

**ADVANCED SUBSIDIARY GCE
CHEMISTRY B (SALTERS)**
Chemistry for Life

F331

Candidates answer on the question paper

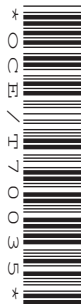
OCR Supplied Materials:

- *Data Sheet for Chemistry B (Salters)* (inserted)

Other Materials Required:

- Scientific calculator

**Wednesday 3 June 2009
Morning**

Duration: 1 hour 15 minutes

Candidate Forename		Candidate Surname	
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Centre Number						Candidate Number				
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INSTRUCTIONS TO CANDIDATES

- Write your name clearly in capital letters, your Centre Number and Candidate Number in the boxes above.
- Use black ink. Pencil may be used for graphs and diagrams only.
- Read each question carefully and make sure that you know what you have to do before starting your answer.
- Answer **all** the questions.
- Do **not** write in the bar codes.
- Write your answer to each question in the space provided, however additional paper may be used if necessary.

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 **16** pages. Any blank pages are indicated.

FOR EXAMINER'S USE

Qu.	Max.	Mark
1	14	
2	12	
3	17	
4	17	
TOTAL	60	

Answer **all** the questions.

- 1 The Shroud of Turin is a linen cloth imprinted with a faint image of a man. Some people believe the image to be that of Jesus Christ.

In order to measure the Shroud's age, small samples were analysed using radiocarbon dating.

- (a) Radiocarbon dating involves measuring the amount of a radioactive isotope ^{14}C in a sample of the cloth. The amount of ^{14}C is compared to the amount of ^{12}C in the cloth.

- (i) Complete the following table for the two isotopes.

	protons	neutrons	electrons
^{14}C			
^{12}C			

[2]

- (ii) Write a nuclear equation to show the β -decay of ^{14}C .

[2]

- (iii) The half-life for the decay of ^{14}C is 5730 years.

Explain what is meant by the term *half-life*.

.....
 [1]

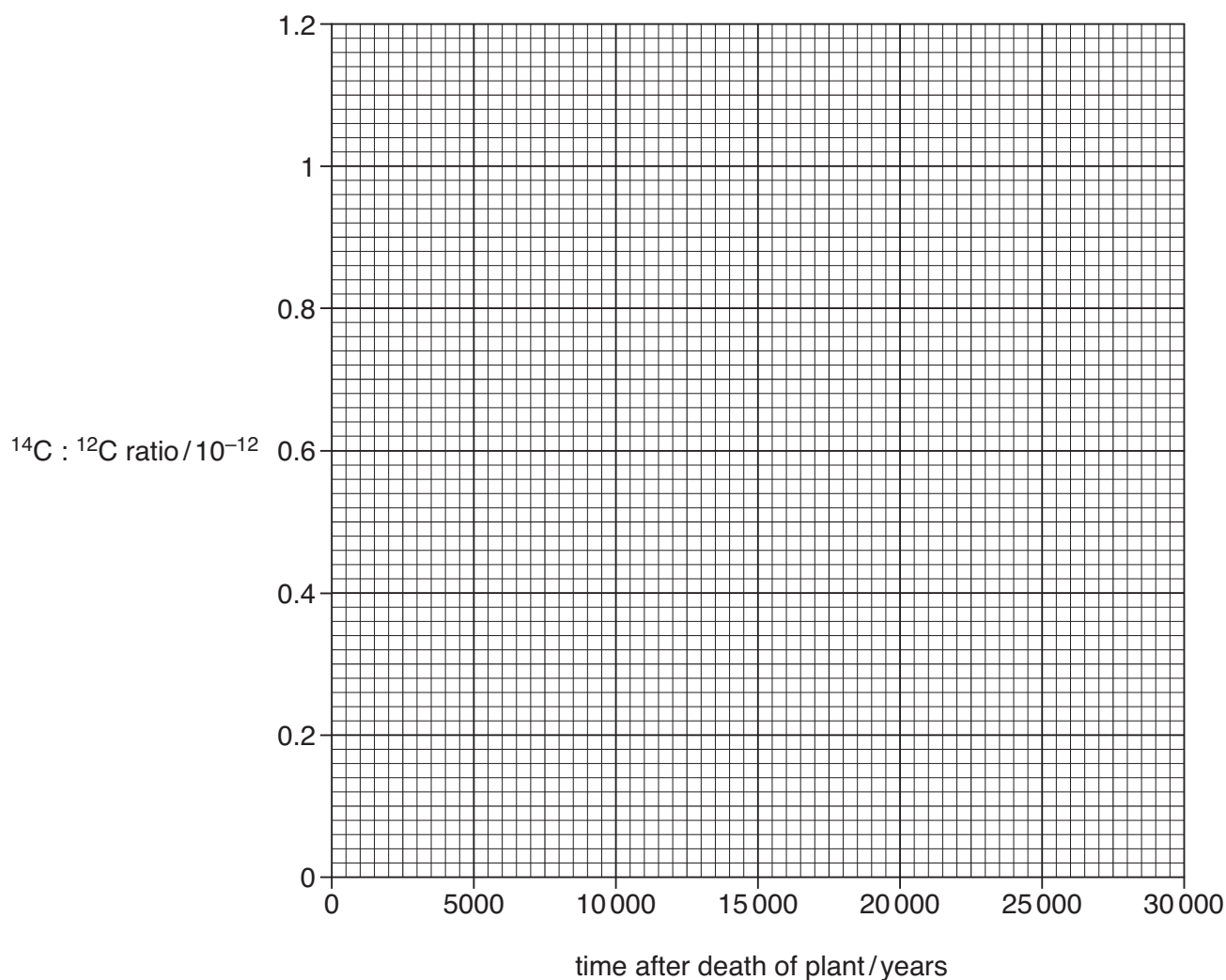
- (b) The linen in the Shroud was made from plants. The amount of ^{14}C in plants remains constant until that plant dies. The amount of ^{14}C then falls steadily. The amount of ^{12}C does **not** change.

- (i) Complete the table below for the decay of ^{14}C .

number of half-lives	time after death of organism/years	$^{14}\text{C} : ^{12}\text{C}$ ratio/ 10^{-12}
0	0	1.000
1	5730	0.500
2		
3		

[1]

(ii) Use the figures in the completed table to plot a decay curve for ^{14}C on the axes below.



[2]

(iii) The sample of linen cloth from the Shroud gave a $^{14}\text{C} : ^{12}\text{C}$ ratio of 0.920×10^{-12} .
Use your graph to estimate the age of the cloth.

age of cloth = years [1]

(c) Other radioactive isotopes are used as medical tracers.

Suggest why it is not advisable to use an isotope with either a very short or a very long half-life as a medical tracer.

very short half-life

.....

very long half-life

..... [2]

(d) In the Sun, ${}^3_2\text{He}$ is formed when **two** different isotopes of hydrogen join together.

(i) What term is used to describe this process?

..... [1]

(ii) Write a nuclear equation for this process.

[2]

[Total: 14]

5
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- 2 In the early 1800s, chemists had to learn the individual properties of all elements. Fortunately they then developed ways of grouping the elements so that patterns of chemical and physical behaviour emerged. This led to our modern Periodic Table.

- (a) The Russian chemist Mendeleev organised the known elements into a pattern widely regarded as the first Periodic Table.

A version of Mendeleev's Periodic Table is shown below.

	Group I	Group II	Group III	Group IV	Group V	Group VI	Group VII	Group VIII
Period 1	H							
Period 2	Li	Be	B	C	N	O	F	
Period 3	Na	Mg	Al	Si	P	S	Cl	
Period 4	K Cu	Ca Zn	* *	Ti *	V As	Cr Se	Mn Br	Fe, Co, Ni
Period 5	Rb Ag	Sr Cd	Y In	Zr Sn	Nb Sb	Mo Te	* I	Ru, Rh, Pd

- (i) Why did Mendeleev leave gaps in his Periodic Table?

.....
 [1]

- (ii) How did later evidence from the scientific community support Mendeleev's decision to leave gaps in his Periodic Table?

.....

 [2]

- (iii) Which group in the modern Periodic Table is missing from Mendeleev's table?

..... [1]

- (b) Before Mendeleev, John Newlands, another chemist, had been thinking on similar lines. He also identified patterns in the behaviour of elements. The table below shows how Newlands grouped the elements.

H	F	Cl	Co/Ni	Br	Pd	I	Pt/Ir
Li	Na	K	Cu	Rb	Ag	Cs	Tl
Gi	Mg	Ca	Zn	Sr	Cd	Ba/V	Pb
Bo	Al	Cr	Y	Ce/La	U	Ta	Th
C	Si	Ti	In	Zr	Sn	W	Hg
N	P	Mn	As	Di/Mo	Sb	Nb	Bi
O	S	Fe	Se	Ro/Ru	Te	Au	Os

- (i) Newlands and Mendeleev both put the elements in order of atomic mass.

What property is used to order the elements in the modern Periodic Table?

..... [1]

- (ii) Suggest why Newlands' arrangement was less useful than Mendeleev's arrangement.

.....

 [1]

- (c) One physical property chemists examined was the melting point of the elements. This is tabulated below for the Period 2 elements.

element	Li	Be	B	C (diamond)	N	O	F	Ne
atomic number	3	4	5	6	7	8	9	10
melting point/K	453	1560	2349	3800	63	55	53	25

- (i) Describe the pattern in melting point as you go across the period.

..... [1]

- (ii) The change in melting point across the period can be explained in terms of the structure and bonding of the elements.

Describe the changes, both in type of bonding and in structure, as the period is crossed from left to right.

.....

.....

.....

.....

.....

.....

.....

..... [4]

- (d) The electron structure of an element is 2.8.8.2.

In which group and period of the modern Periodic Table is this element found?

Group Period [1]

[Total: 12]

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- 3 In the 1970s the UK produced around 100 000 tons of a compound called lead tetraethyl, $\text{Pb}(\text{C}_2\text{H}_5)_4$. This compound was used in petrol to stop auto-ignition.

(a) Explain what is meant by *auto-ignition* and why it is undesirable in an engine.

.....

 [2]

(b) Each ethyl group forms a single carbon to lead covalent bond. The other elements in Group 4, including tin, also form bonds with carbon atoms.

The average length of bonds between carbon atoms and other atoms in Group 4 are given below.

	C–C	Si–C	Ge–C	Sn–C	Pb–C
bond length/nm	0.154	0.194	0.199	0.217	

(i) Suggest a value for the Pb–C bond length.

Pb–C bond length = nm [1]

(ii) Use the data in the table to suggest the trend in bond enthalpies of the bonds shown.

Explain your answer.

.....

 [2]

(c) (i) Predict the shape and bond angle around the lead atom in lead tetraethyl.

.....
 [2]

(ii) Explain your answer to (c)(i).

.....

 [3]

(d) Catalytic converters could **not** be used with 'leaded' petrol because the lead acted as a catalyst poison.

- (i) Describe the **type** of catalysis used in catalytic converters and describe the mechanism of this type of catalysis.



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

.....

.....

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.....

..... [5]

- (ii) Explain how a *catalyst poison* works.

.....

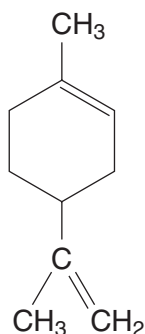
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..... [2]

[Total: 17]

4 The oils from many plants have the potential to be used as biofuels.

- (a) Oranges and lemons both contain a hydrocarbon called limonene. The structural formula of limonene is given below.



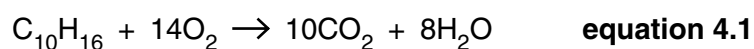
- (i) Underline the **two** words that can be applied to the structure of limonene.

aliphatic aromatic saturated unsaturated [2]

- (ii) What functional group is present in limonene?

..... [1]

- (iii) Limonene undergoes complete combustion as represented by the following equation.



Calculations using average bond enthalpies give the following data.

	enthalpy change/kJ mol ⁻¹
to break all bonds in the reactants	17 578
energy released when new bonds are formed	23 524

Use this data to calculate a value for the overall enthalpy change for **equation 4.1**.
Include the sign with your answer.

overall enthalpy change = kJ mol⁻¹ [2]

- (iv) The data book value for the enthalpy change of combustion of liquid limonene is slightly different from the value calculated above.

Suggest **two** reasons why this is the case.

.....

.....

.....

..... [2]

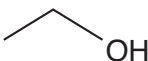
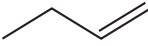
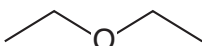
- (v) Lemons contain 1.00% by mass of limonene.

Calculate the number of **moles** of limonene in 100 g of lemon.
Give your answer to **three** significant figures.

moles of limonene = [3]

(b) There are a variety of compounds that could be used in fuels.

(i) Some are shown in the table below. Complete the table.

homologous series	skeletal formula	name
alcohol		
		but-1-ene
		ethoxyethane

[3]

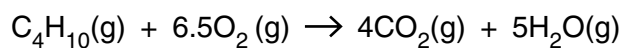
(ii) Draw the **skeletal** formula of a branched chain alkane containing six carbon atoms.

[1]

(iii) Name the alkane you have drawn in (ii).

..... [1]

(c) The following reaction occurs when butane burns in an engine.



This reaction is accompanied by an increase in entropy.

Explain why the entropy increases.

.....

 [2]

[Total: 17]

END OF QUESTION PAPER

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