OCR
RECOGNISING ACHIEVEMENT

ADVANCED SUBSIDIARY GCE **2850/01**

CHEMISTRY (SALTERS)

Chemistry for Life

WEDNESDAY 4 JUNE 2008

Morning

Time: 1 hour 15 minutes

Candidates answer on the question paper

Additional materials (enclosed): *Data Sheet for Chemistry (Salters)* (Inserted)

Additional materials (required):
Scientific Calculator

CUP/T46080

Candidate Forename		Candidate Surname	
Centre Number		Candidate Number	

INSTRUCTIONS TO CANDIDATES

- Write your name in capital letters, your Centre Number and Candidate Number in the boxes above.
- Use blue or 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.

INFORMATION FOR CANDIDATES

- The number of marks for each question is given in brackets [ ] at the end of each question or part question.
- The total number of marks for this paper is **75**.
- You may use a scientific calculator.
- You may use the *Data Sheet for Chemistry (Salters)*.
- You are advised to show all the steps in any calculations.

FOR EXAMINER'S USE		
Qu.	**Max.**	**Mark**
1	**12**	
2	**23**	
3	**21**	
4	**19**	
TOTAL	**75**	

This document consists of **13** printed pages, **3** blank pages and a *Data Sheet for Chemistry (Salters)*.

[Turn over

Answer **all** the questions.

1 The search for 'green' fuels from renewable sources is attracting much interest.

(a) Brazil produces ethanol, from the fermentation of sugar cane, for use as a fuel in car engines.

(i) An advantage of ethanol as a fuel is that it is less likely than petrol to cause 'knocking' in the car engine.

What causes 'knocking' in a car engine?

.....

..... [1]

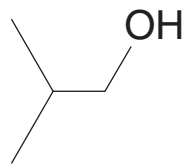
(ii) How is the octane number related to the tendency of a fuel to cause knocking?

.....

..... [1]

(iii) Ethanol is an alcohol. Other alcohols can also be used as fuels.

Name the branched alcohol drawn in the box below and state the type of formula drawn.



name .....

type of formula .....

[3]

(b) The sugar cane could be used as food for humans and animals. A much 'greener' approach would be to use biological waste materials such as wood-chippings or straw to make ethanol.

However, breaking down the cellulose fibres in these materials is difficult.

(i) A research group claim to have developed a process in which a catalyst of platinum and ruthenium metals speeds up the breakdown of the cellulose dispersed in water.

The two metals are used as a thin layer supported on a porous inert solid.

Suggest **one** reason why the support should be porous.

..... [1]

(ii) The platinum and ruthenium metals together act as a heterogeneous catalyst.

Explain the term *heterogeneous*.

.....

..... [2]

(iii) Cellulose can be represented by the empirical formula, $C_6H_{10}O_5$.

Explain the term *empirical formula*.

.....

..... [2]

(iv) A sample of cellulose was found to have a relative molecular mass of 1.0×10^6.

How many empirical formula units ($C_6H_{10}O_5$), were present in the cellulose?

A_r: C, 12; H, 1.0; O,16

answer = ... [2]

[Total: 12]

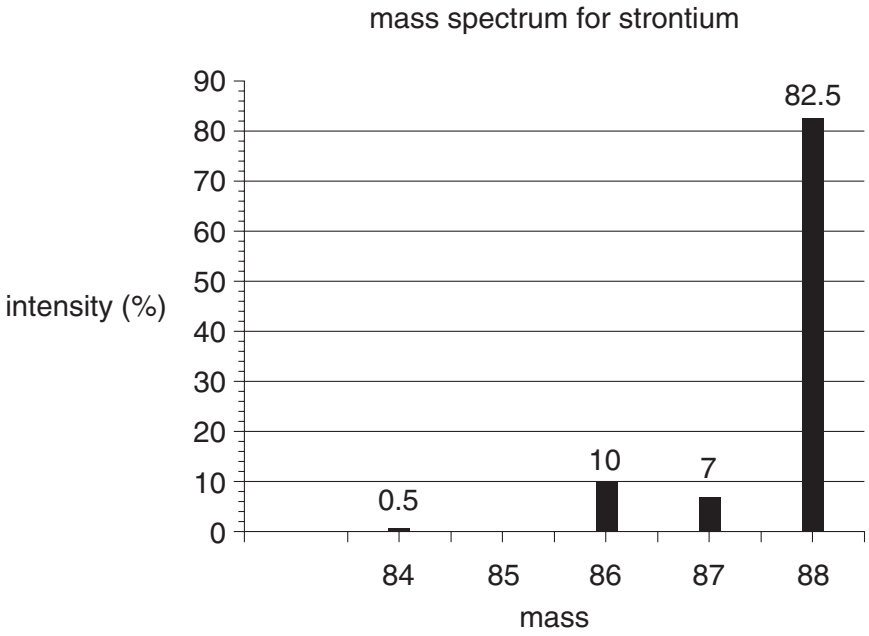
2 Strontium is the sixteenth most abundant metal in the Earth's crust.

The average abundance of strontium in the Earth's crust is 0.0370% by mass.

(a) Calculate the average mass of strontium, in kg, found in 1000 kg of crust.

answer = ... kg [1]

(b) A mass spectrum for a sample of naturally occurring strontium is shown below. The percentage intensity of each of the mass peaks is shown (Note: the peak at mass 84 is too small to be seen clearly).



(i) Give **two** pieces of information about the isotopes of strontium that you can obtain from the mass spectrum.

.....

..... [2]

(ii) Use the information on the mass spectrum to calculate the relative atomic mass of this sample of strontium. Give your answer to **three significant figures**.

answer = ... [3]

(c) Strontium reacts with water in a similar way to calcium but the reaction is faster.

Use your knowledge of atomic structure to:

- explain the similarity between the reactions of the metals
- explain the increased reactivity of strontium.

Include in your answer a balanced equation for the reaction of strontium with water.

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..... [5]

(d) In the 1960s increased levels of radioactive strontium-90 were found in the bones and teeth of children. This was probably due to the testing of nuclear weapons in the 1950s.

(i) Strontium-90 is a beta emitter. Tick the properties in the table below which apply to beta particles.

property	tick (✓)
are strongly deflected by electric fields	
are stopped by thin paper	
are only slightly deflected by an electric field	
have negligible mass	
are stopped by aluminium foil	

[2]

(ii) Write the nuclear equation for the beta-decay of strontium-90.

[3]

(iii) Suggest why strontium-90 was deposited in bones and teeth.

.....

..... [2]

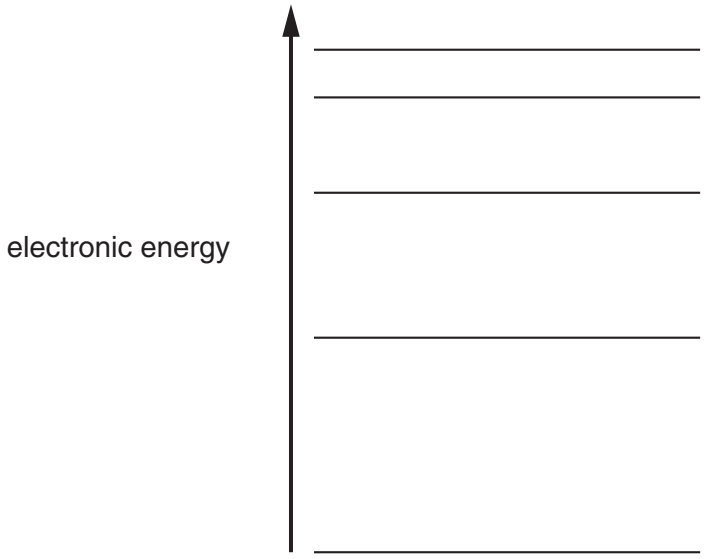
(e) Strontium compounds give a vivid bright crimson–red colour to the flame of signal flares or fireworks.

The visible region in the **emission** spectrum of strontium contains several coloured lines. The vivid flame colour is due to a very intense line at the red end of the spectrum.

The diagram below represents electronic energy levels in a strontium atom.

On the diagram, draw two arrows:

- one to represent an electron energy level change that might give rise to a **red**, low frequency line; label this arrow 'red'
- one to represent an electron energy level change that might give rise to a **blue**, high frequency line; label this arrow 'blue'.



[2]

(f) **(i)** Strontium carbonate, occurring naturally as the mineral 'strontianite', is a compound that can be used in warning flares to produce the crimson–red colour.

Give the formula of strontium carbonate.

formula ..... [1]

(ii) The high temperature of flares causes the strontium carbonate to decompose.

Name the **two** products formed when strontium carbonate decomposes.

.....

..... [2]

[Total: 23]

3 The UK's energy needs are currently supplied by a mix of fossil fuel-burning power stations, nuclear fission reactors and a small contribution from renewable energy sources.

(a) A disadvantage of fossil fuels is that, on combustion, toxic oxides are produced such as nitrogen monoxide, NO.

Give the formulae of **two** other possible toxic oxides formed during the combustion of fossil fuels.

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

(b) **(i)** NO reacts with oxygen to form NO_2. Write a balanced equation for this reaction.

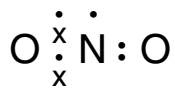
[1]

(ii) Nitrogen dioxide reacts with water and oxygen in the atmosphere to form a dilute solution of nitric acid, HNO_3.

Write a balanced equation for this reaction. Include state symbols.

[3]

(c) Nitrogen dioxide is a 'radical' as it has an unpaired electron. Part of the dot-cross diagram for NO_2, showing the electrons around the nitrogen atom, is shown below.



(i) In order to draw this diagram, it is necessary to know the number of electrons supplied by the nitrogen atom. Explain how you know that nitrogen has five outer-shell electrons.

.....

.....[1]

(ii) Complete the dot-cross diagram above by adding electrons around the oxygen atoms. [2]

(iii) Describe the type of bond shown between the nitrogen atom and the right-hand oxygen atom.

.....[1]

(d) A typical nuclear fission reactor contains a mix of uranium and plutonium isotopes, such as uranium-235, uranium-233 and plutonium-239. Complete the following table.

isotope	number of protons	number of neutrons	number of electrons
uranium-235			92
uranium-233		141	
plutonium-239	94		

[3]

(e) Plutonium-239 is present in nuclear reactors as the oxide, PuO_2.

Calculate the percentage by mass of plutonium in PuO_2.

A_r: O, 16; Pu, 239

percentage by mass = ... [3]

(f) Another approach to supplying our future energy needs might involve nuclear **fusion**. This takes place readily in the Sun and releases large amounts of energy.

(i) The nuclear equation below shows a typical fusion reaction in the Sun.

Complete the reaction to show the products.

$$^{2}_{1}H + {}^{3}_{1}H \rightarrow {}^{\cdots\cdots}_{\cdots\cdots}\cdots\cdots + {}^{\cdots\cdots}_{\cdots\cdots}n$$

[3]

(ii) It is possible to achieve this fusion in special reactors such as the 'JET' reactor developed in the UK.

This reactor runs at about 150 million °C.

Suggest why such a high temperature is needed before fusion will take place.

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.....

..... [2]

[Total: 21]

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4 A group of students used a data search to investigate the standard enthalpy change of combustion for the structural isomers of molecular formulae C_5H_{12} and C_2H_6O.

The values are given below.

molecular formula	isomers	standard enthalpy change of combustion, $\Delta H_c^{\ominus}$ / kJ mol^{-1}
C_5H_{12}	$CH_3CH_2CH_2CH_2CH_3$	–3509
	$CH_3CH(CH_3)CH_2CH_3$	–3503
	$C(CH_3)_4$	–3517
C_2H_6O	C_2H_5OH	–1367
	$(CH_3)_2O$	–1454

(a) Explain the term *standard enthalpy change of combustion*.

.....

.....

..... [3]

(b) In the table below name the three isomers of C_5H_{12}.

isomer	name
$CH_3CH_2CH_2CH_2CH_3$	
$CH_3CH(CH_3)CH_2CH_3$	
$C(CH_3)_4$	

[3]

(c) (i) Draw the **full** structural formulae for both ethanol, CH_3CH_2OH, and its isomer, $(CH_3)_2O$, in the boxes below.

ethanol	**isomer of ethanol, $(CH_3)_2O$**

[2]

(ii) Name the functional group in $(CH_3)_2O$.

..... [1]

(iii) Both isomers of C_2H_6O produce CO_2 and H_2O on complete combustion.

Write a balanced equation to show the complete combustion of C_2H_6O.

[2]

(d) (i) Explain, using ideas of bond breaking and bond making, why some reactions are exothermic.

.....

.....

..... [3]

(ii) The values in the table show the hydrocarbon isomers to have similar values for $\Delta H_c^{\ominus}$, whereas those for the C_2H_6O isomers are different even though the products are the same.

Suggest, using ideas of bond enthalpy and specifying the bonds involved:

- why the hydrocarbon isomers have similar values
- why the isomers of C_2H_6O have different values.

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..... [5]

[Total: 19]

END OF QUESTION PAPER

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