OCR
RECOGNISING ACHIEVEMENT

Thursday 10 January 2013 – Morning

AS GCE CHEMISTRY B (SALTERS)

F331/01 Chemistry for Life

Candidates answer on the Question Paper.

OCR supplied materials:
- *Data Sheet for Chemistry B (Salters)* (inserted)

Other materials required:
- Scientific calculator

Duration: 1 hour 15 minutes

MODIFIED LANGUAGE

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. 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.
- 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.
- 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 **60**.
- This document consists of **12** pages. Any blank pages are indicated.

Answer **all** the questions.

1 Reforming is a process used by oil refineries to increase the octane number of fuels. However, it is now possible to fit cars directly with an 'on-board' reformer. The reformer converts unburnt hydrocarbons in the exhaust to molecules with a higher octane number. These molecules are recycled.

(a) **(i)** State what *octane number* measures and explain why it is an advantage to increase the octane number of a fuel.

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.... **[2]**

(ii) State the **type** of hydrocarbon molecule produced by the reforming process.

.... **[1]**

(b) An on-board reformer uses the heat from the car exhaust gases and a heterogeneous catalyst to convert unburnt hydrocarbons from the fuel into the 'reformate'.

(i) Explain the terms *heterogeneous* and *catalyst* in the sentence above.

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.... **[2]**

(ii) Older, leaded fuels cannot be used with on-board reformers because they poison the catalyst.

Explain how the catalyst is poisoned.

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.... **[2]**

(iii) Hydrogen gas is also produced in reforming. Hydrogen is used as a fuel in some cars.

Suggest a benefit from using hydrogen as a fuel in cars.

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.... **[1]**

(iv) The on-board reforming process is endothermic. Use ideas of bond breaking and bond making to explain how a process can be endothermic.

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.... **[3]**

(c) Cracking is another process that can be used to improve the performance of hydrocarbon fuels.

Explain what happens in cracking reactions and what **types** of molecules are produced.

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.... **[3]**

[Total: 14]

2 In recent years much more of the isotope helium-3 has been needed. This isotope is used widely in cold temperature research and medical imaging.

(a) (i) Complete the following table to show the atomic structures of helium-3 and helium-4.

Isotope	**Number of protons**	**Number of neutrons**	**Number of electrons**
Helium-3			
Helium-4			

[1]

(ii) Helium-3 is produced by the radioactive decay of hydrogen-3, one of the isotopes of hydrogen.

State the type of radioactive decay in which hydrogen-3 is converted to helium-3.

Explain your answer.

....

....

.... **[2]**

(b) Helium-3 is also formed in the Sun by nuclear **fusion** processes involving isotopes of hydrogen.

(i) Write the nuclear fusion equation for the production of helium-3 from **two** different isotopes of hydrogen.

[1]

(ii) Nuclear fusion processes could be a useful energy source. It is very difficult, however, to reach the high temperatures and pressures to bring about safe fusion on Earth.

Suggest why very high temperatures and pressures are needed for nuclear fusion.

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.... **[2]**

(c) The presence of helium in the Sun was detected when its atomic absorption spectrum was recorded during a solar eclipse.

(i) Describe the appearance of an atomic absorption spectrum.

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.... **[2]**

(ii) Explain, in terms of electronic energy levels, why the atomic absorption spectrum of a particular element is unique.

In your answer you should include the relationship between energy and the radiation absorbed.

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.... **[3]**

(d) The isotopic composition of a sample of helium can be determined by using a time-of-flight mass spectrometer.

Describe the main stages in the operation of a time-of-flight mass spectrometer and explain why it is able to separate different isotopes of helium.

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

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.... **[5]**

[Total: 16]

3 'GVL' is an organic compound made from the woody parts of food crops. It is an oxygenate and can be blended in small amounts in petrol or diesel.

(a) Explain why the addition of an oxygenate to petrol or diesel might improve the efficiency of the fuel.

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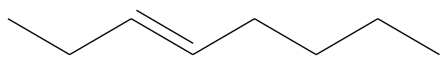
.... **[1]**

(b) Techniques have now been found to convert GVL into a fuel that can be used on its own, without blending.

One component of the fuel is hydrocarbon **A** with the following skeletal formula.



hydrocarbon A

(i) Give the molecular formula of hydrocarbon **A**.

.... **[1]**

(ii) The energy density of a fuel is the amount of energy, in kJ, released when 1.0 kg of the fuel is burned.

The enthalpy change of combustion of hydrocarbon **A** is $-5300\,kJ\,mol^{-1}$.

Calculate its energy density.

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

energy density = ... kJ per kg **[3]**

(c) Several structural isomers of hydrocarbon **A** are also present in the fuel manufactured from GVL.

(i) Explain the term *structural isomers*.

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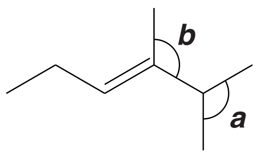
.... **[1]**

(ii) One isomer of hydrocarbon **A** is shown below, where ***a*** and ***b*** represent bond angles.



isomer of hydrocarbon A

Suggest a value for bond angle ***b*** and explain your answer.

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.... **[4]**

(iii) Would you expect the value of bond angle ***a*** to be greater, smaller or the same as the value of bond angle ***b***?

Explain your answer.

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.... **[2]**

(d) A student designs an experiment to measure the energy transferred when hydrocarbon **A** and one of its isomers are burned separately in air.

The student burns the liquid isomers in order to heat up water in copper cans. Care is taken to keep the heating conditions the same for the two liquids.

(i) The student's results table for hydrocarbon **A** is shown below.

Use the data in the table to calculate the energy transferred to the water.

Starting temperature of water / °C	**Final temperature of water / °C**	**Volume of water used / cm^3**
22.0	47.0	200

specific heat capacity of water = $4.18\,J\,g^{-1}\,K^{-1}$

energy transferred to water = ... J **[1]**

(ii) The student knows the M_r of hydrocarbon **A**.

What further information does the student need to calculate the enthalpy change of combustion of hydrocarbon **A**?

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.... **[1]**

(iii) The enthalpy changes of combustion of hydrocarbon **A** and its isomer are approximately the same.

Suggest why the enthalpy changes of combustion are approximately the same.

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.... **[2]**

(iv) The student's calculated values for the enthalpy changes of combustion were very much lower in magnitude than the data book values.

The main reason for this was heat loss to the surroundings.

Suggest **one** other possible reason for the low values.

Assume that the student carries out the experiment carefully and calculates the enthalpy changes correctly.

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.... **[1]**

[Total: 17]

Question 4 begins on page 10

4 Gas lighters can be used to create a spark to light a Bunsen burner. These gas lighters contain one of three metals, iron, titanium or cerium, or possibly an alloy of two of these metals.

When the metal is struck against a hard material, such as a flint or ceramic wheel, a little piece of metal becomes detached and rapidly reacts with the oxygen in the air, glowing white hot and creating the spark.

(a) (i) Write the equation for the reaction of cerium with oxygen to form the oxide Ce_2O_3.

[1]

(ii) Cerium forms another oxide containing 81.4% by mass of cerium.

Calculate the empirical formula of this oxide. Show your working.

A_r Ce, 140.1

empirical formula of oxide .... **[2]**

(b) Flint is a form of silicon dioxide.

(i) Silicon dioxide has a melting point above 1600 °C, does not conduct electricity and does not dissolve in water.

Suggest the structure and bonding of silicon dioxide.

....

.... **[1]**

(ii) Silicon is in the same group as carbon.

Draw a '*dot-and-cross*' diagram for **carbon dioxide** in the space below.

Show outer electrons only.

[1]

(iii) A '*dot-and-cross*' diagram for silicon dioxide is different from the '*dot-and-cross*' diagram for carbon dioxide.

In what way is it different?

....

....

.... **[1]**

(c) Titanium has a giant metallic structure.

Draw a **labelled** diagram to show a simple model of metallic bonding.

[3]

(d) Mendeleev, in his early Periodic Table, arranged the known elements in order of their 'atomic weights'. However in several places, including between calcium and titanium, he left gaps.

(i) Explain why he left gaps and how subsequent research confirmed this decision.

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.... **[2]**

(ii) State the property used in a modern Periodic Table to arrange the elements.

.... **[1]**

(iii) What feature of an element's atomic structure is related to the element's position in the Periodic Table?

.... **[1]**

[Total: 13]

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 margin.