
(f)	chromatography	1

03. 0620_s21_ms_42 Q: 6

Question	Answer	Marks
(a)(i)	carboxylic acid	1
(a)(ii)	any correct displayed ester link between any two blocks showing all atoms and all bonds (1) correct orientation of three displayed inter-block ester links with correct orientation (1) continuation bonds on polyester (1)	3

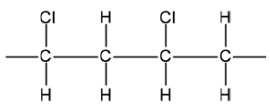
Question	Answer	Marks
(a)(iii)	water	1
(b)(i)	two blocks linked by –O–	1
(b)(ii)	acid (and heat) (1) enzymes (ignore names) (1)	2
(b)(iii)	chromatography	1
(c)(i)	fermentation	1
(c)(ii)	$C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$ C_2H_5OH (1) rest of equation (1)	2

04. 0620_s21_ms_43 Q: 1

Question	Answer	Marks
(a)	polymerisation	1
(b)	fractional distillation	1
(c)	fermentation	1
(d)	distillation	1
(e)	electrolysis	1
(f)	chromatography	1
(g)	filtration	1

05. 0620_w21_ms_43 Q: 7

Question	Answer	Marks
(a)	1 for each for any 2 of: • (same) general formula • similar chemical properties • (consecutive members) differ by CH_2 • same functional group • common (allow similar or same) methods of preparation • physical properties **and** vary in predictable manner **or** show trends **or** gradually change **OR** example of a physical property variation, e.g. melting points increase boiling points increase volatility decreases	2
(b)(i)	cracking	1
(b)(ii)	$\rightarrow C_2H_4 + C_4H_{10}$ (2)	2
(b)(iii)	$C_2H_4 + H_2O \rightarrow C_2H_5OH$	1
(b)(iv)	hydration / addition	1
(b)(v)	1 mark for **ANY 1** of: • 300 °C • 60 atmospheres • H_3PO_4	1

Question	Answer	Marks
(c)	1 mark each for any 2 of: • **carbohydrates** are renewable • **fossil fuels** are non-renewable **OR** fossil fuels conserved • lower temperature **OR** lower energy • hydration is equilibrium meaning lower yield • lower pressure (used)	2
(d)(i)	substitution	1
(d)(ii)	addition	1
(d)(iii)	 **M1** any one repeat unit with extension bonds (1) **M2** both units fully correct (1)	2
(e)	1 mark for each functional group fully correct (2)	2

06. 0620_m20_ms_42 Q: 5

(a)(i)	monomer	1
(a)(ii)	any **hydrocarbon** with one C=C bond (with both C atoms having 4 bonds) (1) structure of methylpropene (1)	2
(b)	water is a product (when polymer is made)	1
(c)(i)	any correct amide link between any two blocks showing all atoms and all bonds (1) correct orientation of 3 inter-block amide links (1) continuation bonds (1)	3
(c)(ii)	nylon	1

07. 0620_p20_ms_40 Q: 9

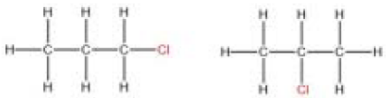
(a) addition: polymer is the only product / only one product; [1]
condensation: polymer and water formed / small molecule formed; [1]

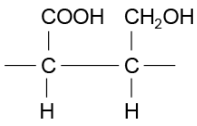
(b) Any two from:
ingestion can be fatal to animals / owtte;
animals can be caught in plastics e.g. fishing line / owtte;
combustion releases toxins / owtte;
land-fill uses natural resources / owtte;
allow: any appropriate example [2]

(c) CH_2=CHOCOCH_3 [1]
note: double bond does not need to be shown

(d) -OC$(CH_2)_4$CONH$(CH_2)_6$NH-
amide linkage correct; [1]
correct repeat units; [1]
continuation bonds shown; [1]

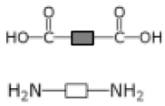
08. 0620_s20_ms_42 Q: 6

(a)(i)	substitution	1
(a)(ii)	ultraviolet light / ultraviolet radiation	1
(a)(iii)		2
(b)(i)	only one product / double bond becomes single bond / two molecules join (to make one molecule)	1
(b)(ii)	(energy required to break bonds =) 854 (1) (energy given out when bonds form =) 1025 (1) overall energy change 854 – 1025 = –171 (1)	3

(c)(i)	alkene (1) alcohols / alkanols (1) carboxylic acids/alkanoic acids (1)	3
(c)(ii)	turns colourless / decolourised (1) bubbles / fizzing / effervescence (1)	2
(d)(i)	 C–C (1) each C bonded to $–CH_2OH$ / –COOH and H with no other atoms + extension bonds (1)	2
(d)(ii)	polyester	1

09. 0620_s20_ms_43 Q: 8

(a)(i)		1

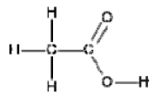
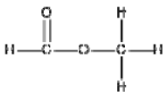
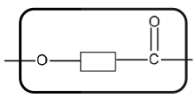
(a)(ii)		2
(a)(iii)	water	1
(b)	non-biodegradable / running out of space / toxic / leaching	1
(c)	(complex) carbohydrate / protein	1

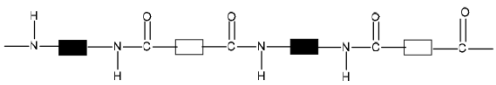
10. 0620_w20_ms_42 Q: 5

Question	Answer	Marks
(a)(i)	presence of an acid	1
(a)(ii)	oxidation	1
(a)(iii)	all single bonding dot and cross pairs correct (1) double C=O bond dot and cross pairs are correct (1) Complete diagram is correct (1)	3
(b)	partial (dissociation) (1) full / 100% (dissociation) (1) both acid colours (1) HC*l* indicating a lower pH acid colour than CH_3COOH (1) fizzing **OR** dissolving / disappearing in both (1) either observation happens quicker with HC*l* (1)	6

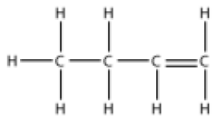
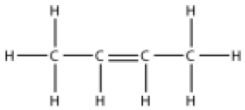
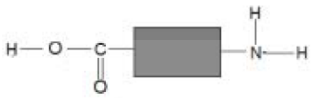
Question	Answer	Marks
(c)(i)	water	1
(c)(ii)	acid (catalyst)	1
(c)(iii)	any one alcohol group on a molecule (1) structure of propan-2-ol (1)	2
(d)(i)	the atoms / group of atoms which give (any molecule its) **chemical** properties	1
(d)(ii)	$C_3H_5O_2$	1
(d)(iii)	M_r of $HO–CH_2–CH_2–OH$ = 62 (1) %ge = 100 × 32/62 = 52% (1)	2
(d)(iv)	any correct ester link between any two blocks showing all atoms and all bonds (1)  correct orientation of 3 inter-block ester links and continuation bonds (1)	2
(d)(v)	Terylene	1

11. 0620_w20_ms_43 Q: 6

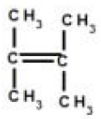
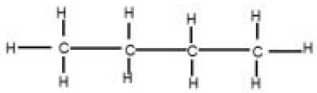
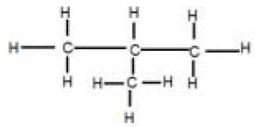
Question	Answer	Marks
(a)(i)	compounds with the same molecular formula (1) different structural formula (1)	2
(a)(ii)	  diagram (1) ethanoic **acid** (1) diagram (1) methyl methanoate (1)	4
(b)(i)		1
(b)(ii)	condensation	1
(b)(iii)	 1 for each correct functional group	2

Question	Answer	Marks
(c)	 one correct linkage fully displayed (1) the whole structure fully correct (1)	2
(d)(i)	proteins	1
(d)(ii)	amino acids	1

12. 0620_s19_ms_43 Q: 6

(a)(i)	**M1** contain hydrogen and carbon **M2** only	**2**
(a)(ii)	**M1** (Reagent): Bromine (water / solution) **M2** (Result with hydrocarbon A): becomes colourless / decolourised **M3** (Result with hydrocarbon B): no change / stays orange	**3**
(b)		**1**
(c)(i)	addition	**1**
(c)(ii)		**1**
(c)(iii)	**M1** CO on right **M2** 2n O_2 2n(CO)	**2**
(d)	 **M1** $-NH_2$ group drawn as displayed on one end **M2** carboxylic acid group drawn as displayed on the other end	**2**

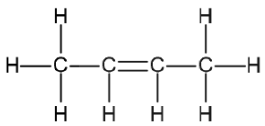
13. 0620_w19_ms_41 Q: 5

(a)(i)	addition	**1**
(a)(ii)	CH_2	**1**
(a)(iii)	 one C=C (1) fully correct structure (1)	**2**
(b)(i)	(compounds / molecules with) the same molecular formula (1) different structural formulae (1)	**2**
(b)(ii)	 (1)  (1)	**2**
(b)(iii)	H_2O **and** CO **or** C formed (1) $2\ C_4H_{10} + 9\ O_2 \rightarrow 8\ CO + 10\ H_2O$ (1)	**2**

14. 0620_w19_ms_42 Q: 2

(a)	78	1
(b)	fractional (1) distillation (1)	2
(c)	acid rain	1
(d)	nitrogen **and** oxygen (from the air) react (in the engine) (1) (due to) high temperatures (1)	2
(e)	nitrogen (1) carbon dioxide (1) platinum (1)	3
(f)	$CH_4 + 1½O_2 \rightarrow CO + 2H_2O$ CO and H_2O as products and methane as reactant (1) rest of the equation (1)	2
(g)(i)	A photosynthesis (1) B respiration (1)	2
(g)(ii)	– □ –O– □ –O– □ –O– two –O– link between three 'blocks' (1) three complete units with continuation bonds (1)	2
(g)(iii)	acid (and heat) (1) enzymes (ignore names) (1)	2
(g)(iv)	chromatography	1

15. 0620_w19_ms_43 Q: 7

(a)	carbon-carbon double bond / C = C	1
(b)(i)	3	1
(b)(ii)	 (1) but-2-ene (1)	2
(b)(iii)	CH_2 (1) CH_2 (1)	2
(c)	(broken down by) hydrolysis (1) acid (used to break down) (1) enzymes (used to break down) (1) chromatography (used to separate) (1) locating agent / (view under) UV light (used to detect) (1) measure R_f (values) or retention factor / compare with standards (used to identify) (1)	6
(d)(i)	Nylon / Kevlar	1
(d)(ii)	water	1

16. 0620_m18_ms_42 Q: 4

(a)(i)	proton acceptor	1
(a)(ii)	ammonia + named acid → correct ammon**ium** salt M1 ammon**ium** product (from ammonia / ammonium hydroxide + acid) M2 fully correct equation	2
(b)(i)	M1 (moles of NH_3 = 0.68 / 17 =) 0.04(00) M2 (M1 × 3 / 2 =) 0.06(00) M3 (volume of Cl_2 = 0.06(00) × 24000 =) 1440 (cm^3)	3
(b)(ii)	M1 (reactants 2 × 3 × 390 (= 2340) + 3 × 240 (= 720) =) 3060 M2 (products 945 + 6 × 430 (= 2580) =) 3525 M3 M1 – M2	3
(b)(iii)	((**b)(ii)** is exothermic then) exothermic **and** more energy released than used OR ((**b)(ii)** is endothermic then) endothermic **and** less energy released than used	1
(c)(i)	ammonia / it is oxidised / oxygen is reduced	1
(c)(ii)	M1 platinum M2 transition metal / element	2

17. 0620_m18_ms_42 Q: 5

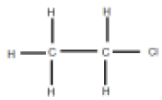
(a)	homologous series	1
(b)	$C_nH_{2n+2}O$ OR $C_nH_{2n+1}OH$	1
(c)(i)	M1 steam M2 catalyst	2
(c)(ii)	$2C_3H_7OH + 9O_2 \rightarrow 6CO_2 + 8H_2O$ M1 species M2 fully correct equation	2
(d)(i)	M1 at least one –O– link between two blocks M2 correct structure including continuation bonds	2
(d)(ii)	hydrolysis	1
(d)(iii)	enzyme OR heat + acid	1
(e)(i)	locating ((re)agent)	1
(e)(ii)	distance travelled by substance / distance travelled by solvent	1
(e)(iii)	compare to known data	1
(e)(iv)	similar R_f values	1

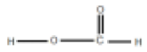
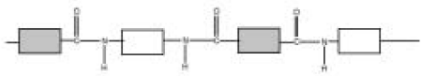
18. 0620_s18_ms_41 Q: 6

(a)	(they contain) carbon and hydrogen (atoms)	1
	only	1
(b)	(all) the (C–C) bonds are single	1
(c)(i)	(one) atom or group is replaced by another (atom or group)	1
(c)(ii)	ultra-violet light **OR** sunlight	1
(c)(iii)	$C_2H_6 + Cl_2 \rightarrow C_2H_5Cl + HCl$ 1 mark for C_2H_5Cl 1 mark for the rest of the equation	2
(d)(i)	only one product (compound) forms	1
(d)(ii)	fully displayed formula of 1,2-dibromopropane	1
(e)	fully displayed formula of but-2-ene	1
	but-2-ene	1

(f)(i)	poly(ethene)	1
(f)(ii)	single bond between two C atoms	1
	fully correct answer	1
(g)	any one correct amide link showing all bonds	1
	both amide links shown in the correct orientation for three amino acids	1
(h)	ethanol + butanoic acid → ethyl butanoate + water 1 mark for the names of the reactants 1 mark for the name of the ester 1 mark for water as a product	3

19. 0620_w18_ms_41 Q: 6

(a)(i)	**M1** (compound that) contains carbon and hydrogen	1
	M2 and no other elements / only	1
(a)(ii)	Alkanes: C_nH_{2n+2}	1
	Alcohols $C_nH_{2n+1}OH$ **OR** $C_nH_{2n+2}O$	1
(a)(iii)	any **two** from: Similar / same chemical properties Same functional group Trend **or** gradual change in physical properties (Neighbouring) members differ by CH_2	max 2
(b)(i)	ultraviolet light / sunlight	1
(b)(ii)		1
(b)(iii)	hydrogen chloride	1
(c)	propyl ethanoate	1
(d)(i)	$C_5H_{10}O_2$	1

(d)(ii)	**M1** 	**1**
	M2 methanoic acid	**1**
	M3 	**1**
	M4 butan-2-ol	**1**
(e)	 **M1** correct amide link between at least one pair of boxes **M2** all three amide linkages between boxes are correct **M3** continuation bonds shown	**3**

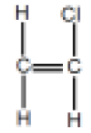
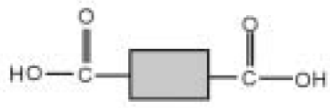
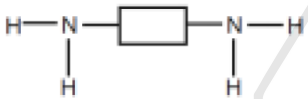
20. 0620_w18_ms_42 Q: 5

(a)	C_4H_6 Propyne	**2**
(b)	M1 one shared pair between each H and C M2 three shared pairs of electrons between the C atoms and no other unpaired electrons	**2**
(c)(i)	Any two from: same or similar chemical properties (contain) the same functional group (show) a trend or gradual change in physical properties (consecutive) members differ by CH_2 common methods of preparation	**2**

(c)(ii)	C_nH_{2n-2}	**1**
(d)	M1 Bromine water **or** aqueous bromine M2 Changes to colourless **or** decolourises	**2**
(e)(i)	M1 Acidified; M2 (Potassium) manganate (VII)	**2**
(e)(ii)	Diagram of ethanoic acid	**1**
(f)(i)	M1 Methyl propanoate M2 Diagram of methyl propanoate	**2**
(f)(ii)	Any four carbon ester not named in **5(f)(i)**	
(g)(i)	Condensation	**1**
(g)(ii)	Terylene	**1**

21. 0620_w18_ms_43 Q: 6

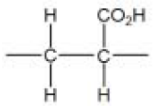
(a)(i)	**SUMMARY** **M1 and M4** reactants **M2 and M5** conditions **M3 and M6** equation **FERMENTATION:** **M1** glucose / sucrose / starch / other named carbohydrate can score in equation as correct formula **M2** Zymase / Yeast / 37□C **M3** $C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$ **HYDRATION:** **M4** Ethene and steam or water can score in equation as correct formulae **M5** H_3PO_4 (catalyst) / 300□C / 60 atm **M6** $C_2H_4 + H_2O \rightarrow C_2H_5OH$	**6**
(a)(ii)	**ANY TWO FROM:-** □ carbohydrates are renewable □ fossil fuels are non-renewable □ lower temperature means fossil fuels conserved **ORA** □ lower temperature means lower energy costs **ORA** □ hydration reaches an equilibrium meaning lower yield **ORA**	**2**
(a)(iii)	**M1** solvent **M2** fuel	**2**
(b)(i)	**E**	**1**
(b)(ii)	**D**	**1**
(b)(iii)	**B**	**1**
(b)(iv)	**C**	**1**
(b)(v)	**A**	**1**

(a)(i)	circle drawn round two consecutive carbons which includes 3 H atoms and 1 C*l* atom	**1**
(a)(ii)		**1**
(a)(iii)	**M1** stays yellow / orange / brown or no change	**1**
	M2 becomes colourless	**1**
(b)(i)	polyamide	**1**
(b)(ii)	circle must include exactly two C=O, two N–H, one shaded square and one unshaded square	**1**
(b)(iii)	**M1** 	**1**
	M2 	**1**

(c)(i)	**M1** 34.61/12 : 61.54/16 : 3.85/1 **OR** 2.885 : 3.846 : 3.85	**1**
	M2 2.885/2.885 : 3.846/2.885 : 3.85/2.885 **OR** 1 : 1.3(33) : 1.3(33) **OR** 3:4:4	**1**
	M3 $C_3O_4H_4$	**1**
(c)(ii)	relative formula mass / relative molecular mass	**1**

23. 0620_s17_ms_42 Q: 6

(a)(i)	alkene	1
	carboxylic acid	1
(a)(ii)	any 2 from: • same / similar chemical properties • (same) general formula • (consecutive members) differ by CH_2 • same functional group • common (allow similar) methods of preparation • physical properties vary in predictable manner / show trends / gradually change / example of a physical property variation	2
(b)	carboxylic acid / aldehyde	1
	ester	1
(c)(i)	colourless / decolourised	1
	bubbles / fizzing / effervescence	1

(c)(ii)	addition	1
	 repeat unit	1
	continuation bonds at both ends	1

24. 0620_w17_ms_42 Q: 3

(a)	*exothermic mark*: horizontal line representing the energy of the products below the energy of the reactants	1
	label of products mark: product line labelled with $2CO_2$ + $3H_2O$	1
	correct direction of vertical heat of reaction arrow: arrow starts level with reactant energy and finishes level with product energy **AND** has (only) **one** arrow head	1
(b)	activation energy / E_a	1

(c)	–650 kJ / mol **M1** bonds broken 2 □ ((3 □ 410) + 360 + 460) + (3 □ 500) 2 □ (1230 + 360 + 460) + 1500 2 □ 2050 + 1500 4100 + 1500 = 5600 **M2** bonds formed (2 □ (2 □ 805)) + (4 □ (2 □ 460)) 2 □ 1610 + 4 □ 920 3220 + 3680 = 6900 **M3** = **M1** – **M2** energy change of reaction = 5600 – 6900 = –1300 **M4** = **M3** / 2	**4**
(d)(i)	cracking	**1**
(d)(ii)	$C_{12}H_{26} \rightarrow 3C_2H_4 + C_6H_{14}$ **M1** $C_{12}H_{26}$ **M2** rest of equation	**2**
(d)(iii)	phosphoric acid	**1**
	heat	**1**
(d)(iv)	addition / hydration	**1**
(d)(v)	measure its boiling temperature	**1**
	compare to (known) data	**1**
(e)(i)	any 2 from: □ 37 °C □ anaerobic □ glucose is aqueous □ yeast	**2**
(e)(ii)	$C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$ **M1** CO_2 as a product **M2** Rest of equation	**2**
(e)(iii)	yeast is killed by the ethanol	**1**
(e)(v)	slow rate of reaction	**1**
(e)(v)	uses renewable resources / does not use a finite resource	**1**
(e)(vi)	fractional distillation	**1**
(f)(i)	CH_3O	**1**
(f)(ii)	no (C=C) double bonds	**1**
(f)(iii)	at least two alternating rectangles with attempted linking	**1**
	one displayed ester link (all atoms and all bonds)	**1**
	fully correct structure with at least one repeat unit including continuation bonds from correct atom or rectangle	**1**
(f)(iv)	polyester	**1**

25. 0620_w17_ms_43 Q: 7

(a)(i)	diffusion	**1**
(a)(ii)	silicon(IV) oxide is a solid, whereas carbon dioxide is a gas	**1**
(a)(iii)	photosynthesis	**1**
	chlorophyll / chloroplasts	**1**
	M2 sunlight / UV (light)	**1**
	$6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$ **M1** species correct **M2** balanced	**2**
(b)(i)	condensation	**1**
(b)(ii)	hydrolysis	**1**
(b)(ii)	HO–□–OH **OR** H–O–□–O–H	**1**

26. 0620_m16_ms_42 Q: 7

(a)(i)	compound containing carbon and hydrogen only;	1
(a)(ii)	C_nH_{2n+2}; C_nH_{2n};	2
(b)(i)	mol C = 54.54 / 12 or 4.5(45) **and** mol H = 9.09 / 1 or 9.09 **and** mol O = 36.37 / 16 or 2.27; C_2H_4O;	2
(b)(ii)	M_r of C_2H_4O = 44; 88 / 44 = 2 therefore $C_4H_8O_2$;	2
(c)	methyl ethanoate; CH_3COOCH_3; / ethyl methanoate; $HCOOC_2H_5$;	4
(d)	methyl propanoate;	1
(e)(i)	condensation;	1
(e)(ii)	water / H_2O;	1
(e)(iii)	dicarboxylic acid or diacyl chloride; diol;	2

27. 0620_p16_ms_40 Q: 9

(a) addition: polymer is the only product / only one product; [1]
condensation: polymer and water formed / small molecule formed; [1]

(b) Any two from:
ingestion can be fatal to animals / owtte;
animals can be caught in plastics e.g. fishing line / owtte;
combustion releases toxins / owtte;
land-fill uses natural resources / owtte;
allow: any appropriate example [2]

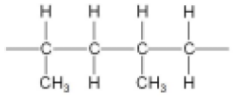
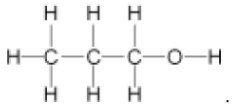
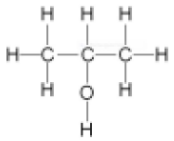
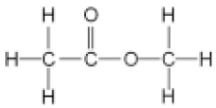
(c) CH_2=CHOCOCH$_3$ [1]
note: double bond does not need to be shown

(d) -OC$(CH_2)_4$CONH$(CH_2)_6$NH-
amide linkage correct; [1]
correct repeat units; [1]
continuation bonds shown; [1]

28. 0620_s16_ms_41 Q: 5

(a)	(sulfur-containing) fossil fuels;	1
(b)	**M1** vanadium pentoxide / vanadium(V) oxide / V_2O_5 (catalyst); **M2** 1–5 atmospheres (units required); **M3** 450 °C (units required); **M4** $2SO_2 + O_2 \rightarrow 2SO_3$; **M5** equilibrium / reversible reaction;	5 1 1 1 1 1
(c)	$H_2S_2O_7$;	1
(d)(i)	3 correct (2 marks) 2 correct (1 mark) bubbles / effervescence / fizzing; dissolves / disappears / *forms* a solution; blue (solution);	2
(d)(ii)	carbon dioxide and water and copper(II) sulfate;	1
(e)(i)	carbon;	1
(e)(ii)	dehydration;	1

29. 0620_s16_ms_41 Q: 6

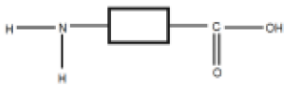
(a)	fractional distillation; cracking;	**2** 1 1
(b)(i)	addition;	**1**
(b)(ii)	CH_2;	**1**
(b)(iii)	 **M1** chain of 4 carbon atoms with single bonds and continuation bonds; **M2** correctly positioned CH_3 side chains;	**2**
(c)	 ;  ;	**2**
(d)(i)	(concentrated) sulfuric acid;	**1**
(d)(ii)	methyl ethanoate;	**1**
(d)(iii)	 **M1** ester link; **M2** rest of molecule;	**2**
(d)(iv)	terylene;	**1**

30. 0620_s16_ms_42 Q: 5

(a)(i)	more than enough to react (with all the hydrocarbon); **OR** (some) oxygen remaining;	**1**
(a)(ii)	75 cm^3;	**1**
(a)(iii)	2 : 15 : 10;	**1**
(a)(iv)	2 : 15 : 10 : 10; C_5H_{10};	**2** 1 1
(b)(i)	C_7H_{16};	**1**
(b)(ii)	contains a double bond/triple bond/multiple bond; **OR** not all bonds are single bonds;	**1**
(b)(iii)	test: aqueous bromine/bromine (water)/Br_2; result: (orange/yellow/brown) to colourless/decolourised/colour disappears;	**2** 1 1
(c)(i)	addition;	**1**
(c)(ii)	1 (kg);	**1**
(c)(iii)	propene: CH_2; polypropene: CH_2;	**2** 1 1

31. 0620_s16_ms_43 Q: 6

(a)(i)	NH_3 + HCl → NH_4Cl;	1
(a)(ii)	diffusion;	1
(a)(iii)	solid forms at: A; explanation: ammonia molecules / particles have a smaller mass; (and so) move / diffuse faster;	3 1 2
(a)(iv)	**M1** solid forms in less time / faster / quicker; **M2** particles / molecules have more energy; **M3** (and so) move faster / diffuse faster;	3 1 1 1
(b)(i)	test: add sodium hydroxide (solution and warm); result: test gas / ammonia with (red) litmus / Universal Indicator / pH paper; indicator turns blue / ammonia produced;	3 1 2
(b)(ii)	test: add silver nitrate (solution); result: add (dilute) nitric acid; white precipitate;	3 1 2

(c)(i)	covalent;	1
(c)(ii)	**M1** one shared pair of electrons between each N and H; **M2** one shared pair of electrons between the N atoms; **M3** one lone pair on each N and no additional electrons anywhere;	3 1 1 1
(d)(i)	amide;	1
(d)(ii)	proteins are made from more than two monomers; **OR** nylon is made from 1 or 2 monomers (only);	1
(d)(iii)	amino acids;	1
(e)	 ;	1

32. 0620_w16_ms_41 Q: 5

(a)	(gas) oxygen (test) glowing splint (result of test) relights	1 1 1
(b)	reference to ions / ionic ions cannot move in solid **OR** are in fixed positions in solid ions can move when in solution	1 1 1
(c)(i)	copper ions / Cu^{2+} gain of electrons / oxidation number decreases	1 1
(c)(ii)	any 3 from: anode decreases (in mass) copper removed (from anode) / solid (copper from anode) becomes aqueous cathode increases (in mass) copper deposited / added / Cu^{2+} deposited as Cu (on cathode)	3
(c)(iii)	copper is both added and removed (at same rate) **OR** the concentration (of copper ions) does not change	1

33. 0620_w16_ms_41 Q: 6

(a)	large / big molecule made from (many) monomers (joined together)	1 1
(b)(i)	amide / peptide	1
(b)(ii)	(can be) broken down by microbes / bacteria	1 1
(b)(iii)	starch / cellulose / DNA / RNA / polysaccharides /	1

(c)(i)	**M1** at least one correct ester linkage between boxes **M2** at least two boxes shown and sufficient correct C and O atoms to make **two correct** ester linkages **M3** continuation bond(s) **AND** if more than one repeat unit is shown, the repeat unit must be correctly identified	1 1 1

34. 0620_w16_ms_42 Q: 7

(a)	large / big molecule made from (many) monomers (joined together)	2
(b)(i)	hydrolysis	1
(b)(ii)	acid (conditions) / enzyme	1
(c)(i)	$\frac{\text{distance moved by substance}}{\text{distance moved by solvent (front)}}$	1
(c)(ii)	circle around top spot	1
(c)(iii)	mixture of amino acids is placed as a spot onto a (pencil) baseline placed into a (suitable) solvent / water a locating agent is added to the (finished) chromatogram (to reveal spots)	

(d)	fully displayed amide link between any two 'blocks' dipeptide 1: amino acid **A** on left-hand side and amino acid **B** on right-hand side **AND** dipeptide 2: amino acid B on left-hand side and amino acid A on right-hand side correct terminal amine and carboxylic acid group on both correct dipeptides	3

35. 0620_w16_ms_43 Q: 6

(a)(i)	*condensation:* **M1** (two) molecules / monomers joining **M2** with the removal of a (small) molecule *polymerisation:* **M3** (to form) a large molecule / a long chain	3
(a)(ii)	addition	1
(b)(i)	circled amide link	1
(b)(ii)	all missing atoms and bonds shown on the diacid all missing atoms and bonds shown on the diamine	1 1

(b)(iii)	nylon / Kevlar / Nomex	1
(c)(i)	amino acids	1
(c)(ii)	hydrolysis chromatography (spray with) locating agent / UV determine R_f values / compare with standards	1 1 1 1

36. 0620_m15_ms_32 Q: 4

(a) (i) 82.76/12 and 17.2(4)(/1)
or evaluation: 6.89 / 6.9(0) and 17.2(4) [1]

C_2H_5 [1]

OR
82.76 / 100 × 58 = 48 and 17.24 / 100 × 58 = 10
or evaluation i.e. 48 and 10 [1]

C_2H_5 [1]

(ii) (C_2H_5 =) 29 [1]

(58 / 29 =2) C_4H_{10} [1]

OR:
82.76 / 100 × 58 = 48 and 17.24 / 100 × 58 = 10
or evaluation i.e. 48 and 10 [1]

48 / 12 = 4 10 / 1 = 10 (therefore) C_4H_{10} [1]

(b) (i) C_nH_{2n} [1]

(ii) CH_2 [1]

(c) (contains) double bond / triple bond / multiple bond(s) / not all bonds are single [1]

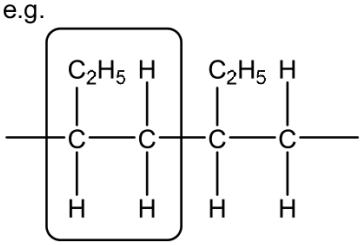
(contains) carbon and hydrogen **only** [1]

(d) bromine / bromine water [1]

no change / stays brown / orange / yellow / red-brown or only changes in UV [1]

(brown / orange / yellow) to colourless / decolourised [1]

(e) (i) circle / brackets around any 2 consecutive carbon atoms in the main chain and all attached atoms [1]
e.g.



(ii) $CH_3CH_2CH{=}CH_2$ / $C_2H_5CH{=}CH_2$ (double bond must be shown) [1]

butene / but-1-ene [1]

(iii) $(CH_3)_2C=CH_2$ / $CH_3CH=CHCH_3$ / $(CH_2)_2CHCH_3$ / $(CH_2)_4$ [1]

[Total:15]

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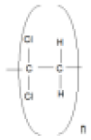
37. 0620_s15_ms_33 Q: 7

(a)(i)	alkenes have a (carbon to carbon) double bond;	1	**A** "they" for alkenes **A** alkanes do not have a (carbon to carbon) double bond
(a)(ii)	alkene; C_nH_{2n} **or** twice as many hydrogen atoms as carbon atoms;	2	**A** fits general formula for alkenes
(a)(iii)	add bromine (water); remains brown / orange / yellow / no change; becomes colourless / decolourised;	3	**I** red **A** M2 and M3 only available if M1 correct or close (such as bromide or bromination) **I** clear
(b)(i)	 correct structure with at least two carbons and single C-C bond; continuation bonds with at least 2 carbon atoms in chain; two or more correct repeat units (with correct use of n, if used) **OR** correct use of n;	3	**I** incorrect additional units **R** any incorrect units or non-integral number of repeat units
(b)(ii)	CH_3-CH=CH-CH_3;	2	**A** award 1 mark for any monomer with C=C as long as both carbons have the correct valency **I** names

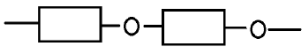
(b)(iii)	*one from:* addition polymerisation polymer only product; addition polymerisation same functional group in all monomers **or** C=C in monomers; addition polymer has same empirical formula as monomer; *one from:* condensation makes (polymer and) simple/small molecule **OR** water **OR** hydrogen chloride; condensation polymerisation monomers have two (different) functional groups;	2	**A** only one monomer **A** (normally two) different monomers
(b)(iv)	polyester / polyamide;	1	**A** protein / polysaccharide / polypeptide / complex carbohydrate **I** names

38. 0620_w15_ms_31 Q: 4

(a)(i)	any two from: • shortage of sites / landfill sites fill up; • visual pollution / litter; • danger to wild life;	2
(a)(ii)	(produce) toxic gases or CO or HC*l* or HF / carbon dioxide / greenhouse gases;	1
(b)	any two from: bags / clothing or specified clothing / packaging / bowls / cups / plates / flooring / carpets / pipes / insulation / non-stick coatings / ropes;	1

(c)(i)	$CH_2=CHCH_3$ double bond is shown; rest of structure correct;	2
(c)(ii)	ester;	1
(c)(iii)	(carboxylic) acid; alcohol;	1 1
(d)	addition – polymer only product / only one product; condensation – (polymer and) simple molecule / water / hydrogen chloride made; polymer **A** is an addition polymer **and** polymer **B** is a condensation polymer;	1 1 1

39. 0620_w15_ms_31 Q: 7

(a)(i)	**step 2 and** it is electron gain / oxidation state decreases;	**1**
(a)(ii)	silver (ion) **and** it accepts electrons / gets reduced / oxidation state decreases;	**1**
(b)	*prediction:* the '*not covered*' section will be black; the '*covered in thick card*' section will be white / cream; the '*covered in thin card*' section will be grey; *explanation:* the more light, the more silver ions are reduced;	 **1** **1** **1** **1**
(c)(i)	carbon dioxide + water → glucose + oxygen reactants correct; products correct;	 **1** **1**
(c)(ii)	chlorophyll;	**1**
(c)(iii)	 one correct –O– link between rectangles; two correct glucose units with continuation bonds;	 **1** **1**
(c)(iv)	the reaction of glucose with oxygen to release (carbon dioxide and water and) energy; **or** the reaction of glucose in a biological system to release energy;	**1**

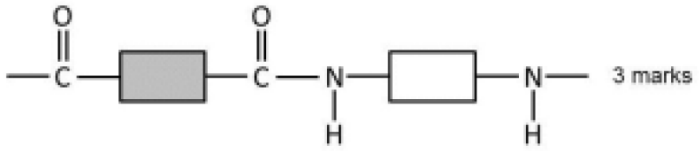
40. 0620_s14_ms_31 Q: 8

(a) (i) $CH_3–CH=CH–CH_3$ (1) [1]

(ii) one correct amide linkage between two rectangles (1)

correct sequencing of a second amide link and monomers (1)

two correct amide links **and** rest of structure correct (including additional monomers if seen) **and** correct continuation bonds (1) [3]



3 marks

(iii) protein **or** polypeptide **or** named protein (1) [1]

(iv) addition: **only** the polymer **or** one product is formed (1)

condensation: the polymer **and** a small molecule / water / HC*l* is formed (1) [2]

(b) (i) does not break down **or** rot **or** decompose (1)

by microbes **or** fungi **or** bacteria **or** by living organisms (1) [2]

(ii) Any **three** from: [3]
visual pollution (1)

(shortage of) landfill sites (1)

danger to wildlife / animals (including at sea) (1)

toxic gases when burnt **or** greenhouse gases produced when burned (1)

(c) Any **two** from: [2]
resistant to corrosion / unreactive to water / more durable (1)

lighter / less dense (1)

easier to manufacture / can be moulded (1)

good insulator / keeps the water cold (1)

[Total: 14]

41. 0620_s14_ms_33 Q: 3

(a) (i) enzymes (1) [1]

(ii) reduces growth of microbes/rate of reproduction of microbes is lower/ microbes are dormant (1)
fewer (enzymes) to decay food (1)
OR
enzymes less efficient at lower temperatures (1)
slower reaction rate (1) [2]

(b) correct linkage (1)
rest of molecule correct **and** continuation shown (1)
(other product is) water (1) [3]

(c) any **three** from:
photosynthesis (1)
light/photochemical (1)
chlorophyll/chloroplasts (1)
carbon dioxide and water needed (1)
(glucose and) oxygen (1) [3]

[Total: 9]

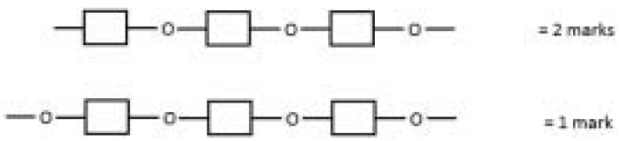
42. 0620_w14_ms_32 Q: 5

(a) (i) M1 Contain carbon, hydrogen and oxygen (only) [1]

M2 hydrogen and oxygen is in a 2:1 ratio (or in the same ratio as water) [1]

(ii) M1 -O- linkage [1]

M2 3 monomer units with 3 blocks and 3 Oxygen atoms **Cond** [1]



(b) catalyst [1]

biological or protein [1]

(c) (i) C A B [2]

ABC = 1 ACB = 1 BCA = 1 CBA = 1 BAC = 0
Allow 70 for C, 40 for B and 20 for A

(ii) M1 Energy mark: at higher temperature particles/molecules more have more energy or move faster [1]

M2 Collision frequency mark: collide more frequently/often **or** more collisions per unit time **or** higher rate of collisions. [1]
Ignore: 'more collisions'

M3 Collision energy mark: more molecules have enough energy to react or more collisions are above activation energy or successful [1]

(iii) C rate zero or enzymes denatured [1]

[Total: 12]

43. 0620_s13_ms_32 Q: 5

(a) (i) does not decay **or** non-biodegradable **or** flexible **or** bendable **or** easily moulded **or** low density / light / lightweight **or** waterproof / insoluble in water **or** does not corrode **or** durable [1]

(ii) any two from: [2]
chlorine
hydrogen chloride
carbon monoxide

(b) (i) CH_3—CH = CH_2 [1]
note: can be fully or semi-displayed, C = C must be shown

(ii) correct repeat unit [1]
–$CH(C_6H_5)$–CH_2–

continuation shown [1]

(c) glucose two products (polymer and water) / condensation (polymerisation) / (small) molecules removed [1]

phenylethene one product (polymer) / addition (polymerisation) [1]

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44. 0620_s13_ms_32 Q :7

(a) (i) $CH_3COOCH_2CH_3$ / $CH_3CO_2CH_2CH_3$ / $CH_3COOC_2H_5$ / $CH_3CO_2C_2H_5$ / $C_2H_5OOCCH_3$ / $CH_3CH_2OOCCH_3$ **not:** –OCO– linkage [1]
note: formulae can be displayed or semi-displayed
note: penalise sticks (i.e. any missing atoms)

(ii) butyl methanoate [1]

(b) (i) fats / vegetable oils / triglycerides / lipids [1]

(ii) two correct ester linkages, e.g. –OOC / –O_2C and –COO / –CO_2 [1]

contents of the 'boxes' being C_6H_4 and C_2H_4 or CH_2CH_2 [1]
continuation bonds at **both** ends [1]

(c) (i) to make colourless / invisible (spots) [1]
visible / coloured / seen / position made clear / indicate [1]

(ii) $\frac{\text{distance travelled by sample}}{\text{distance travelled by solvent (front)}} = R_f$ [1]

(iii) sample 1 R_f = 0.20 to 0.24 tartaric (acid) [1]
sample 2 R_f = 0.44 to 0.48 malic (acid) [1]

(a) (i) a compound which contains carbon and hydrogen **only** [1]

(ii) alkanes contain **only** C-C single bonds
or they are saturated (hydrocarbons)
or have the general formula C_nH_{2n+2} [1]

alkenes contain at least one C=C double bond
or they are unsaturated (hydrocarbons)
or have the general formula C_nH_{2n} [1]

(b) $C_{20}H_{42} \rightarrow 2C_4H_8 + 2C_2H_4 + \mathbf{C_8H_{18}}$ [1]

(c) (i) any unambiguous structure of $BrCH_2CH_2Br$ [1]
NOT just $C_2H_4Br_2$

(ii) $CH_3\text{-}CH{=}CH\text{-}CH_3$ [2]
For any butene [1] only

(iii) $(CH_3\text{-}CH_2\text{-}CH{=}CH_2) + H_2O$ [1] $\rightarrow CH_3\text{-}CH_2\text{-}CH_2\text{-}CH_2OH$ [1] [2]
ALLOW $CH_3\text{-}CHOH\text{-}CH_2\text{-}CH_3$
butene reacts with **water/steam** (to form butanol) **ONLY [1]**

(iv) $C_6H_{12} + H_2 \rightarrow C_6H_{14}$ [2]
alkenes react with **hydrogen** [1] **ONLY**

(d) volume of oxygen used = 150 cm^3 [1]

volume of carbon dioxide formed = 100 cm^3 [1]
any equation of the combustion of an alkene
e.g. $2C_5H_{10} + 15O_2 \rightarrow 10CO_2 + 10H_2O$
formulae [1]
COND balancing [1]

46. 0620_w13_ms_31 Q: 5

(a) (i) have same molecular formula / both are C_5H_{12} [1]
they have different structural formulae / different structures [1]

(ii) CH_3-CH_2-CH=CH-CH_3 / any other correct isomer [1]

(b) (i) CH_2-(Br)-CH_2Br [1]
NOT: $C_2H_4Br_2$
dibromoethane [1]
NOTE: numbers not required but if given must be 1, 2

(ii) CH_3-CH_2-CH_3 [1]
NOT: C_3H_8
propane [1]

(iii) CH_3-CH_2-CH_2-CH_2-OH / CH_3-CH_2-CH(OH)-CH_3 [1]
butanol [1]
numbers not required but if given must be correct and match formula

(c) (i) CH_3-CH=CH-CH_2-CH_3 [1]
CH_3-CH=CH-CH_3 [1]

(ii) pink / purple [1]
colourless [1]
NOT: clear

(d) -CH_2-CH(CN)-CH_2-CH(CN)-
correct repeat unit CH_2-CH(CN) [1]
COND: at least 2 units in diagram [1]
continuation [1]

[Total:16]

(a) (i) contains only carbon, hydrogen and oxygen [1]
hydrogen (atom) to oxygen (atom) ratio is 2:1 [1]
ALLOW: C:H:O as 1:2:1 or $C_n(H_2O)_n$

(ii) condensation [1]
polymerisation [1]

(b) (i) cells / micro-organisms / plants / animals / metabolic reactions [1]
obtaining energy from food / glucose / nutrients [1]

(ii) $2C_2H_5OH + 2CO_2$ [2]
allow: C_2H_6O for C_2H_5OH
not balanced = (1) only

(iii) to prevent aerobic respiration / to get anaerobic respiration / to prevent ethanoic acid / lactic acid / carboxylic acids being formed / to prevent oxidation of ethanol [1]

(c) displayed formula of methyl butanoate [2]
NOTE: all bonds must be shown
NOTE: award (1) if error in alkyl groups but correct displayed structure of –COO–

(d) (i) alcohol, e.g. glycerol, circled [1]
ALLOW: if only part of glycerol molecule is circled as long as it involves an OH group

(ii) saturated
correct reason based on group $C_{17}H_{35}$ / all C–C bonds / no C = C bonds [1]

(iii) salt / carboxylate / alkanoate [1]
(making) soap [1]
ACCEPT: detergent / washing

(e) at least one correct amide linkage –CONH– [1]
continuation shown at both ends of chain [1]
diagram showing three (different) amino acid residues [1]

[Total: 18]

48. 0620_w13_ms_33 Q: 5

(a) protective / layer **and** of oxide [1]

(b) correct repeat unit [1]
continuation shown [1]

(c) **(i)** catalyst [1]
biological / protein [1]

(ii) hydrochloric acid / any strong acid / any strong alkali [1]

(iii) amino acids [1]

(iv) chromatography [1]

(v) nylon / kevlar [1]

(d) **(i)** non-biodegradable [1]

(ii) $CH_2=CH(C_6H_5)$ [1]

[Total: 11]

49. 0620_s12_ms_31 Q: 7

(a) burning
produces toxic gases / harmful to health
increases greenhouse gases / global warming
reduces visual pollution / litter
reduces risks to wildlife
shortage of landfill sites / reduces space needed in landfill sites / saves space
non-biodegradable / long time to rot / decompose / accumulates waste
burning source of energy / used to generate electricity

recycling
conserves petroleum / natural resources
difficult to recycle / expensive / takes much energy
problems over sorting
reduces need for landfill
quality of plastic is reduced each time it is recycled
four DIFFERENT valid points which are advantages or disadvantages of burning and/or recycling [4]

(b) (i) addition (polymerisation); [1]

(polymer) only product / no by-products; [1]

condensation (polymerisation); [1]

(polymer and) simple molecule / water / hydrogen chloride / one other product forms; [1]

(ii) a correct linkage (for a polyamide / polyester); [1]
two different monomers; [1]

[Total: 10]

50. 0620_s12_ms_32 Q: 5

(a) (i) correct -O- linkage; [1]
correct unit and continuation -O-□- (minimum); [1]

(ii) any name or correct formula of a (strong) acid / H^+; [1]

(iii) contain carbon hydrogen and oxygen /C, H and O; [1]

(b) (i) glucose → ethanol + carbon dioxide [1]

(ii) yeast is catalyst / provides enzymes / speeds up reaction / too slow without yeast; [1]
yeast cells grow / multiply / reproduce / undergo budding / breed; [1]

(iii) heat or high temperature would kill yeast (cells) / heat or high temperature denatures enzymes; [1]
not: enzyme killed / denatures yeast
reduces rate of reaction / slows reaction / (yeast or enzyme) no longer catalyses / no catalyst / stops reaction / no more product; [1]

(c) (i) would produce carbon dioxide or carboxylic or organic acids (if oxygen is present) / to prevent aerobic respiration / so products are not oxidised / anaerobic bacteria can't live with oxygen; [1]

(ii) fossil fuels have a reduced need / conserved / no need to import / will last longer / cracking hydrocarbons to make methane no longer required;
(methane) is renewable / carbon neutral;
reduce pollution of water or sea / prevents visual pollution / prevents need for waste disposal or accumulation (**accept:** any methods of waste disposal) / so that waste is recycled; **any two** [2]

(a) (i) CH_2/H_2C [1]

(ii) same ratio of C:H (atoms) / all cancel to CH_2 / because general formula is C_nH_{2n} / same ratio of atoms or elements (in the compound) / C:H ratio is 1:2; [1]

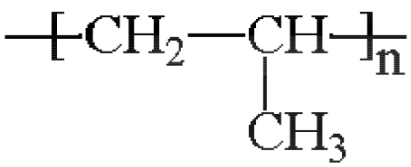
(b) (i) propanoic / propionic (acid); [1]
ethanoic / acetic (acid); [1]

(ii) formula of ethene / but-2-ene / any symmetrical alkene; [1]

(c) (i) $CH_3CH(Br)CH_2Br$ [1]

(ii) $CH_3CH(OH)CH_3$ / $CH_3CH_2CH_2OH$ / C_3H_7OH [1]

(d)



correct unit; [1]
accept: more than one repeat unit
continuation bonds at **both** ends; [1]

(e) if C_5H_{10} is given award 3 marks;;; [3]
if $C_{10}H_{20}$ is given award 2 marks;;
if 1:7.5:5 / 2:15:10 is given award 2 marks;;
in all other cases a mark can be awarded for moles of O_2 (= 2.4/32 =) 0.075 **AND** moles of CO_2 (= 2.2/44 =) 0.05;

$2C_5H_{10} + 15O_2 \rightarrow 10CO_2 + 10H_2O$ [1]
accept: multiples including fractions
allow: ecf for correct equation from any incorrect alkene

52. 0620_w12_ms_31 Q: 6

(a) (i) amino acid / peptides; [1]
salt / carboxylate or soap / fatty acid or glycerine / alcohol; [1]
sugars or glucose; [1]
accept: named sugar

(ii) polyester; [1]
allow: named polyester
polyamide; [1]
allow: nylon

(b) one correct amide linkage; [1]
second amide linkage correctly orientated
– NHCO – followed by – NHCO –; [1]
note: monomers are amino acids not diamines or dicarboxylic acid

(c) bromine / bromine water / aqueous bromine; [1]
unsaturated - brown / orange to colourless **not:** clear [1]
saturated - stays brown / orange [1]

or: alkaline potassium manganate(VII);
from purple / pink to green / brown;
stays purple;
or: acidic potassium manganate(VII)
from purple / pink to colourless; **not:** clear
stays purple;

[Total: 10]

(a) (i) $Zn + 2HCl \rightarrow ZnCl_2 + H_2$ [2]
not balanced = [1]

(ii) 3 bps and 1 nbp around As; [1]
1 bp each hydrogen atom; [1]

(b) (i) (97.4 / 75 =) 1.3 **and** (2.6 / 1 =) 2.6; [1]
empirical formula AsH_2; [1]
note: correct formula with no working = [1]

(ii) As_2H_4; [1]

(iii) $H_2As–AsH_2$ / $AsH_2–AsH_2$; [1]

(c) (i) amide / peptide; [1]

(ii) named strong acid / alkali; [1]
allow: HCl / enzymes

(iii) amino acid; [1]
allow: peptides

(d) (i) Cu and As have more than one oxidation state / valency; [1]

(ii) $3Cu^{2+} + 2AsO_4^{3-} \rightarrow Cu_3(AsO_4)_2$ [2]
either side correct = [1]

[Total: 14]