

A Level Chemistry B (Salters)
H433/01 Fundamentals of chemistry
Sample Question Paper

Date – Morning/Afternoon

Version 2.0

Time allowed: 2 hours 15 minutes

You must have:

- the Data Sheet for Chemistry B (Salters)

You may use:

- a scientific or graphical calculator

First name											
Last name											
Centre number							Candidate number				

INSTRUCTIONS

- Use black ink. You may use an HB pencil for graphs and diagrams.
- Complete the boxes above with your name, centre number and candidate number.
- Answer **all** the questions.
- Where appropriate, your answers should be supported with working. Marks may be given for a correct method even if the answer is incorrect.
- Write your answer to each question in the space provided.
- Additional paper may be used if required but you must clearly show your candidate number, centre number and question number(s).
- Do **not** write in the barcodes.

INFORMATION

- The total mark for this paper is **110**.
- The marks for each question are shown in brackets [].
- Quality of extended responses will be assessed in questions marked with an asterisk (*).
- This document consists of **36** pages.

SECTION A

You should spend a maximum of 40 minutes on this section.

Answer **all** the questions.

1 Which two compounds can react together to form a condensation polymer?

- A** C_2H_4 and C_3H_6
- B** $\text{C}_2\text{H}_5\text{OH}$ and CH_3COOH
- C** $\text{H}_2\text{N}(\text{CH}_2)_6\text{NH}_2$ and CH_3COOH
- D** $\text{HOOC}(\text{CH}_2)_4\text{COOH}$ and $\text{HOCH}_2\text{CH}_2\text{OH}$

Your answer

☐

[1]

2 Which of the following is a correct statement about the test for Fe^{2+} ions in solution?

- A** add $\text{NaOH}(\text{aq})$; brown precipitate formed, soluble in $\text{NH}_3(\text{aq})$
- B** add $\text{NaOH}(\text{aq})$; brown precipitate formed, insoluble in $\text{NH}_3(\text{aq})$
- C** add $\text{NaOH}(\text{aq})$; green precipitate formed, soluble in $\text{NH}_3(\text{aq})$
- D** add $\text{NaOH}(\text{aq})$; green precipitate formed, insoluble in $\text{NH}_3(\text{aq})$

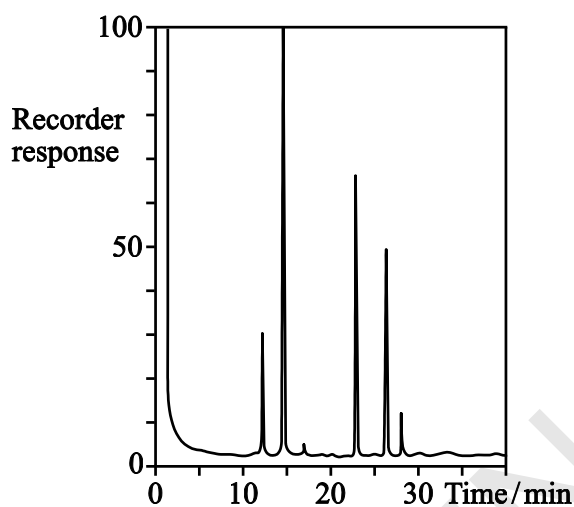
Your answer

☐

[1]

- 3 Instrumental techniques are crucially important in the analysis of many mixtures. These may involve wide ranging areas such as in forensic work or the analysis of a potential forged painting.

The figure below shows a graphical analysis of a mixture using a particular technique.



Identify the technique used to produce this graph.

- A mass spectrometry
- B infrared spectroscopy
- C proton NMR spectroscopy
- D gas-liquid chromatography

Your answer ☐

[1]

- 4 Which of the following factors is most important in determining the relative reactivity of the haloalkanes?

- A bond polarity
- B bond enthalpy
- C intermolecular bonding
- D molar mass

Your answer ☐

[1]

5 Choose the statement that is **not** a principle of 'green chemistry'.

- A Cleaning up waste after it is formed.
- B Keeping the atom economy as high as possible.
- C Use of selective catalysts.
- D Choosing reactants to avoid explosions.

Your answer

☐

[1]

6 On complete combustion, a sample of a hydrocarbon produces 33 g of carbon dioxide and 18 g of water.

What is the empirical formula of this hydrocarbon?

- A C_3H_8
- B CH_2
- C C_2H_4
- D C_3H_4

Your answer

☐

[1]

7 38.49 g of $\text{MgSO}_4 \cdot x\text{H}_2\text{O}$ crystals were heated to drive off the water. 18.79 g of solid remained.

What is the value of x ?

- A 1
- B 2
- C 6
- D 7

Your answer

☐

[1]

- 8** Strontium oxide reacts with water to form an alkaline solution.

What mass of water would react with 10 g strontium oxide?

- A** 0.94 g
- B** 1.7 g
- C** 1.9 g
- D** 3.5 g

Your answer

[1]

- 9** What mass of sodium hydroxide should be dissolved in 250 cm³ of water to make a solution that has a concentration of 0.05 mol dm⁻³?

- A** 0.0125 g
- B** 0.5 g
- C** 2 g
- D** 8 g

Your answer

[1]

- 10** Which of the following is a correct statement about the bonding in a CO molecule?

- A** Carbon provides an electron pair in a dative covalent bond.
- B** Oxygen has two lone pairs of electrons.
- C** There are three covalent bonds between the atoms.
- D** The molecule has no dipole.

Your answer

[1]

11 Which molecule has the smallest bond angle?

- A BCl_3
- B BeCl_2
- C NCl_3
- D SiCl_4

Your answer

☐

[1]

12 A student has three solutions, **X**, **Y**, **Z**. Each contains one of potassium chloride, potassium bromide and potassium iodide but it is not known which solution is which.

A student adds drops of chlorine solution separately to each of **X**, **Y** and **Z**. In each case the student also adds a few drops of cyclohexane. The colours of the cyclohexane layer are shown below.

Solution X	red/brown colour
Solution Y	colourless
Solution Z	violet colour

Which represents the correct identities of solutions **X**, **Y** and **Z**?

- A **X** = potassium chloride, **Y** = potassium bromide, **Z** = potassium iodide
- B **X** = potassium bromide, **Y** = potassium chloride, **Z** = potassium iodide
- C **X** = potassium chloride, **Y** = potassium iodide, **Z** = potassium bromide
- D **X** = potassium iodide, **Y** = potassium chloride, **Z** = potassium bromide

Your answer

☐

[1]

- 13** A teacher tests a solution that has been used by students in some experiments with potassium halides to see if it can be used with a different class.

The teacher adds silver nitrate solution to the solution that the students were using. A pale yellow precipitate is formed. The teacher adds a few drops of dilute ammonia solution to the precipitate. Some of the precipitate appears to dissolve and the precipitate remaining has a stronger yellow tinge. The teacher adds excess concentrated ammonia solution to the remaining precipitate. The precipitate does not dissolve.

What is the most likely conclusion that the teacher will reach about the solution that the students were using?

- A** The solution contains chloride ions.
- B** The solution contains bromide ions.
- C** The solution contains chloride and bromide ions.
- D** The solution contains chloride and iodide ions.

Your answer

☐

[1]

- 14** Four gases, **W**, **X**, **Y** and **Z**, are known to be N_2 , NO , NH_3 and O_2 . It is not known which gas is which.

When gases **X** and **Y** are mixed a brown gas is formed.

Gas **Y** relights a glowing splint.

Gases **W**, **X** and **Z** extinguish a burning splint.

Gas **Z** turns red litmus paper blue.

Which gas is N_2 ?

- A** Gas **W**
- B** Gas **X**
- C** Gas **Y**
- D** Gas **Z**

Your answer

☐

[1]

- 15** A white solid has the following properties:

It all melts at the same temperature.

It gives a purple colour with neutral $\text{FeCl}_3(\text{aq})$.

There is fizzing when $\text{Na}_2\text{CO}_3(\text{aq})$ is added.

The white solid could be

- A** A mixture of a phenol and a carboxylic acid.
- B** A compound with phenol and carboxylic acid functional groups.
- C** A phenol.
- D** A carboxylic acid.

Your answer

☐

[1]

- 16** RNA is a polymer made of nucleotides. Nucleotides are monomers made of phosphates, sugars, and bases.

Which statement is correct about RNA?

- A** Phosphate and deoxyribose units join together by a condensation reaction to form the phosphate–sugar backbone in RNA.
- B** In RNA, adenine forms a base pair with thymine; cytosine forms a base pair with guanine.
- C** Bases join to the phosphate–sugar backbone by a condensation reaction.
- D** Base pairs form by a condensation reaction between the bases.

Your answer

☐

[1]

17 The process of protein synthesis involves DNA and RNA in the following steps.

1. An anti-codon on tRNA binds to a triplet code on mRNA.
2. A ribosome moves along a strand of mRNA.
3. DNA transcription occurs to make a strand of mRNA.
4. Amino acids carried by tRNA are assembled into a protein chain.

What is the correct order of these steps in protein synthesis?

- A** 3 – 2 – 1 – 4
- B** 3 – 1 – 2 – 4
- C** 2 – 3 – 4 – 1
- D** 1 – 3 – 4 – 2

Your answer

[1]

18 What template DNA sequence will produce the polypeptide GluValLeu?

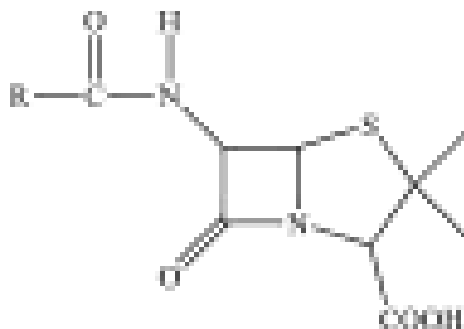
You may need to refer to your Data Sheet.

- A** CUGGUCGAA
- B** GTTCAGGAC
- C** GUUCAGGAC
- D** CAGGACTTC

Your answer

[1]

- 19** The diagram below shows the structure of a penicillin. The properties of the penicillin can be modified by changing the 'R' group side chain.



What name is given to the part of the drug that is medically active?

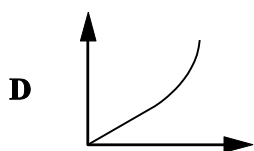
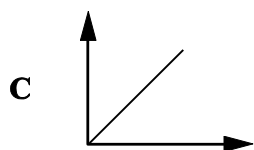
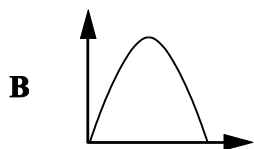
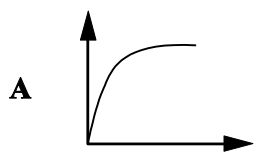
- A** modifier
- B** pharmacophore
- C** receptor
- D** chromophore

Your answer

☐

[1]

- 20** Which one of the following graphs correctly represents the shape of a rate versus substrate concentration plot for an enzyme-catalysed reaction?

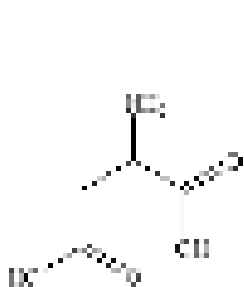


Your answer

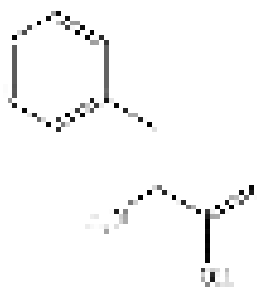
☐

[1]

- 21 Aspartame is a sweetener which can be used instead of sugar. It is a methyl ester of a dipeptide formed from a reaction between the amino acids aspartic acid and phenylalanine, the structures of which are shown below.



Aspartic acid

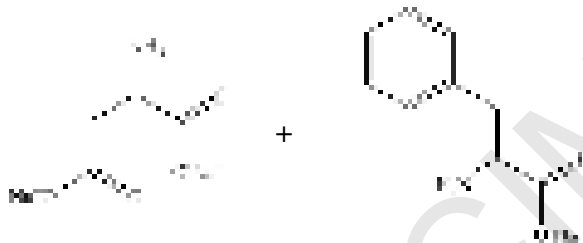


Phenylalanine

Alkaline hydrolysis of aspartame produces salts of the above amino acids.

Which pair of compounds is produced?

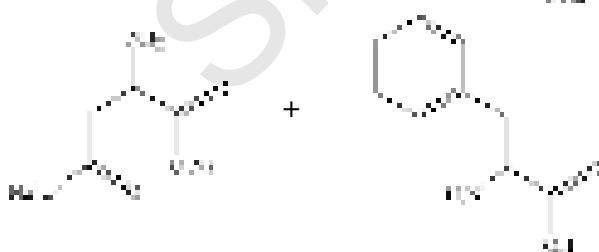
A



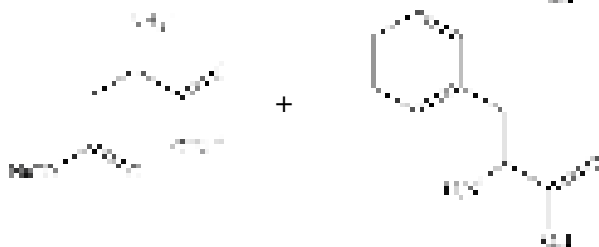
B



C



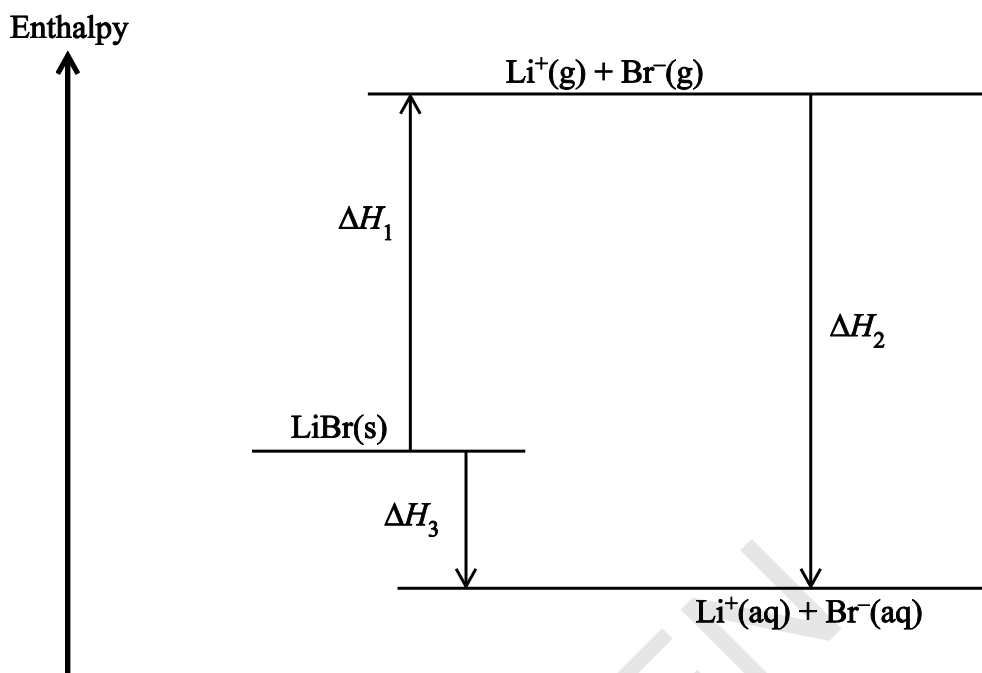
D



Your answer

[1]

22 Below is an enthalpy-level diagram for the solution of lithium bromide.



Which enthalpy change is represented by ΔH_2 ?

- A $\Delta_{\text{sol}}H(\text{Li}^+) + \Delta_{\text{sol}}H(\text{Br}^-)$
- B $\Delta_{\text{hyd}}H(\text{Li}^+) + \Delta_{\text{hyd}}H(\text{Br}^-)$
- C $\Delta_{\text{LE}}H(\text{LiBr})$
- D $\Delta_{\text{sol}}H(\text{LiBr})$

Your answer

☐

[1]

- 23** Four changes **W**, **X**, **Y** and **Z** have the following signs for their ΔH and $\Delta_{\text{sys}}S$ values.

	W	X	Y	Z
ΔH	+	+	–	–
$\Delta_{\text{sys}}S$	+	–	+	–

Which of the following is a correct statement?

- A** Change **W** never occurs.
- B** Change **X** could be the reaction of a solid carbonate with an acid.
- C** Change **Y** could be a precipitation reaction.
- D** Change **Z** could be the condensation of a gas to a liquid.

Your answer ☐

[1]

- 24** A pure sample of fat was known to be a triester of propane-1,2,3-triol with a fatty acid.

0.15 mol of the fat required 10.8 dm³ of hydrogen at room temperature and pressure for complete hydrogenation.

Identify which fatty acid formed the triester.

- A** Palmitic acid, C₁₅H₃₁COOH
- B** Linoleic acid, C₁₇H₃₁COOH
- C** Oleic acid, C₁₇H₃₃COOH
- D** Stearic acid, C₁₇H₃₅COOH

Your answer ☐

[1]

- 25** Chemists use knowledge of bonding between molecules and ions to explain why different substances are soluble in water.

Which of the following statements is correct?

- A** pentane is insoluble in water because pentane molecules are non-polar and **do not** form hydrogen bonds with water molecules
- B** propanone is soluble in water even though water molecules **do not** form hydrogen bonds with propanone molecules
- C** sodium chloride is soluble in water because water molecules are polar and form hydrogen bonds with Na^+ ions and Cl^- ions
- D** carbon dioxide is insoluble in water because it is non-polar and **does not** form hydrogen bonds with water

Your answer

☐

[1]

- 26** The decomposition of calcium carbonate is a reaction that takes place in cement manufacture.



	CaCO₃	CaO	CO₂
S / J mol⁻¹ K⁻¹	93	40	214

What is $\Delta_{\text{tot}} S$ for this reaction at 298 K?

- A** $-436 \text{ J mol}^{-1} \text{ K}^{-1}$
- B** $+160 \text{ J mol}^{-1} \text{ K}^{-1}$
- C** $+161 \text{ J mol}^{-1} \text{ K}^{-1}$
- D** $+758 \text{ J mol}^{-1} \text{ K}^{-1}$

Your answer

☐

[1]

- 27** A few drops of universal indicator solution are added to a solution of sodium chloride. Two carbon electrodes are dipped into the solution. The electrodes are connected to a power pack which is switched on.

The following statements describe changes that might be seen around the positive electrode during electrolysis. Which of the statements is/are true?

Statement 1: The solution turns red

Statement 2: The solution turns colourless

Statement 3: The solution turns green

- A** 1, 2 and 3
B Only 1 and 2
C Only 2 and 3
D Only 1

Your answer

☐

[1]

- 28** Some possible ligands are shown below.

Which of the following could be bidentate ligands?

1: $\text{NH}_2\text{CH}_2\text{CH}_2\text{NH}_2$

2: $(\text{COO}^-)_2$

3: $\text{C}_2\text{H}_5\text{OH}$

- A** 1, 2 and 3
B Only 1 and 2
C Only 2 and 3
D Only 1

Your answer

☐

[1]

- 29** Which statement(s) about the reaction of aqueous sodium hydroxide with 1-chloropentane is/are correct?

Statement 1: The reaction is a substitution reaction

Statement 2: The reaction occurs at a slower rate than with 1-bromopentane

Statement 3: 'Curly arrows' can be used to show the movement of pairs of electrons in the mechanism for this reaction

- A** 1, 2 and 3
B Only 1 and 2
C Only 2 and 3
D Only 1

Your answer

☐

[1]

- 30** Which of the following quantities increase from left to right along the series:
 MgSO_4 ; CaSO_4 ; SrSO_4 ; BaSO_4 ?

- 1:** Size of the metal ions
2: The magnitude of enthalpy change of hydration of the metal ions
3: The magnitude of lattice enthalpy of the compounds

- A** 1, 2 and 3
B Only 1 and 2
C Only 2 and 3
D Only 1

Your answer

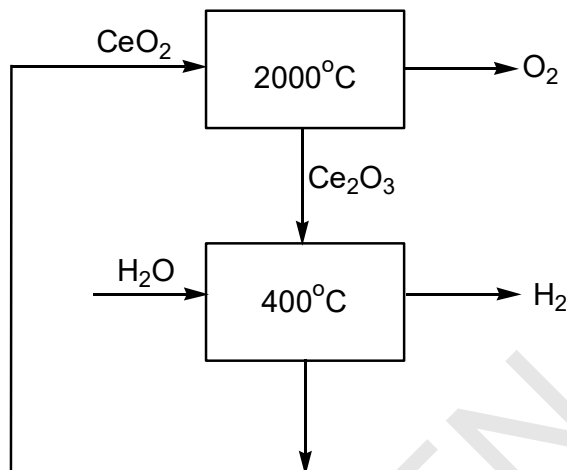
☐

[1]

SECTION B

Answer **all** the questions.

- 31** Ceria, CeO_2 , is used in a thermochemical cycle for splitting water. A simplified diagram of the process is shown below.



- (a) (i) Give the systematic name for ceria.

.....

[1]

- (ii) Give chemical equations for the **two** reactions involved in the cycle.

State symbols are not required.

equation 1:

equation 2:

[2]

- (iii) One of the reactions in the cycle is endothermic.

What data for each reactant and product is required to decide which reaction is endothermic?

.....

.....

.....

[1]

- (b) Aqueous solutions of $\text{Ce}(\text{SO}_4)_2$ and KMnO_4 can be used as oxidising agents in redox titrations. In both cases reactions are carried out in acidic solutions.

- (i) KMnO_4 should **not** be acidified with hydrochloric acid.

Select and use data from the table below to determine which acid can be used with Ce^{4+} to oxidise Cl^- .

Explain your answer.

Half-reaction	E^\ominus / V
$\text{Ce}^{4+} + \text{e}^- \rightleftharpoons \text{Ce}^{3+}$	+1.28 measured in $1 \text{ mol dm}^{-3} \text{HCl(aq)}$
$\text{Cl}_2 + 2 \text{e}^- \rightleftharpoons 2\text{Cl}^-$	+1.36
$\text{Ce}^{4+} + \text{e}^- \rightleftharpoons \text{Ce}^{3+}$	+1.44 measured in $1 \text{ mol dm}^{-3} \text{H}_2\text{SO}_4(\text{aq})$
$\text{MnO}_4^- + 8\text{H}^+ + 5 \text{e}^- \rightleftharpoons \text{Mn}^{2+} + 4\text{H}_2\text{O}$	+1.51

.....

.....

.....

.....

..... [3]

- (ii) A student devises an experiment to find out how much cerium is present in an impure sample of ceria.

First the student converts 2.5 g of powdered ceria into 100 cm³ of a solution of Ce(SO₄)₂ in sulfuric acid. Then 25.0 cm³ of this Ce(SO₄)₂ solution is titrated with a standard solution of arsenic(III) in sulfuric acid. In the reaction Ce⁴⁺ is reduced to Ce³⁺.

1.00 dm³ of solution is made up by dissolving 0.250 mol of As₂O₃ in sulfuric acid. The arsenic is present in the solution as AsO₃³⁻ ions. 25.0 cm³ samples of the Ce(SO₄)₂ solution required an average titre of 3.00 cm³ of this AsO₃³⁻ solution.

The half-equation for the oxidation of AsO₃³⁻ ions is given below.



Calculate the percentage purity of the student's ceria sample.

Give your answer to an **appropriate** number of significant figures.

percentage purity = % [5]

- (iii) Suggest one improvement to the student's method that will reduce the percentage error in the answer to (ii) without changing the apparatus.

Give a reason for your choice.

.....

.....

..... [1]

- (iv) Calculate the number of oxygen atoms in 2.5 g of **pure** ceria.

number of atoms = [2]

- (v) Ceria is also used as a heterogeneous oxidation catalyst for self-cleaning ovens. Ceria is incorporated on the surface of the inside panels of an oven.

Describe how a heterogeneous catalyst works.

.....

.....

.....

.....

..... [4]

- 32** Ethanol is sometimes used as a biofuel to replace petrol in car engines. However it has several disadvantages.

(a) Give **two** disadvantages of ethanol as a replacement fuel for petrol.

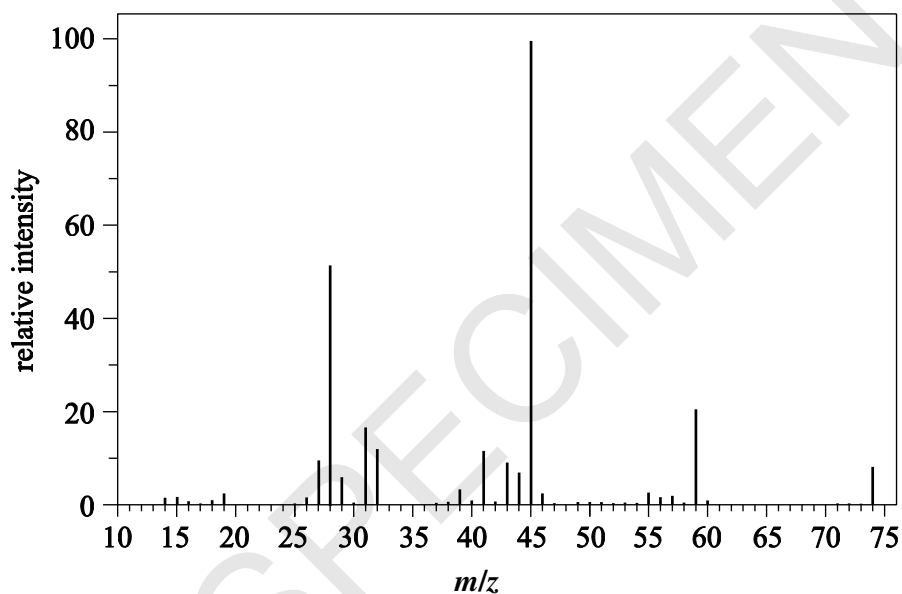
.....

.....

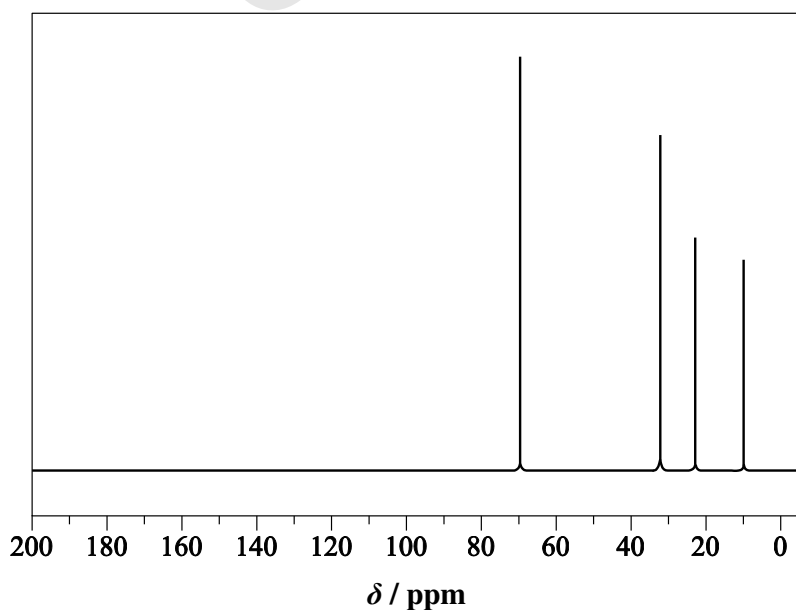
..... [2]

(b)* The mass spectrum and ^{13}C NMR spectrum for compound **A** are given below.

Mass spectrum (Compound A)



^{13}C NMR spectrum (Compound A)



Compound **A** reacts with heated Al_2O_3 to form two unsaturated compounds, **C** and **D**.

[6]

SPECIMEN

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

- (c) The electricity-tolerant bacteria used to convert methanoic acid contain an enzyme used to synthesise compound A. This enzyme is specific to this synthesis.

Explain why an enzyme is specific for a particular reaction.

.....

.....

..... [2]

- (d) A mixture of 4.0 g of ethanol vapour and 25 dm³ of air is ignited.

Determine whether the ethanol will be completely burned.

All volumes are measured at room temperature and pressure.

Assume air contains 21% oxygen.

.....

.....

.....

.....

..... [3]

SPECIMEN

- 33** Coconut oil contains a large amount of compound **E**. The sodium salt, **F**, of compound **E** is used as a soap.



Compound E

- (a) Circle an ester group on the diagram of the structure of **E** above. [1]
- (b) After **F** is formed from **E**, **F** remains dissolved in the solution. **F** is precipitated out as a solid soap by adding NaCl.
- (i) Using Na^+L^- to represent the solid **F**, give the mathematical equation for the solubility product of **F**. [1]

- (ii) Explain why adding NaCl to a solution of **F** causes the salt to precipitate out.

.....

.....

..... [2]

- (iii) The solubility in water of **F** is 24.0 g dm^{-3} at 24°C .

The molar mass of **F** is 222 g mol^{-1} .

Calculate the minimum mass (in g) of solid NaCl that is needed to form a precipitate when added to 500 cm^3 of a $1.00 \times 10^{-2} \text{ mol dm}^{-3}$ of **F** at 24°C .

Assume you can neglect the $[\text{Na}^+(\text{aq})]$ from salt **F** in comparison with the $[\text{Na}^+(\text{aq})]$ from NaCl.

Give one **other** assumption you make in your calculation.

minimum mass of NaCl = g

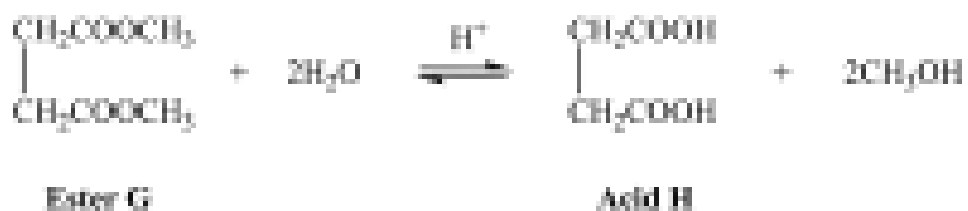
assumption:

.....

.....

[5]

- (c) Ester **G** is a fruit-flavoured additive for some ice cream and chewing gum. Ester **G** can be hydrolysed to form acid **H** and methanol.



A mixture of ester **G** and water is left to reach equilibrium with a small amount of acid catalyst.

The initial concentrations are:

- Ester **G**: 2.0 mol dm^{-3}
- Water: 5.0 mol dm^{-3}

The equilibrium concentration of ester **G** is 1.4 mol dm^{-3} .

Calculate the value of K_c for this equilibrium.

$K_c = \dots\dots\dots$ [4]

- (d) Sodium ethanoate may be used in the production of ester **G**. It can also be used in buffer solutions.

Calculate the mass of solid sodium ethanoate (molar mass = 82 g mol^{-1}) that would need to be added to ethanoic acid (concentration 1.0 mol dm^{-3}) in order to make 250 cm^3 of buffer solution with a pH of 4.80.

K_a of ethanoic acid is $1.74 \times 10^{-5} \text{ mol dm}^{-3}$.

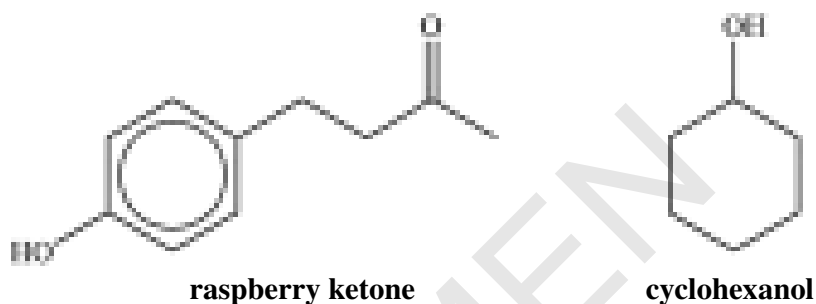
mass of solid sodium ethanoate = g [4]

- 34** Raspberry ketone, extracted from various berries, is widely used as a flavouring, a constituent of perfumes and as a diet supplement. The cost of natural raspberry ketone is often over 2000 times the cost of raspberry ketone manufactured synthetically.

(a) Suggest a reason why natural raspberry ketone is expensive to produce.

.....
 [1]

(b)* The structures of raspberry ketone and cyclohexanol are shown below.



The difference between the structures of the carbon ring in raspberry ketone and cyclohexanol has an effect on the chemical properties of the hydroxyl group.

Describe the difference between the structures of the two carbon rings and how the reactions of the hydroxyl group are different in the two compounds.

Include examples, and at least two equations.

[6]

.....

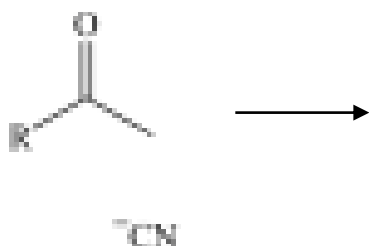
[illegible]

- What technique could be used to show that two organic products are present in the mixture?

.....

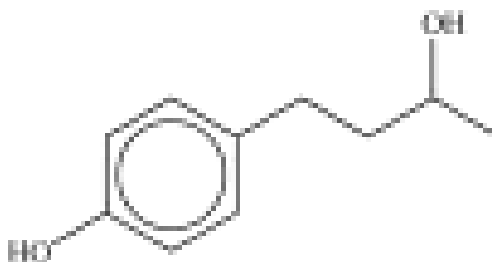
- Complete the diagram below to show the mechanism for the formation of a cyanhydrin, showing the intermediate and the product.

Include curly arrows and partial charges where appropriate.



© OCR 2016

- (e) Raspberry ketone can be reduced to the compound shown below.



Explain why this compound has two stereoisomers and describe how they differ.

.....

 [2]

- (f) 4-Phenylbutan-2-one is a liquid which boils at 235 °C whereas raspberry ketone is a solid, melting at 83 °C.



4-phenylbutan-2-one

Explain this difference in properties.

.....

 [3]

35 Aluminium is produced by the electrolysis of molten aluminium oxide, Al_2O_3 .

(a) Demonstrate how the formula of aluminium oxide can be deduced using the periodic table.

.....

 [1]

(b) (i) Write the equation for the reaction at the cathode when molten aluminium oxide is electrolysed.

[1]

(ii) The oxygen produced at the anode reacts with the carbon electrodes.

Calculate the maximum volume of carbon dioxide (measured at RTP) that would be produced during the electrolysis of 100 kg of Al_2O_3 .

volume = dm^3 [3]

- (c) (i) Aluminium is not produced at the cathode when a solution of an aluminium salt is electrolysed.

A solution of aluminium sulfate is electrolysed.

Suggest equations for:

- the reaction at the cathode
- the reaction at a carbon anode.

[2]

- (ii) Give details of a simple test that can be used to test for the sulfate ion in solution.

.....

.....

[2]

- (d) Aluminium can be used to clean silver cutlery that has been ‘tarnished’ by a layer of black silver sulfide. The silver object is placed in a hot solution of sodium carbonate in contact with a piece of aluminium foil. An electrochemical reaction occurs and the tarnished silver becomes shiny again.

	E^{\ominus} / V
$\text{Al}^{3+} + 3\text{e}^{-} \rightleftharpoons \text{Al}$	-1.66
$\text{Ag}^{+} + \text{e}^{-} \rightleftharpoons \text{Ag}$	+0.80

- (i) Draw a labelled diagram of the cell you could set up in a laboratory to measure the $E^{\ominus}_{\text{cell}}$ of the reaction involved in cleaning tarnished silver.

[3]

- (ii) When $[Al^{3+}]$ is changed, the value for the electrode potential of an aluminium half-cell, E , is given by

$$E = E^{\circ} + \frac{RT}{nF} \ln [Al^{3+}]$$

Where R = gas constant

T = temperature in kelvin

F = Faraday constant, $9.65 \times 10^4 \text{ C mol}^{-1}$

n = number of electrons transferred

Calculate the electrode potential, E , of an aluminium half-cell at $T = 298 \text{ K}$ and $[Al^{3+}] = 0.1 \text{ mol dm}^{-3}$.

$E = \dots\dots\dots \text{ V} \quad [2]$

END OF QUESTION PAPER

Copyright Information:

OCR is committed to seeking permission to reproduce all third-party content that it uses in the assessment materials. OCR has attempted to identify and contact all copyright holders whose work is used in this paper. To avoid the issue of disclosure of answer-related information to candidates, all copyright acknowledgements are reproduced in the OCR Copyright Acknowledgements booklet. This is produced for each series of examinations and is freely available to download from our public website (www.ocr.org.uk) after the live examination series.

If OCR has unwittingly failed to correctly acknowledge or clear any third-party content in this assessment material, OCR will be happy to correct its mistake at the earliest possible opportunity.

For queries or further information please contact the Copyright Team, First Floor, 9 Hills Road, Cambridge CB2 1GE.

OCR is part of the Cambridge Assessment Group; Cambridge Assessment is the brand name of University of Cambridge Local Examinations Syndicate (UCLES), which is itself a department of the University of Cambridge.

...day June 20XX – Morning/Afternoon

A Level Chemistry B (Salters)

H433/01 Fundamentals of chemistry

SAMPLE MARK SCHEME

Duration: 2 hours 15 minutes

MAXIMUM MARK 110

MARKING INSTRUCTIONS**PREPARATION FOR MARKING****SCORIS**

1. Make sure that you have accessed and completed the relevant training packages for on-screen marking: *scoris assessor Online Training*; *OCR Essential Guide to Marking*.
2. Make sure that you have read and understood the mark scheme and the question paper for this unit. These are posted on the RM Cambridge Assessment Support Portal <http://www.rm.com/support/ca>
3. Log-in to scoris and mark the **required number** of practice responses (“scripts”) and the **required number** of standardisation responses.

YOU MUST MARK 10 PRACTICE AND 10 STANDARDISATION RESPONSES BEFORE YOU CAN BE APPROVED TO MARK LIVE SCRIPTS.

MARKING

1. Mark strictly to the mark scheme.
2. Marks awarded must relate directly to the marking criteria.
3. The schedule of dates is very important. It is essential that you meet the scoris 50% and 100% (traditional 50% Batch 1 and 100% Batch 2) deadlines. If you experience problems, you must contact your Team Leader (Supervisor) without delay.
4. If you are in any doubt about applying the mark scheme, consult your Team Leader by telephone, email or via the scoris messaging system.

5. Work crossed out:
- where a candidate crosses out an answer and provides an alternative response, the crossed out response is not marked and gains no marks
 - if a candidate crosses out an answer to a whole question and makes no second attempt, and if the inclusion of the answer does not cause a rubric infringement, the assessor should attempt to mark the crossed out answer and award marks appropriately.
6. Always check the pages (and additional objects if present) at the end of the response in case any answers have been continued there. If the candidate has continued an answer there then add a tick to confirm that the work has been seen.
7. There is a NR (No Response) option. Award NR (No Response)
- if there is nothing written at all in the answer space
 - OR if there is a comment which does not in any way relate to the question (e.g. 'can't do', 'don't know')
 - OR if there is a mark (e.g. a dash, a question mark) which isn't an attempt at the question.
- Note: Award 0 marks – for an attempt that earns no credit (including copying out the question).
8. The scoris **comments box** is used by your Team Leader to explain the marking of the practice responses. Please refer to these comments when checking your practice responses. **Do not use the comments box for any other reason.**
- If you have any questions or comments for your Team Leader, use the phone, the scoris messaging system, or email.
9. Assistant Examiners will send a brief report on the performance of candidates to their Team Leader (Supervisor) via email by the end of the marking period. The report should contain notes on particular strengths displayed as well as common errors or weaknesses. Constructive criticism of the question paper/mark scheme is also appreciated.

10. For answers marked by levels of response:

Read through the whole answer from start to finish, concentrating on features that make it a stronger or weaker answer using the indicative scientific content as guidance. The indicative scientific content indicates the expected parameters for candidates' answers, but be prepared to recognise and credit unexpected approaches where they show relevance.

Using a 'best-fit' approach based on the science content of the answer, first decide which set of level descriptors, Level 1, Level 2 or Level 3, **best** describes the overall quality of the answer using the guidelines described in the level descriptors in the mark scheme.

Once the level is located, award the higher or lower mark.

The higher mark should be awarded where the level descriptor has been evidenced and all aspects of the communication statement (in *italics*) have been met.

The lower mark should be awarded where the level descriptor has been evidenced but aspects of the communication statement (in *italics*) are missing.

In summary:

- **The science content determines the level.**
- **The communication statement determines the mark within a level.**

Level of response questions on this paper are **32(b)** and **34(b)**.

11. Annotations

Annotation	Meaning
DO NOT ALLOW	Answers which are not worthy of credit
IGNORE	Statements which are irrelevant
ALLOW	Answers that can be accepted
()	Words which are not essential to gain credit
—	Underlined words must be present in answer to score a mark
ECF	Error carried forward
AW	Alternative wording
ORA	Or reverse argument
✓	Marking point

12. Subject-specific Marking Instructions

INTRODUCTION

Your first task as an Examiner is to become thoroughly familiar with the material on which the examination depends. This material includes:

- the specification, especially the assessment objectives
- the question paper
- the mark scheme.

You should ensure that you have copies of these materials.

You should ensure also that you are familiar with the administrative procedures related to the marking process. These are set out in the OCR booklet **Instructions for Examiners**. If you are examining for the first time, please read carefully **Appendix 5 Introduction to Script Marking: Notes for New Examiners**.

Please ask for help or guidance whenever you need it. Your first point of contact is your Team Leader.

SECTION A

Question	Answer	Marks	Guidance
1	D	1	
2	D	1	
3	D	1	
4	B	1	
5	A	1	
6	A	1	
7	D	1	
8	B	1	
9	B	1	
10	C	1	
11	C	1	
12	B	1	
13	D	1	
14	A	1	
15	B	1	
16	C	1	
17	A	1	
18	B	1	
19	B	1	
20	A	1	

Question	Answer	Marks	Guidance
21	B	1	
22	B	1	
23	D	1	
24	C	1	
25	A	1	
26	A	1	
27	B	1	
28	B	1	
29	A	1	
30	D	1	
	Total	30	

SECTION B

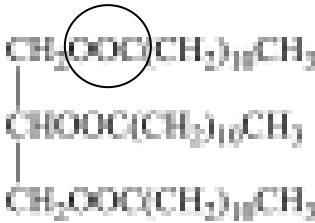
Question			Answer	Marks	Guidance
31	(a)	(i)	Cerium(IV) oxide ✓	1	ALLOW without parentheses
		(ii)	$4\text{CeO}_2 \rightarrow 2\text{Ce}_2\text{O}_3 + \text{O}_2$ OR $2\text{CeO}_2 \rightarrow \text{Ce}_2\text{O}_3 + 0.5\text{O}_2$ ✓ $\text{Ce}_2\text{O}_3 + \text{H}_2\text{O} \rightarrow 2\text{CeO}_2 + \text{H}_2$ ✓	2	
		(iii)	Enthalpy changes of formation ✓	1	ALLOW bond enthalpies/energies
	(b)	(i)	E^\ominus of $\text{Ce}^{4+}/\text{Ce}^{3+}$ in $\text{H}_2\text{SO}_4(\text{aq})$ is more positive than E^\ominus of Cl_2/Cl^- ✓ So will oxidise Cl^- to Cl_2 ✓ In $\text{HCl}(\text{aq})$ E^\ominus of $\text{Ce}^{4+}/\text{Ce}^{3+}$ is less positive so will not oxidise Cl^- to Cl_2 AND so $\text{H}_2\text{SO}_4(\text{aq})$ is used ✓	3	ALLOW less negative ALLOW more negative
		(ii)	FIRST CHECK ANSWER ON ANSWER LINE answer = 83% to 2 sig figs award 5 marks $n(\text{AsO}_3^{3-})$ used in titration = $3.00/1000 \times 0.500$ OR 0.00150 (mol) (conc. of AsO_3^{3-} is double that of As_2O_3) ✓ $n(\text{Ce}^{4+})$ used in titration = $2 \times (3.00/1000 \times 0.500)$ OR 2×0.00150 OR 0.00300 (mol) ✓ M_r of CeO_2 = 172.1 ✓ mass CeO_2 present in 100 cm^3 of solution = $4 \times 172.1 \times 0.00300$ = 2.0652 g ✓ % purity of CeO_2 sample = $2.0652 \times 100/2.5$ = 83% to 2 sig figs ✓	5	 ALLOW ECF from first marking point ALLOW ECF from second marking point

Question			Answer	Marks	Guidance
		(iii)	Use a more dilute AsO_3^{3-} solution to increase volume of titre / reduce % error in titre OR Use more ceria sample to increase volume of titre / reduce % error in titre ✓	1	
		(iv)	FIRST CHECK ANSWER ON ANSWER LINE answer = 1.7×10^{22} atoms of oxygen award 2 marks $n(\text{CeO}_2) = 2.5/172.1 = 0.01453 \text{ (mol)} \checkmark$ $n(\text{O}) = 0.01453 \times 2 = 0.02905 \text{ (mol)}$ $0.02905 \times 6.02 \times 10^{23} = 1.7 \times 10^{22} \text{ atoms of oxygen } \checkmark$	2	ALLOW ECF from first marking point ALLOW 2 or more sig figs
		(v)	Reactants adsorbed onto surface of catalyst and form bonds to surface (AW) ✓ Bonds within reactants weaken and break ✓ New bonds form (AW) ✓ Products formed desorb/leave from catalyst (AW) ✓	4	
			Total	19	

Question			Answer	Marks	Guidance
32	(a)		<p><i>Two marking points from the following:</i></p> <ul style="list-style-type: none">• Large amounts of arable land are required to produce the crops required to obtain large amounts ethanol• (Environmental problem caused by) disposal of fermentation waste• Current car engines need to be modified to use high concentrations of ethanol <p>✓ ✓</p>	2	<p>ALLOW ethanol has a lower enthalpy change of combustion than petrol</p> <p>IGNORE better for the environment</p>

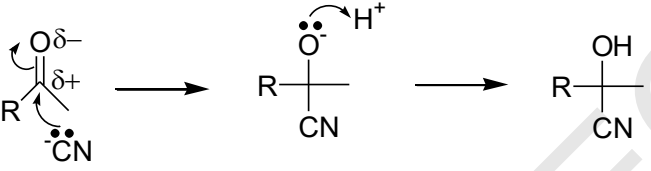
Question	Answer	Marks	Guidance
(b)*	<p><i>Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question.</i></p> <p>Level 3 (5–6 marks) Analyses information AND spectral data to provide evidence to support the correct and full identification of all compounds A, B, C and D. Evidence from reactions of A AND no reaction of B with Tollens' reagent or NaOH AND MS spectrum AND ^{13}C NMR spectrum.</p> <p><i>The information and evidence used is relevant and fully supports the identification. The answer is clear and logically structured.</i></p> <p>Level 2 (3–4 marks) Analyses information AND data to provide evidence to support the partial identification of compound A as a secondary alcohol, B as a ketone and C and D as alkenes. Evidence from reactions of A AND no reaction of B with Tollens' reagent or NaOH AND EITHER MS spectrum OR ^{13}C NMR spectrum</p> <p><i>The information and evidence used is in the most-part relevant and supports the identification. The answer is presented with some structure.</i></p> <p>Level 1 (1–2 marks) Analyses information OR data to provide evidence allowing partial identification of the compounds A AND B OR C AND D using reactions of A OR no reaction of B with Tollens' reagent or NaOH OR using information from MS Spectrum OR ^{13}C NMR spectrum</p>	6	<p>Indicative scientific points may include:</p> <p>Full identification Compound A is $\text{CH}_3\text{CH}_2\text{CH}(\text{OH})\text{CH}_3$ Compound B is $\text{CH}_3\text{CH}_2\text{COCH}_3$ Compounds C & D are $\text{CH}_3\text{CH}_2\text{CH}=\text{CH}_2$ and $\text{CH}_3\text{CH}=\text{CHCH}_3$</p> <p>Evidence from spectral data MS Spectrum:</p> <ul style="list-style-type: none"> $M_r (\text{C}_x\text{H}_y\text{O}) = 74$ $M_r (\text{C}_x\text{H}_y) 74 - 16 = 58$ so $x = 4$ and $y = 10$. <p>^{13}C NMR: 2 from</p> <ul style="list-style-type: none"> 4 carbon environments no $\text{C}=\text{O}$ or $\text{C}=\text{C}$ $\text{C}-\text{O}$ (and $\text{C}-\text{C}$) present. <p>Evidence from the Reactions:</p> <ul style="list-style-type: none"> A is alcohol from formula plus $\text{H}^+/\text{Cr}_2\text{O}_7^{2-}$ reaction Heating A with Al_2O_3 results in elimination of water from A forms 2 different alkenes, C and D Thus A secondary and B a ketone. A reacts with $\text{H}^+/\text{Cr}_2\text{O}_7^{2-}$ when heated \rightarrow B is aldehyde, ketone or carboxylic acid No reaction with Tollens' \rightarrow B is NOT an aldehyde No reaction with NaOH \rightarrow B is NOT a carboxylic acid Conclusion: B is a ketone AND A a secondary alcohol.

Question			Answer	Marks	Guidance
			<p><i>The information and evidence is used to make a partial identification of A AND B OR C and D. The evidence chosen does not fully support the identification and is not presented in a logical order.</i></p> <p><i>There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.</i></p> <p>0 marks No response or no response worthy of credit.</p>		For Level 1: partial identification of A required. May be supplemented by partial identification of B OR partial identification of C and D .
	(c)		<p>Substrate/reactant has specific <u>shape</u> ✓</p> <p>Fits <u>active site</u> in enzyme ✓</p>	2	
	(d)		<p>$n(\text{O}_2) = 25 \times 0.21/24.0 = 0.219 \text{ mol}$ ✓</p> <p>M_r of $\text{C}_2\text{H}_5\text{OH} = 46.0$</p> <p>$n(\text{C}_2\text{H}_5\text{OH}) = 4.0/46.0 = 0.087 \text{ mol}$</p> <p>Recognition of ratio $\text{O}_2 / \text{C}_2\text{H}_5\text{OH}$: $0.219 / 0.087 = 2.5$ ✓</p> <p>This is smaller than the required ratio of 3 (from $\text{C}_2\text{H}_5\text{OH} + 3\text{O}_2 \rightarrow 2\text{CO}_2 + 3\text{H}_2\text{O}$), so the ethanol is not completely burned. ✓</p>	3	ALLOW ECF from first marking point.
			Total	13	

Question			Answer	Marks	Guidance
33	(a)		 <p>Any of the ester groups circled correctly ✓</p>	1	IGNORE circled adjacent carbons
	(b)	(i)	$K_{sp} = [\text{Na}^+(\text{aq})] \times [\text{L}^-(\text{aq})]$ ✓	1	State symbols required ALLOW $K_{sp} = [\text{Na}^+(\text{aq})] [\text{L}^-(\text{aq})]$
		(ii)	$[\text{Na}^+]$ increases but K_{sp} remains constant ✓ so NaL precipitates to make $[\text{L}^-]$ smaller / to move equilibrium left ✓	2	
		(iii)	<p>FIRST CHECK ANSWER ON ANSWER LINE minimum mass of NaCl = 34.2 g award 4 marks</p> <p>Solubility of F = $24.0/222 = 0.108 \text{ mol dm}^{-3}$</p> <p>$K_{sp} = (\text{solubility})^2 = 0.0117$ ✓</p> <p>$0.0117 = [\text{Na}^+(\text{aq})] \times 1.0 \times 10^{-2}$ ✓</p> <p>$[\text{NaCl}]$ to exceed $K_{sp} = 0.0117 / 1.0 \times 10^{-2} = 1.17 \text{ (mol dm}^{-3})$ ✓</p> <p>Min mass of NaCl to add to 500 cm^3 to form ppt of F = $(1.17/2) \times 58.5 = 34.2 \text{ g}$ ✓</p> <p>Assumption: volume of solution does not change when NaCl added ✓</p>	5	IGNORE units

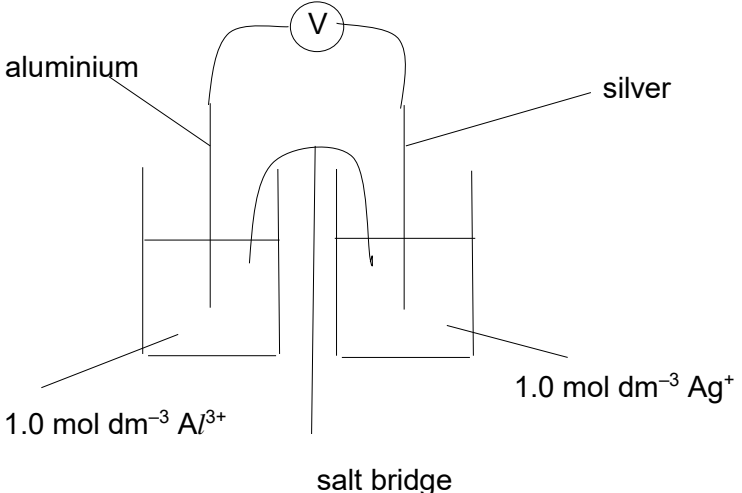
Question		Answer	Marks	Guidance
	(c)	<p>FIRST CHECK ANSWER ON ANSWER LINE Answer = 0.043 award 4 marks</p> <p>concentration of $\text{H}_2\text{O} = 5.00 - 1.20 = 3.80 \text{ (mol dm}^{-3}\text{)} \checkmark$</p> <p>concentration of acid H = $0.60 \text{ (mol dm}^{-3}\text{)}$ AND concentration of $\text{CH}_3\text{OH} = 1.20 \text{ (mol dm}^{-3}\text{)} \checkmark$</p> $K_c (= \frac{[(\text{CH}_2\text{COOH})_2][\text{CH}_3\text{OH}]^2}{[(\text{CH}_2\text{COOCH}_3)_2][\text{H}_2\text{O}]^2}) = \frac{0.6 \times 1.2^2}{1.4 \times 3.8^2} \checkmark$ <p>= 0.043 \checkmark (no units)</p>	4	<p>ALLOW 2 or more sig figs</p>
	(d)	<p>FIRST CHECK ANSWER ON ANSWER LINE Answer = 22.5 g award 4 marks</p> <p>$[\text{H}^+] = 10^{-4.8} = 1.585 \times 10^{-5} \text{ mol dm}^{-3} \checkmark$</p> $K_a = \frac{[\text{H}^+][\text{salt}]}{[\text{acid}]} \text{ AND } \frac{[\text{salt}]}{[\text{acid}]} = \frac{K_a}{[\text{H}^+]} \checkmark$ $= \frac{1.74 \times 10^{-5}}{1.585 \times 10^{-5}} = 1.0979 \checkmark$ <p>Therefore amount of ethanoate required = $1.0979 \times n(\text{ethanoic acid})$ = $1.0979 \times 0.250 = 0.274 \text{ (mol)}$</p> <p>$0.274 \times 82.0 = 22.5 \text{ (g)} \checkmark$</p>	4	<p>ALLOW ECF from first marking point</p> <p>ALLOW ECF from third marking point</p>
		Total	17	

Question			Answer	Marks	Guidance
34	(a)		Only small amount of raspberry ketone present in raspberries / difficult / high cost to extract ✓	1	
	(b)*		<p><i>Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question.</i></p> <p>Level 3 (5–6 marks) Fully describes the differences between the two compounds in detail with both ring descriptions correct. Describes at least three reactions with examples and equations.</p> <p><i>The full description is detailed and correct. There is a clear and logical structure. The reactions are relevant and fully supported with examples and equations. Demonstrates a clear and confident knowledge of relevant technical language (names of compounds, 'substitution', 'elimination', 'delocalisation').</i></p> <p>Level 2 (3–4 marks) Describes the differences between the two compounds in detail including electron delocalisation in phenol. Describes at least two reactions with equations but not necessarily showing reactions for both structures.</p> <p><i>The description is detailed and is presented with some structure. The reactions are in the most-part relevant and supported by equations. Demonstrates ability to answer question with some indications of a sound grasp of technical language.</i></p>	6	<p>Indicative scientific points may include:</p> <p>Ring structures:</p> <ul style="list-style-type: none"> • saturated ring of 6 carbons in alcohol • unsaturated ring of 6 carbons in phenol with 6 delocalised electrons <p>Reactions of –OH group:</p> <ul style="list-style-type: none"> • acidic in phenol neutral in alcohol e.g. with alkalis* (NOT with carbonates) • nucleophilic substitution in alcohol e.g. with halide* • elimination in alcohol not in phenol e.g. form alkenes* with Al_2O_3 / H_2SO_4 • phenols give purple colour with FeCl_3 • phenols will not react with carboxylic acids but alcohols will*. <p>* an equation can be written here</p> <p>If other correct reactions are given which are NOT different between the two compounds mark lower at each level</p>

Question	Answer	Marks	Guidance
	<p>Level 1 (1–2 marks) Identifies the differences between the two structures mentioning phenol and alcohol. Describes at least two reactions.</p> <p><i>There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.</i></p> <p>0 marks No response or no response worthy of credit.</p>		
(c)	<p>Gas–liquid chromatography OR Thin layer chromatography OR paper chromatography ✓</p>	1	ALLOW glc or tlc
(d)	 <p>Arrow from negative charge on cyanide ✓</p> <p>Partial charges on C=O correct AND arrow on carbonyl ✓</p> <p>Intermediate correct ✓</p> <p>Arrow from O to H AND correct cyanohydrin structure ✓</p>	4	<p>Arrows MUST BE double headed AND pointing towards correct atom</p> <p>ALLOW lone pair inserted on C and arrow starting from there</p>
(e)	<p>(compound contains a) chiral C / chiral centre / asymmetric C ✓</p> <p>(the enantiomers are) mirror images ✓</p>	2	ALLOW 3-D sketch showing stereoisomers

Question			Answer	Marks	Guidance
	(f)		Stronger intermolecular bonds present in raspberry ketone (than in 4-phenylbutan-2-one) ✓ due to hydrogen bonding ✓ so more energy needed to separate molecules ✓	3	ALLOW intermolecular forces
			Total	17	

Question			Answer	Marks	Guidance
35	(a)		Al^{3+} since group 3, O^{2-} since Group 6; charges balance (in Al_2O_3) ✓	1	
	(b)	(i)	$Al^{3+} + 3e^- \rightarrow Al$ ✓	1	ALLOW 'e' without minus IGNORE state symbols
		(ii)	FIRST CHECK ANSWER ON ANSWER LINE Answer = 35000 OR 35280 award 3 marks $n(Al_2O_3) = 100000/102$ OR 980 (mol) ✓ half a mol CO_2 for every mol O ✓ (stated or shown in calc) volume $CO_2 = 24 \times 980 \times 3/2$ = 35000 OR 35280 ✓	3	ALLOW ECF from first marking point
	(c)	(i)	cathode: $2H_2O + 2e^- \rightarrow H_2 + 2OH^-$ ✓ anode: $2H_2O \rightarrow 4H^+ + O_2 + 4e^-$ ✓	2	ALLOW 'e' without minus IGNORE state symbols ALLOW multiples and halves ALLOW $2H^+ + 2e^- \rightarrow H_2$ and $4OH^- \rightarrow O_2 + 2H_2O + 4e^-$
		(ii)	white ppt ✓ after adding Ba^{2+} / solution of (named) barium salt OR (formation of) barium sulfate/ $BaSO_4$ ✓	2	Any named barium salt must be soluble

Question	Answer	Marks	Guidance
(d) (i)	 <p>labelled metal rods in labelled solutions of corresponding ions ✓ both ions 1.0 mol dm⁻³ ✓ wires, voltmeter and salt bridge ✓</p>	3	<p>ALLOW:</p> <ul style="list-style-type: none"> cell either way round any unambiguous representation of the voltmeter descriptions of solutions as, e.g., 'AgNO₃' and 'Al(NO₃)₃' (but molarity must be correct, in next mark, for ,e.g., Al₂(SO₄)₃). <p>IGNORE temperature any other label on salt bridge</p>
(ii)	<p>FIRST CHECK ANSWER ON ANSWER LINE Answer = - 1.68 V award 2 marks</p> $\frac{RT}{nF} \ln 0.1 = 8.314 \times 298 \times (-2.3) / 3 \times 9.65 \times 10^4$ $= -0.02 \text{ } (-0.0197) \text{ (V) } \checkmark$ $E = -1.66 - 0.02 = -1.68 \text{ V } \checkmark$	2	
	Total	14	

Summary of updates

Date	Version	Change
January 2019	2.0	Minor accessibility changes to the paper: i) Additional answer lines linked to Level of Response questions ii) One addition to the rubric clarifying the general rule that working should be shown for any calculation questions

BLANK PAGE

SPECIMEN

BLANK PAGE

SPECIMEN

BLANK PAGE

SPECIMEN