OCR
RECOGNISING ACHIEVEMENT

ADVANCED SUBSIDIARY GCE

CHEMISTRY B (SALTERS)

Chemistry of Natural Resources

F332/TEST

Candidates answer on the question paper.

OCR supplied materials:
- *Data Sheet for Chemistry B (Salters)* (inserted)
- *Advance Notice: 'Polymers on the move'* (inserted)

Other materials required:
- Scientific Calculator

Friday 27 May 2011
Afternoon

Duration: 1 hour 45 minutes

* F 3 3 2 T E S T *

* O C E / 2 6 1 9 3 *

Candidate forename		Candidate surname	

Centre number						Candidate number				

INSTRUCTIONS TO CANDIDATES

- The insert will be found in the centre of this document.
- Write your name, centre number and candidate number in the boxes above. Please write clearly and in capital letters.
- Use black ink. Pencil may be used for graphs and diagrams only.
- 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.
- Answer **all** the questions.
- Do **not** write in the bar codes.

INFORMATION FOR CANDIDATES

- The number of marks is given in brackets **[ ]** at the end of each question or part question.
- 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 *'Polymers on the move'* 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.
- The total number of marks for this paper is **100**.
- This document consists of **20** pages. Any blank pages are indicated.

Answer **all** the questions.

1 In 2008, many people in Zimbabwe died because of a cholera epidemic, caused largely by a lack of water treatment.

(a) It is possible to stop the spread of diseases like cholera by treating water with chlorine. The chlorine forms chloric(I) acid, HC*l*O, and hydrochloric acid, HC*l*, when it reacts with the water.

(i) Write the equation for this **reversible** reaction of chlorine with water.

[2]

(ii) Explain what is meant by the (I) in the name of chloric(I) acid.

..... **[1]**

(iii) Explain why adding chlorine to drinking water can stop the spread of cholera.

.....

..... **[1]**

(b) Chloric(I) acid, HC*l*O, can be produced by adding solid calcium chlorate(I), which is a salt of chloric(I) acid, to water. HC*l*O can also be formed by adding the gas chlorine dioxide, $C\mathit{l}O_2$, to water.

(i) Give the formula of calcium chlorate(I).

..... **[1]**

(ii) Chlorine dioxide reacts with water in a disproportionation reaction.

A disproportionation reaction is one in which an element is both oxidised and reduced during the reaction.

Explain why the reaction below is an example of a disproportionation reaction. Give details of the oxidation states involved.

$$4C\mathit{l}O_2 + 2H_2O \rightarrow HC\mathit{l}O + 3HC\mathit{l}O_3$$

.....

.....

.....

.....

.....

..... **[3]**

(iii) Suggest **two** reasons why it may be preferable to use calcium chlorate(I) rather than chlorine for treating drinking water.

.....

.....

..... **[2]**

(c) A student decides to analyse some swimming pool water to find the amount of chlorine it contains. The student takes a 250 cm^3 sample of the water and treats it with an excess of potassium iodide solution.

$$Cl_2(aq) + 2I^-(aq) \longrightarrow I_2(aq) + 2Cl^-(aq) \qquad \textbf{equation 1.1}$$

(i) Write the half-equation for the conversion of iodide ions to iodine in the process shown by **equation 1.1**.

$\longrightarrow$ **[2]**

(ii) The student titrates the treated sample with sodium thiosulfate solution to find out how much iodine has formed. The equation for the reaction is shown below.

$$I_2(aq) + 2S_2O_3^{2-}(aq) \longrightarrow S_4O_6^{2-}(aq) + 2I^-(aq) \qquad \textbf{equation 1.2}$$

The titration requires 12.30 cm^3 of 0.00100 mol dm^{-3} sodium thiosulfate solution.

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

moles $S_2O_3^{2-}$ = ...mol **[1]**

(iii) Give the number of moles of iodine, I_2, in the 250 cm^3 sample of treated water, using your answer to **(ii)** and **equation 1.2**.

moles I_2 = ...mol **[1]**

(iv) Calculate the concentration of the Cl_2 in the original swimming pool water sample, in mol dm^{-3}.

Give your answer to **two** significant figures.

concentration Cl_2 = ... mol dm^{-3} **[3]**

(d) Give the outer sub-shell structure of an iodide ion.

[2]

(e) Give **one** use for chlorine other than water treatment.

..... **[1]**

[Total: 20]

BLANK PAGE

PLEASE TURN OVER FOR QUESTIONS 2, 3, 4 AND 5

PLEASE DO NOT WRITE ON THIS PAGE

2 Many gases can pollute our troposphere, including ozone and oxides of nitrogen.

(a) Oxides of nitrogen are involved in the production of ozone, as shown in the equations below.

$NO(g) + ½\ O_2(g) \rightarrow NO_2(g)$ **equation 2.1**
$NO_2(g) \rightarrow NO(g) + O(g)$ **equation 2.2**
$O_2(g) + O(g) \rightarrow O_3(g)$ **equation 2.3**

(i) Write the overall equation for the reaction sequence shown in **equations 2.1** to **2.3**.

$\rightarrow$ **[1]**

(ii) Identify the catalyst involved in this series of reactions. Explain your choice.

.....

..... **[2]**

(iii) The chemicals taking part in these reactions are radicals. Explain what is meant by the term *radical*.

.....

..... **[1]**

(b) Ozone reacts with hydrocarbons in the troposphere to form smog. One example is the reaction of ozone with ethene to form methanal, HCHO, which is found in smog.

$O_3(g) + C_2H_4(g) \rightarrow 2HCHO(g) + ½\ O_2(g)$ **equation 2.4**

(i) Draw the full structural formula for a molecule of methanal.

[1]

(ii) Methanal can be made from methanol in a laboratory. Give the reagents and conditions required for this reaction.

.....

.....

..... **[3]**

(iii) The reaction represented by **equation 2.4** occurs at different rates in winter and summer, because of the seasonal temperature differences.

Describe and explain how the rate of a reaction varies with temperature.

In your answer, you should make it clear how the steps you describe are linked to one another.

.....

.....

.....

.....

.....

.....

..... **[3]**

(iv) The presence of ozone in the troposphere can cause other problems, apart from smog formation. Give **one** other problem associated with tropospheric ozone.

.....

..... **[1]**

(c) The presence of ozone in the stratosphere is important to humans.

Describe and explain:

- why the presence of ozone in the stratosphere is important to humans and
- the natural processes by which ozone is formed in the stratosphere.

In your answer, you should make it clear how the steps you describe are linked to one another.

.....

.....

.....

.....

.....

.....

.....

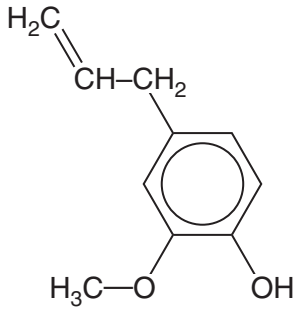
.....

.....

..... **[7]**

[Total: 19]

3 Eugenol is a liquid that can be extracted from some spices. Eugenol is used by dentists as a painkiller.



eugenol

(a) Name **two** functional groups, other than a benzene ring, which are present in eugenol.

.....

.....

..... **[2]**

(b) Describe the colour change you would see when bromine water is added to eugenol.

.....

..... **[2]**

(c) Eugenol is only slightly soluble in water.

(i) Name the type of intermolecular bond present between molecules of water. Explain how these intermolecular bonds form.

.....

.....

.....

..... **[3]**

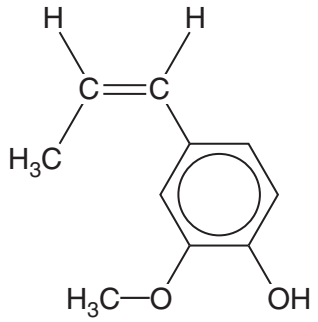
(ii) Explain, using ideas of intermolecular bonds, why eugenol is only slightly soluble in water.

.....

.....

..... **[1]**

(d) Eugenol can be converted into isoeugenol.



isoeugenol

(i) Explain why isoeugenol can exist as two *E/Z* isomers.

.....

.....

..... **[2]**

(ii) Isoeugenol reacts with hydrogen by an addition reaction. Give the conditions that are required for this reaction.

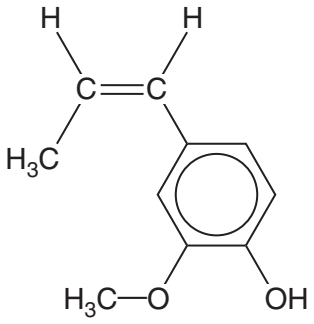
.....

..... **[2]**

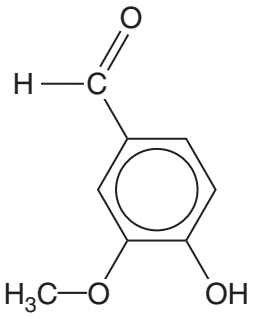
(iii) Under certain conditions, isoeugenol reacts with water by an addition reaction. Draw the structures of the two isomeric products that could form.

[2]

(e) Isoeugenol can be converted to vanillin, which is used as a food flavouring.



isoeugenol



vanillin

(i) Name the functional group that is present in vanillin but not in isoeugenol.

..... **[1]**

(ii) This functional group can be identified by infrared spectroscopy. State the wavenumber range of the peak that it would give.

..... **[1]**

(iii) Explain what is meant by the *fingerprint region* in an infrared spectrum and explain the significance of the fingerprint region.

.....

.....

.....

..... **[2]**

[Total: 18]

4 Methanol is manufactured from carbon monoxide and hydrogen. It is used as a fuel and for making chloroalkanes.

(a) The carbon monoxide and hydrogen for making methanol can be produced by reacting the carbon in coke with steam.

$$C(s) + H_2O(g) \longrightarrow CO(g) + H_2(g) \qquad \textbf{equation 4.1}$$

Draw a '*dot-and-cross*' diagram to represent the bonding in a molecule of carbon monoxide. The molecule contains a dative covalent bond.

[2]

(b) In order to obtain the correct ratio of carbon monoxide to hydrogen for the next stage of the process, some of the carbon monoxide is reacted with more steam, forming carbon dioxide and hydrogen.

(i) Write the equation for the reaction between the carbon monoxide and steam. Include state symbols.

$\longrightarrow$ **[1]**

(ii) The carbon dioxide produced in the reaction in **(i)** is disposed of once it has been separated from the hydrogen. Suggest **one** method for disposal of the carbon dioxide, other than releasing it straight into the atmosphere.

.....

.....

..... **[1]**

(iii) Calculate the atom economy for the production of hydrogen in **(i)**.

atom economy = ... % **[1]**

(iv) Comment on the usefulness of the reaction in **(i)**, in terms of atom economy.

.....

..... **[1]**

(c) Methanol can be made from the carbon monoxide and hydrogen.

$$CO(g) + 2H_2(g) \rightleftharpoons CH_3OH(g) \quad \Delta H = -91\,kJ\,mol^{-1} \qquad \textbf{equation 4.2}$$

(i) The reaction represented by **equation 4.2** is an example of a dynamic equilibrium.

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

.....

.....

..... **[2]**

(ii) Describe and explain the effect of the following changes on the **yield** of methanol produced in the reaction represented by **equation 4.2**.

Carrying out the reaction at a higher temperature: .....

.....

.....

.....

Increasing the total pressure of the reaction system: .....

.....

.....

.....

..... **[4]**

(iii) Describe **and** explain the effect that the use of a catalyst would have on the rate at which methanol is produced.

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

.....

.....

..... **[2]**

(d) Methanol can be converted into chloromethane.

(i) Give the reagent and condition required.

.....

.....

..... **[2]**

(ii) If this chloromethane gas gets into Earth's atmosphere, a C–C*l* bond can be broken by UV radiation from the Sun.

The bond enthalpy of the C–C*l* bond is +346 kJ mol^{-1}.

Calculate the minimum energy (in Joules) needed to break a **single** C–C*l* bond.

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

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

(iii) Calculate the frequency of radiation that is needed to break one C–C*l* bond.

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

frequency = ... Hz **[2]**

(iv) It has been found that halogenoalkanes have been responsible for some of the ozone depletion in the stratosphere.

Describe how halogenoalkanes deplete ozone and give the evidence for the ozone depletion.

.....

.....

.....

.....

.....

..... **[3]**

[Total: 23]

5 This question is based on the Advance Notice article '**Polymers on the move**' which is provided as an insert to this paper.

(a) Explain what is meant by the term *thermoplastic* used in the article to describe certain types of polymer. Give **one** example of a polymer identified in the article as being thermoplastic.

Meaning of *thermoplastic*: .....

.....

Example..... **[2]**

(b) Burning fuel for transport is one of the major sources of atmospheric carbon dioxide. Give **one** other industrial source of carbon dioxide emissions.

..... **[1]**

(c) From the 1970s, vehicle components made from metal, glass and wood have been replaced with parts made from polymer materials. Suggest **two** reasons for this, apart from cost.

.....

.....

..... **[2]**

(d) ABS is made from two different monomers. What term is used to describe a polymer that is formed from two different monomers?

..... **[1]**

(e) **(i)** Draw a diagram of the repeating unit in poly(chloroethene).

[1]

(ii) Draw a diagram of the repeating unit in poly(butadiene).

[1]

(f) A radical chain reaction is described in **Box 1** of the article.

(i) Name the **stage** of a radical chain reaction that is occurring in both **reaction 1** and **reaction 2**.

..... **[1]**

(ii) Name the stage that causes a radical chain reaction to start.

..... **[1]**

(g) The phrase "*because they can't get a chemical 'grab' on the unreactive surfaces*" is used in **Box 1** to explain why some adhesives are ineffective on poly(ethene).

(i) Explain, in terms of intermolecular bonds, what is meant by this phrase.

.....

..... **[1]**

(ii) Name the strongest type of intermolecular bonds that can form between chains of poly(ethene).

..... **[1]**

(h) Explain why polyurethanes are classed as **addition** polymers.

.....

..... **[1]**

(i) One method that is described for dealing with waste polyurethane foam is to '*recover some of the energy by burning it in an incinerator*'.

(i) Suggest how this could '*recover some of the energy*'.

.....

..... **[1]**

(ii) Name **two** gases that could be produced when waste polyurethane foam is burnt.

Explain why each of these gases is described as '*not particularly environmentally friendly*'.

.....

.....

.....

.....

.....

..... **[4]**

(j) Information about the two polymers below is given in **Table 1** of the article.

Choose **one** property of each polymer and explain how the property is linked to the use of the polymer.

Poly(propene)

Property: .....

Link between property and use: .....

.....

Poly(chloroethene)

Property: .....

Link between property and use: .....

..... **[2]**

[Total: 20]

END OF QUESTION PAPER

ADDITIONAL PAGE

If additional space is required, you should use the lined pages below. The question number(s) must be clearly shown.

ADDITIONAL PAGE

ADDITIONAL PAGE