OCR
RECOGNISING ACHIEVEMENT

Thursday 23 May 2013 – Morning

AS GCE CHEMISTRY B (SALTERS)

F331/01   Chemistry for Life
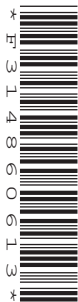
Candidates answer on the Question Paper.	
OCR supplied materials: • *Data Sheet for Chemistry B (Salters)* (inserted) **Other materials required:** • Scientific calculator	**Duration:** 1 hour 15 minutes *F33101*

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. Additional paper may be used if necessary but you must clearly show your candidate number, centre number and question number(s).
* 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.

OCR is an exempt Charity

Turn over

Answer **all** the questions.

1 'Fuel ethers' are oxygenates which are often blended in petrol to improve its properties.

(a) The fuel ether, MTBE, is manufactured according to the following equation:

compound A   **compound B**   **MTBE**
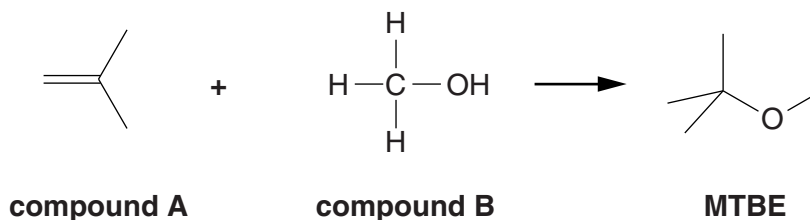
   (i) Give the systematic name for compound **B**.

.... [1]

   (ii) Name the homologous series of which compound **A** is a member.

.... [1]

   (iii) Name the type of formula used to represent compound **A** and MTBE.

.... [1]

(b) Compound **A** is obtained from crude oil.

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

.... [1]

   (ii) Name the process used to separate the mixture of compounds in crude oil.

.... [1]

   (iii) Compound **A** can be obtained by cracking a larger hydrocarbon such as $C_{12}H_{26}$.

In one cracking reaction, one mole of $C_{12}H_{26}$ produces one mole of compound **A** and one mole of another compound.

Write the equation for this cracking reaction.

[1]

(iv) The cracking reaction in **(b)(iii)** uses a heterogeneous catalyst.

Describe a simple model to explain the function of a heterogeneous catalyst.

In your answer, you should use appropriate technical terms, spelled correctly.
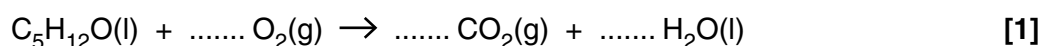
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.... **[4]**

(c) It is claimed that the addition of fuel ethers makes the fuels 'cleaner burning'.

(i) Balance the equation given below for the complete combustion of **one mole** of MTBE, $C_5H_{12}O$.

$$C_5H_{12}O(l) \ + \ .... \ O_2(g) \ \rightarrow \ .... \ CO_2(g) \ + \ .... \ H_2O(l)$$ **[1]**

(ii) Pentane is a component of petrol and has five carbon atoms.

The proportion of **carbon monoxide** in the combustion products of MTBE is lower than that from the combustion of pentane.

Explain why this is so.

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.... **[2]**

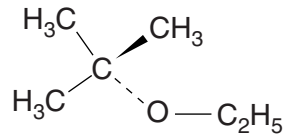**(iii)** Carbon monoxide can be removed from car exhaust fumes by the catalysed reaction with nitrogen monoxide.

Name the products of this reaction.

....

.... **[1]**

Turn over

(d) ETBE is another fuel ether. It has a similar structure to MTBE and is represented below.

$$H_3C \diagdown \underset{H_3C \diagup}{\overset{}{C}} \diagup CH_3$$
$$O — C_2H_5$$

ETBE

 (i) Explain the significance of the wedge and dashed line in the above structure.

 ....

 .... **[1]**

 (ii) ETBE is **not** a structural isomer of MTBE.

 Explain the term *structural isomers* and explain why ETBE and MTBE are **not** structural isomers.

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 .... **[2]**

(e) ETBE can be manufactured from bioethanol. Both ETBE and bioethanol are called biofuels.

 Explain why biofuels are regarded as a sustainable energy source, and why they are often described as 'carbon neutral'.

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 .... **[3]**

[Total: 20]

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Question 2 begins on page 6

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2 Magnesium hydroxide and magnesium carbonate are ingredients of some indigestion tablets. Their purpose in the tablet is to neutralise excess hydrochloric acid in the stomach.

(a) Write an equation for the reaction of solid magnesium hydroxide with dilute hydrochloric acid.

Include state symbols.

[2]

(b) A student measures the enthalpy change of the reaction in **(a)**. The student adds magnesium hydroxide solid to $50\,cm^3$ (an excess) of hydrochloric acid in a polystyrene cup. The student measures a temperature rise of $5\,°C$.

  (i) Suggest why the student chooses a polystyrene cup instead of a glass beaker.

....

.... **[1]**

  (ii) The student calculates the heat transferred as follows:

Heat transferred = $50 \times 4.18 \times 5\,J$

Suggest **two** approximations that the student makes in doing the calculation.

....

....

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.... **[2]**

(c) Aluminium hydroxide, $Al(OH)_3$, is an ingredient of some indigestion tablets.

Suggest why one mole of aluminium hydroxide neutralises more acid than one mole of magnesium hydroxide.

....

.... **[1]**

(d) When magnesium carbonate neutralises excess stomach acid it can cause a bloated feeling because of the carbon dioxide gas released in the reaction.

The equation for the reaction is shown below:

$$MgCO_3(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + CO_2(g) + H_2O(l)$$ **equation 2.1**
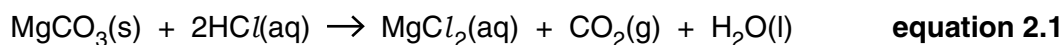
(i) A student reacts an indigestion tablet containing magnesium carbonate with excess hydrochloric acid.

The mass of magnesium carbonate in the indigestion tablet is 0.20 g.

Calculate the volume of carbon dioxide gas, in **cm³**, produced at room temperature and pressure.

One mole of any gas occupies 24 dm³ at room temperature and pressure.

volume of carbon dioxide = ... cm³ **[3]**

(ii) The reaction shown in **equation 2.1** is accompanied by an increase in entropy.

Explain the term *entropy* and explain why there is an increase in entropy in this reaction.

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.... **[2]**

[Total: 11]

3 Life on Earth is based on the element carbon. Some science fiction novels, however, suggest the possibility of silicon-based life forms.

(a) Use your knowledge of the Periodic Table to explain why silicon would be expected to show a similar chemistry to carbon.

....

.... **[1]**

(b) The table below shows the structure and properties of carbon and silicon and some of their compounds.
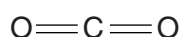
Complete the table by ticking the appropriate boxes to show the link between the type of structure and melting point.

Substance	Type of structure		Melting point	
	Simple molecular	Covalent network	High	Low
C (diamond)		✓		
silicon			✓	
CO_2	✓			
SiO_2			✓	

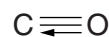**[1]**

(c) Carbon forms two oxides, CO_2 and CO.

Representation of the bonding in these oxides is shown below.

O═C═O   C⇌O

carbon dioxide   **carbon monoxide**

(i) Use the electron pair repulsion principle to state and explain the shape of a carbon dioxide molecule.

....

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.... **[3]**

(ii) State the type of bond represented by the arrow in the carbon monoxide structure.

.... **[1]**

(iii) Draw a '*dot-and-cross*' diagram for the carbon monoxide molecule.

Show outer electrons only.

[2]

(d) The isotope carbon-14 can be used to estimate the time since an organism died.

There is a roughly constant amount of carbon-14 in living material. When an organism dies, the amount of carbon-14 within it gradually decays and is not replaced.

Carbon-14 undergoes β-decay with a half-life of approximately 6000 years.

(i) Write an equation for the β-decay of carbon-14.

[2]

(ii) Fossil remains from an organism that died during the last ice age can be dated by determining the count rate of the remaining carbon-14.

A fossil has a count rate that is 12.5% of the value in living material.

Calculate the number of years since the organism died.

number of years = ... **[2]**

(iii) Suggest **two** assumptions that have to be made if the above determination is to be valid.

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.... **[2]**

[Total: 14]

　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　Turn over

4 Analysis of tooth enamel from ancient human skeletons provides information on the place of origin of people from the past.

The technique is based on the fact that the concentrations of strontium and oxygen isotopes in tooth enamel vary with geographical locality.

(a) (i) Give the number of protons, electrons and neutrons in the strontium isotope, Sr-88.

protons .... electrons .... neutrons .... **[1]**

(ii) A sample of strontium has four stable isotopes with abundances as shown in the table below.

Isotope	Abundance (%)
Sr-84	0.56
Sr-86	9.86
Sr-87	7.02
Sr-88	82.56

Use the above data to calculate a value for the relative atomic mass of strontium in the sample.

Show your working and give your answer to **three** significant figures.

relative atomic mass of strontium in the sample = ... **[3]**

(b) Strontium ions can replace calcium ions in tooth enamel because they both have the same charge.

State the charge on a strontium ion.

.... **[1]**

(c) Calcium reacts with water.

Describe **two observations** that you would make when calcium reacts with water.

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....

.... **[2]**

(d) The isotope variation in strontium across Britain is closely related to the age and type of underlying rocks.

Some of these rocks contain strontium carbonate.

(i) The carbonates in Group 2 show a trend in thermal stability.

Write an equation to show the decomposition of strontium carbonate on heating.

....

[1]

(ii) Samples of strontium carbonate and calcium carbonate are taken, each having the same particle size and number of moles. They are heated in separate test-tubes under the same conditions.

Describe how the difference in thermal stability could be shown, giving the results you would expect.

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.... **[4]**

(e) Oxygen has three stable isotopes, with the O-16 isotope being by far the most abundant.

The oxygen combined in tooth enamel is derived mainly from drinking water.

A mass spectrum of water shows a large peak at an *m*/*z* value of 18.

A second, much smaller, peak is found at an *m*/*z* value of 20.

(i) What information is given by the height of a peak in a mass spectrum?

....

.... [1]

(ii) Give the formula of the ion responsible for the peak at an *m*/*z* value of 18.

.... [1]

(iii) Suggest why there is a peak at an *m*/*z* value of 20.

....

.... [1]

[Total: 15]

END OF QUESTION PAPER