OCR
RECOGNISING ACHIEVEMENT

Tuesday 15 May 2012 – Afternoon

AS GCE CHEMISTRY B (SALTERS)

F331 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

F331

Candidate forename		Candidate surname	

Centre number						Candidate number				

MODIFIED LANGUAGE

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. Pencil may be used for graphs and diagrams only.
- 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.
- Answer **all** the questions.
- 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.

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Answer **all** the questions.

1 Medical imaging techniques use radiotracers to provide three-dimensional images of soft tissue during whole-body scans.

(a) One radiotracer, FDG, is a modified glucose molecule. An FDG molecule contains an ^{18}F atom.

(i) When atoms of ^{18}F undergo radioactive decay, gamma radiation is emitted.

Tick **three** of the statements in the table below that describe the properties of gamma radiation.

Place your ticks (✓) in the boxes next to the correct statements.

stopped by paper	
charged particles	
highly penetrating	
deflected by magnetic fields	
electromagnetic radiation	
unaffected by electric fields	

[3]

(ii) The half-life of the ^{18}F isotope is around 100 minutes.

Explain the term *half-life*.

Suggest why an isotope with a half-life much longer or much shorter than 100 minutes would be **unsuitable** for use as a radiotracer.

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

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(b) The molecular formula of FDG is $C_6H_{11}{}^{18}FO_5$. Traces of FDG in a patient's urine can be detected by mass spectrometry for several hours after a scan.

The mass spectrum of FDG shows several peaks.

(i) There is a peak in the mass spectrum of FDG at *m/z* 181.

Explain why you would expect to see a peak at this value.
Include a calculation in your answer.

.....

.....

.....

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

(ii) What has happened to FDG to produce other peaks at lower *m/z* values in the mass spectrum?

.....

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

(c) Other fluorine-containing compounds are also used in health-related applications. For example, sodium fluoride is used in some toothpastes.

(i) Draw a '*dot-and-cross*' diagram to show the **ionic** bonding in sodium fluoride.

Show outer electron shells only.

[2]

(ii) Sulfur hexafluoride is used in some types of eye surgery.

Use the electron pair repulsion principle to predict and explain the shape of the sulfur hexafluoride, SF_6, molecule and suggest the F–S–F bond angle.

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

[Total: 15]

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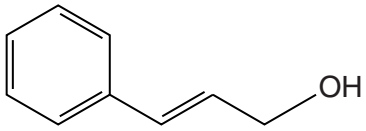
2 Unusual household lighting systems such as 'lava lamps' have become popular in recent years. These lamps contain two immiscible liquids of slightly different densities. When switched on, the heat of the bulb causes one of the liquids to rise up and then fall in a bubble through the other liquid.

(a) The immiscible liquids in one type of lava lamp are organic compound **X** and brine (sodium chloride solution). A structure of compound **X** is shown below.



compound X

(i) Name **two** functional groups, apart from the benzene ring, found in compound **X**.

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

(ii) The structure of compound **X** is shown above as a skeletal formula.

Give the molecular formula of compound **X**.

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

(b) Another substance that can be used in lava lamps is 'paraffin wax'. Paraffin wax is a mixture of long chain alkanes.

(i) Paraffin wax is obtained from crude oil.

Name the process used to separate different hydrocarbons from crude oil.

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

(ii) In some lava lamps, the liquid 'ethylene glycol' is used instead of brine. Analysis of ethylene glycol gives the following composition by mass.

C, 38.7% O, 51.6% H, 9.7%

Use this information to calculate the empirical formula of ethylene glycol.

empirical formula = ... **[2]**

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(iii) Why is the empirical formula of a compound not necessarily the same as its molecular formula?

.....

.....

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

(iv) When liquid ethylene glycol mixes completely with water there is a change in entropy.

Explain the term *entropy*.

.....

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

(c) The physical properties of ethylene glycol, sodium chloride and paraffin wax are important to the working of a lava lamp.

The physical properties of these substances are a result of their bonding and their structure type.

Complete the following table to show the relationship between the bonding and structure of these substances and a characteristic physical property of each one.

substance	type of bonding	structure type	characteristic physical property
ethylene glycol			low melting point
sodium chloride	ionic		
paraffin wax		simple molecular	insoluble in water

[3]

[Total: 11]

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3 'Avgas' is a high octane aviation fuel used in many aircraft.

(a) Explain the meaning of 'high octane' in terms of the behaviour of fuels.

.....

.....

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

(b) An essential component of Avgas is a product of oil refining called 'alkylate'. Alkylate consists mainly of 'isopentane' and 'isooctane'.

(i) The systematic name for isopentane is methylbutane.

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

[1]

(ii) C_8H_{18} has many structural isomers, one of which is octane.

Explain the term *structural isomer* and draw **skeletal** formulae in the boxes for **two** other structural isomers of C_8H_{18}.

Structural isomer .....

.....

.....

[3]

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(c) One advantage of alkylate is that it is a 'clean burning' fuel.

(i) Write an equation for the complete combustion of isopentane, C_5H_{12}.

[1]

(ii) The enthalpy change for the combustion of isopentane, in common with any combustion process, has a negative value.

Explain, in terms of bond making and breaking processes, why some enthalpy changes have a negative value.

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

(iii) Suggest what is meant by *clean burning* in the context of a fuel.

.....

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

(iv) Another clean burning fuel is hydrogen.

Suggest **one** benefit and **one** problem associated with the use of hydrogen as a fuel.

benefit .....

.....

problem .....

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

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(d) The equation for the complete combustion of isooctane, C_8H_{18}, shows that one mole of isooctane combines with 12.5 moles of oxygen.

Calculate the volume of **air** in **dm^3** required for the complete combustion of 60 cm^3 of gaseous isooctane under the temperature and pressure conditions operating in an aircraft engine cylinder.

Assume air is 21% by volume oxygen gas.

volume of air = ... dm^3 **[3]**

(e) In an oil refinery, the production of hydrocarbon fuels requires the use of heterogeneous catalysts.

(i) Explain the term *catalyst*.

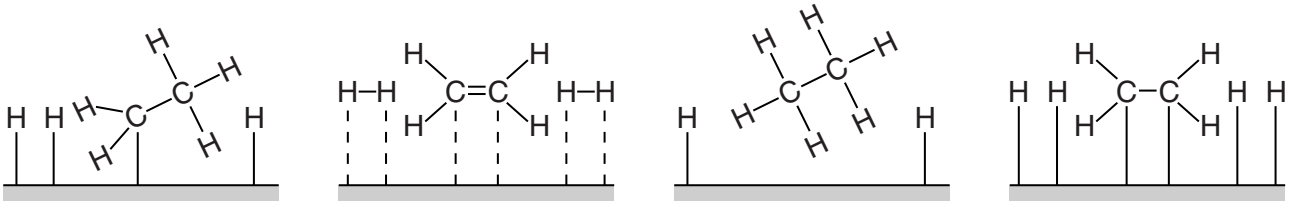
.....

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

(ii) In heterogeneous catalysis there are four essential stages. One example is the reaction of ethene with hydrogen. This reaction is shown below with the stages represented by diagrams **A**, **B**, **C** and **D**.

The diagrams are **not** in the correct order.

Using the letters, place the stages shown in the diagrams in the correct order.



A **B** **C** **D**

stage 1 ..... stage 2 ..... stage 3 ..... stage 4 ..... **[2]**

[Total: 17]

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4 In 1875, a French chemist noticed two lines in the atomic emission spectrum of a sample of zinc ore. These lines did not match the known spectrum of zinc. They were lines from an undiscovered element, later named as gallium, Ga.

(a) Explain how the lines in an atomic emission spectrum are formed **and** why the frequencies of these lines are unique for a given element.

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

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

(b) The French chemist knew about Mendeleev's prediction that there were elements which had not yet been discovered.

In what way did Mendeleev's Periodic Table allow for the discovery of new elements, such as gallium?

.....

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

(c) An important use of gallium is in the manufacture of the solid gallium arsenide, GaAs, which is used in the semi-conductor industry.

(i) Write an equation to represent the standard enthalpy change of formation, $\Delta H^{\ominus}_{f,298}$, of gallium arsenide. Include state symbols.

Explain your choice of state symbols.

T_m Ga, 303 K; T_m As, 1090 K (T_m = melting temperature/K)

equation:

.....

.....

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

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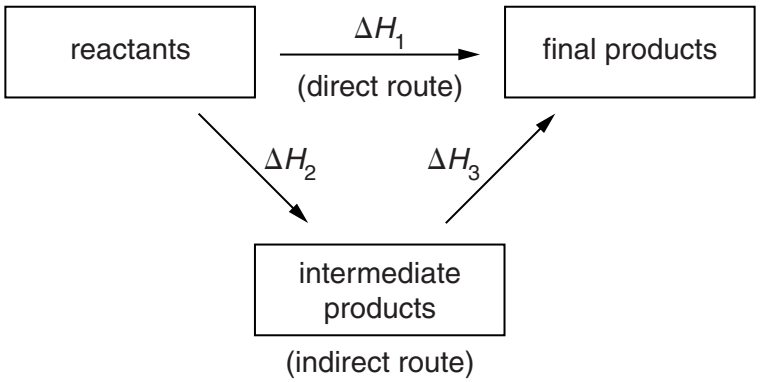
(ii) It is sometimes impossible to measure an enthalpy change directly. However, an enthalpy change can usually be measured indirectly using an enthalpy cycle based on Hess' law.

Use the enthalpy cycle below to write an equation relating ΔH_1 to ΔH_2 and ΔH_3.

Use this cycle to explain your understanding of Hess' law.



equation .....

explanation of Hess' law .....

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

(d) Use your knowledge of the Periodic Table to predict the number of electrons in the outer shell of a gallium atom. Explain your reasoning.

.....

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

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(e) Gallium has two naturally occurring isotopes: ^{69}Ga and ^{71}Ga.

A chemist determines that the percentage abundances of these isotopes in gallium are:

^{69}Ga	60.1%
^{71}Ga	39.9%

(i) Calculate the relative atomic mass, A_r, of gallium.

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

A_r = ... **[2]**

(ii) Complete the table below to show the atomic structures of the two gallium isotopes.

isotope	number of protons	number of electrons	number of neutrons
^{69}Ga			
^{71}Ga			

[2]

[Total: 17]

END OF QUESTION PAPER

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ADDITIONAL PAGE

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

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