

Tuesday 2 June 2015 – 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: 'Catalysis'* (inserted)

Other materials required:

- Scientific calculator

Duration: 1 hour 45 minutes



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 at the end of this booklet. The question number(s) must be clearly shown.
- 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.
- 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 '*Catalysis*' 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 Methanol, CH_3OH , is made industrially by the catalysed reaction between carbon monoxide and hydrogen.



- (a) People dealing with a leak during this process would need to wear protective equipment.

State **one** piece of protective equipment that would be worn **and** state why it is needed.

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

- (b) The process represented by **equation 1.1** can reach a position of dynamic equilibrium.

Explain, in terms of reaction rates and concentrations, what is meant by the term *dynamic equilibrium*.

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

- (c) The maximum equilibrium yield of methanol would be obtained by using high pressures and low temperatures.

What information given in **equation 1.1** suggests that these conditions give the maximum yield?

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

- (d) Suggest why the industrial process might not use high pressures and low temperatures.

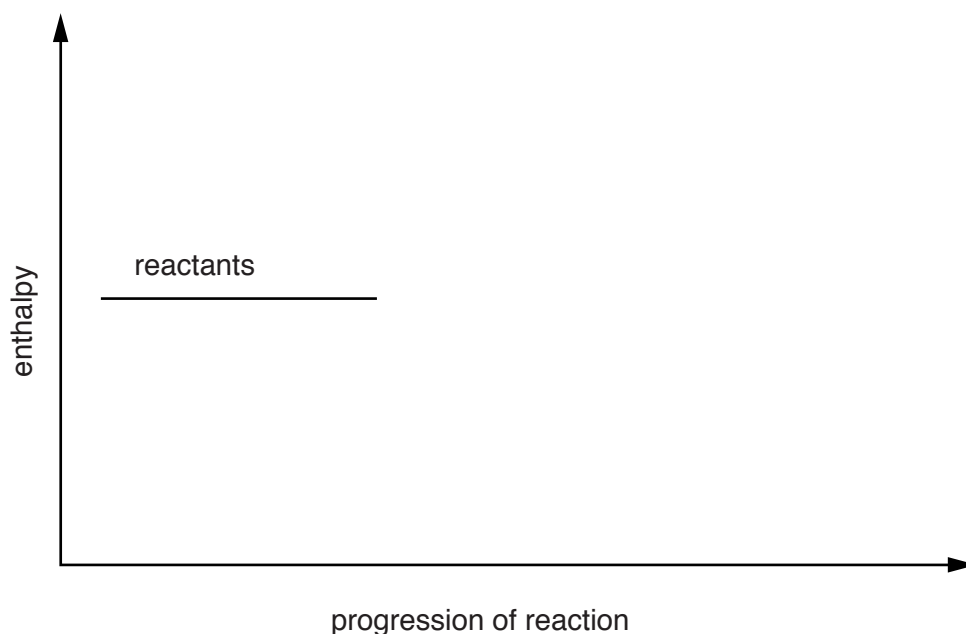
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..... [2]

(e) A catalyst of copper and zinc oxide is used in this process.

Complete the diagram below to show how a catalyst provides an alternative reaction route for an **exothermic** reaction.

Include on your diagram labels for:

- products
- enthalpy change, ΔH
- activation enthalpy for the uncatalysed route, E_a
- activation enthalpy for the catalysed route, E_c .



[3]

(f) The catalyst is coated onto an inert alumina support.

Why is the catalyst spread as a thin layer on the alumina?

.....

 [1]

- (g) Name the strongest type of intermolecular bond present between molecules of methanol.

Explain how these intermolecular bonds form.

.....

.....

.....

.....

..... [3]

- (h) Scientists producing methanol by this process can check the progress of the reaction using infrared spectroscopy.

- (i) Give the wavenumber range of **one** peak that is present in the infrared spectrum for methanol and identify the bond that produces this peak.

.....

.....

.....

..... [1]

- (ii) Give **one** use for the fingerprint region in an infrared spectrum.

.....

.....

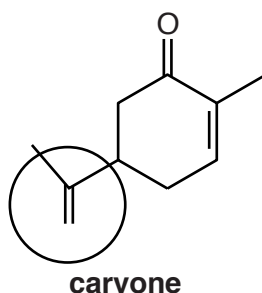
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[Total: 16]

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- 2 'Carvone' can be extracted from some mint plants. It can be used to flavour chewing gum.



- (a) Name the functional group that is circled on the diagram of the carvone molecule.

..... [1]

- (b) Carvone can be produced in a process in which the reaction mixture requires heating under reflux.

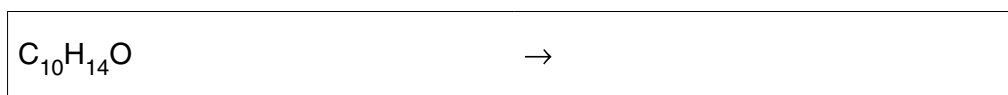
Describe the process of *heating under reflux*.

.....

 [2]

- (c) Carvone reacts with bromine at room temperature and pressure.

- (i) Write the equation for the reaction of carvone, $C_{10}H_{14}O$, with **excess** bromine.



[2]

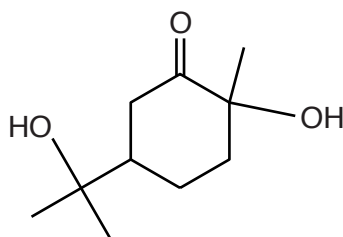
- (ii) Ethene reacts with bromine in a similar way to the reaction of carvone with bromine.

Draw the mechanism for the reaction of bromine with ethene to form an **intermediate**.

Add relevant full and partial charges and curly arrows to your diagram.

[4]

- (d) Carvone can be converted into **compound A**.



compound A

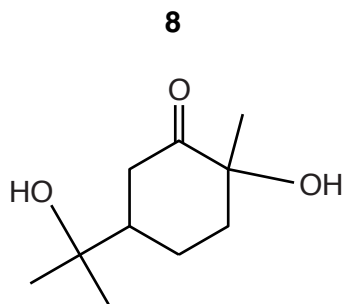
Give the reagents and conditions for the reaction to convert carvone into **compound A**.

.....
 [2]

- (e) The reaction in (d) can produce other alcohols that have the same molecular formula as **compound A** but different structural formulae.

Draw the structures of **two** of these alcohols.

[2]



compound A

(f) A student does some experiments using a sample of **compound A**.

- (i) Describe and explain what the student would **see** when **compound A** is heated with acidified potassium dichromate solution.

.....

 [2]

- (ii) The student does an elimination reaction on **compound A** to form carvone.

Explain what is meant by the term *elimination reaction*.

.....

 [2]

- (iii) After the elimination reaction, the student collects a mixture of unreacted **compound A**, carvone and a trace of water. Carvone is miscible with **compound A**.

State how the student would remove the water from the mixture and how carvone and **compound A** could be separated.

Remove trace of water

 Separate carvone and **compound A**
 [2]

[Total: 19]

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- 3 In 2013, researchers discovered a new hydrothermal vent at a site in the Caribbean. Hydrothermal vents are gaps in the sea floor where very hot water emerges, carrying large amounts of dissolved minerals.

(a) The solution around a hydrothermal vent contains calcium and sulfide ions.

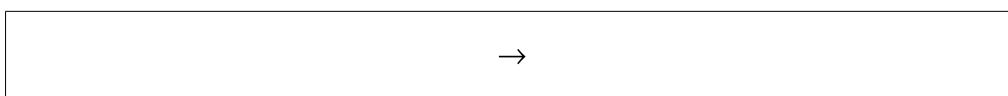
- (i) A calcium ion has the same electronic configuration as an argon atom.

Write the electronic configuration, in terms of s and p sub-shells, for a calcium ion.

..... [1]

- (ii) The calcium and sulfide ions take part in a precipitation reaction to form calcium sulfide.

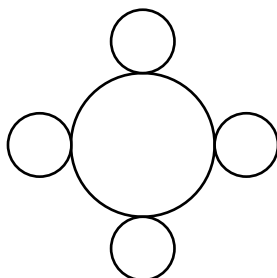
Write the ionic equation for the precipitation reaction. Include state symbols.



[2]

- (iii) Pure calcium sulfide and sodium chloride have a similar lattice structure. The diagram below shows part of a layer of the calcium sulfide lattice.

Complete the diagram by drawing enough particles to show the structure of the **layer** clearly. Label each type of particle.



[3]

(b) Seawater produced from hydrothermal vents is acidic because it contains H^+ ions. A scientist analyses a sample of the seawater by titrating 40.0 cm^3 of the seawater with sodium hydroxide, NaOH, solution.

- (i) The titration requires 15.70 cm^3 of a $0.0250\text{ mol dm}^{-3}$ solution of sodium hydroxide. Calculate the number of moles of hydroxide ions, OH^- , used.

moles = ... [1]

- (ii) Give the number of moles of H^+ ions in the 40.0 cm^3 sample of seawater.

moles = ... [1]

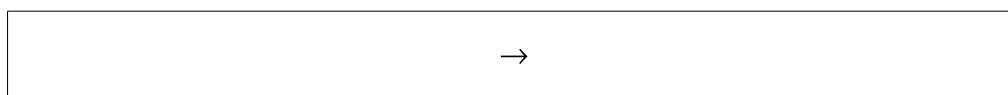
- (iii) Calculate the concentration of H^+ ions in the seawater in mol dm^{-3} .

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

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

(c) The solution around the hydrothermal vent also contains Group 1 metal ions.

- (i) Write an equation representing the first ionisation enthalpy of lithium.



[1]

- (ii) The first ionisation enthalpy of lithium is greater than that of any other Group 1 element.

Explain why.



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

.....

.....

.....

.....

..... [2]

- (d) Scientists analysed a sample of seawater collected near the hydrothermal vent. They found that the sample contained calcium ions at a concentration of 1.70%. On average, ocean water contains calcium ions at a concentration of 400 ppm.

How much more concentrated is the calcium ion in the hydrothermal vent seawater than in average ocean water?

calcium ion in hydrothermal vent water is times more concentrated [2]

- (e) Reactions that occur in seawater happen more quickly near hydrothermal vents.

Explain why.

.....

.....

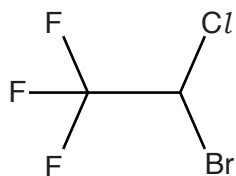
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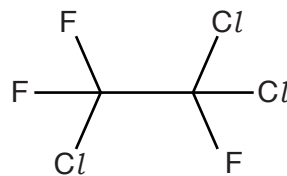
..... [3]

[Total: 19]

- 4 Halogenated organic compounds have been used in many ways. 'Fluothane' and CHCl_3 can both be used as anaesthetics. CFC-113 has been used as a refrigerant.



Fluothane



CFC-113

- (a) Give the systematic name for CFC-113.

..... [2]

- (b) When fluothane goes into the Earth's atmosphere it can be broken down by electromagnetic radiation from the Sun.

- (i) Suggest which bond in the fluothane molecule is most likely to break.

..... [1]

- (ii) Name the type of electromagnetic radiation that is emitted from the Sun that causes this bond to break.

..... [1]

- (iii) In a particular part of the Earth's atmosphere, the available radiation has a maximum frequency of $5.30 \times 10^{14} \text{ Hz}$. The weakest bond in the fluothane molecule has a bond enthalpy of $+290 \text{ kJ mol}^{-1}$.

Explain whether or not this bond will break.

Include a calculation in your answer.

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

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

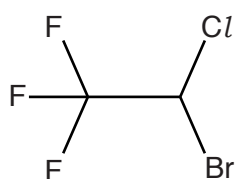
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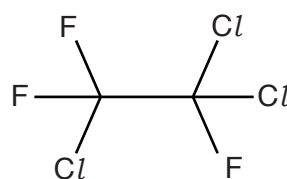
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..... [4]

- (c) Both CFC-113 and fluothane could cause ozone depletion in the stratosphere.



Fluothane



CFC-113

Suggest why CFC-113 and fluothane can cause ozone depletion and why CFC-113 has a greater ozone depletion potential than fluothane.

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..... [3]

- (d) CHCl_3 can be made industrially from a mixture of chlorine and methane.

Chlorine and methane are pollutants in the atmosphere.

Give **one** reason why each chemical is classed as a pollutant.

Chlorine

.....

Methane.....

..... [2]

- (e) Draw a 'dot-and-cross' diagram for a CHCl_3 molecule.

Show outer electron shells only.

[1]

(h) Scientists have collected evidence for the relationship between the concentration of greenhouse gases and global warming.

(i) Describe **two** different methods that scientists have used to find evidence for this relationship.

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..... [2]

(ii) Describe the relationship that scientists have worked out from this evidence.

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..... [1]

(i) Some compounds like CFC-113 have now been replaced by HFCs.

Give **one** advantage and **one** disadvantage of using HFCs in place of CFCs, other than ozone depletion potential.

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..... [2]

[Total: 26]

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

(a) The manufacture of propanone is outlined in **Table 1** of the article.

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

[1]

(ii) Name the functional group in a molecule of propanone.

..... [1]

(b) Using the information in **Fig. 1**, name the **mechanism** of the first step of the reaction that produces ethane-1,2-diol from epoxyethane.

..... [1]

(c) **Fig. 2** shows part of a reaction mechanism.

(i) Name the type of organic ion that is produced from 2-methylpropene in **Fig. 2**.

..... [1]

(ii) Give the atom economy for the overall reaction sequence shown in **Fig. 2**.

..... [1]

(d) The article describes the hydrogenation of 2,4,4-trimethylpent-2-ene using nickel as a catalyst.

Give the conditions that are required for this reaction and name another catalyst that can be used for this reaction.

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

- (e) The article describes two different methods for the production of 2,2,4-trimethylpentane from 2-methylpropene.

Give **three** differences between the two methods.

.....

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..... [3]

- (f) Some polymers are shown in **Table 2**.

Name the **polymer** that has a chain containing an arene group.

..... [1]

- (g) Some polymers are made by a reaction that involves radicals.

(i) Describe how radicals form from a molecule.

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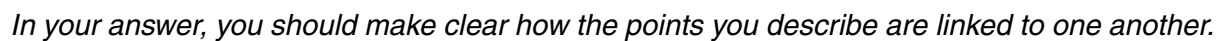
..... [1]

(ii) Write an equation for a propagation reaction in the formation of poly(propene).

[1]

In your explanation, you should include:

- **one** physical property for each of these two forms of poly(propene)
- the name of the type of intermolecular bond in these two forms of poly(propene).



..... [7]

END OF QUESTION PAPER

This image shows a blank sheet of white paper designed for writing. It features a series of evenly spaced horizontal blue lines across its entire width. A single vertical red line runs down the left side, creating a narrow margin. The paper is otherwise completely empty, with no text or markings.

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