Candidate Forename		Candidate Surname	

Centre Number						Candidate Number				

OXFORD CAMBRIDGE AND RSA EXAMINATIONS

ADVANCED SUBSIDIARY GCE

F331

CHEMISTRY B (SALTERS)

Chemistry for Life

WEDNESDAY 3 JUNE 2009: Morning
DURATION: 1 hour 15 minutes

SUITABLE FOR VISUALLY IMPAIRED CANDIDATES

Candidates answer on the question paper

OCR SUPPLIED MATERIALS:
Data Sheet for Chemistry B (Salters) (inserted)

OTHER MATERIALS REQUIRED:
Scientific calculator

READ INSTRUCTIONS OVERLEAF

DC (LEO/SLM) OV90809 11172/1

INSTRUCTIONS TO CANDIDATES

- **Write your name clearly in capital letters, your Centre Number and Candidate Number in the boxes on the first page.**

- **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.**

- **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.**

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.

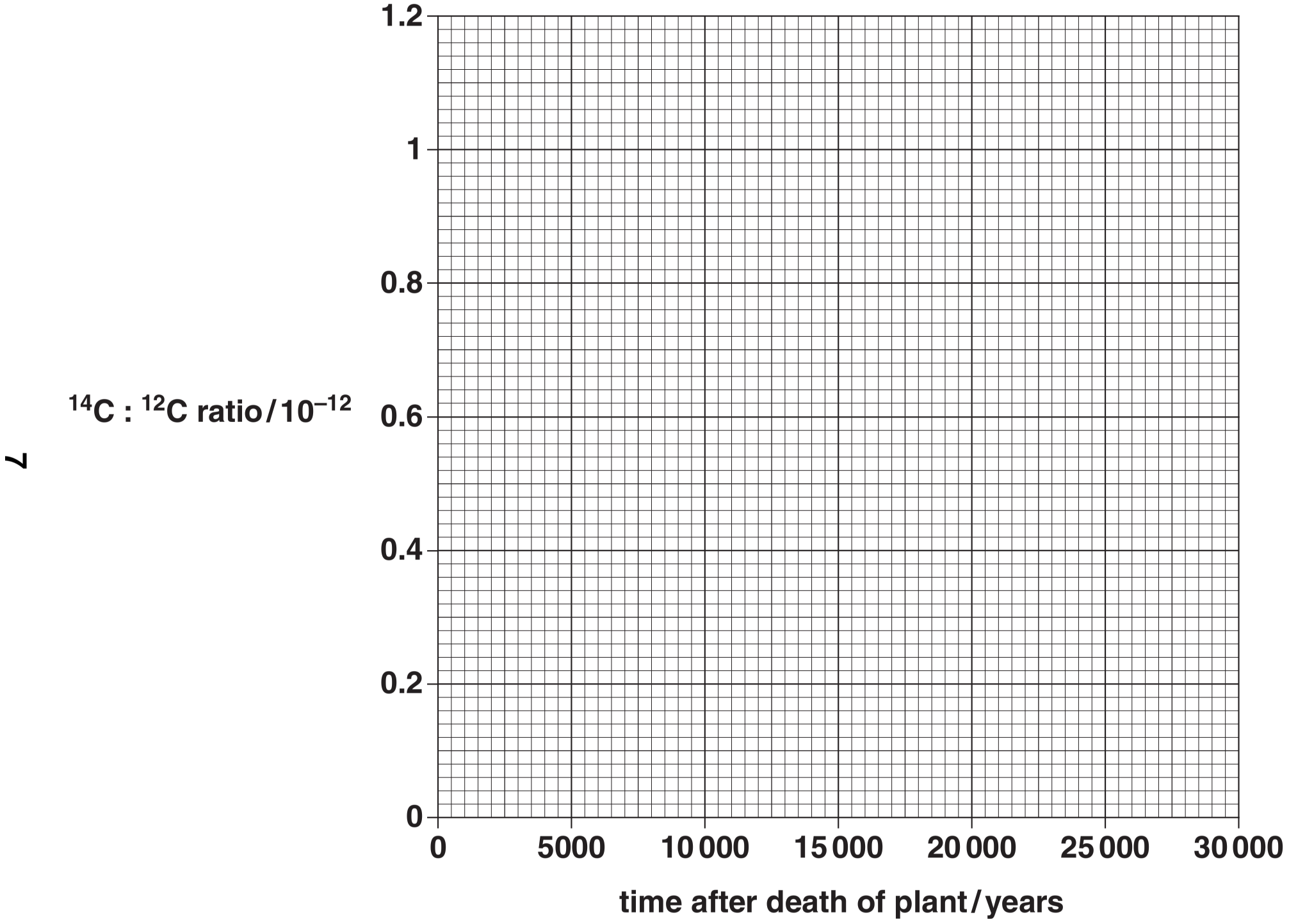
NUMBER OF HALF-LIVES	TIME AFTER DEATH OF ORGANISM/YEARS	^{14}C : ^{12}C ratio/10^{-12}
0	0	1.000
1	5730	0.500
2		
3		

[1]

(ii) Use the figures in the completed table to plot a decay curve for ^{14}C on the axes opposite. [2]

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

age of cloth = _____ years [1]


1.2
1
0.8
0.6
0.4
0.2
0
0
5000
10 000
15 000
20 000
25 000
30 000
$^{14}C : {}^{12}C$ ratio / 10^{-12}
time after death of plant / years

7

(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, $^{3}_{2}He$ is formed when <u>TWO</u> 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]

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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 on the opposite page.

(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]**

	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	A*l*	Si	P	S	C*l*	
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

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

(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]**

H	F	C*l*	Co/Ni	Br	Pd	I	Pt/Ir
Li	Na	K	Cu	Rb	Ag	Cs	T*l*
Gi	Mg	Ca	Zn	Sr	Cd	Ba/V	Pb
Bo	A*l*	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

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

(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]**

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**

(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, $Pb(C_2H_5)_4$. 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.

_____

_____

_____

_____

_____

_____ **[5]**

(ii) Explain how a catalyst poison works.

_____

_____

_____ **[2]**

[Total: 17]

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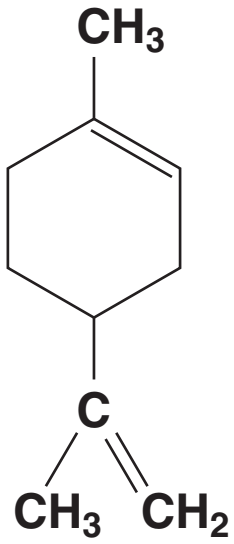
4 The oils from many plants have the potential to be used as biofuels.

(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.

$$C_{10}H_{16} + 14O_2 \rightarrow 10CO_2 + 8H_2O$$ **EQUATION 4.1**

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 <u>TWO</u> reasons why this is the case.

_____

_____

_____

_____ **[2]**

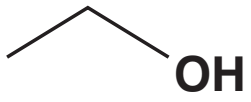
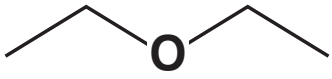
(v) Lemons contain 1.00% by mass of limonene.

Calculate the number of <u>MOLES</u> of limonene in 100 g of lemon.
Give your answer to <u>THREE</u> 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.

$$C_4H_{10}(g) + 6.5O_2(g) \rightarrow 4CO_2(g) + 5H_2O(g)$$

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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