FOR OFFICIAL USE

Total for Section B

C273/SQP365

Chemistry
Higher (Revised)
Specimen Question Paper
for use in and after 2012

Time: 2 hours 30 minutes

NATIONAL QUALIFICATIONS

Fill in these boxes and read what is printed below.

Full name of centre

Town

Forename(s)

Surname

Date of birth
Day Month Year

Scottish candidate number

Number of seat

Reference may be made to the Chemistry Higher and Advanced Higher Data Booklet (2007 edition).

SECTION A—Questions 1–30

Instructions for completion of **Section A** are given on page two.

For this section of the examination you must use an **HB pencil**.

SECTION B

1 All questions should be attempted.

2 The questions may be answered in any order but all answers are to be written in the spaces provided in this answer book, **and must be written clearly and legibly in ink**.

3 Rough work, if any should be necessary, should be written in this book and then scored through when the fair copy has been written.

4 Additional space for answers and rough work will be found at the end of the book. If further space is required, supplementary sheets may be obtained from the Invigilator and should be inserted inside the **front** cover of this book.

5 The size of the space provided for an answer should not be taken as an indication of how much to write. It is not necessary to use all the space.

6 Before leaving the examination room you must give this book to the Invigilator. If you do not, you may lose all the marks for this paper.

SQA ©

SECTION A

Read carefully

1 Check that the answer sheet provided is for **Chemistry (Revised) Higher (Section A)**.

2 Print your name in the boxes provided.

3 For this section of the examination you must use an **HB pencil** and, where necessary, an eraser.

4 The answer to each question is **either** A, B, C or D. Decide what your answer is, then, using your pencil, put a horizontal line in the space provided (see sample question below).

5 There is **only one correct** answer to each question.

6 Any rough working should be done on the question paper or the rough working sheet, **not** on your answer sheet.

7 At the end of the exam, put the **answer sheet for Section A inside the front cover of your answer book**.

Sample Question

To show that the ink in a ball-pen consists of a mixture of dyes, the method of separation would be

A chromatography

B fractional distillation

C fractional crystallisation

D filtration.

The correct answer is **A**—chromatography. The answer **A** has been clearly marked in **pencil** with a horizontal line (see below).

Changing an answer

If you decide to change your answer, carefully erase your first answer and using your pencil, fill in the answer you want. The answer below has been changed to **D**.

1. Diamond has

A an ionic lattice structure

B a covalent network structure

C covalent molecules linked by London dispersion forces

D covalent sheets with only London dispersion forces acting between sheets.

2. Which of the following elements would require the most energy to convert one mole of gaseous atoms into gaseous ions each carrying two positive charges?

(You may wish to use the data booklet.)

A Scandium

B Titanium

C Vanadium

D Chromium

3. Which of the following elements has the greatest attraction for bonding electrons?

A Caesium

B Oxygen

C Fluorine

D Iodine

4. Which of the following chlorides is likely to have the most ionic character?

A LiCl

B CsCl

C $BeCl_2$

D $CaCl_2$

5. Which of the following is **not** an example of a Van der Waals' force?

A Covalent bonding

B Hydrogen bonding

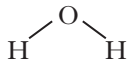
C London dispersion forces

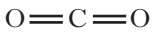
D Permanent dipole-permanent dipole interactions

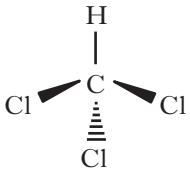
6. The shapes of some common molecules are shown below and each contains at least one polar bond.

Which molecule is non-polar?

A

B 

C 

D 

7. Which of the following elements is the strongest reducing agent?

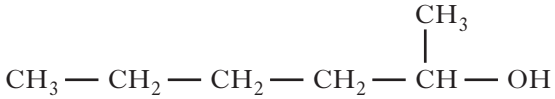
A Fluorine

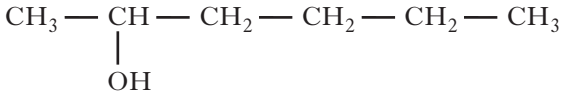
B Hydrogen

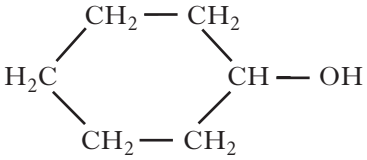
C Potassium

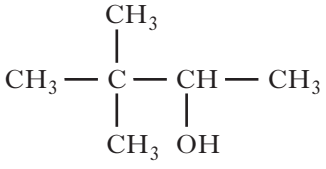
D Magnesium

8. Which of the following is an isomer of hexan-2-ol?

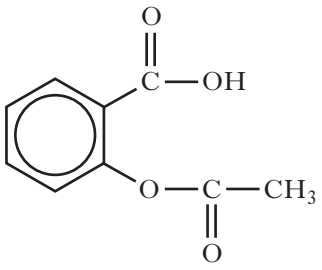
A 

B 

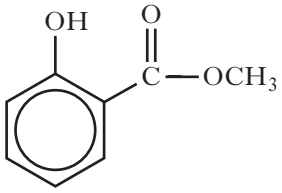
C 

D 

9. Aspirin and oil of wintergreen are used in medicine. Their structures are shown below.



Aspirin



Oil of wintergreen

Identify the term which can be applied to aspirin but **not** to oil of wintergreen.

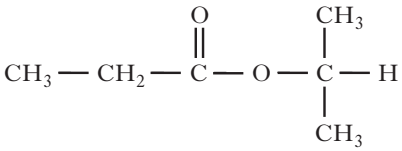
A Aldehyde

B Ketone

C Ester

D Carboxylic acid

10. An ester has the structural formula:



On hydrolysis, the ester would produce

A ethanoic acid and propan-1-ol

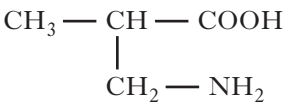
B ethanoic acid and propan-2-ol

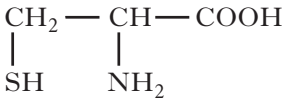
C propanoic acid and propan-1-ol

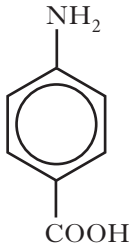
D propanoic acid and propan-2-ol.

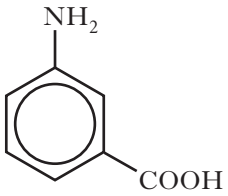
11. Some amino acids are called α-amino acids because the amino group is on the carbon atom next to the acid group.

Which of the following is an α-amino acid?

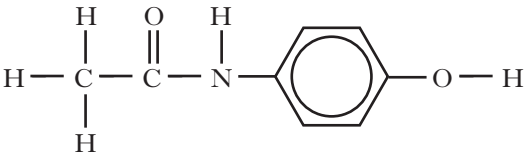
A 

B 

C 

D 

12. Paracetamol is one of the most widely used pain relievers. It has the structure:



Which functional groups are present in a paracetamol molecule?

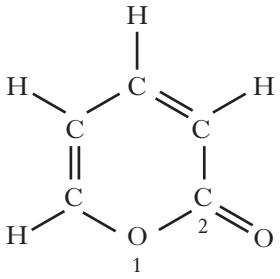
A Aldehyde, amine and hydroxyl

B Ketone, amine and hydroxyl

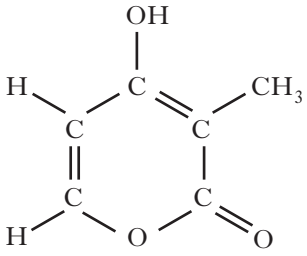
C Amide link and hydroxyl

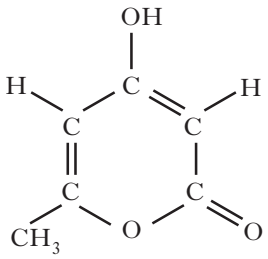
D Amino acid and hydroxyl

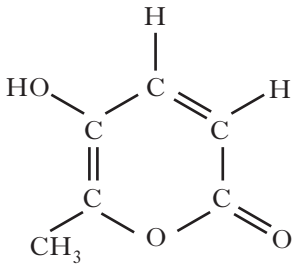
13. The 2-pyrones are esters widely used as flavourings and in perfumes. The name "2-pyrone" comes from the fact that the carbonyl group is in the 2-position, counting from the oxygen in the ring as shown.

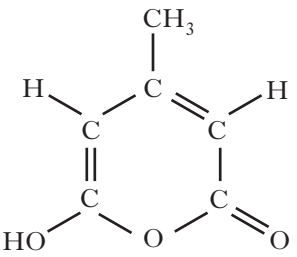


Which of the following structures is the pyrone responsible for the smell of chocolate, 4-hydroxy-6-methyl-2-pyrone?

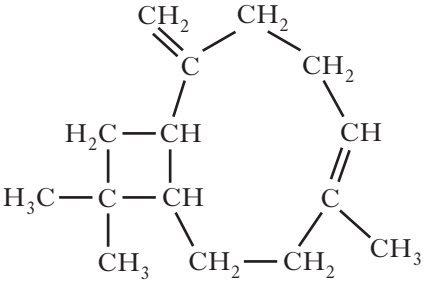
A 

B 

C 

D 

14. The structure of caryophyllene, which can be extracted from clove oil, is



Which of the following would be the best solvent for extracting caryophyllene?

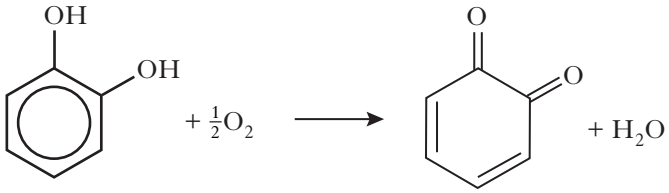
A Hexane

B Hexanal

C Hexanol

D Hexanone

15. Apples and bananas turn brown when cut or bruised. The first step of the reaction causing the browning is shown below.



Which of the following terms correctly describes this reaction?

A Reduction

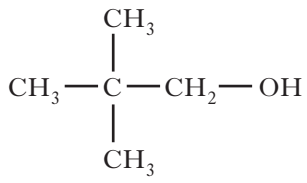
B Oxidation

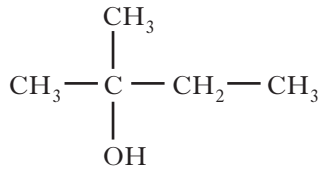
C Dehydration

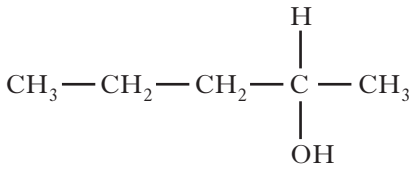
D Condensation

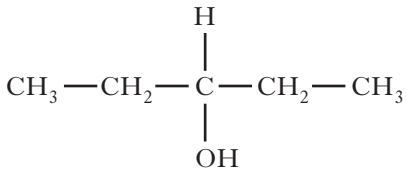
[Turn over

16. Which of the following structural formulae represents a tertiary alcohol?

A 

B 

C 

D 

17. Which process is used to convert ethanal to ethanoic acid?

A Hydrogenation

B Condensation

C Hydration

D Oxidation

18. Which of the following could **not** be a possible source of a fatty acid?

A Soaps

B Edible oils

C Emulsifiers

D Essential oils

19. A mixture of sodium bromide and sodium sulfate is known to contain 5 moles of sodium and 2 moles of bromide ions.

How many moles of sulfate ions are present?

A 1·5

B 2·0

C 2·5

D 3·0

21. In which reaction is the volume of products less than the volume of reactants?

A $CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(g)$

B $2NH_3(g) \rightarrow N_2(g) + 3H_2(g)$

C $H_2(g) + Cl_2(g) \rightarrow 2HCl(g)$

D $2CO(g) + O_2(g) \rightarrow 2CO_2(g)$

22. A student obtained a certain volume of carbon dioxide by the reaction of 20 cm^3 of 2 mol l^{-1} hydrochloric acid with excess sodium carbonate.

$2HCl(aq) + Na_2CO_3(aq) \rightarrow 2NaCl(aq) + CO_2(g)$

Which solution of sulfuric acid would give the same final volume of carbon dioxide when added to excess sodium carbonate?

$H_2SO_4(aq) + Na_2CO_3(aq) \rightarrow Na_2SO_4(aq) + CO_2(g)$

A 10 cm^3 of 2 mol l^{-1} sulfuric acid

B 20 cm^3 of 2 mol l^{-1} sulfuric acid

C 10 cm^3 of 4 mol l^{-1} sulfuric acid

D 20 cm^3 of 4 mol l^{-1} sulfuric acid

22. In a reversible reaction, equilibrium is reached when

A molecules of reactants cease to change into molecules of products

B the concentrations of reactants and products are equal

C the concentrations of reactants and products are constant

D the activation energy of the forward reaction is equal to that of the reverse reaction.

23. Ethanol is manufactured by reacting ethene with steam.

$$C_2H_4(g) + H_2O(g) \rightleftharpoons C_2H_5OH(g) \qquad \Delta H = -46\ kJ\ mol^{-1}$$

Which set of conditions would give the best yield of ethanol at equilibrium?

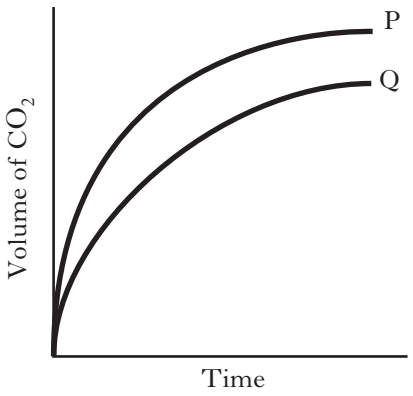
A High temperature, low pressure

B High temperature, high pressure

C Low temperature, high pressure

D Low temperature, low pressure

24.



When copper carbonate is reacted with excess acid, carbon dioxide is produced. The curves shown above were obtained under different conditions.

The change from P to Q could be brought about by

A increasing the concentration of the acid

B decreasing the mass of copper carbonate

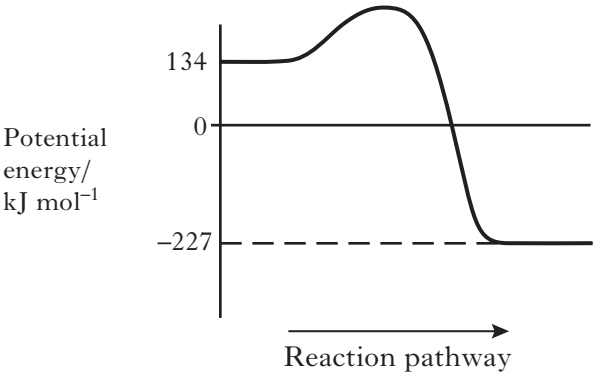
C decreasing the particle size of the copper carbonate

D adding a catalyst.

25. The potential energy diagram for the reaction

$CO(g) + NO_2(g) \rightarrow CO_2(g) + NO(g)$

is shown.



ΔH, in kJ mol^{-1}, for the forward reaction is

A +361

B –93

C –227

D –361.

26. Which of the following is **not** a correct statement about the effect of a catalyst?

The catalyst

A provides energy so that more molecules have successful collisions

B lowers the energy which molecules need for successful collisions

C provides an alternative route to the products

D forms bonds with reacting molecules.

[Turn over

27. Which of the following equations represents an enthalpy of combustion?

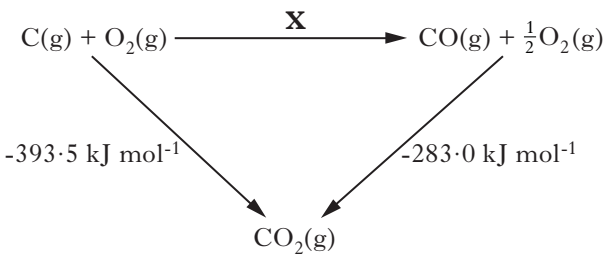
A $C_2H_6(g) + 3\frac{1}{2}O_2(g) \rightarrow 2CO_2(g) + 3H_2O(\ell)$

B $C_2H_5OH(\ell) + O_2(g) \rightarrow CH_3COOH(\ell) + H_2O(\ell)$

C $CH_3CHO(\ell) + \frac{1}{2}O_2(g) \rightarrow CH_3COOH(\ell)$

D $CH_4(g) + 1\frac{1}{2}O_2(g) \rightarrow CO(g) + 2H_2O(\ell)$

28. Consider the reaction pathways shown below.



According to Hess's law, the enthalpy change for reaction **X** is

A –676·5 kJ mol^{-1}

B –110·5 kJ mol^{-1}

C +110·5 kJ mol^{-1}

D +676·5 kJ mol^{-1}.

29. The mean bond enthalpy of the N–H bond is equal to one third of the value of ΔH for which change?

A $N(g) + 3H(g) \rightarrow NH_3(g)$

B $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$

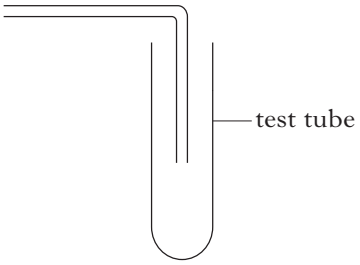
C $\frac{1}{2}N_2(g) + 1\frac{1}{2}H_2(g) \rightarrow NH_3(g)$

D $NH_3(g) \rightarrow \frac{1}{2}N_2(g) + 1\frac{1}{2}H_2(g)$

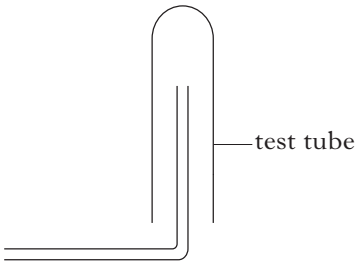
30. Sulphur dioxide gas is more dense than air and is very soluble in water.

Which of the following diagrams shows the most appropriate apparatus for collecting and measuring the volume of sulphur dioxide given off in a reaction?

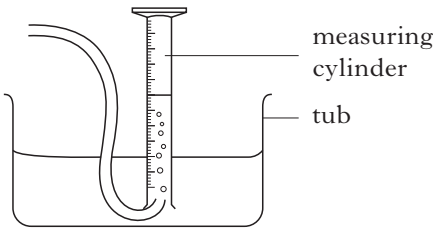
A



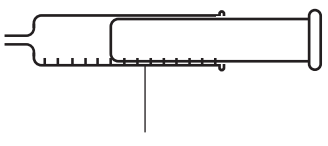
B



C



D



[*END OF SECTION A*]

Candidates are reminded that the answer sheet for Section A MUST be placed INSIDE the front cover of your answer book.

[Turn over for Section B on *Page ten*

DO NOT WRITE IN THIS MARGIN

SECTION B

Marks

1. (*a*) Complete the table below by adding the name of an element for each of the types of bonding and structure described.

Bonding and structure at room temperature and pressure	**Name of element**
metallic solid	sodium
monatomic gas	
covalent network solid	
discrete covalent molecular gas	
discrete covalent molecular solid	

2

(*b*) Many patterns in the physical and chemical properties of elements are observed.

Why does the electronegativity of elements increase across the second row of the Periodic Table from lithium to fluorine?

1

DO NOT WRITE IN THIS MARGIN

Marks

1. (continued)

(*c*) The Periodic Table groups together elements with similar properties. In most Periodic Tables hydrogen is placed at the top of Group 1, but on some it is placed at the top of Group 7.

Using your knowledge of Chemistry, comment on why hydrogen can be placed in both Group 1 and Group 7.

3
(6)

[Turn over

DO NOT WRITE IN THIS MARGIN

Marks

2. The table below contains information about some diatomic molecules.

	H–H	H–Cl	Cl–Cl	I–Cl	Br–Br
Boiling point / °C	–253	–85	–35	97	59
Bond enthalpy / kJ mol^{-1}	432	428	243	211	194

(*a*) Boiling points can be used to show the effect of intermolecular forces.

Explain why a comparison of the boiling points of ICl and Br_2 provides good evidence about the strength of permanent dipole-permanent dipole interactions.

3

(*b*) In the table above, which of the diatomic molecules listed has the strongest covalent bond?

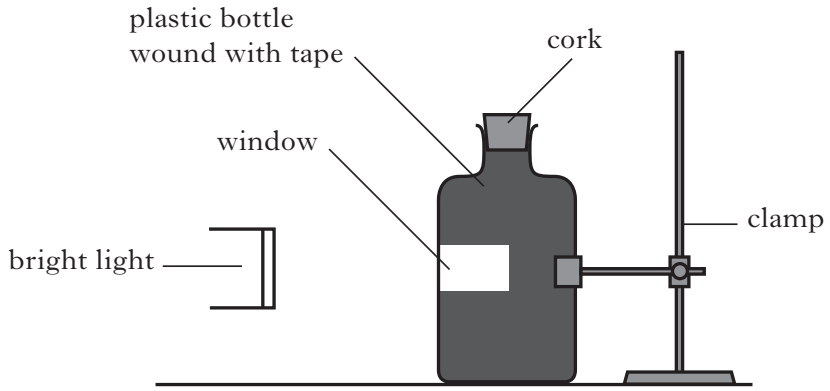
1

Marks

2. (continued)

(*c*) Hydrogen and chlorine gases are used in an experiment to demonstrate a free radical reaction.

A plastic bottle is wrapped with black tape leaving a "window" on one side. The bottle is filled with a mixture of hydrogen and chlorine. When bright light shines on the bottle there is an explosion.



A free radical chain reaction is initiated when light energy causes chlorine radicals to form as shown below.

Initiation $Cl-Cl \xrightarrow{\text{light}} Cl\bullet + Cl\bullet$

(i) Complete the equations below showing possible propagation and termination steps.

Propagation $Cl\bullet + H-H \longrightarrow \quad +$

Termination $H\bullet + H\bullet \longrightarrow$

2

(ii) Why is the plastic bottle used in the experiment wrapped in black tape?

1

Marks

2. (*c*) (continued)

(iii) The production of hydrogen chloride from hydrogen and chlorine is exothermic.

$$H_2(g) + Cl_2(g) \rightarrow 2HCl(g)$$

Using bond enthalpy values, calculate the enthalpy change, in kJ mol^{-1}, for this reaction.

2

(iv) The chlorine used in the experiment is made in a redox reaction between permanganate ions and chloride ions.

The ion-electron equations for the oxidation and reduction reactions are shown below.

$$2Cl^-(aq) \rightarrow Cl_2(g) + 2e^-$$

$$MnO_4^-(aq) + 8H^+(aq) + 5e^- \rightarrow Mn^{2+}(aq) + 4H_2O(\ell)$$

Write a balanced equation for the reaction of permanganate ions with chloride ions to produce chlorine gas.

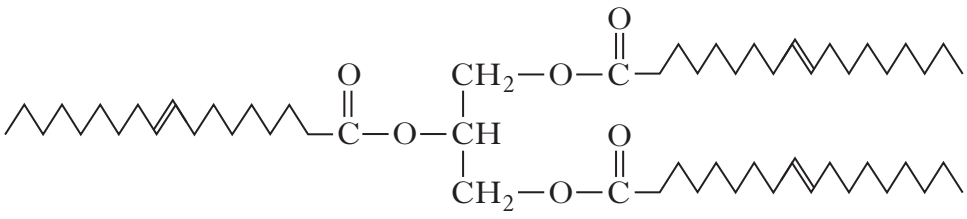
1

(10)

DO NOT WRITE IN THIS MARGIN

Marks

3. The structure of a molecule found in olive oil can be represented as shown.



(*a*) Olive oil can be hydrolysed using sodium hydroxide solution to produce sodium salts of fatty acids.

Name the other product of this reaction.

1

(*b*) In what way does the structure of a fat molecule differ from that of an oil molecule?

1

(*c*) Over time, open containers of olive oil develop a rancid flavour. What substance is reacting with the oil to cause these unwanted changes to take place?

1

(3)

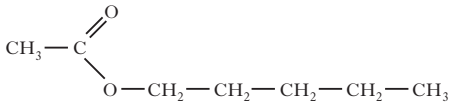
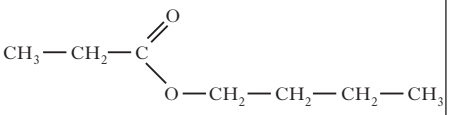
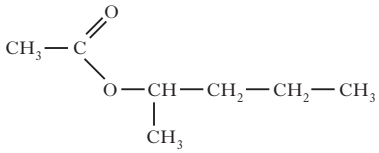
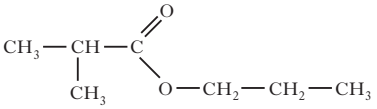
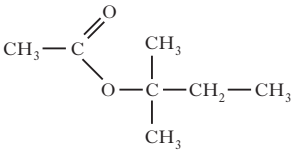
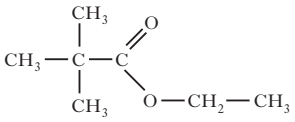
[Turn over

DO NOT WRITE IN THIS MARGIN

Marks

4. A team of chemists are developing a fragrance for use in a shower gel for men.

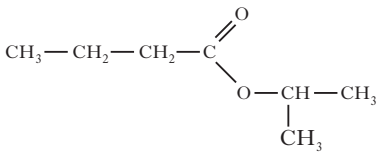
(*a*) To give the gel a fruity smell the chemists are considering adding an ester. They synthesise six isomeric esters. Volunteers smell each ester and give it a rating out of one hundred depending on how fruity the smell is.

Structure	Fruit-smell rating	Structure	Fruit-smell rating
	100		92
	34		44
	0		32

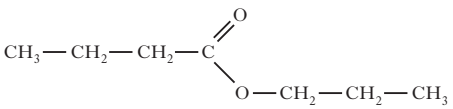
(i) Name the ester with the fruit-smell rating of 92.

1

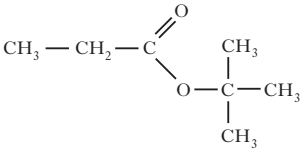
(ii) Shown below are the structures of three more isomers.



Ester **A**



Ester **B**



Ester **C**

Arrange these esters in order of **decreasing** fruit-smell rating.

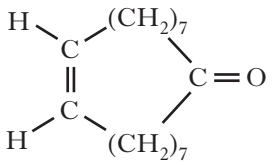
Ester ☐ > Ester ☐ > Ester ☐ **1**

Marks

4. (continued)

(*b*) To create a fragrance for men, the compound civetone is added.

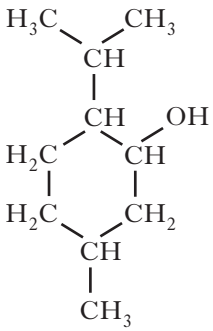
civetone



Draw a structural formula for the alcohol that can be oxidised to form civetone.

1

(*c*) To make the shower gel produce a cold, tingling sensation when applied to the skin, menthol is added.



Like terpenes, menthol is formed from isoprene (2-methylbuta-1,3-diene).

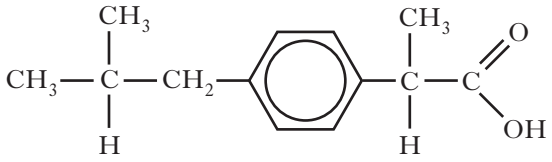
Circle an isoprene unit on the menthol structure above. **1**

[Turn over

DO NOT WRITE IN THIS MARGIN

Marks

5. Ibuprofen is one of the best selling pain killers in the UK.

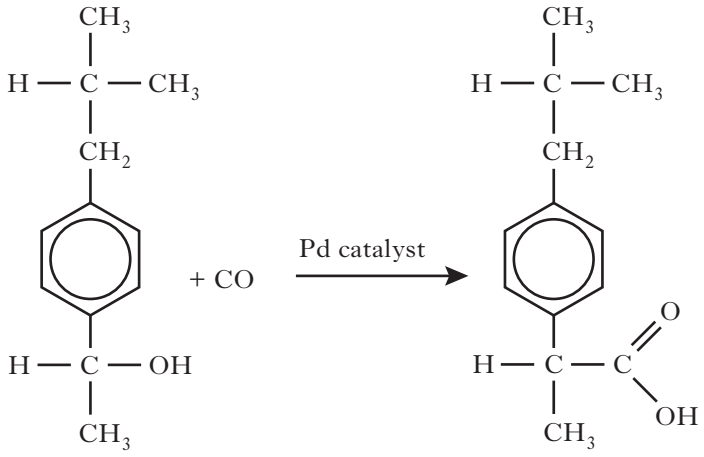


(*a*) Ibuprofen tablets should not be taken by people who suffer from acid indigestion. Name the functional group present in ibuprofen that makes this drug unsuitable for these patients?

1

(*b*) From the 1990s, ibuprofen has been synthesised by a three step process.

The equation below shows the final step of the synthesis.



ibuprofen

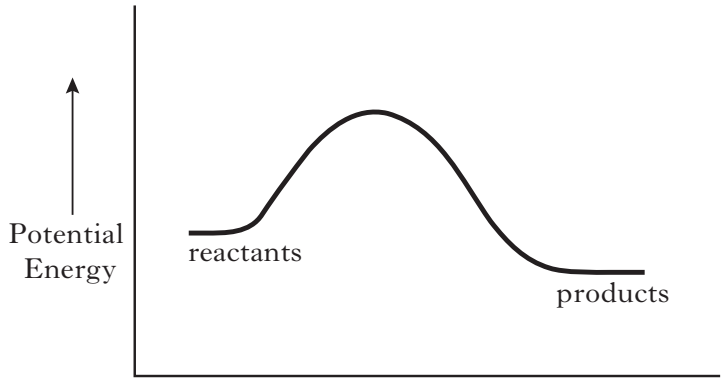
(i) What is the atom economy of this step?

1

Marks

5. (*b*) (continued)

(ii) The diagram below represents the changing potential energy during this reaction carried out without the palladium catalyst.

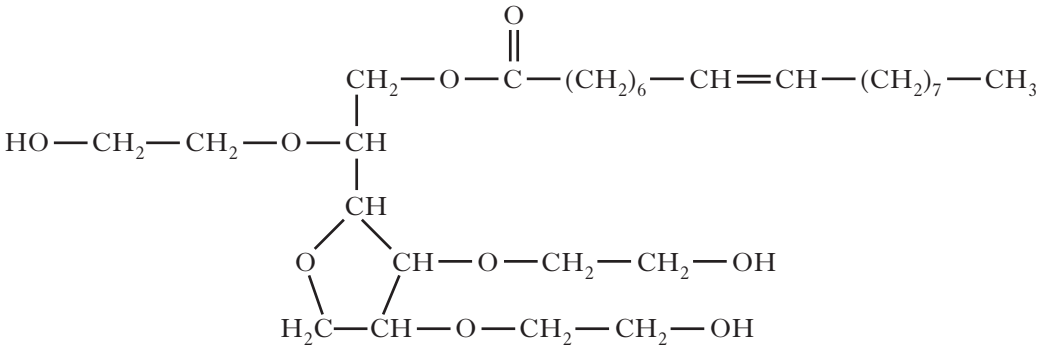


Add a line to the diagram showing the changing potential energy when the catalyst is used. **1**

(An additional diagram, if required, can be found on *Page thirty-nine*.)

(*c*) Small children can find it difficult to swallow tablets or pills so ibuprofen is supplied as an "infant formula" emulsion.

(i) The emulsifier used is polysorbate 80. Its structure is shown below.



Explain why this molecule acts as an emulsifier. **2**

DO NOT WRITE IN THIS MARGIN

Marks

5. (*c*) (continued)

(ii) The emulsion contains 2 g of ibuprofen in every 100 cm^3 of emulsion.

The recommended dose for treating a 6 month old baby is 0·050 g.

Calculate the volume, in cm^3, of "infant formula" needed to treat a 6 month old baby.

1

(6)

DO NOT WRITE IN THIS MARGIN

Marks

6. Butanone is an important solvent. Butan-2-ol is required for its production.

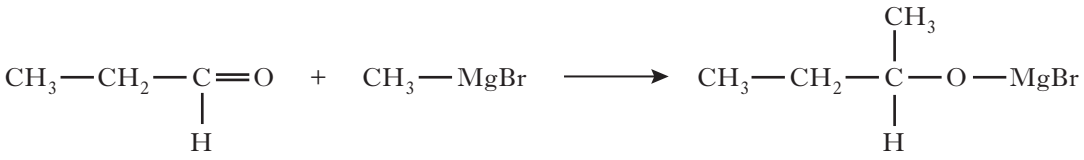
(*a*) Name the type of reaction that takes place when butan-2-ol is converted into butanone.

1

(*b*) A chemist tested whether it would be possible to make money by producing butan-2-ol from propanal using a two step process.

Step One

Methyl magnesium bromide reacts with propanal.

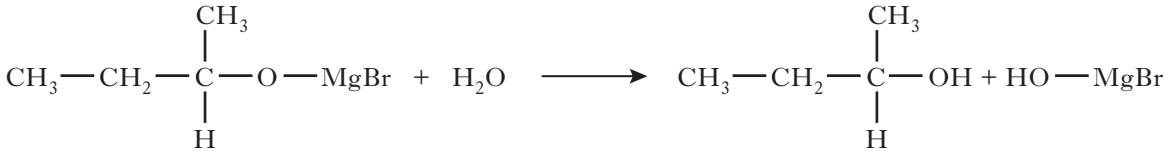


propanal
GFM 58

methyl magnesium bromide

Step Two

The product from step one reacts with water to produce butan-2-ol.



butan-2-ol
GFM 74

The chemist managed to make 5·75 g of butan-2-ol using 5·01 g of propanal and 20·0 g of methyl magnesium bromide.

The costs of the chemicals used are shown below.

Propanal	£22·10 for 1 kg
Methyl magnesium bromide	£75·00 for 25 kg

[Turn over

DO NOT WRITE IN THIS MARGIN

Marks

6. (*b*) (continued)

(i) Calculate the cost of the chemicals needed to produce 100 g of butan-2-ol using this method.

2

(ii) Calculate the percentage yield obtained in this experiment assuming that the CH_3MgBr is in excess.

2

(iii) Suggest **one** alteration to the quantity of either propanal or methyl magnesium bromide used which might reduce the cost of producing butan-2-ol.

1

Marks

6. (continued)

(*c*) The industrial method currently used to produce butan-2-ol is the hydration of but-2-ene.

$$\underset{\text{but-2-ene}}{C_4H_8(g)} + H_2O(g) \rightarrow \underset{\text{butan-2-ol}}{C_4H_{10}O(g)}$$

The enthalpy values for the following reactions are:

$4C(s) + 4H_2(g) \rightarrow C_4H_8(g)$ $\quad \Delta H = -7{\cdot}1 \text{ kJ mol}^{-1}$

$4C(s) + 5H_2(g) + \frac{1}{2}O_2(g) \rightarrow C_4H_{10}O(g)$ $\quad \Delta H = -292{\cdot}8 \text{ kJ mol}^{-1}$

$2H_2(g) + O_2(g) \rightarrow 2H_2O(g)$ $\quad \Delta H = -483{\cdot}6 \text{ kJ mol}^{-1}$

Using the data above, calculate the enthalpy change, in kJ mol^{-1}, for the production of butan-2-ol by hydration of but-2-ene.

2

(8)

[Turn over

DO NOT WRITE IN THIS MARGIN

Marks

7. In many bathroom cleaning products, the bleaching agent is the hypochlorite ion, $ClO^-(aq)$.

(*a*) Hypochlorite bleaches can be made by reacting sodium hydroxide with chlorine. Sodium hypochlorite, sodium chloride and water are formed.

Write a balanced equation for the reaction.

2

(*b*) In the bleach solution, the following equilibrium exists.

$$Cl_2(aq) + H_2O(\ell) \rightleftharpoons 2H^+(aq) + ClO^-(aq) + Cl^-(aq)$$

Explain why the addition of sodium hydroxide increases the bleaching efficiency of the solution.

2

(*c*) When $ClO^-(aq)$ acts as a bleach, it is reduced to produce the $ClO^-(aq)$ ion.

$$ClO^-(aq) \quad \rightarrow \quad Cl^-(aq)$$

Complete the above to form the ion-electron equation for the reduction reaction.

1

DO NOT WRITE IN THIS MARGIN

Marks

7. (continued)

(*d*) An experiment was carried out to measure the concentration of hypochlorite ions in a sample of bleach. In this experiment, the bleach sample reacted with excess hydrogen peroxide.

$$H_2O_2(aq) + ClO^-(aq) \rightarrow H_2O(\ell) + Cl^-(aq) + O_2(g)$$

By measuring the volume of oxygen given off, the concentration of bleach can be calculated.

(i) $80\,cm^3$ of oxygen gas was produced from $5{\cdot}0\,cm^3$ of bleach.

Calculate the concentration of the hypochlorite ions in the bleach.

(Take the molecular volume of oxygen to be 24 litre mol^{-1}.)

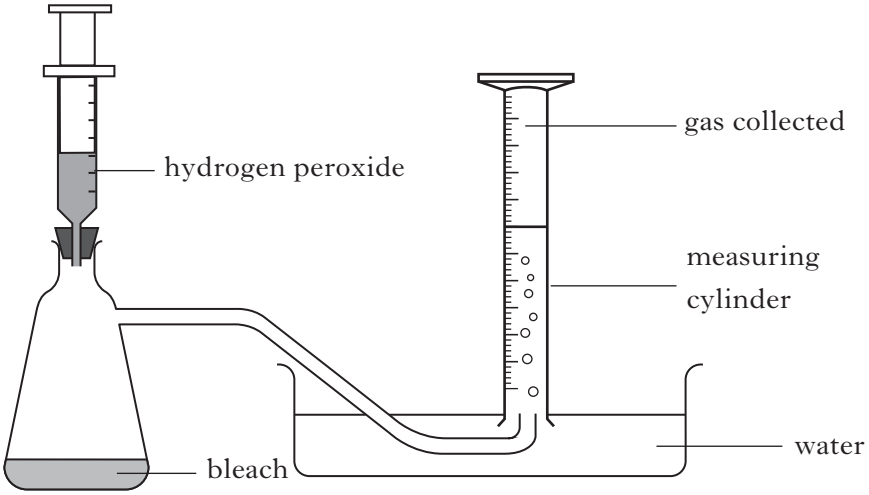
4

[Turn over

Marks

7. (*d*) (continued)

(ii) The apparatus used for this type of experiment is shown below.



At the start of the experiment the measuring cylinder is **completely filled** with water. 20 cm^3 of hydrogen peroxide solution is added to the flask using the syringe. When the bubbling stops, the volume of gas collected in the measuring cylinder is recorded.

How would the volume of oxygen given off be calculated?

1

(10)

[Turn over for Question 8 on *Page twenty-eight*

DO NOT WRITE IN THIS MARGIN

Marks

8. Chemists have developed cheeses specifically for use in cheeseburgers.

(*a*) When ordinary cheddar cheese is grilled the shapes of the protein molecules change and the proteins and fats separate leaving a chewy solid and an oily liquid.

What name is given to the change in protein structure which occurs when ordinary cheddar is grilled?

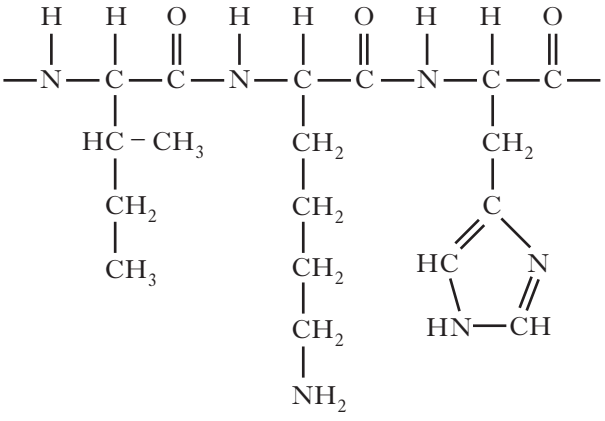
1

(*b*) To make cheese for burgers, grated cheddar cheese, soluble milk proteins and some water are mixed and heated to no more than 82 °C. As the cheese begins to melt an emulsifying agent is added and the mixture is stirred.

(i) Why would a water bath be used to heat the mixture?

1

(ii) A section of the structure of a soluble milk protein is shown below.



Draw a structural formula for any **one** of the amino acids formed when this section of protein is hydrolysed.

1

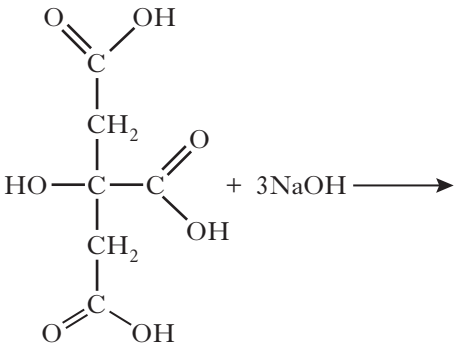
DO NOT WRITE IN THIS MARGIN

Marks

8. (*b*) (continued)

(iii) The emulsifier used is trisodium citrate, a salt formed when citric acid is neutralised using sodium hydroxide.

Complete the equation below showing a structural formula for the trisodium citrate formed.



+ $3H_2O$

1

(4)

[Turn over

DO NOT WRITE IN THIS MARGIN

Marks

9. A student carried out an investigation to measure the nitrite level in the school water supply.

A compound, which reacts with the nitrite ions to form a product that absorbs light, is added to water samples. The higher the concentration of nitrite ions present in a water sample, the greater the amount of light absorbed.

(*a*) The student prepared potassium nitrite solutions of known concentration by diluting samples from a stock solution.

(i) Calculate the mass, in mg, of potassium nitrite, KNO_2, needed to make 1 litre of stock solution with a **nitrite ion** concentration of 250 mg l^{-1}.

2

(ii) Describe how the weighed potassium nitrate is dissolved to prepare the stock solution to ensure that its concentration is accurately known.

2

(iii) Why should the student use distilled or deionised water rather than tap water when dissolving the potassium nitrite?

1

DO NOT WRITE IN THIS MARGIN

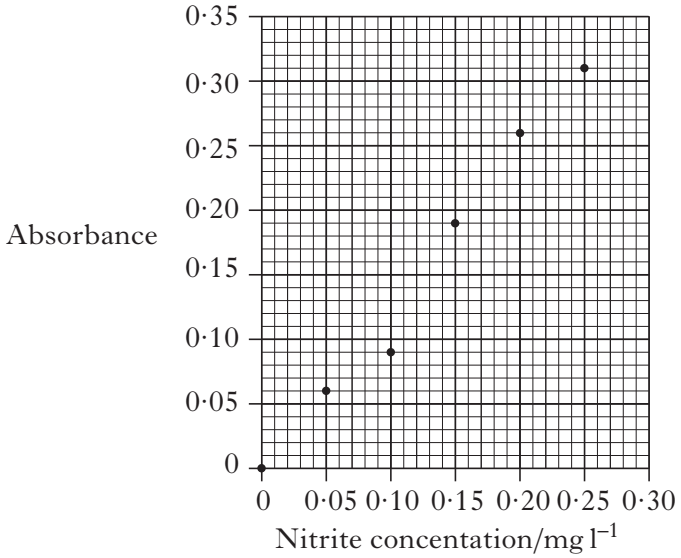
Marks

9. (*a*) (continued)

(iv) To prepare a solution with a nitrite ion concentration of 0·05 mg l^{-1} the student dilutes the stock solution. Why is this method more accurate than preparing a solution by weighing out potassium nitrite?

1

(*b*) The graph below shows results for five solutions of potassium nitrite and a sample of distilled water.



The results for four tap water samples are shown below.

	Absorbance
Sample One	0·09
Sample Two	0·09
Sample Three	0·33
Sample Four	0·09

What is the concentration of nitrite ions, in mg l^{-1}, in the tap water?

2

(8)

Marks

10. Genetically modified bacteria can produce 2-methylpropan-1-ol by fermentation.

(*a*) Draw a structural formula for 2-methylpropan-1-ol.

1

(*b*) 2-Methylpropan-1-ol may be used as an alternative to ethanol as a fuel.

(i) Ethanol releases 29·7 kJ of energy for every gram of fuel burned.

Using the information from the table below, show by calculation that 2-methylpropan-1-ol releases more energy than the same mass of ethanol when burnt.

	2-methylpropan-1-ol
Mass of one mole/g	74
Enthalpy of combustion/kJ mol^{-1}	–2669

1

DO NOT WRITE IN THIS MARGIN

Marks

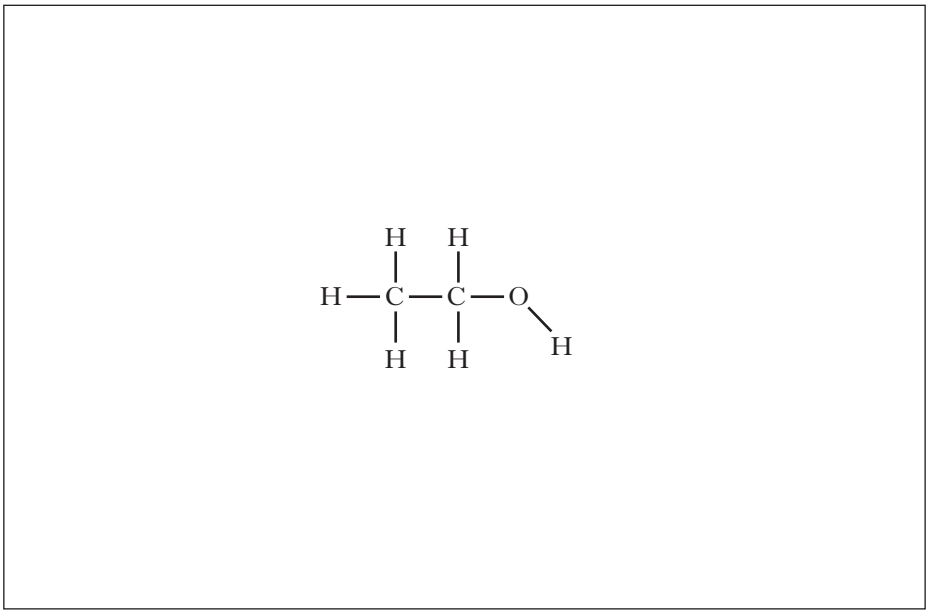
10. (*b*) (continued)

(i) Problems can be caused by water dissolved in alcohols that are to be used as fuels.

2-Methylpropan-1-ol absorbs less water from the atmosphere than ethanol. Water is absorbed because alcohols can form hydrogen bonds with water molecules.

In the box below showing a molecule of ethanol, draw a molecule of water and use a dotted line to show where a hydrogen bond exists between the two molecules.

(An additional diagram, if required, can be found on *Page thirty-nine*.)



1

(3)

[Turn over

DO NOT WRITE IN THIS MARGIN

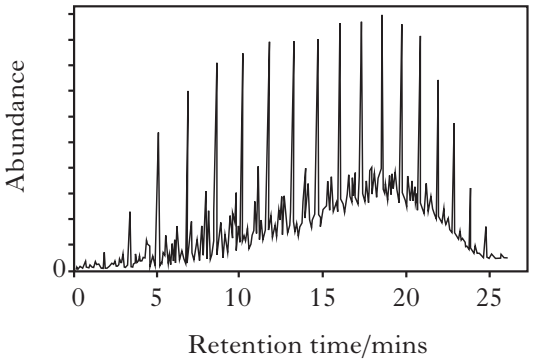
Marks

11. When a fire has been started deliberately, gas liquid chromatography (GLC) can be used to identify the tiny amounts of fuel or flammable liquid used to help start the fire.

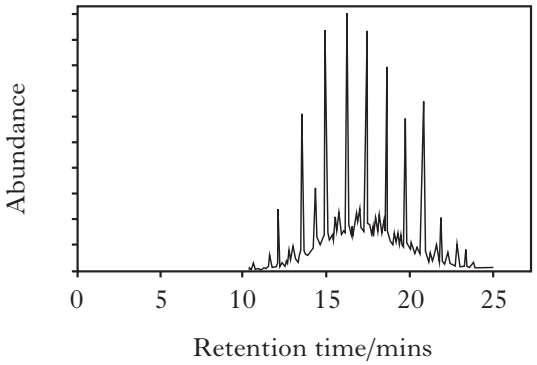
(*a*) Diesel contains a mixture of non-polar molecules of different sizes.

Below are the chromatograms recorded using a normal sample of diesel and a sample of diesel that has been heated until around 90% of the diesel had evaporated.

Fresh diesel



Diesel residue after evaporation



Explain how these chromatograms show that large molecules have longer retention times than small molecules in this type of chromatography.

2

(*b*) A suspicious house fire was found to have started in a chair.

An almost empty bottle of paint thinner was found in a suspect's car.

In the house there were two cans of furniture polish which might have been used to clean the chair at some time.

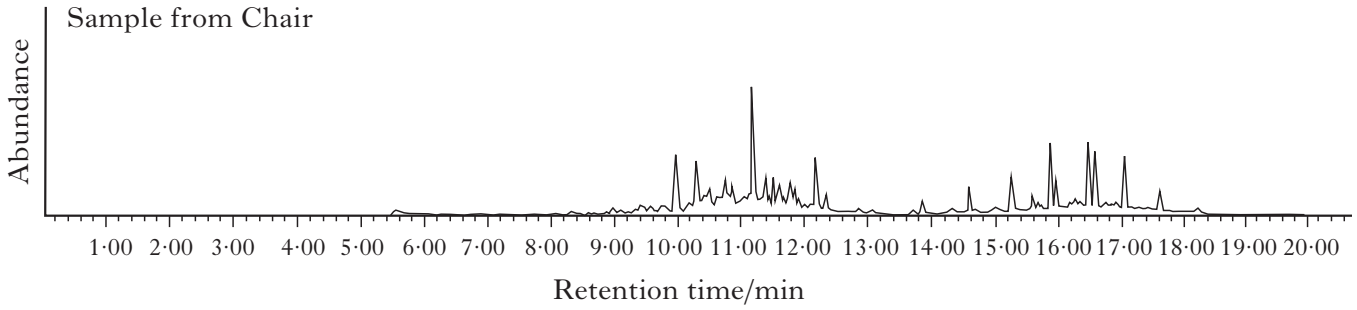
The chromatograms obtained from the remains of the chair, the paint thinner and the furniture polishes are shown opposite.

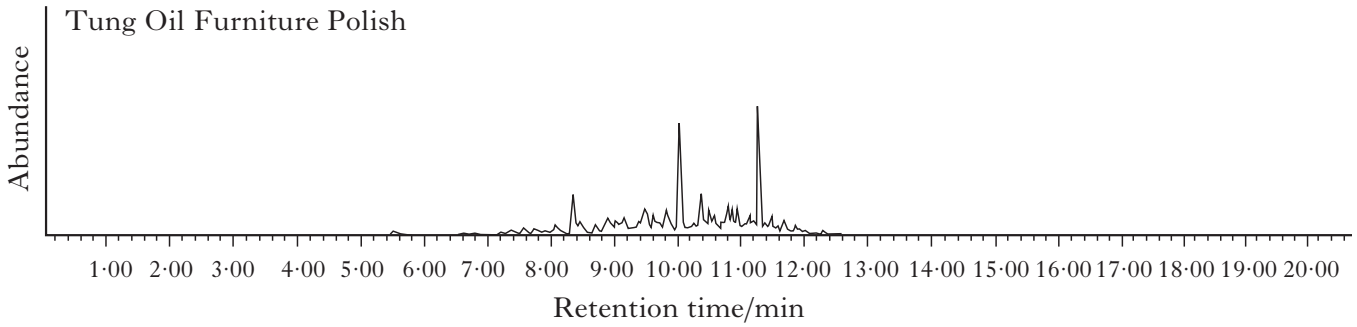
Which of the substances tested were present on the armchair?

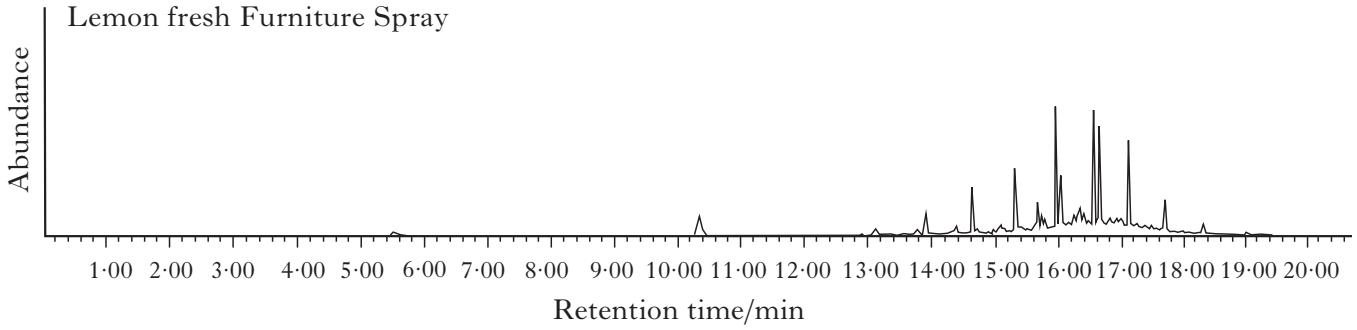
1

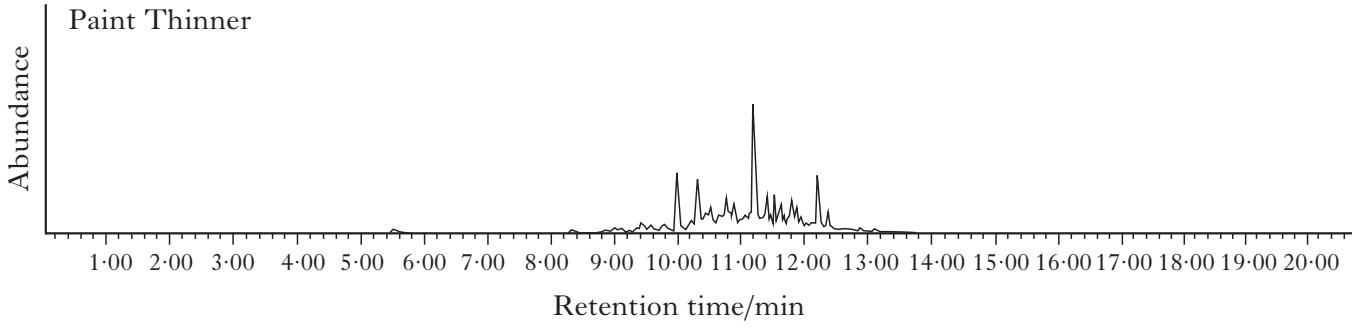
(3)

11. (continued)







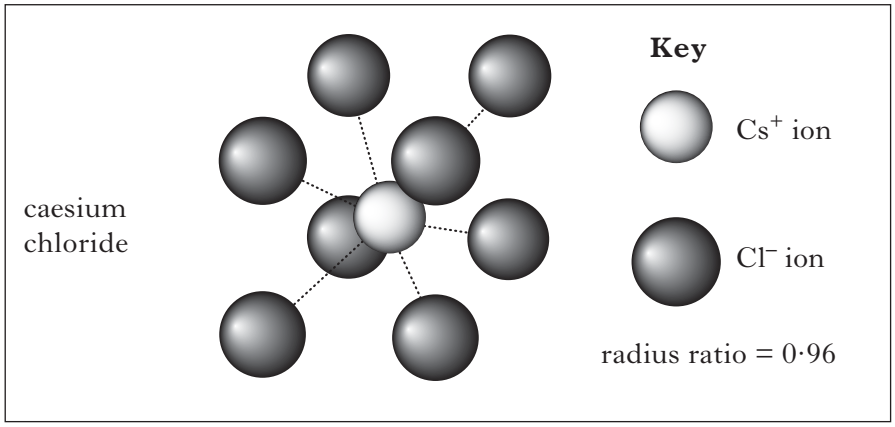


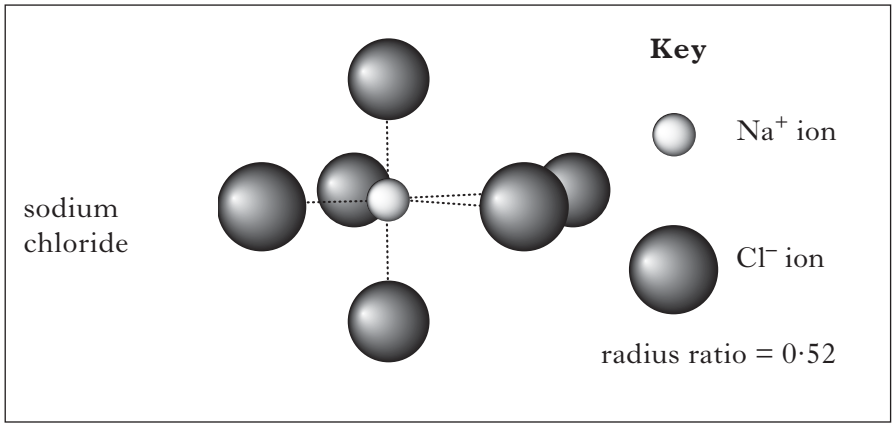
Marks

12. The structure of an ionic compound consists of a giant lattice of oppositely charged ions. The arrangement of ions is determined mainly by the "radius ratio" of the ions involved.

$$\text{radius ratio} = \frac{\text{radius of positive ion}}{\text{radius of negative ion}}$$

The arrangements for caesium chloride, CsCl, and sodium chloride, NaCl, are shown below.





(*a*) By using the table of ionic radii on page 16 of the data booklet, calculate the radius ratio for magnesium oxide, MgO, **and** state which of the two arrangements, caesium chloride or sodium chloride, it is more likely to adopt.

1

DO NOT WRITE IN THIS MARGIN

Marks

12. (continued)

(*b*) The enthalpy of lattice breaking is the energy required to completely separate the ions from one mole of an ionic solid. The table shows the enthalpies of lattice breaking, in kJ mol^{-1}, for some alkali metal halides.

Ions	F^-	Cl^-	Br^-
Li^+	1030	834	788
Na^+	910	769	732
K^+	808	701	671

Write a general statement linking the enthalpy of lattice breaking to ion size.

1

(2)

[Turn over

DO NOT WRITE IN THIS MARGIN

Marks

13. To improve the shelf-life of foods, food manufacturers use several methods to remove oxygen from inside the food packaging. In one method, an enzyme is added which catalyses a reaction between oxygen and glucose present in the foods.

glucose + oxygen + water $\rightarrow$ gluconic acid + hydrogen peroxide

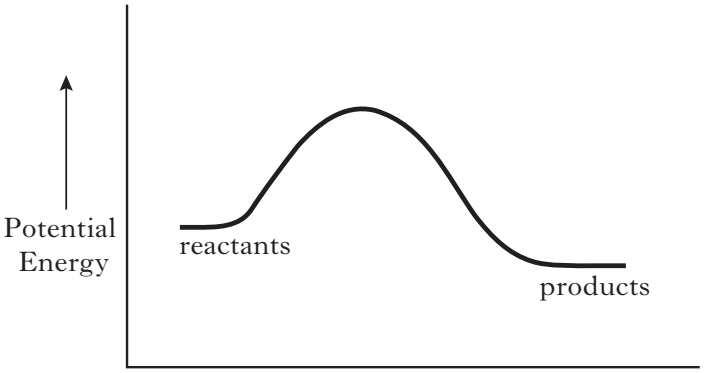
Using your knowledge of Chemistry, comment on why this method may not be suitable to improve the shelf-life for all foods.

3

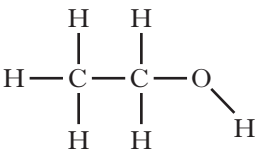
[*END OF SPECIMEN QUESTION PAPER*]

DO NOT WRITE IN THIS MARGIN

ADDITIONAL DIAGRAM FOR QUESTION 5(*b*)(ii)



ADDITIONAL DIAGRAM FOR QUESTION 10(*b*)(ii)



DO NOT WRITE IN THIS MARGIN

ADDITIONAL SPACE FOR ANSWERS

C273/SQP365

Chemistry
Higher (Revised)
Specimen Marking Instructions
for use in and after 2012

NATIONAL
QUALIFICATIONS

SQA ©

Chemistry (Revised) Higher

Specimen Paper

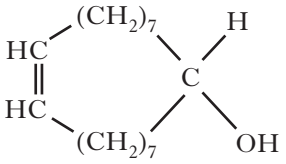
Marking Scheme

Section A

1	B	11	B	21	A
2	A	12	C	22	C
3	C	13	B	23	C
4	C	14	A	24	B
5	A	15	B	25	D
6	C	16	B	26	A
7	C	17	D	27	A
8	D	18	D	28	B
9	D	19	A	29	A
10	D	20	D	30	D

Mark Scheme	Worth 0
1. (*a*) If 4 correct elements chosen – 2 marks If 2 or 3 correct elements chosen – 1 mark	Only one element correctly chosen
(*b*) Increasing nuclear charge – 1 mark Increasing number of protons – 1 mark Decreasing atomic size – 1 mark	Electrons more tightly held Ionisation energy is increasing
(*c*) This is an open ended question.	
1 mark: The student has demonstrated a limited understanding of the chemistry involved. The candidate has made some statement(s) which is/are relevant to the situation, showing that at least a little of the chemistry within the problem is understood.	The student has demonstrated no understanding of the chemistry involved. There is no evidence that the student has recognized the area of chemistry involved or has given any statement of a relevant chemistry principle. This mark would also be given when the student merely restates the chemistry given in the question.
2 marks: The student has demonstrated a reasonable understanding of the chemistry involved. The student makes some statement(s) which is/are relevant to the situation, showing that the problem is understood.	
3 marks: The maximum available mark would be awarded to a student who has demonstrated a good understanding of the chemistry involved. The student shows a good comprehension of the chemistry of the situation and has provided a logically correct answer to the question posed. This type of response might include a statement of the principles involved, a relationship or an equation, and the application of these to respond to the problem. This does not mean the answer has to be what might be termed an 'excellent' answer or a 'complete' one.	

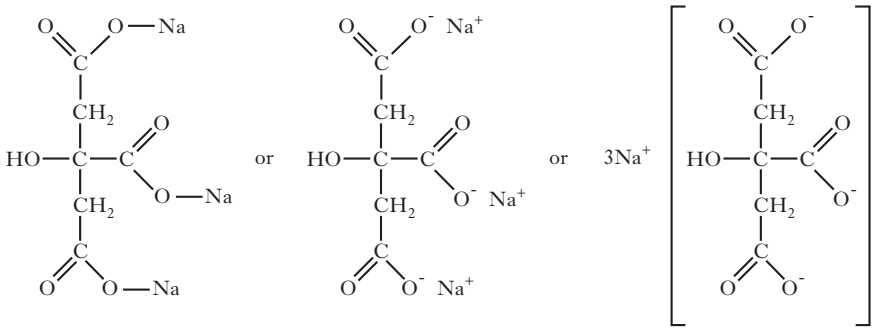
Mark Scheme	Worth 0
2. (*a*) Looking for three ideas Br_2 non-polar/ICl polar – 1 mark Br_2 and ICl have same number of electrons – 1 mark BPt ICl higher than BPt Br_2 – 1 mark ICl has permanent dipole/permanent dipole – 1 mark (*b*) H_2 – 1 mark (*c*) (i) H — Cl + H• 1 mark for both species H_2 1 mark (ii) to prevent light/UV shining on sample – 1 mark or To prevent initiation – 1 mark or To prevent radicals from forming – 1 mark or To prevent shattering – 1 mark or To prevent premature explosion – 1 mark (iii) For 1 mark candidate can have: "432+243" or "675" or "2×428" or "856" or "181" For 2 marks must have "-181" (iv) $10Cl^-(aq) + 2MnO_4^-(aq) + 16H^+(aq) \rightarrow 5Cl_2(g) + 2Mn^{2+}(aq) + 8H_2O(\ell)$ – 1 mark (Award one mark if $10e^-$ shown on each side of this eqn)	

Mark Scheme	Worth 0
3. (*a*) glycerol or propane-1,2,3-triol or propan-1,2,3-triol or glycerine – 1 mark (*b*) fat molecules have fewer/no double bonds/more saturated OR oil molecules have more double bonds/unsaturated (or similar) – 1 mark (*c*) oxygen or O_2 – 1 mark	
4. (*a*) (i) butyl propanoate – 1 mark (ii) B > A > C – 1 mark (*b*)  1 mark (*c*) Any set of atoms consisting of 5 carbon atoms, four connected in a line with one branching from carbon 2 of this chain – 1 mark	

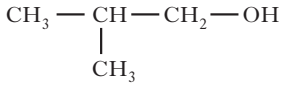
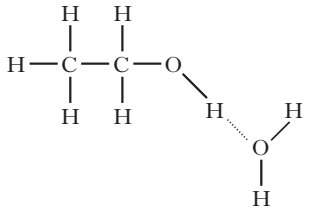
Mark Scheme	Worth 0
5. (*a*) carboxylic acid group or carboxyl group – 1 mark	Acid group – 0 marks
(*b*) (i) 100% – 1 mark	100 – 0 marks
(ii) for curve starting and finishing at R and P but with maximum below the existing maximum – 1 mark	
(*c*) (i) Mention of OH groups being hydrophilic/soluble in water/soluble in polar liquids – 1 mark	
mention of hydrocarbon chain being hydrophobic/ insoluble in water/soluble in non-polar liquids/soluble in oil – 1 mark	
(ii) 2·5 – 1 mark	

Mark Scheme	Worth 0
6. (*a*) oxidation – 1 mark (*b*) (i) £1045·40 – 2 marks £60·11 or (87·1 g and 347·8 g both appearing) – 1 mark Here 1 mark is given for working out the cost of the reactants used in preparing 5·75 g, and another 1 mark is given for "scaling" this up to give a value for 100 g. As an alternative, the students can "scale" the quantities used to get 100 g, and then price this up. Allow follow through. (ii) 90 % – 2 marks 6·39(g) or (0·086 and 0·078 both appearing) – 1 mark Here 1 mark is given for calculating the theoretical yield or the numbers of moles of reactant and product, and the second 1 mark for calculating the % yield. For the second mark, do not award the mark if the value 5·01 is used as the theoretical or actual yield in the % yield calculation as this would demonstrate an incorrect concept. (iii) Candidate answer suggests using more propanal / or less CH_3MgBr (so that propanal now in excess) – 1 mark (*c*) –43·9 – 2 marks 43·9 – 1 mark Any two values from this list (+7·1, +241·8, -292·8) – 1 mark Correct addition of three "sensible" values – 1 mark	

Mark Scheme	Worth 0
7. (*a*) $2NaOH + Cl_2 \rightarrow NaClO + NaCl + H_2O$ – 2 marks Correct formulae for all but one substance, whether balanced or not – 1 mark	
(*b*) NaOH results in decrease in H+ ion concentration – 1 mark Position of equilibrium moves to the right and ClO^- increases – 1 mark	Statement that hypochlorite bleach is made by reacting sodium hydroxide with chlorine – 0 marks (This is in the question.)
(*c*) $ClO^- + 2H^+ + 2e^- \rightarrow Cl^- + H_2O$ – 1 mark (The electrons can be shown as 2e without penalty)	
(*d*) (i) $0{\cdot}67\ mol\ l^{-1}$ – 4 marks	
Partial marks can be awarded using a scheme of two "concept" marks, one "arithmetic" mark and one "unit" mark.	
1 mark is awarded for a correct strategy to work out number of moles of oxygen (a volume of oxygen in whatever unit is shown being divided by a molar volume in whatever unit) 1 mark is awarded for correct strategy to work out the concentration of bleach (eg a number of moles of ClO^- is divided by the volume of the sample in any units) 1 mark is awarded for correct arithmetic in both of these steps- units correct within both calculations (ie. Gas volume and molar volume both in cm^3 or both in l, volume in concentration calculation in l) This arithmetic mark can only be awarded if both of the concept marks are awarded. 1 mark is allocated to the correct statement of units of concentration. This is the mark in the paper earmarked to reward a candidate's knowledge of chemical units.	
(ii) volume of oxygen = (total volume of gas – 20) – 1 mark	

Mark Scheme	Worth 0
8. (*a*) denaturing / denature / denatured – 1 mark (*b*) To prevent the temperature rising too high or gentle method of heating or to prevent the protein structure changing or to prevent denaturing of protein or to prevent separation of protein and fat or mention of flammability – 1 mark (*c*) Correct drawing of any one of the three amino acids showing – NH_2 and –COOH groups completed – 1 mark (*d*)  – 1 mark	

Mark Scheme	Worth 0
9. (*a*) (i) 462·5 – 2 marks 462·5 mg – 2 marks 0·462 g – 2 marks If GFM of KNO_2 and NO_2 calculated, (85·1 and 46) – 1 mark Second mark for arith of scaling $250 \times 85{\cdot}1/46$ – 1 mark	
(ii) mention of transfer of rinsings – 1 mark making up to the mark of standard/volumetric flask – 1mark	
(iii) tap water could contain nitrites – 1 mark Or Distilled water will not contain nitrites – 1 mark Mention of nitrites required for this mark	Tap water is less clean than distilled (or similar) – 0 marks
(iv) Mass required to make 250 cm^3 of 0·05 $mg\,l^{-1}$ solution is too small to weigh accurately – 1 mark	
(*b*) answer between 0·07 → 0·08 – 2 marks	
0·10 – 1 mark (this answer comes from using a valid mean, but not a line of best fit on the calibration graph)	
Answer between 0·115 → 0·125 – 1 mark (this answer comes from averaging all of the titres, including the rogue, but then using line of best fit)	0·13 – 0 marks, because this value can arise from incorrect mean and using "dot-to-dot" line rather than line of best fit

Mark Scheme	Worth 0
10. (*a*)  1 – mark (*b*) (i) for figure of 36·1 – 1 mark (ii) any valid diagram – 1 mark eg 	
11. (*a*) during evaporation, smaller molecules lost – 1 mark Evaporated sample has peaks with shorter RT missing – 1 mark (*b*) both "paint thinner" and "lemon fresh furniture spray" – 1 mark	
12. (*a*) 0·48 and sodium chloride structure – 1 mark (*b*) as ion size increases, enthalpy of lattice breaking decreases or any other valid answer – 1 mark	

Mark Scheme	Worth 0
13. This is an open ended question 1 mark: The student has demonstrated a limited understanding of the chemistry involved. The candidate has made some statement(s) which is/are relevant to the situation, showing that at least a little of the chemistry within the problem is understood. 2 marks: The student has demonstrated a reasonable understanding of the chemistry involved. The student makes some statement(s) which is/are relevant to the situation, showing that the problem is understood. 3 marks: The maximum available mark would be awarded to a student who has demonstrated a good understanding of the chemistry involved. The student shows a good comprehension of the chemistry of the situation and has provided a logically correct answer to the question posed. This type of response might include a statement of the principles involved, a relationship or an equation, and the application of these to respond to the problem. This does not mean the answer has to be what might be termed an 'excellent' answer or a 'complete' one.	The student has demonstrated no understanding of the chemistry involved. There is no evidence that the student has recognized the area of chemistry involved or has given any statement of a relevant chemistry principle. This mark would also be given when the student merely restates the chemistry given in the question.

Course coverage

	P, P and P			Consumer Chemistry										P to P			
	1	2	3	1	2	3	4	5	6	7	8	9	10	1	2	3	4
	Trends and Bonding	Intermolecular Forces	Oxidising & Reducing Agents	Alcohols	Carboxylic acids	Fruit Flavours	Fats and Oils	Proteins	Chemistry of Cooking	Oxidation of Food	Soaps and Emulsions	Fragrances	Skincare products	Getting the most from costly reactants	Controlling the rate	Chemical Energy	Chemical Analysis
Section A	4	2	1	1	1	1	0	2	2	3	0	1	0	5	3	3	0
Section B	9	3	2	2	2	1	2	1	1	6	2	1	3	14	1	6	3
Total	13	5	3	3	3	2	2	3	3	9	2	2	3	19	4	9	3
	21			32										35			

Classification of Question type

	Knowledge			Skills							Description					
	a	b	c	a	b	c	d	e	f	g						
	Accurate Recall	Apply knowledge	Explain	Select information	Present information	Process information (inc.calcs)	Design experiments	Evaluate procedures.	Draw conclusions	Make predictions	Extended answer	Calculation (Apply knowledge)	Calculation (skills)	Open Question	Researching Chemistry	A-type
Section A	6	21	0	0	0	3	0	0	0	0	0	5	1	0	1	3
Section B	7	26	14	1	0	10	5	2	3	2	15	11	7	6	9	19
Total	13	47	14	1	0	13	5	2	3	2	15	16	8	6	10	22
	74			26												
	14±4	45±5	12±3													

Section A	30	
Section B	70	
Total	100	

Knowledge	74	70-75
Skills	26	25-30

Section A	
Knowledge	27
Skills	3

Calculations	A	B	Total	
Knowledge	5	11	16	15±3
Skills	1	7	8	8±2
Total	6	18	24	

A-type Questions		
Section A	3	
Section B	19	
Total	22	20±3

Section B	
Knowledge	47
Skills	23

	A	B	Total	
Periodicity, Polarity and Properties	7	14	21	≥18
Consumer Chemistry	11	21	32	≥28
Principles to Profit	11	24	35	≥28
Researching Chemistry	1	9	10	10±3
Totals	30	68	98	

Section A

		Course coverage																	Classification of Question type																			
		P, P and P			Consumer Chemistry										P to P				Knowledge			Skills									Description							
		1	2	3	1	2	3	4	5	6	7	8	9	10	1	2	3	4	a	b	c	a	b	c	d	e	f	g									
	Code	Trends and Bonding	Intermolecular Forces	Oxidising & Reducing Agents	Alcohols	Carboxylic acids	Fruit Flavours	Fats and Oils	Proteins	Chemistry of Cooking	Oxidation of Food	Soaps and Emulsions	Fragrances	Skincare products	Getting the most from costly reactants	Controlling the rate	Chemical Energy	Chemical Analysis	Accurate Recall	Apply knowledge	Explain	Select information	Present information	Process information (inc.calcs)	Design experiments	Evaluate procedures.	Draw conclusions	Make predictions	Extended answer	Calculation (Apply knowledge)	Calculation (skills)	Open Question	Researching Chemistry	A-type	**Facility Value**	**Key**
1	PPP.1(b)	1																	1																	B
2	PPP.1(c)	1																		1									1							A
3	PPP.1(d)	1																		1																C
4	PPP.1(f)	1																		1																C
5	PPP.2(a)		1																1																	A
6	PPP.2(c)		1																	1																C
7	PPP.3(a)			1																1																C
8	CC.1(b)				1															1																D
9	CC.2(a)					1														1																D
10	CC.3(a)						1													1																D
11	CC.5(b)								1															1												B
12	CC.5(c)								1											1																C
13	CC.6(a)									1														1											1	B
14	CC.6(a)									1										1																A
15	CC.7(a)										1								1																	B
16	CC.7(a)										1									1																B
17	CC.7(b)										1									1																D
18	CC.9(a)												1						1																	D
19	P2P.1(b)														1					1										1				1		A
20	P2P.1(b)														1					1																D
21	P2P.1(c)														1					1									1				1			A
22	P2P.1(d)														1				1																	C

Section A

		Course coverage																	Classification of Question type																			
		P, P and P			Consumer Chemistry										P to P				Knowledge			Skills									Description							
		1	2	3	1	2	3	4	5	6	7	8	9	10	1	2	3	4	a	b	c	a	b	c	d	e	f	g									
	Code	Trends and Bonding	Intermolecular Forces	Oxidising & Reducing Agents	Alcohols	Carboxylic acids	Fruit Flavours	Fats and Oils	Proteins	Chemistry of Cooking	Oxidation of Food	Soaps and Emulsions	Fragrances	Skincare products	Getting the most from costly reactants	Controlling the rate	Chemical Energy	Chemical Analysis	Accurate Recall	Apply knowledge	Explain	Select information	Present information	Process information (inc.calcs)	Design experiments	Evaluate procedures.	Draw conclusions	Make predictions	Extended answer	Calculation (Apply knowledge)	Calculation (skills)	Open Question	Researching Chemistry	A-type	**Facility Value**	**Key**	
23	P2P.1(e)														1					1																C	
24	P2P.2(a)															1				1																B	
25	P2P.2(b)															1				1									1							D	
26	P2P.2(d)															1			1																	A	
27	P2P.3(b)																1			1																A	
28	P2P.3(c)																1			1									1							B	
29	P2P.3(d)																1			1																A	
30																								1						1		1				D	
																																				A	8
																																				B	7
																																				C	7
																																				D	8

Section B

		Course coverage																	Classification of Question type															
		P, P and P			Consumer Chemistry										P to P				Knowledge			Skills									Description			
		1	2	3	1	2	3	4	5	6	7	8	9	10	1	2	3	4	a	b	c	a	b	c	d	e	f	g					
	Code	Trends and Bonding	Intermolecular Forces	Oxidising & Reducing Agents	Alcohols	Carboxylic acids	Fruit Flavours	Fats and Oils	Proteins	Chemistry of Cooking	Oxidation of Food	Soaps and Emulsions	Fragrances	Skincare products	Getting the most from costly reactants	Controlling the rate	Chemical Energy	Chemical Analysis	Accurate Recall	Apply knowledge	Explain	Select information	Present information	Process information (inc.calcs)	Design experiments	Evaluate procedures.	Draw conclusions	Make predictions	Extended answer	Calculation (Apply knowledge)	Calculation (skills)	Open Question	Researching Chemistry	A-type
1(a)	PPP1(b)	2																	2														
1(b)	PPP1(d)	1																			1												
1(c)	PPP1	3																			3							3				3		1
2(a)	PPP2(b)		3																		3							3						2
2(b)	P2P.3(d)	1															1			1														
2(c)(i)	CC.10(b)													2						2														
2(c)(ii)	P2P.3(d)																2			2									2					
2(c)(iii)	PPP.3(d)			1																1														
2(c)(iv)	RC													1											1								1	
3(a)	CC.4(a)							1											1															
3(b)	CC.4(b)							1											1															
3(c)	CC.7(c)										1								1															
4(a)(i)	CC.3(a)						1													1														
4(a)(ii)																											1						1
4(b)	CC.7(a)										1									1														1
4(c)	CC.9(b)												1							1														
5(a)	CC.2(a)					1														1														
5(b)(i)	P2P.1(f)														1					1									1					1

Section B

		Course coverage																	Classification of Question type																
		P, P and P			Consumer Chemistry										P to P				Knowledge			Skills									Description				
		1	2	3	1	2	3	4	5	6	7	8	9	10	1	2	3	4	a	b	c	a	b	c	d	e	f	g						
	Code	Trends and Bonding	Intermolecular Forces	Oxidising & Reducing Agents	Alcohols	Carboxylic acids	Fruit Flavours	Fats and Oils	Proteins	Chemistry of Cooking	Oxidation of Food	Soaps and Emulsions	Fragrances	Skincare products	Getting the most from costly reactants	Controlling the rate	Chemical Energy	Chemical Analysis	Accurate Recall	Apply knowledge	Explain	Select information	Present information	Process information (inc.calcs)	Design experiments	Evaluate procedures.	Draw conclusions	Make predictions	Extended answer	Calculation (Apply knowledge)	Calculation (skills)	Open Question	Researching Chemistry	A-type
5(b)(ii)	P2P.2(d)															1			1															
5(c)(i)	CC.8(c)											2									2								2						
5(c)(ii)																								1						1				
6(a)	CC.7(a)										1									1														
6(b)(i)	P2P.1(b)														2									2							2			1
6(b)(ii)	P2P.1(f)														2					2									2					1
6(b)(iii)	P2P.1(g)														1					1														1
6(c)	P2P.3(c)																2			2									2					
7(a)	P2P.1(b)														2									2										
7(b)	P2P.1(e)														2						2								2					2
7(c)	PPP.3(d)			1																1														1
7(d)(i)	P2P.1(b)														4					4									4					
7(d)(ii)	R2P																								1							1		1
8(a)	CC.6(b)									1									1															
8(b)(i)	RC																								1							1		
8(b)(ii)	CC.5(d)								1											1														
8(b)(iii)	CC.2(a)					1														1														1
9(a)(i)	P2P.1(c)																							2						2				1

Section B

		Course coverage																	Classification of Question type																	
		P, P and P			Consumer Chemistry										P to P				Knowledge			Skills									Description					
		1	2	3	1	2	3	4	5	6	7	8	9	10	1	2	3	4	a	b	c	a	b	c	d	e	f	g							
	Code	Trends and Bonding	Intermolecular Forces	Oxidising & Reducing Agents	Alcohols	Carboxylic acids	Fruit Flavours	Fats and Oils	Proteins	Chemistry of Cooking	Oxidation of Food	Soaps and Emulsions	Fragrances	Skincare products	Getting the most from costly reactants	Controlling the rate	Chemical Energy	Chemical Analysis	Accurate Recall	Apply knowledge	Explain	Select information	Present information	Process information (inc.calcs)	Design experiments	Evaluate procedures.	Draw conclusions	Make predictions	Extended answer	Calculation (Apply knowledge)	Calculation (skills)	Open Question	Researching Chemistry	A-type
9(a)(ii)	RC																								2								2	
9(a)(iii)																										1							1	
9(a)(iv)																										1							1	1
9(b)																								2						1			2	
10(a)	CC.1(b)				1															1														
10(b)(i)	P2P.3(b)																1							1						1				1
10(b)(ii)	CC.1(b)				1															1														
11(a)	P2P.4(a)																	2								2								
11(b)	P2P.4(a)																	1				1													
12(a)		1																									1							
12(b)		1																								1								1
13	CC.7(c)										3										3							3			3			1