

**Friday 23 May 2014 – 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




Candidate forename		Candidate surname	
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Centre number							Candidate number				
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**INSTRUCTIONS TO CANDIDATES**

- The Insert 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.
-  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 Alkenes are important in the chemical industry. Simple alkenes occur naturally and form a small percentage of the hydrocarbons in crude oil.

(a) Name the process used to separate individual groups of hydrocarbons in crude oil.

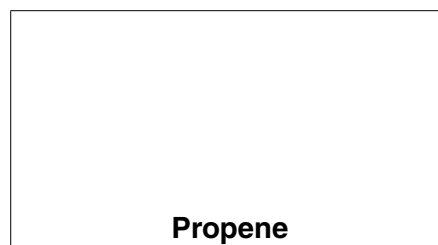
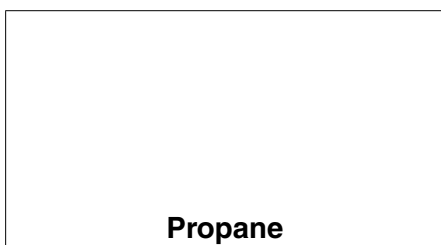
On which property of the hydrocarbons does this process depend?

name of process .....

property .....

[1]

(b) (i) Draw, in the boxes below, the **full** structural formulae for the hydrocarbons propane and propene.



[1]

(ii) Give the term used to describe molecules, such as alkenes, containing a C=C bond.

..... [1]

(c) About 10% of crude oil is converted into alkenes by the process of catalytic cracking.

(i) Write the equation for the cracking of decane to produce ethene and one other product.

Use **molecular** formulae in your equation.

[1]

(ii) Heterogeneous catalysts are used in cracking.

Explain, in the context of catalysis, the term *heterogeneous* and describe the **first** stage in the mechanism of this type of catalysis.



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

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

- (iii) The shorter chain alkanes produced in the cracking process are useful for blending in petrol, because they have higher octane numbers than the original molecules.

Explain what octane number measures and why a high octane number is desirable for a fuel.

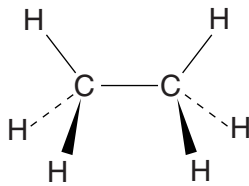
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.....

.....

..... [2]

- (iv) The structure of ethane can be represented by the diagram below.



Explain the significance of the wedges and dotted lines in this structure.

.....

..... [1]

- (v) Reforming is another process used in the oil industry to produce hydrocarbons with high octane numbers. This process produces cyclic hydrocarbons and one other product.

Name this other product.

..... [1]

- (d) Alkenes are also used in drilling oils. Some of these alkenes are structural isomers.

- (i) Explain the meaning of the term *structural isomers*.

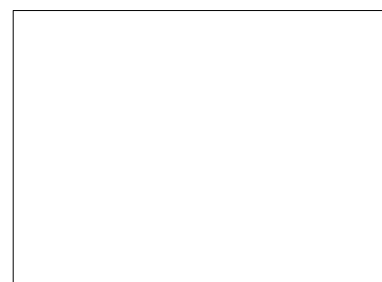
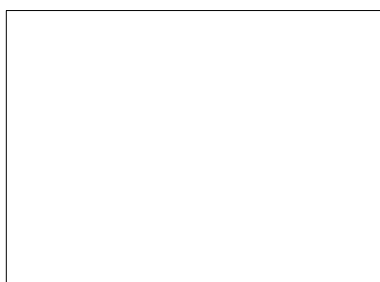
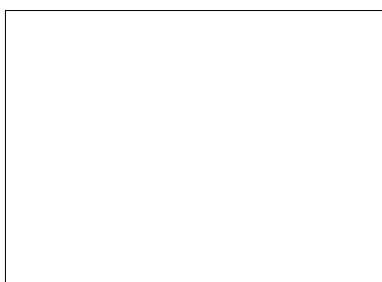
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..... [1]

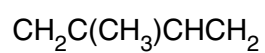
4

(ii) Draw the **skeletal** structures for **three** alkene isomers of C<sub>4</sub>H<sub>8</sub>.



[2]

(e) 'Isoprene' is produced and emitted into the atmosphere by many species of trees. It can be represented by the following formula.



Draw the **full** structural formula of isoprene.

[2]

[Total: 15]

2 Coal fired power stations produce the pollutant gas sulfur dioxide,  $\text{SO}_2$ . This gas is toxic and produces 'acid rain'.

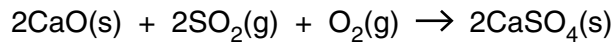
(a) The sulfur dioxide reacts with water and oxygen in the atmosphere to produce sulfuric acid,  $\text{H}_2\text{SO}_4$ .

Write a balanced equation for this reaction.

Include state symbols.

[2]

(b) One way to reduce the sulfur dioxide emissions is to allow the waste gas from the power station to pass through a fine powder of calcium oxide. The following reaction takes place.



Explain why calcium oxide would be expected to react with sulfur dioxide.

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

(c) Both carbon and sulfur form dioxides when burnt.  
 $\text{CO}_2$  is a linear molecule.  $\text{SO}_2$  is a bent (v-shaped) molecule.



Explain why  $\text{CO}_2$  is linear and  $\text{SO}_2$  is a bent molecule.

Give the bond angle in  $\text{SO}_2$ .

.....  
 .....  
 .....  
 .....

Bond angle in  $\text{SO}_2$  ..... [4]

- (d) The sulfur dioxide is the result of sulfur impurities in the coal burning in air. In some coals, the sulfur content can be up to 10% by mass.

Calculate the mass of sulfur dioxide produced when 1.0 kg of coal is burnt. Assume the sulfur content to be 10% by mass.

mass of  $\text{SO}_2$  = ..... g [2]

- (e) A more radical approach to cutting sulfur dioxide pollution is to use alternative energy generation methods, not dependent on fossil fuels.

One such method is to use 'nuclear energy'.

Suggest one advantage (other than production of less  $\text{SO}_2$ ) and one disadvantage of using nuclear energy compared to burning fossil fuels.

advantage .....

.....

disadvantage .....

.....

[2]

- (f) Carbon has a very high melting point and sulfur has a low melting point.

Name the type of bonding **and** structure in carbon and sulfur.

	Type of bonding	Type of structure
<b>Carbon</b>		
<b>Sulfur</b>		

[2]

[Total: 13]

- 3 Terrorists try to smuggle neutron-emitting material across international borders. Neutron detectors are used to combat this.

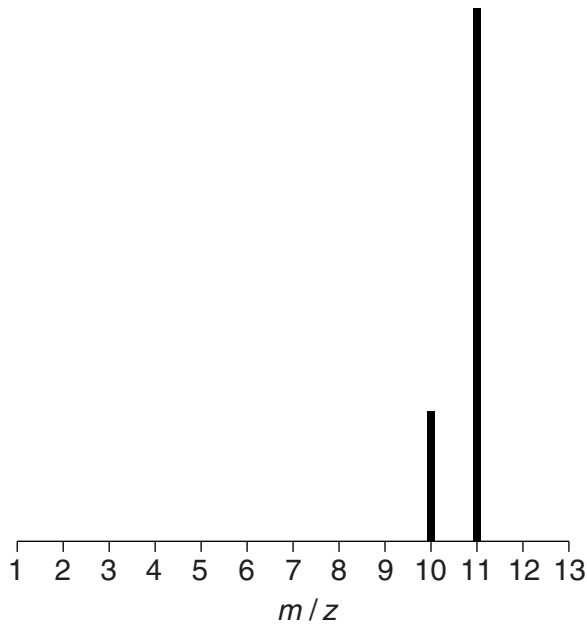
One material that can be used in neutron detectors is the isotope, boron-10.

- (a) Boron has two stable isotopes. Complete the table below to show their atomic structures.

Isotope	Number of protons	Number of neutrons	Number of electrons
Boron-10			
Boron-11			

[1]

- (b) Analysis of a sample of boron by a time-of-flight mass spectrometer produced the following mass spectrum.



- (i) What information is given by the height of the two peaks on the mass spectrum?

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

- (ii) Explain how the information given on a mass spectrum, such as the one shown above for boron, can be used to calculate the relative atomic mass of an element.

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

- (iii) A key stage in the operation of a time-of-flight mass spectrometer is the acceleration of positive ions.

Explain how this process allows the instrument to separate ions of different masses.

.....

.....

.....

.....

..... [3]

- (c) Neutron-emitting material may also produce ionising radiation consisting of alpha or beta particles.

- (i) Complete the table below by selecting from the following list.

**paper; 4; +2; large; -1; aluminium foil; small; 0**

Property	Ionising radiation	
	Alpha ( $\alpha$ )	Beta ( $\beta$ )
Relative mass		
Relative charge		
Deflection by electrical field		
Stopped by a minimum of ...		

[2]

- (ii) A boron-10 nucleus absorbs a neutron and splits into an alpha particle and an isotope of a different element. The alpha particles can then be detected.

Complete the following nuclear equation for this process.



[2]

- (iii) It is difficult to detect smuggled radioactive material using the **direct** emission of alpha or beta particles.

Suggest why this is so.

.....

..... [1]



(d) Another material used in neutron detectors is boron trifluoride,  $\text{BF}_3$ .

Draw a 'dot-and-cross' diagram for  $\text{BF}_3$ , showing outer electrons only.

[2]

(e) The isotope uranium-235 is present in some radioactive material. This breaks down by alpha decay with a half-life of approximately 700 million years.

(i) Explain the term *half-life*.

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

(ii) Radioisotopes such as uranium-235 can be used in the dating of geological material. The final product in the decay of uranium-235 is a stable lead isotope.

Explain the principles behind this dating.

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

(iii) Explain why the long half-life of uranium-235 means it cannot be used in dating **archaeological** material.

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

(iv) The energy released when uranium-235 breaks down in nuclear reactors can be used to generate electricity. Another process releasing energy is nuclear fusion.

Explain the process of nuclear fusion.

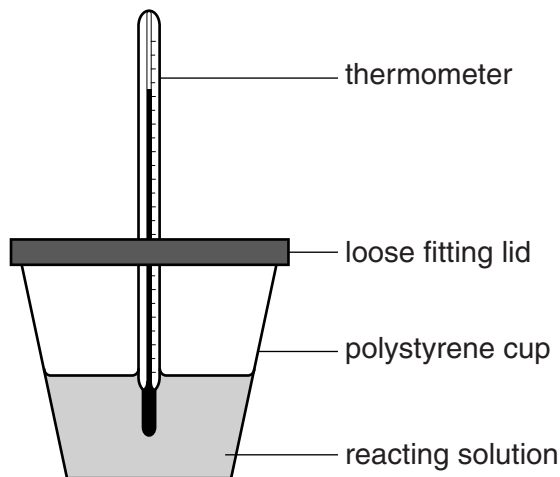
.....  
..... [1]

[Total: 19]

Turn over

- 4 Many children's science kits contain the chemicals 'sodium bicarbonate',  $\text{NaHCO}_3$ , and 'citric acid',  $\text{C}_6\text{H}_8\text{O}_7$ . If solid sodium bicarbonate is added to a solution of citric acid, the resulting evolution of gas can be used to 'power' small toys such as boats and cars.

- (a) A student decides to measure the enthalpy change for this reaction using the apparatus below.



The student adds 12 g of sodium bicarbonate to **excess** citric acid solution. The results are given below.

Mass of solution formed = 25.0 g

Starting temperature of solution = 22 °C

Finishing temperature of solution = 6 °C

- (i) Calculate the energy transferred from the solution.

The solution has a specific heat capacity of  $4.18 \text{ J g}^{-1} \text{ K}^{-1}$ .

energy transferred = ..... J [1]

- (ii) Calculate the enthalpy change,  $\Delta H$ , per mole of sodium bicarbonate in this reaction.

Give your answer, in **kJ**, to **two** significant figures.

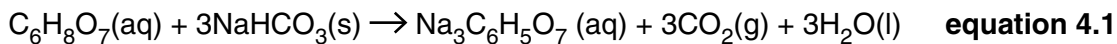
$\Delta H = \dots\dots\dots \text{ kJ mol}^{-1}$  [3]

(iii) The answer calculated in (ii) is different from the value quoted in data books.

Suggest one limitation in the practical procedure which would lead to the difference.

..... [1]

(iv) The reaction between sodium bicarbonate and citric acid can be represented by **equation 4.1** below.



Calculate the volume of carbon dioxide gas produced, in dm<sup>3</sup>, in the student's experiment, at room temperature and pressure. Assume none of the carbon dioxide dissolves.

One mole of gas at room temperature and pressure occupies 24 dm<sup>3</sup>.

volume of carbon dioxide = ..... dm<sup>3</sup> [2]

(b) The enthalpy change of a reaction depends on endothermic and exothermic processes.

Describe, in terms of bonds made and broken, which processes are exothermic and which are endothermic. Explain how the relative values of these processes affect the enthalpy change of the reaction in **equation 4.1**.

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

(c) The reaction represented by **equation 4.1** is accompanied by an increase in entropy.

Explain the term *entropy*.

Describe the differences in magnitude of the entropy of a solid, a liquid and a gas and use your answers to explain the increase in entropy accompanying this reaction.

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

[Total: 13]

**ADDITIONAL ANSWER SPACE**

If additional answer space is required, you should use the following lined page. The question number(s) must be clearly shown in the margin.

A large rectangular area with a vertical solid line on the left side and horizontal dotted lines across the rest of the page, providing space for writing answers.



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