OCR
RECOGNISING ACHIEVEMENT

ADVANCED SUBSIDIARY GCE

CHEMISTRY (SALTERS)

2850/01

Chemistry for Life

WEDNESDAY 6 JUNE 2007

Morning

Time: 1 hour 15 minutes

Additional materials: Scientific calculator
Data Sheet for Chemistry (Salters) (Inserted)

Candidate Name	

Centre Number						Candidate Number				

INSTRUCTIONS TO CANDIDATES

- Write your name, Centre number and Candidate number in the boxes above.
- Answer **all** the questions.
- Use blue or black ink. Pencil may be used for graphs and diagrams only.
- Read each question carefully and make sure you know what you have to do before starting your answer.
- Do **not** write in the bar code.
- Do **not** write outside the box bordering each page.
- WRITE YOUR ANSWER TO EACH QUESTION IN THE SPACE PROVIDED. ANSWERS WRITTEN ELSEWHERE WILL NOT BE MARKED.

INFORMATION FOR CANDIDATES

- The number of marks for each question is given in brackets [ ] at the end of each question or part question.
- You will be awarded marks for the quality of written communication where this is indicated in the question.
- You may use a scientific calculator.
- A copy of the *Data Sheet for Chemistry (Salters)* is provided as an insert with this question paper.
- You are advised to show all the steps in any calculation.

FOR EXAMINER'S USE		
Qu.	**Max.**	**Mark**
1	**16**	
2	**22**	
3	**17**	
4	**20**	
TOTAL	**75**	

This document consists of **15** printed pages, **1** blank page and a *Data Sheet for Chemistry (Salters)*.

Answer **all** the questions.

1 One widely available type of smoke detector contains a radioisotope of americium (Am), americium-241. This isotope, contained in a separate container within the detector, decays by alpha emission.
The alpha particles emitted by the americium-241 collide with air molecules in the chamber and produce ions.

(a) Use your Periodic Table to complete the following equation for the decay of americium-241.

$$^{241}_{95}\text{Am} \rightarrow {}^{\ldots\ldots}_{\ldots\ldots}\alpha + {}^{\ldots\ldots}_{\ldots\ldots}\ldots\ldots$$

[3]

(b) Although alpha particles are normally hazardous to health, the alpha particles generated in smoke detectors do not pose a risk provided the detector is not damaged in any way.

(i) Suggest why there is no significant health risk in normal usage of smoke detectors.

.....

.....[2]

(ii) Suggest how alpha particles cause ionisation of air molecules in the smoke detector.

.....

.....[1]

(c) The americium in smoke detectors is in the form of an oxide. A sample of the oxide contains 88.3% by mass of americium.

(i) Calculate the empirical formula of the oxide.

A_r: Am, 241; O, 16

empirical formula = ... [2]

(ii) 0.008 moles of americium oxide is enough for 5000 smoke detectors.
Calculate the mass, in grams, of americium oxide **per** smoke detector.

Give your answer to **one** significant figure.

mass = ...g [3]

(d) Another isotope of americium is americium-243.

(i) Complete the following table for the two isotopes, americium-243 and americium-241.

isotope	protons	neutrons	electrons
americium-243			
americium-241			

[3]

(ii) Americium-243 is produced by the **beta** decay of an isotope of plutonium.

Fill in the mass number and atomic number of this plutonium isotope in the appropriate places below.

$$^{\ldots\ldots}_{\ldots\ldots}\mathrm{Pu}$$

[2]

[Total: 16]

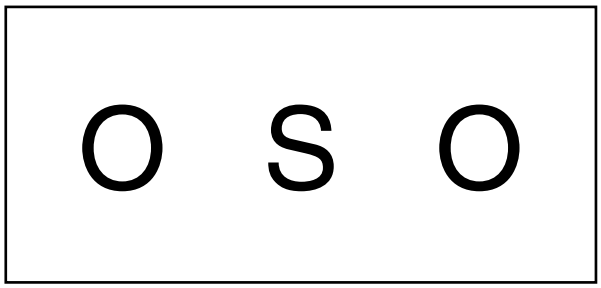
2 'Low sulphur fuel' is now a familiar label on the pumps at petrol stations. The removal of sulphur from diesel and petrol significantly reduces the emission of toxic oxides of sulphur from vehicle exhausts.

(a) (i) One oxide of sulphur is the gas sulphur dioxide, SO_2.

One way to represent the bonding in sulphur dioxide is given below.

$$O{=}S{\rightarrow}O$$

Use the structure above to draw a dot-cross diagram in the box below.
Show **all outer electrons**.



[3]

(ii) The **actual** shape of the sulphur dioxide molecule is 'V'-shaped.

Explain why you would predict this shape for the SO_2 molecule.

.....

.....

.....

.....

..... [3]

(b) Sulphur dioxide reacts with water and oxygen in the atmosphere to produce 'acid rain', a dilute solution of sulphuric acid.
Write a balanced equation to show the formation of sulphuric acid from the reaction between sulphur dioxide, water and oxygen. Include state symbols.

[3]

(c) One process used to remove sulphur compounds from petroleum and diesel is called 'hydroprocessing'. This process uses catalysts consisting of metals deposited as thin layers on porous aluminium supports.

(i) Name the **type** of catalysis used in hydroprocessing.

.....[1]

(ii) Suggest **two** reasons for the metals being used as thin layers.

.....

.....[2]

(d) Hydroprocessing converts the sulphur compounds in the fuel to the gas hydrogen sulphide, H_2S. **Some** of the hydrogen sulphide produced is oxidised to sulphur dioxide and water as shown in **equation 2.1**.

$$2H_2S(g) + 3O_2(g) \longrightarrow 2SO_2(g) + 2H_2O(g) \qquad \textbf{equation 2.1}$$

The sulphur dioxide produced is then reacted with the remaining hydrogen sulphide to produce solid sulphur as follows.

$$2H_2S(g) + SO_2(g) \longrightarrow 3S(s) + 2H_2O(l) \qquad \textbf{equation 2.2}$$

(i) What volume of oxygen is needed to react with 1 dm^3 of hydrogen sulphide gas in **equation 2.1**? Assume the gases are under the same conditions of temperature and pressure.

volume = ...dm^3 [1]

(ii) Suggest why oil companies convert the sulphur compounds into sulphur.

.....

.....[1]

(e) The reaction represented by **equation 2.2** is accompanied by an entropy change.

$$2H_2S(g) + SO_2(g) \longrightarrow 3S(s) + 2H_2O(l) \qquad \textbf{equation 2.2}$$

The table below contains some statements relating to this reaction or to the idea of entropy in general. Four of these statements are correct.
Put a tick in the box next to each correct statement.

statement	(✓)
Entropy can be thought of in terms of the number of ways of arrangement of a chemical system.	
The entropy change in **equation 2.2** above has a positive sign.	
Entropy is a measure of the disorder of a system.	
A substance in the solid state has higher entropy than when molten.	
The symbol for entropy is *S*.	
The reaction in **equation 2.2** is accompanied by a decrease in entropy.	

[3]

(f) Use the bond enthalpy data provided below to work out an **enthalpy** change for the reaction in **equation 2.1**.

$$2H_2S(g) + 3O_2(g) \longrightarrow 2SO_2(g) + 2H_2O(g) \qquad \textbf{equation 2.1}$$

bond	bond enthalpy/kJ mol^{-1}
H–S	364
S=O	525
S⟶O	265
H–O	464
O=O	498

Clearly lay out all your working using the grid below.

bonds broken	enthalpy change	bonds formed	enthalpy change
total for breaking bonds		total for forming new bonds	
overall enthalpy change/kJ mol^{-1}			

[4]

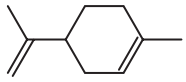
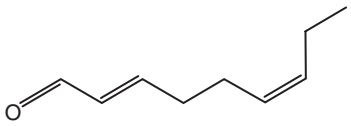
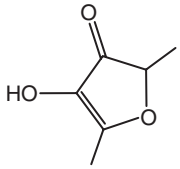
(g) The calculated value using the bond enthalpies above is not the same as the enthalpy change for this reaction done under standard conditions.
Suggest **one** reason for the difference in values.

.....[1]

[Total: 22]

3 A scientific approach to cooking is seen by some chefs as increasingly important. Knowledge of the nature of some reactions and the molecules involved in preparing exciting dishes is now much better understood.

(a) The table below shows molecules contributing to some characteristic flavours.

letter	molecule	flavour
A		orange
B		cucumber
C		strawberries

(i) Which letter(s) show a molecule or molecules

with an alcohol group .....

that is a hydrocarbon .....

with an ether group .....

with an alkene group ..... [4]

(ii) The above formulae are skeletal. Give the molecular formula for **molecule A**.

.....[1]

(iii) What extra piece of information does a skeletal formula provide that is not given by a molecular formula?

.....[1]

(b) Baking powder is used in the manufacture of foodstuffs that require a honeycomb structure, such as bread.
Baking powder contains sodium hydrogencarbonate, $NaHCO_3$. This decomposes on heating as shown below.

$$2NaHCO_3(s) \longrightarrow Na_2CO_3(s) + CO_2(g) + H_2O(l)$$

10 g of sodium hydrogencarbonate were needed in the manufacture of a sponge cake.

Calculate the maximum volume (in dm^3) of carbon dioxide that could be produced, at room temperature and pressure, by decomposing this mass of sodium hydrogencarbonate.

One mole of any gas has a volume of 24 dm^3 at room temperature and pressure.

A_r: Na, 23; H,1.0; C,12; O,16

volume = ...dm^3 [3]

(c) The calcium ion content of water can affect both the colour and texture of cooked vegetables.
Hard water areas contain relatively high concentrations of calcium ions. This is caused by groundwater running over naturally occurring calcium compounds such as limestone, an impure form of calcium carbonate.

(i) Describe the trend in the solubility of the Group 2 carbonates.

.....

.....[1]

(ii) Calcium, like all the Group 2 elements, forms a 2+ ion in its compounds.

Suggest why the elements in Group 2 do not readily form 3+ ions.

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.....[2]

(iii) The Group 2 elements form 2+ ions more easily as the group is descended and this is directly related to their reactivity.

Describe and compare the reactivity of calcium and magnesium metals with water. Include a balanced equation in your answer.

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.....[5]

[Total: 17]

4 Chemists play an important role in developing fuels for the future.
One area of interest has been in the 'hydrogen economy' where chemists have been looking at the possibilities of using hydrogen as a fuel, either directly or indirectly.

(a) (i) Hydrogen can be burnt as a fuel in an internal combustion engine. Give **one** advantage of hydrogen over petrol.

.....[1]

(ii) Describe **one** way in which hydrogen can be produced.

.....

.....[1]

(iii) Why might your method of production in **(ii) not** save fossil fuels?

.....

.....[1]

(b) One novel way of producing hydrogen is to use 'Powerballs'. These contain the **ionic** compound sodium hydride, NaH, encapsulated inside poly(ethene) spheres.

The Powerballs are stored in water and are cut open automatically to allow the sodium hydride to react with the water and produce hydrogen when required.

(i) The hydride ion is H^-. Draw a dot-cross diagram to represent **both** of the ions in sodium hydride. You should show outer electrons only.

[2]

(ii) The reaction of the sodium hydride with water produces sodium hydroxide solution as well as hydrogen.

Write a balanced equation for this reaction.

[2]

(iii) One hazard involved in this process is the flammability of hydrogen.
Suggest another chemical hazard.

.....[1]

(c) Methanol can be used in internal combustion engines.

(i) One advantage of methanol is that it has a high octane number.

Explain the term *octane number*.

.....

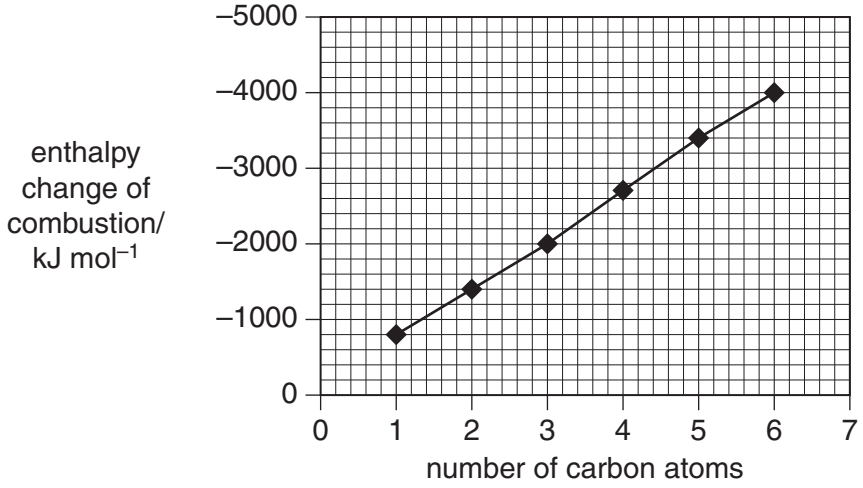
.....

.....[2]

(ii) Methanol is an alcohol. Other alcohols could potentially be used as fuels.

The following graph shows the relationship between the number of carbon atoms in straight-chain alcohols and their enthalpy changes of combustion under standard conditions.

Enthalpy change of combustion for successive alcohols



Describe and explain the pattern shown by the graph.

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.....[5]

(iii) The graph shows data for successive straight-chain alcohols.

Alcohols with three or more carbon atoms have structural isomers.

Explain the term *structural isomer*.

.....

.....[1]

(iv) Draw the **full structural** formulae for **both** the branched chain alcohols containing four carbon atoms. Give the names of the alcohols you have drawn.

name: .....

name: .....

[4]

[Total: 20]

END OF QUESTION PAPER

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