OCR
Oxford Cambridge and RSA

Friday 9 June 2017 – Afternoon

AS GCE CHEMISTRY B (SALTERS)

F332/01/TEST Chemistry of Natural Resources

Candidates answer on the Question Paper.

OCR supplied materials:
- *Data Sheet for Chemistry B (Salters)* (inserted)
- *Advance Notice: 'Homogeneous catalysts'* (inserted)

Other materials required:
- Scientific calculator

Duration: 1 hour 45 minutes

* F 3 3 2 0 1 *

* 6 7 6 5 8 8 3 3 4 6 *

Candidate forename		Candidate surname	

Centre number						Candidate number				

INSTRUCTIONS TO CANDIDATES

- The Inserts will be found inside this document.
- Write your name, centre number and candidate number in the boxes above. 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 page(s) at the end of this booklet. The question number(s) must be clearly shown.
- Do **not** write in the barcodes.

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 'Homogenous Catalysts' 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.
- This document consists of **20** pages. Any blank pages are indicated.

Answer **all** the questions.

1 The planet Venus has a very thick atmosphere composed of 96% carbon dioxide. Venus is shrouded in thick clouds made of sulfuric acid. The high CO_2 concentrations contribute to a strong greenhouse effect that keeps the planet's surface temperature at about 460 °C.

(a) Answer the following questions about the greenhouse effect.

(i) What is the main type of radiation from the Sun that warms the Earth?

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

(ii) What radiation does the Earth emit as a result of being warmed?

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

(iii) How do carbon dioxide molecules absorb this radiation?

.....

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

(iv) How does the result of **(a)(ii)** warm the Earth's atmosphere?

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

(v) The Earth's temperature has remained roughly constant for many years. Venus's temperature has also remained constant in spite of having a much greater greenhouse effect than the Earth.

Suggest why the temperatures on Venus do not change.

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

(b) State **one** way in which humankind can reduce the amount of CO_2 **released** into the atmosphere.

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

(c) Describe the bonding in carbon dioxide in terms of covalent bonds, polar bonds and intermolecular bonds.

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

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

(d) Ultraviolet photons of frequencies greater than 1.77×10^{15} Hz can cause carbon dioxide to photodissociate into carbon monoxide and atomic oxygen.

The following sequence takes place:

$CO_2 \rightarrow CO + O$ **equation 1.1**

$SO_2 + O \rightarrow SO_3$ **equation 1.2**

$SO_3 + H_2O \rightarrow H_2SO_4$ **equation 1.3**

(i) Describe the **type** of bond-breaking that is occurring in **equation 1.1**.

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

(ii) Calculate the energy (in $kJ\,mol^{-1}$) associated with a frequency of 1.77×10^{15} Hz.

$h = 6.63 \times 10^{-34}$ JHz^{-1} $N_A = 6.02 \times 10^{23}\,mol^{-1}$

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

energy = ... $kJ\,mol^{-1}$ **[4]**

(iii) Give the oxidation states of sulfur in the compounds shown below.

SO_2 ..... SO_3 ..... H_2SO_4 ..... **[2]**

[Total: 19]

2 A deficiency of iodine in a person's diet can lead to various medical problems.
In many countries, table salt (sodium chloride) is 'iodised' by adding small amounts of either potassium iodate(V) or potassium iodide.

(a) Aqueous iodide ions react with aqueous silver nitrate.

(i) Describe what is observed and write an **ionic** equation for the reaction between iodide ions and aqueous silver nitrate, giving state symbols.

Observation .....

Ionic equation

[3]

(ii) Some students investigate a sample of iodised table salt. They realise that the reaction from **(a)(i)** will not be useful in telling whether iodide is present.

Suggest why this is so.

.....

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

(b) Suggest a more useful way of testing for the presence of iodide (as distinct from bromide) in a solution of iodised table salt.

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

(c) The students find that iodate(V) ions react with iodide ions as shown in **equation 2.1**.

$IO_3^- + 5I^- + 6H^+ \rightarrow 3I_2 + 3H_2O$ **equation 2.1**

They know their iodised table salt contains iodide ions. They add acid to a solution of their sample of iodised table salt.

What would they see if the salt also contained iodate(V) ions?

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

(d) The students dissolve 100.0 g of iodised table salt in deionised water and make the solution up to 1.00 dm^3.

They take 25.0 cm^3 portions of this solution, add excess iodide and acid, and titrate the iodine formed with sodium thiosulfate.

The reaction is shown in **equation 2.2** and the end-point is when all the iodine has been decolourised.

$$2Na_2S_2O_3 + I_2 \longrightarrow Na_2S_4O_6 + 2NaI \qquad \textbf{equation 2.2}$$

The students' average titre is 19.6 cm^3 of 1.50×10^{-4} mol dm^{-3} $Na_2S_2O_3$.

(i) Calculate the moles of I_2 formed in 25.0 cm^3 of solution.
Use **equation 2.2**.

moles I_2 = ... mol **[2]**

(ii) Use **equation 2.1** to calculate the moles of IO_3^- in 25.0 cm^3 of solution and then in 1.00 dm^3 of solution.

moles iodate(V) in 1.00 dm^3 of solution = ... mol **[2]**

(iii) Calculate the **mass** of KIO_3 in 1.00 dm^3 of solution and then the concentration of KIO_3 in parts per million (by mass) in the 100.0 g sample of table salt.

concentration of KIO_3 = ... ppm **[2]**

(e) Iodised salt containing iodide may slowly lose its iodine content over time if it is exposed to an excess of air.

Suggest why this is so.

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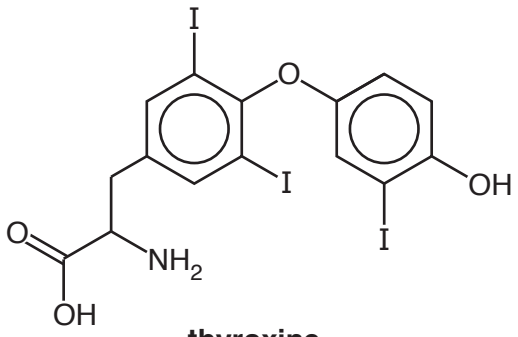
..... **[2]**

(f) Iodine is needed in the body to make the hormone thyroxine.



thyroxine

(i) Name **three** functional groups in the thyroxine molecule, apart from iodine atoms, the OH group and benzene rings.

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

(ii) State the bond angle around the nitrogen atom in the thyroxine molecule. Give reasons for your answer.

In your answer you should make it clear how your points link together.

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

[Total: 22]

3 In 2013, NASA announced that the Cassini orbiter spacecraft had discovered small amounts of naturally-occurring propene in the atmosphere of Titan, a moon of Saturn, using spectroscopy.

(a) Propene is $CH_3CH=CH_2$ and has one cyclic isomer.

(i) Give the **skeletal** formula and name of the cyclic isomer.

formula:

name: ..... **[2]**

(ii) Explain why propene does **not** have *E*/*Z* isomers.

.....

.....

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

(b) **(i)** Give the wavenumber range and bond of a peak in the infrared spectrum of propene.

wavenumber ..... bond ..... **[1]**

(ii) Explain how propene could be fully identified using its infrared spectrum.

.....

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

(c) Propene can be produced by heating C_3H_7OH vapour over an Al_2O_3 catalyst.

(i) Write an equation for this reaction, using **molecular** formulae.

[1]

(ii) Underline the **type** of reaction that is occurring in **(c)(i)**.

condensation **elimination** **hydrolysis**

[1]

(d) Propene can be converted to other compounds in the sequence shown below.

$$CH_3CH{=}CH_2 \xrightarrow[\textbf{step 1}]{HBr} \textbf{compound A} \xrightarrow[\textbf{step 2}]{NaOH} \textbf{alcohol B} \xrightarrow[\textbf{step 3}]{H^+/Cr_2O_7^{2-}} CH_3COCH_3$$

(i) Name the reaction types occurring in steps 1, 2 and 3. Use the following terms:

addition **condensation** **substitution** **oxidation**

Step 1 .....

Step 2 .....

Step 3 .....

[2]

(ii) Give the structural formula and name of compound **A**.

structural formula

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

(iii) Propene can also react with HBr to form a different compound from compound **A**.

Explain how you decided which formula to use in **(d)(i)**.

.....

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

(iv) Write the mechanism of the attack of HBr on propene to form compound **A**.

Show curly arrows and full charges.

[3]

(v) **Name** alcohol **B**.

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

(vi) What **type** of alcohol is **B**?

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

(vii) Name the **type** of carbonyl group in the product CH_3COCH_3.

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

(e) Propene polymerises to form poly(propene).

(i) What **type** of polymerisation is involved?

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

(ii) Write the **full** structural formula for the repeating unit of poly(propene).

[1]

(iii) Poly(propene) is a thermoplastic.

Explain the meaning of the term *thermoplastic*.

.....

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

[Total: 21]

4 Ethanol can be made from ethene by the reaction shown below.

$$C_2H_4(g) + H_2O(g) \rightleftharpoons C_2H_5OH(g) \quad \Delta H = -54\,kJ\,mol^{-1}$$

(a) The reaction is carried out at a high temperature.

Describe and explain the effect of raising the temperature on the rate of achievement of equilibrium and the equilibrium yield.

In your answer you should make it clear how your points link together.

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

(b) **(i)** Describe and explain the effect of pressure on the equilibrium yield.

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

(ii) Name **two** other factors that would affect the choice of pressure in industry.

1 .....

2 ..... **[1]**

(c) Ethanol can be oxidised by acidified dichromate(VI) either to ethanal, CH_3CHO, or to ethanoic acid, CH_3COOH.

(i) State the conditions that are needed to get each product.

conditions for ethanal .....

conditions for ethanoic acid .....

[2]

(ii) Draw the **full** structural formulae of ethanol, ethanal and ethanoic acid.

ethanol	ethanal	ethanoic acid

[2]

(iii) Name **all** the intermolecular bonds in ethanol.
Explain, by labelling a diagram, how the strongest of these bonds form.

Names of intermolecular bonds .....

.....

Labelled diagram of strongest intermolecular bond

[4]

(iv) Explain why ethanal has a lower boiling point than either ethanol or ethanoic acid.

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

[Total: 18]

5 This question is based on the Advance Notice article, **'Homogeneous catalysts'**.

(a) Give an example from the article where the reactants and the homogeneous catalyst are **not** dissolved in water.

.....

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

(b) Complete and balance the equations below for the two steps that occur in the catalysed reaction of 2,3–dihydroxybutanedioate ions with hydrogen peroxide.

$2Co^{2+} + H_2O_2 + 2H^+ \rightarrow$

$C_4H_4O_6^{2-} + 6Co^{3+} + 2H_2O \rightarrow 6H^+ +$

Use the two equations to write an overall equation for the reaction.

Overall equation:

[3]

(c) **(i)** Suggest why the reaction of peroxodisulfate(VI) ions and iodide ions is slow without a catalyst.

.....

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

(ii) Draw an enthalpy profile for the exothermic reaction of peroxodisulfate(VI) ions and iodide ions with an Fe^{2+} catalyst.

Label:

- the reactants and products
- the activation enthalpy of each step
- ΔH.

[4]

(iii) Fe loses its $4s^2$ electrons first when it forms cations.

Complete the electron configuration of **Fe^{3+}**.

$1s^2$ ..... **[1]**

(iv) Fe^{3+} ions can also catalyse the reaction of peroxodisulfate(VI) ions with iodide ions.

Suggest how **Fe^{3+}** ions do this.

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

(d) The article describes the way in which chlorine atoms deplete the ozone layer.

Explain why ozone in the stratosphere is important for us.

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

(e) HFCs are being used as replacements for CFCs since HFCs do not damage the ozone layer.

(i) State the meaning of the term 'HFC'.

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

(ii) Give **two** reasons why HFCs do not damage the ozone layer.

1 .....

.....

2 .....

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

(iii) Give one environmental **disadvantage** of using HFCs.

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

(f) Other radicals catalyse the breakdown of ozone. One such radical is NO.

(i) Draw a '*dot-and-cross*' diagram for NO and explain how it shows that NO is a radical.

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

(ii) Write equations to show how NO catalyses the breakdown of the ozone layer.

[1]

[Total: 20]

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).