

**OXFORD CAMBRIDGE AND RSA EXAMINATIONS
A LEVEL**

H433/02

CHEMISTRY B (SALTERS)

Scientific literacy in chemistry

MONDAY 19 JUNE 2017: Morning

**TIME ALLOWED: 2 hours 15 minutes
plus your additional time allowance**

MODIFIED ENLARGED

First name		Last name	
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Centre number						Candidate number				
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YOU MUST HAVE:

the Insert

the Data Sheet for Chemistry B (Salters)

(sent with general stationery)

Loose Sheet for Question 3(d)

YOU MAY USE:

a scientific or graphical calculator

READ INSTRUCTIONS OVERLEAF



INSTRUCTIONS

Use black ink. You may use an HB pencil for graphs and diagrams.

Complete the boxes on the front page with your name, centre number and candidate number.

Answer ALL the questions.

Write your answer to each question in the space provided. If additional space is required, use the lined page(s) at the end of this booklet. The question number(s) must be clearly shown.

INFORMATION

The total mark for this paper is 100.

The marks for each question are shown in brackets [].

Quality of extended responses will be assessed in questions marked with an asterisk (*).

Answer ALL the questions.

1 Sodium ethanoate is used as an ‘acidity regulator’ in foods.

(a) Sodium ethanoate, CH_3COONa , can be made by reacting solutions of ethanoic acid, CH_3COOH , and sodium carbonate, Na_2CO_3 , in the laboratory.

(i) Write an equation for this reaction below. [2]

(ii) Calculate the volume (in cm^3) of $0.500 \text{ mol dm}^{-3}$ Na_2CO_3 that would react with 25.0 cm^3 of $0.450 \text{ mol dm}^{-3}$ CH_3COOH .

volume of Na_2CO_3 = _____ cm^3 [2]

(b) The ethanoate ion forms an alkaline solution in water.

Write an equation to show this below. [1]

(c) Ethanoic acid is a weak acid.

$$K_a = 1.7 \times 10^{-5} \text{ mol dm}^{-3}.$$

(i) Write an equation for the reaction of ethanoic acid in water below. [1]

(ii) Calculate the pH of a $0.030 \text{ mol dm}^{-3}$ solution of ethanoic acid.

pH = _____ [2]

- (d) When sodium ethanoate is acting as an acidity regulator in food, a buffer solution is set up. This buffer involves sodium ethanoate and ethanoic acid.

Explain, with the help of an appropriate equation, how this buffer solution works when acid is added.

[3]

(e) Some students investigate buffers involving sodium ethanoate and ethanoic acid.

(i) They make a solution containing equal amounts of ethanoic acid and sodium ethanoate.

Calculate the pH of this solution.

$K_a = 1.7 \times 10^{-5} \text{ mol dm}^{-3}$ for ethanoic acid.

pH = _____ [1]

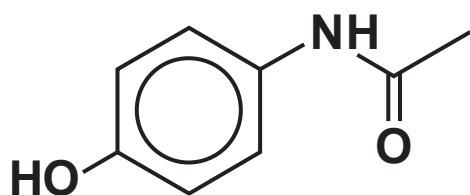
- (ii) The students then set out to make a buffer solution of a known pH. They have 25.0 cm^3 of a 0.100 mol dm^{-3} solution of ethanoic acid.

Calculate the mass of sodium ethanoate they need to add to the acid solution to make a solution of $\text{pH} = 5.00$.

mass of sodium ethanoate = _____ g [4]

2 Paracetamol is a pain-relieving medicine.

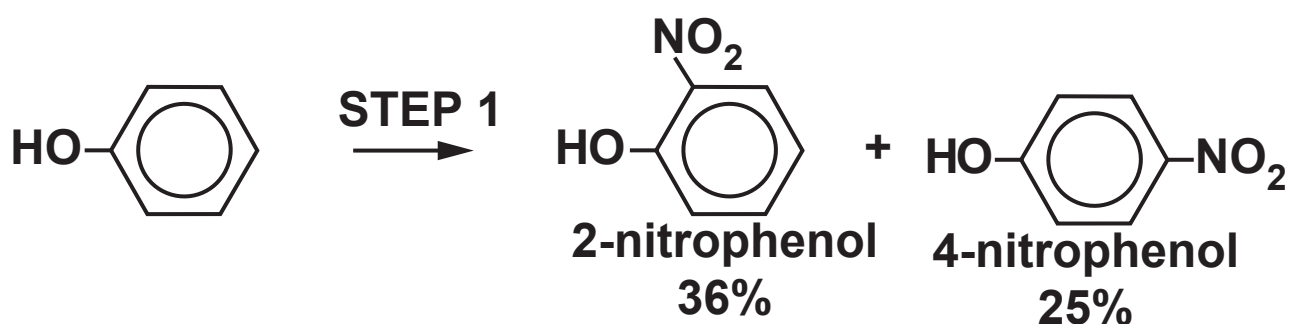
paracetamol



- (a) Name TWO functional groups in paracetamol, apart from the benzene ring.

_____ [2]

- (b) Some students set out to make paracetamol by the method shown below.



- (i) The students want to make 5.0 g of 4-nitrophenol in STEP 1.

Calculate the mass of phenol they should start with.

Give your answer to an APPROPRIATE number of significant figures.

mass of phenol = _____ g [2]

- (ii) The two nitrophenols formed can be separated since they have different boiling points. 2-nitrophenol has a lower boiling point than 4-nitrophenol. This is because internal hydrogen bonding can occur in 2-nitrophenol.

Draw the structure of 2-nitrophenol with the -OH and -NO_2 groups shown as FULL structural formulae; show where the internal hydrogen bond would form. Use the space below. [2]

- (iii) Name the **TYPE** of reaction that occurs in **STEP 2** and name the functional group that has been formed.

Type of reaction _____

Functional group formed _____

[1]

- (iv) Write an equation for the reaction in **STEP 3**.
Use the space below.
Use **SKELETAL** formulae for the organic compounds. [2]

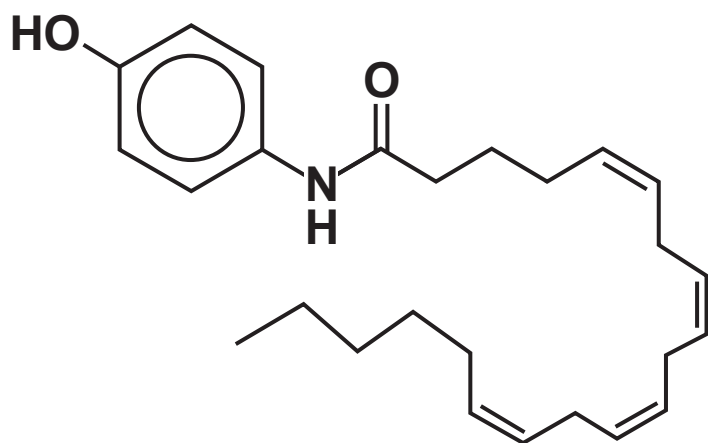
- (v) The students purify the product from STEP 3 by recrystallisation from water.

Describe the steps in the recrystallisation of a solid product from water. Indicate how insoluble and soluble impurities are removed.

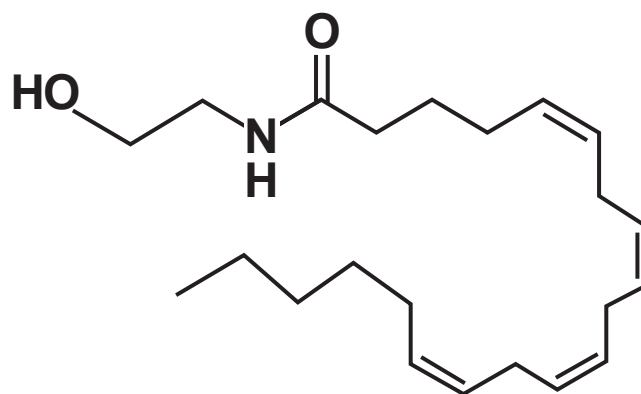
[4]

(c) Paracetamol is thought to be converted to AM404 in the body.

AM404 is thought to inhibit the enzyme-catalysed breakdown of anandamide. Anandamide reduces pain responses.



AM404



anandamide

(i) Suggest how AM404 inhibits the breakdown of anandamide.

[3]

(ii) Describe the stereochemistry of the double bonds in AM404.

[1]

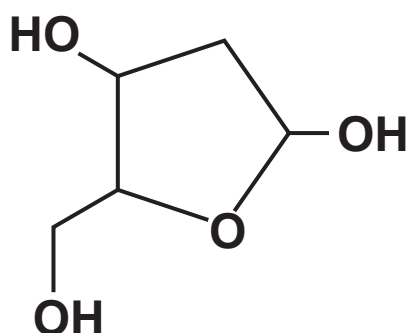
(iii) Explain how the double bonds in AM404 hold the carbon chain in shape.

[1]

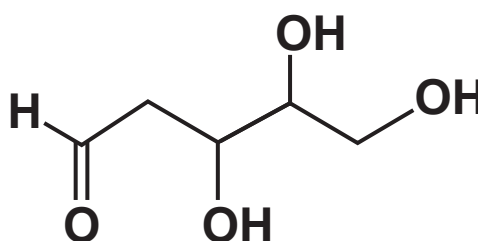
- 3 Deoxyribose, $C_5H_{10}O_4$, has a vital role in our biochemistry as a component of DNA.

Deoxyribose exists in solution as several forms, two of which are shown below.

ring form



linear form



- (a) (i) Circle ALL the chiral centres on BOTH structures above. [1]

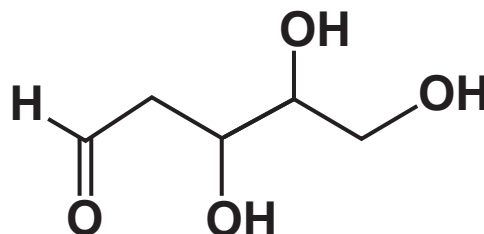
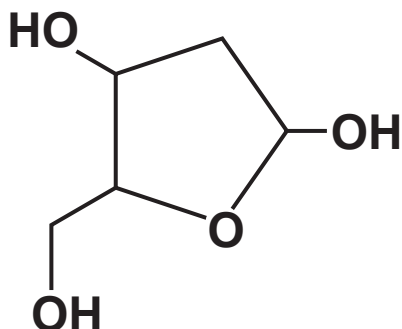
- (ii) Name the functional group that is present in the linear form only.

_____ [1]

- (iii) Describe a laboratory test for the functional group identified in (a)(ii).

_____ [2]

- (iv) Circle a primary alcohol group on each structure below, giving a reason for your choice.



Reason _____
 _____ [2]

- (v) Explain why the reaction in which the linear form changes to the ring form is NOT condensation.

 _____ [1]

- (vi) Complete the equation that shows the reaction when the linear form changes to the ring form. [1]



(b) In DNA, deoxyribose is always present as the ring form.

The primary alcohol group in the ring form of deoxyribose and the alcohol group on the adjacent carbon condense with phosphate groups.

A sugar-phosphate backbone is formed.

Draw a section of the sugar-phosphate backbone below.

Show one deoxyribose and two phosphate groups. [2]

(c) The structure of a fragment of DNA is sometimes represented by a sequence of letters, e.g. GCA. The letters stand for guanine, cytosine and adenine.

(i) What single term describes guanine, adenine and cytosine?

How and where do they attach to the sugar-phosphate backbone?

term _____

_____ **[2]**

(ii) Give the DNA sequence that would produce the CUG sequence in RNA.

_____ **[1]**

(iii) The sequence given in (c)(ii) codes for an amino acid in a protein chain.

Name the amino acid. Use the *Data Sheet* to help you.

_____ **[1]**

(iv) Explain how a sequence in DNA codes for an amino acid.

[2]

(d)* Compound B is a structural isomer of deoxyribose with the molecular formula $C_5H_{10}O_4$.

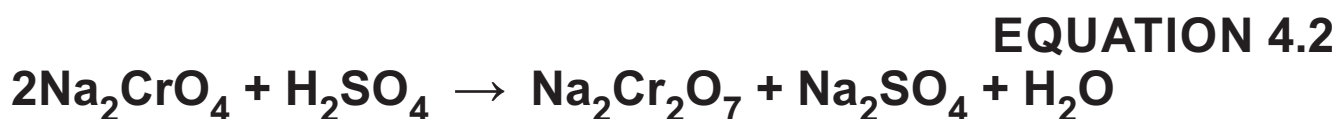
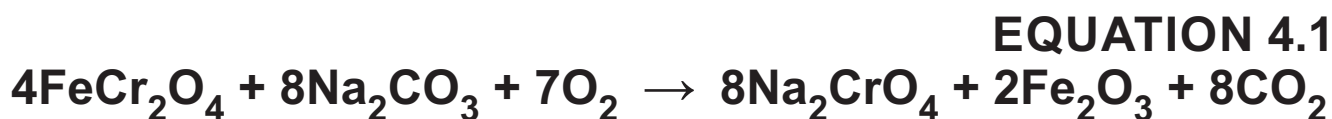
The infrared, 1H and ^{13}C NMR spectra of compound B are shown on the Loose Sheet.

Work out the structure of compound B.

Give evidence from EACH spectrum and show how it relates to the structure you have given. [6]

4 Chromium is a metal with many uses, one of which is the production of a shiny chromium plating on steel.

(a) Chromium is made from its ore chromite, FeCr_2O_4 , by the following reactions. Iron has one of its common oxidation states in chromite.



(i) Complete the table below showing the oxidation states of chromium species in the equations above.

For each equation state whether chromium has been reduced, oxidised or neither. [4]

Equation no.	Oxidation state of Cr in reactant	Oxidation state of Cr in product	Has Cr been oxidised, reduced or neither?
4.1			
4.2			
4.3			
4.4			

- (ii) Calculate the maximum mass of chromium (in kg) that could be obtained from 1000 g of chromite.

mass = _____ kg [2]

(b) Chromium plating is carried out using a solution of chromium(III) chloride with a graphite anode.

(i) Write the electron configuration of a Cr^{3+} ion, using sub-shells and atomic orbitals.

_____ **[1]**

(ii) Draw a labelled diagram below of a simple apparatus to carry out chromium plating of a steel object in a student laboratory. [3]

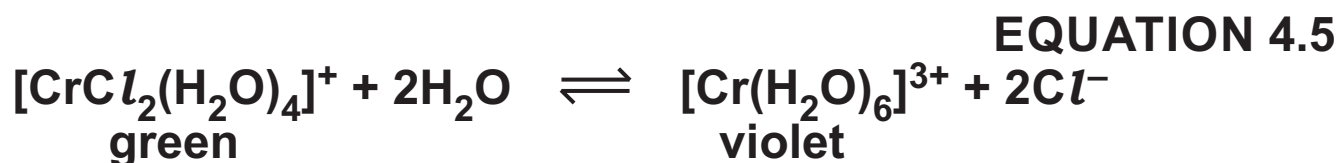
(iii) Write a half-equation below for the cathode reaction in the cell in (b)(ii). [1]

- (iv) A 'mole of electrons' is 96 500 coulombs and a coulomb is a current of 1 amp flowing for 1 second.

Calculate the time (in hours) needed to deposit 26 g of chromium at a current of 5.0 amps in the cell in (b)(ii).

time = _____ hours [3]

- (c) In a solution of chromium(III) chloride an equilibrium exists, as shown in EQUATION 4.5.



- (i) NAME the ligands in the green complex.

_____ [1]

- (ii) Some students have a violet solution of chromium(III) chloride.

Use your knowledge of equilibria to suggest and explain how they might make the violet solution turn green.

Give the NAME of any reagent required.

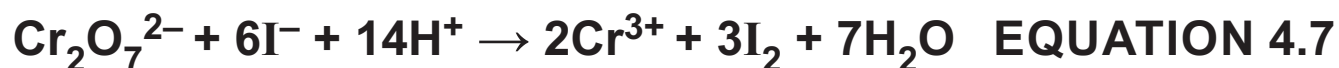
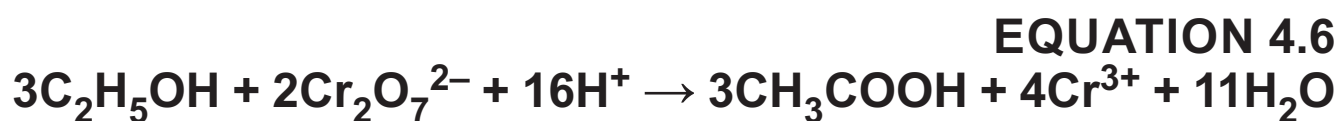
_____ [2]

(d) The concentration of an ethanol solution can be measured using the following steps.

add excess acidified dichromate, $\text{Cr}_2\text{O}_7^{2-}$, some of which reacts with the ethanol.

add excess iodide that reacts with the remaining dichromate.

titrate the iodine produced with sodium thiosulfate.



- (i) Some students add acid and 20.0 cm^3 of $0.200\text{ mol dm}^{-3}\text{ Cr}_2\text{O}_7^{2-}$ to 25.0 cm^3 of a 'low-alcohol' beer.

They add excess iodide ions and find that the iodine produced reacts with 27.6 cm^3 of $0.100\text{ mol dm}^{-3}\text{ Na}_2\text{S}_2\text{O}_3$.

Calculate the concentration of the ethanol in the beer (in mol dm^{-3}) and then the percentage of ethanol (in g per 100 cm^3).

concentration of ethanol = _____ mol dm^{-3}

% ethanol = _____ g/100 cm^3 [6]

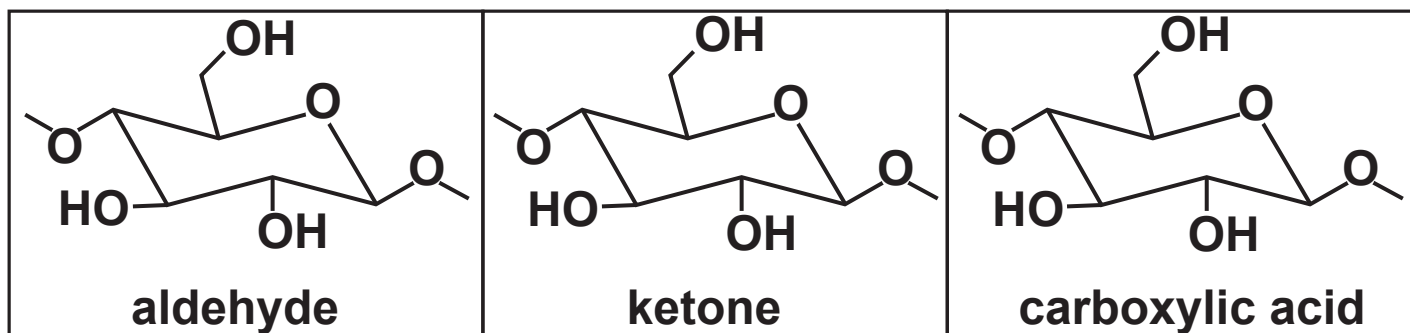
- (ii) Suggest one assumption the students have to make when giving their result.

[1]

- 5 This question is based on the article **SAVING PAPER** from 'Education in Chemistry', March 2013, published by the Royal Society of Chemistry which comes as an insert with this paper.

(a) The article says that hydroxyl groups in cellulose can be oxidised to aldehydes, ketones and carboxylic acids. The structures below each show part of a cellulose chain.

On each chain, **CIRCLE** the hydroxyl group(s) that can be oxidised to give the named group. [3]



(b) (i)* Lignin contains chromophores that absorb in the uv, whereas the decomposition products look yellow.

Explain what affects the frequency of radiation absorbed and why the decomposition products look yellow.

[illegible]

- (ii) Calculate the energy (in kJ mol^{-1}) that corresponds to a wavelength of 350 nm absorbed by lignin.
(1 nm = 10^{-9} m)

energy = _____ kJ mol^{-1} [3]

- (c) (i) What is acting as the acid in the equation shown below?



_____ [1]

- (ii) Draw a diagram to illustrate the shape of the $[\text{Al}(\text{OH})(\text{H}_2\text{O})_5]^{2+}$ ion, naming the shape.

name of shape _____ [2]

(d) The article gives two equations for the 'Fenton mechanism'.

Give the overall equation represented by the two equations.

Explain why the two equations alone do not show that Fe^{2+} is acting as a catalyst.

Overall equation:

Explanation: _____

_____ [2]

- (e) The article describes several methods of neutralising the acidity in paper.
One of these is 'washing in a bath of mild alkali'.

Describe TWO OTHER methods given in the article.

Write equations where appropriate.

[3]

END OF QUESTION PAPER

ADDITIONAL ANSWER SPACE

If additional space is required, you should use the following lined page(s). The question number(s) must be clearly shown in the margin(s).

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