OXFORD CAMBRIDGE AND RSA EXAMINATIONS
AS GCE

F332/01/TEST

CHEMISTRY B (SALTERS)

Chemistry of Natural Resources

TUESDAY 3 JUNE 2014: Afternoon
DURATION: 1 hour 45 minutes
plus your additional time allowance

MODIFIED ENLARGED

Candidate forename		Candidate surname	

Centre number						Candidate number				

Candidates answer on the Question Paper.

OCR SUPPLIED MATERIALS:

Data Sheet for Chemistry B (Salters) (inserted)
Advance Notice: 'Chemistry of Wine' (inserted)

OTHER MATERIALS REQUIRED:

Scientific calculator

READ INSTRUCTIONS OVERLEAF

DC (NH/SW) 4014137838 96736

INSTRUCTIONS TO CANDIDATES

The Inserts will be found inside this document.

Write your name, centre number and candidate number in the boxes on the first page. Please write clearly and in capital letters.

Use black ink. HB pencil may be used for graphs and diagrams only.

Answer ALL the questions.

Read each question carefully. Make sure you know what you have to do before starting your answer.

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

INFORMATION FOR CANDIDATES

The number of marks is given in brackets [ ] at the end of each question or part question.

The total number of marks for this paper is 100.

Where you see this icon you will be awarded marks for the quality of written communication in your answer.

This means for example you should:

ensure that text is legible and that spelling, punctuation and grammar are accurate so that meaning is clear;

organise information clearly and coherently, using specialist vocabulary when appropriate.

You may use a scientific calculator.

The insert 'Chemistry of Wine' is provided for use with Question 5.

A copy of the Data Sheet for Chemistry B (Salters) is provided as an insert with this question paper.

You are advised to show all the steps in any calculations.

Any blank pages are indicated.

Answer ALL the questions.

1 Iodine can be extracted from the ash of burnt seaweed. The ash is washed with water. The remaining solid is heated with manganese(IV) oxide and concentrated sulfuric acid, forming iodine.

EQUATION 1.1

$$2I^- + MnO_2 + 4H^+ \rightarrow Mn^{2+} + 2H_2O + I_2$$

(a) Complete the table below to show the oxidation states for manganese and iodine in the reaction shown in EQUATION 1.1.

Element	Initial oxidation state	Final oxidation state
Mn		
I		

[2]

(b) Write the half-equation for the conversion of iodide ions to iodine.

→

[1]

(c) NAME the reducing agent in the reaction in EQUATION 1.1.

Explain your answer in terms of oxidation states.

_____

_____ **[2]**

(d) Describe the appearance and physical state of iodine at room temperature.

_____

_____ **[1]**

(e) Give ONE use for compounds of the iodine that is produced.

_____

_____ **[1]**

(f) A student extracts iodine from seaweed ash. The student suspects that the water which has been used to wash the ash contains a mixture of salts, including sodium chloride.

The student tests this water to see if it contains chloride ions.

(i) What reagent would the student need to add to the water?

_____

_____ **[1]**

(ii) Give the result of the test for chloride ions and name the compound formed.

_____

_____ **[2]**

(iii) Suggest why the student might not get the expected test result.

_____

_____

_____ **[2]**

(g) Iodine and chlorine are both members of the halogen group.

(i) Write the electron configuration for a chlorine atom in terms of s and p sub-shells.

_____ **[1]**

(ii) Write the electron configuration for the highest energy sub-shell for an iodine atom.

_____ **[1]**

(iii) Chlorine is more readily reduced than iodine.

Explain what is meant by *reduction* in terms of electrons.

_____

_____ **[1]**

(h) The student collected 0.92 g of impure iodine, I_2, and decided to determine its purity.

The student dissolved the impure iodine in potassium iodide solution. This iodine solution was then titrated with sodium thiosulfate solution. The equation for the reaction is shown below.

EQUATION 1.2

$$I_2(aq) + 2S_2O_3^{2-}(aq) \rightarrow S_4O_6^{2-}(aq) + 2I^-(aq)$$

(i) The titration required 28.40 cm^3 of 0.200 mol dm^{-3} sodium thiosulfate solution.

Calculate the number of moles of thiosulfate ions, $S_2O_3^{2-}$, used.

moles thiosulfate = _____ mol [1]

(ii) Give the number of moles of iodine, I_2, in the iodine solution.

moles iodine = _____ mol [1]

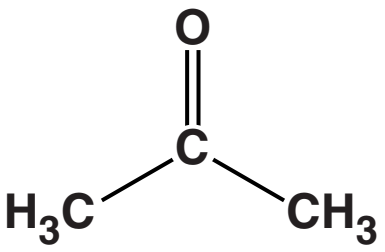
(iii) Calculate the percentage purity of the iodine.

purity of iodine = _____ % [2]

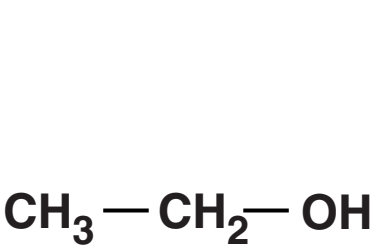
[TOTAL: 19]

2 The structures of some common organic solvents are shown below.

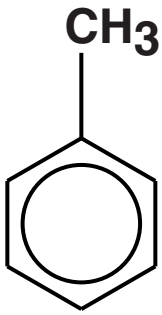
propanone



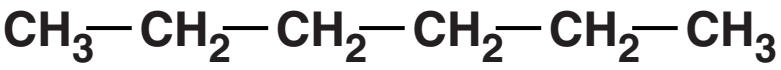
ethanol



methylbenzene



hexane



(a) Propanone can be made by the oxidation of an alcohol.

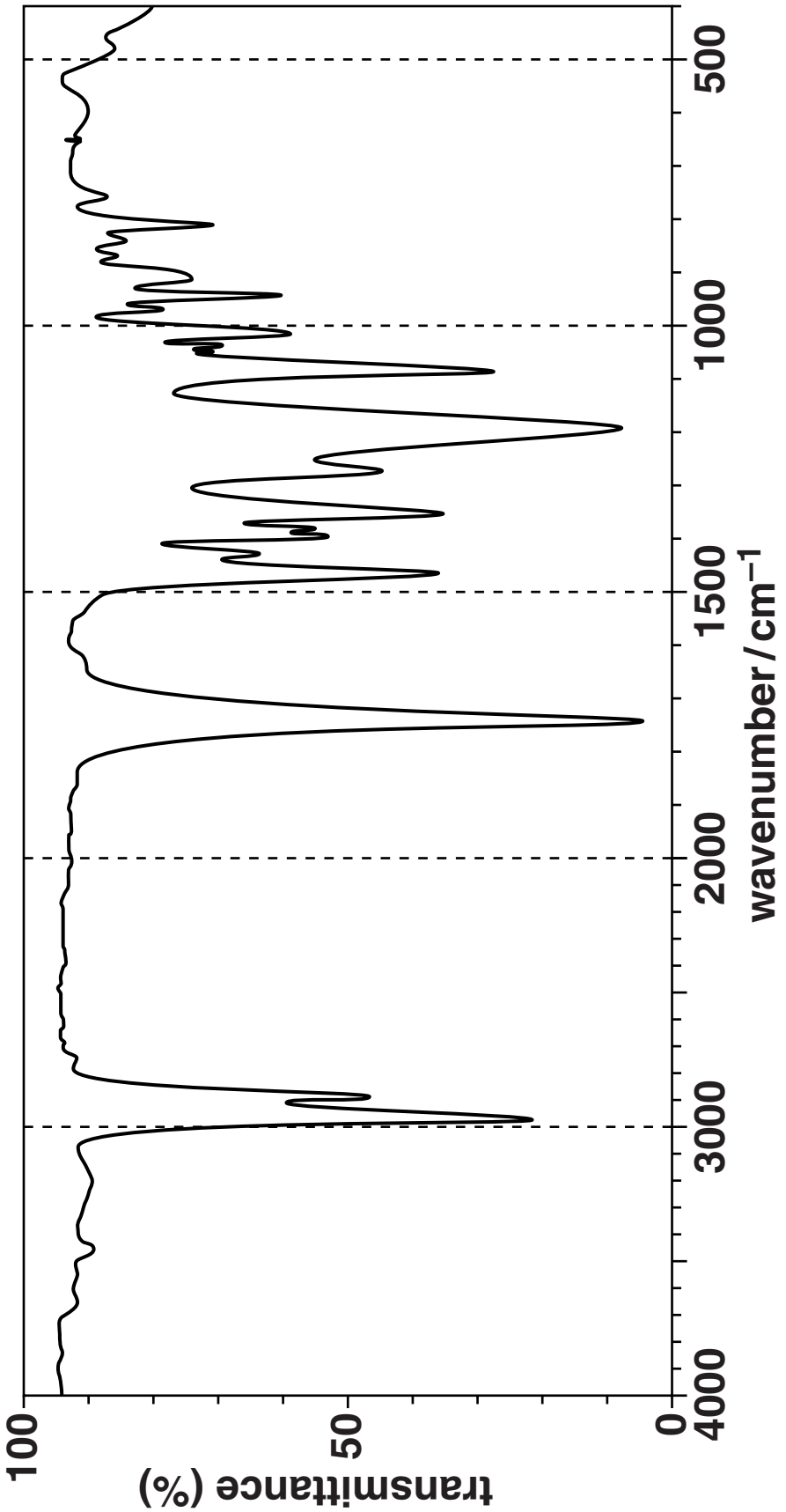
(i) NAME the alcohol from which propanone can be made.

_____ **[1]**

(ii) A student carries out the oxidation of ETHANOL, which can form two different oxidation products. The infrared spectrum of the compound the student obtained is given opposite.

Use the spectrum to identify the compound formed.

_____ **[1]**


transmittance (%)
100
50
0
4000
3000
2000
1500
1000
500
wavenumber / cm−1

(iii) Explain how the spectrum in (ii) shows that no ethanol remains.

_____

_____

_____ **[2]**

(b) Ethanol can be made from ethene in an industrial process.

Give the reagents and conditions required for this reaction.

_____

_____

_____ **[3]**

(c) Propanone dissolves in ethanol and methylbenzene dissolves in hexane.

Name the strongest type of intermolecular bond formed between:

propanone and ethanol

methylbenzene and hexane.

Explain how the intermolecular bonds you have named are produced.

In your answer, you should make it clear how the properties of the molecules you have described result in an intermolecular bond being formed.

_____

_____

_____

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_____

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_____

_____ **[7]**

(d) Another common solvent, ethyl ethanoate, can be made by reacting ethanol with ethanoic acid, as shown in the equation below.

EQUATION 2.1 $CH_3CH_2OH + CH_3COOH \rightleftharpoons CH_3COOCH_2CH_3 + H_2O$

(i) The reaction in EQUATION 2.1 is allowed to reach dynamic equilibrium.

Explain what is meant by the term *dynamic equilibrium*.

_____

_____

_____

_____ **[2]**

(ii) Some ethanoic acid is added to the equilibrium mixture. The mixture is allowed to reach equilibrium again.

Describe the effect on the amount of ethyl ethanoate formed.

Use le Chatelier's principle to explain this effect.

_____

_____

_____ **[2]**

[TOTAL: 18]

3 The halogenoalkanes CBr_4, CF_3Cl and $CBrClF_2$ have been used in fire extinguishers.

(a) CF_3Cl is a chlorofluorocarbon.

(i) Give the systematic name for CF_3Cl.

_____ **[1]**

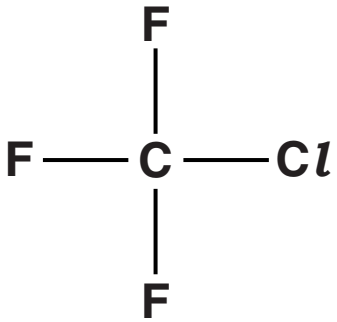
(ii) Draw a 3D diagram to show the shape of a CF_3Cl molecule.

Include the bond angle.

[2]

(iii) The molecules of CF_3Cl, contain polar bonds.

Mark ALL the partial charges on the atoms in the diagram of the CF_3Cl molecule shown below.



[1]

(iv) Explain why the molecule CF_3Cl has the partial charges you have shown in (iii).

In your answer, you should use appropriate technical terms, spelled correctly.

_____

_____

_____

_____ **[2]**

(v) Explain whether or not the molecule of CF_3Cl is polar.

_____

_____

_____

_____ **[2]**

(b) When a different halogenoalkane, $CBrCl F_2$, is exposed to high temperatures in a fire, one of the bonds in the molecule breaks.

Suggest which bond is most likely to break.

_____ **[1]**

(c) When CBr_4 vapour gets into the Earth's atmosphere, a C–Br bond can be broken by UV radiation from the Sun.

(i) Name the TYPE of bond breaking that occurs.

Explain what happens during this process.

_____

_____

_____ **[2]**

(ii) The minimum frequency of radiation needed to break one C–Br bond is 7.14×10^{14} Hz.

Calculate the minimum energy, in J, required to break one C–Br bond.

Planck constant, $h = 6.63 \times 10^{-34}$ J Hz^{-1}

minimum energy = _____ **J [2]**

(iii) Calculate the bond enthalpy of the C–Br bond, in kJ mol^{-1}.

Give your answer to THREE significant figures.

Avogadro constant, $N_A = 6.02 \times 10^{23}$ mol^{-1}

bond enthalpy = + _____ kJ mol^{-1} [3]

(d) The production of $CBrCl F_2$ has been banned in most countries since 1994 because it contributes to ozone depletion.

Describe the theoretical work and research that led to the discovery of ozone depletion in the stratosphere and why the evidence was originally overlooked.

_____

_____

_____

_____

_____

_____

_____ **[3]**

(e) Some halogenoalkanes also contribute to global warming.

(i) Explain how an increase in the concentration of a greenhouse gas leads to an enhanced greenhouse effect.

_____

_____

_____

_____ **[2]**

(ii) Describe the evidence for the relationship between the increased concentration of greenhouse gases and global warming.

_____

_____

_____ **[1]**

[TOTAL: 22]

4 Natural processes in the air can control some types of atmospheric pollutants, such as carbon monoxide and ozone. Although carbon monoxide emissions increased in the twentieth century, the percentage of carbon monoxide in the troposphere has remained almost constant.

(a) The increased use of cars in the twentieth century is one reason for the increase in carbon monoxide emissions.

Explain the origin of these carbon monoxide emissions.

_____

_____ **[1]**

(b) Give TWO reasons why carbon monoxide is classed as a polluting gas.

_____

_____

_____ **[2]**

(c) The reaction of carbon monoxide with hydroxyl radicals helps control atmospheric carbon monoxide concentrations. Hydroxyl radicals form by the breakdown of water molecules.

EQUATION 4.1 represents the reaction of carbon monoxide with hydroxyl radicals to produce carbon dioxide.

EQUATION 4.1 $CO + OH \rightarrow CO_2 + H$

(i) Explain what is meant by the term *radical*.

_____

_____ **[1]**

(ii) Classify the reaction represented by EQUATION 4.1 as initiation, propagation or termination.

Explain your choice.

_____

_____

_____ **[2]**

EQUATION 4.1 $CO + OH \rightarrow CO_2 + H$

(iii) Suggest why OH radicals are not produced in the TROPOSPHERE by the action of sunlight on water molecules.

_____

_____

_____ **[1]**

(iv) The reaction represented by EQUATION 4.1 has a low activation enthalpy.

Suggest why the reaction represented by EQUATION 4.1 still occurs slowly in the atmosphere.

_____

_____

_____ **[1]**

(d) The reaction represented by EQUATION 4.1 produces carbon dioxide, which is a gas at room temperature. Silicon dioxide, another Group 4 oxide, is a solid at room temperature.

Explain this difference in physical state in terms of bonding and structure.

_____

_____

_____

_____

_____

_____ **[3]**

(e) Scientists monitor the composition of the Earth's atmosphere. They have found that the concentration of carbon dioxide in dry, unpolluted tropospheric air has increased from 300 ppm in 1900 to around 380 ppm today.

(i) Calculate the percentage INCREASE in carbon dioxide in the air between 1900 and the present day. Take the present day value to be 380 ppm.

increase in carbon dioxide concentration =

_____ % [1]

(ii) A sample of air is analysed and found to contain 1.20×10^{-5}% carbon monoxide by volume.

How much more abundant is carbon dioxide than carbon monoxide in this sample of air? Take the value for carbon dioxide to be 380 ppm.

carbon dioxide concentration =

_____ times more [2]

(f) Tropospheric ozone is a pollutant, but the presence of ozone in the stratosphere is important to humans.

(i) Give one problem caused by TROPOSPHERIC ozone and one benefit to humans of STRATOSPHERIC ozone.

problem caused by tropospheric ozone

_____

_____

_____

benefit of stratospheric ozone

_____

_____

_____

_____

[2]

(ii) Describe ONE NATURAL process that causes ozone to be BROKEN DOWN in the stratosphere.

_____

_____

_____

_____ **[2]**

(iii) Describe ONE NATURAL process that causes ozone to be FORMED from O_2 in the stratosphere.

_____

_____

_____

_____

_____

_____

_____

_____ **[3]**

[TOTAL: 21]

5 This question is based on the Advance Notice article 'CHEMISTRY OF WINE' which is provided as an insert to this paper.

(a) During wine production, ethanol forms from sugars in grape juice. If the wine is left open to the air, the ethanol reacts with oxygen and the taste of the wine becomes sharp and acidic.

Suggest the name of the organic compound that gives the wine this sharp taste.

_____ **[1]**

(b) Box 1 in the article shows the structures of molecules that can make wine undrinkable because it is 'corked'.

(i) Give the molecular formula of oct-1-en-3-one.

_____ **[2]**

(ii) Name the TWO functional groups in oct-1-en-3-one.

_____

_____ **[2]**

(iii) Draw a circle around the term from the list below which describes the type of reaction that occurs when oct-1-en-3-ol is converted to oct-1-en-3-one.

addition

dehydration

redox

substitution

[1]

(iv) Name a functional group, other than arene, that is in molecules of both 2,4,6-trichloroanisole and 2-methoxyphenol.

_____ **[1]**

(c) Fig. 1 in the article shows some of the organic compounds found in grape juice.

(i) Retinol can exhibit *E*/*Z* isomerism. One part of the molecule responsible for this isomerism is the structure around the C=C nearest to the OH group.

One isomer is shown in Fig. 1.

Draw the skeletal formula of the other isomer caused by this C=C bond.

[2]

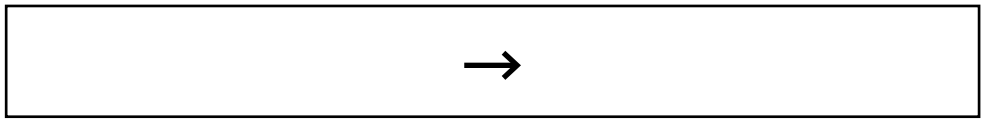
(ii) Retinol reacts with bromine at room temperature and pressure.

Describe the colour change when retinol reacts with liquid bromine.

_____ **[1]**

(iii) **Write the equation for the reaction of retinol with excess bromine.**

Represent retinol by its molecular formula, $C_{20}H_{30}O$.



[2]

(iv) **Fig. 1 in the article shows some of the compounds found in grape juice.**

Give TWO compounds in Fig. 1 that contain a PRIMARY alcohol group.

_____

_____ **[2]**

(d) **During the manufacture of wines, chemical processes often take place that improve their flavour. The article refers to TWO such processes.**

Describe, for each process, the reaction that occurs.

Comment on how the taste of the wine is affected.

In your answer, you should link the change in taste of the wine to the chemical process involved.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____ **[6]**

[TOTAL: 20]

END OF QUESTION PAPER

ADDITIONAL ANSWER SPACE

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

ADDITIONAL ANSWER SPACE

ADDITIONAL ANSWER SPACE

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