OCR
RECOGNISING ACHIEVEMENT

OXFORD CAMBRIDGE AND RSA EXAMINATIONS
Advanced Subsidiary GCE

CHEMISTRY (SALTERS)

Chemistry for Life

2850

Wednesday **7 JUNE 2006** Morning 1 hour 15 minutes

Candidates answer on the question paper.
Additional materials:
Data Sheet for Chemistry (Salters)
Scientific calculator

Candidate Name

Centre Number

Candidate Number

TIME 1 hour 15 minutes

INSTRUCTIONS TO CANDIDATES

- Write your name, Centre number and candidate number in the boxes above.
- Answer **all** the questions.
- Read each question carefully and make sure you know what you have to do before starting your answer.
- Write your answers, in blue or black ink, in the spaces provided on the question paper.
- Pencils may be used for diagrams and graphs **only**.
- Do not write in the bar code. Do not write in the grey area between the pages.
- **DO NOT** WRITE IN THE AREA **OUTSIDE** THE BOX BORDERING EACH PAGE. ANY WRITING IN THIS AREA WILL NOT BE MARKED.

INFORMATION FOR CANDIDATES

- The number of marks is given in brackets [ ] at the end of each question or part question.
- 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	**26**	
2	**13**	
3	**16**	
4	**20**	
TOTAL	**75**	

This question paper consists of 12 printed pages.

[Turn over

Answer **all** the questions.

1 Consumers are demanding food which is fresher and has a longer shelf-life.

Packaging technology makes use of some simple chemical reactions to control the composition of the head space (the space between the food and package). Some of these reactions control the levels of oxygen, carbon dioxide, moisture and ethene in the head space.

(a) Oxygen in the head space often accelerates food spoilage. Iron metal in sachets removes oxygen and is said to act as an oxygen scavenger.

The iron reacts with the oxygen, in the presence of moisture, as shown in the following equation.

Balance the equation.

$$4Fe(s) + ...O_2(g) + ...H_2O(l) \longrightarrow 4Fe(OH)_3(s)$$ [2]

(b) Carbon dioxide regulation is particularly important in coffee packaging. The CO_2 is scavenged by reacting it with moist calcium oxide contained in sachets. The product is calcium carbonate, and the equation is written below.

$$CaO(s) + CO_2(g) \longrightarrow CaCO_3(s)$$ **equation 1.1**

(i) What property of calcium oxide means it reacts readily with carbon dioxide?

..... [1]

(ii) The solubility of the carbonates of the elements in Group 2 decreases as you go down the group.

Name a Group 2 property which **increases** as you go down the group.

..... [1]

(iii) The sachets contain 0.80 g of calcium oxide. Calculate the maximum volume of carbon dioxide (in **cm^3**) that could be removed by the reaction in **equation 1.1**.

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

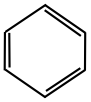
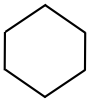
1.0 dm^3 = 1000 cm^3; A_r: Ca, 40; O, 16

One mole of gas occupies 24 dm^3 at room temperature and pressure.

volume = ... cm^3 [4]

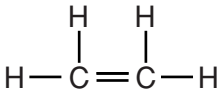
(c) Ethene, CH_2CH_2, is a hydrocarbon gas which can accelerate softening and ageing in fruit.

(i) Classify each of the hydrocarbons below as an alkane, alkene, cycloalkane or arene. The first one has been done for you.

hydrocarbon	classification
CH_2CH_2	alkene
	
$CH_2CHCH_2CH_3$	
	
C_6H_{14}	

[4]

(ii) The ethene molecule can be represented by the following structure.



The bond angles shown in this representation are **not** the actual bond angles in the molecule.

Suggest a value for the HCH bond angle and explain this in terms of electron pair repulsion theory. Give the overall shape of the ethene molecule.

bond angle = ... °

.....

.....

.....

.....

..... [5]

(iii) Ethene is produced in cracking reactions.

Explain the term *cracking* as used in the petrochemical industry.

.....

..... [2]

(iv) In catalytic cracking, some of the hydrocarbons decompose to produce carbon.

This can render the catalyst inactive.

Describe how a heterogeneous catalyst works and suggest why the presence of carbon can cause the catalyst to become inactive.

.....

.....

.....

.....

.....

.....

..... [5]

(v) Naturally occurring compounds called 'zeolites' are used as heterogeneous catalysts but can also be used in food packaging to lower the moisture content in the head space.

What feature of the structure of zeolites makes them good at absorbing small molecules?

.....

.....

..... [2]

[Total: 26]

2 Dying stars often give off carbon, indeed some particularly carbon-rich stars are surrounded by a haze of carbon molecules of different structures and molecular masses.

(a) **(i)** The discovery of the C_{60} molecule, 'buckminsterfullerene' was the result of attempts to make similar carbon molecules to those found around dying stars.

A key piece of evidence in the discovery of C_{60} was provided by mass spectrometry.

The following passage is part of a student's explanation of how a mass spectrometer works. Read it and answer the questions that follow.

'First the sample is injected into a chamber and then the molecules or atoms are ionised by gaining electrons. The resulting ions are accelerated through charged plates into a curved part of the apparatus under high pressure. The ions are deflected according to their mass and focussed onto a detector by varying the magnetic field.'

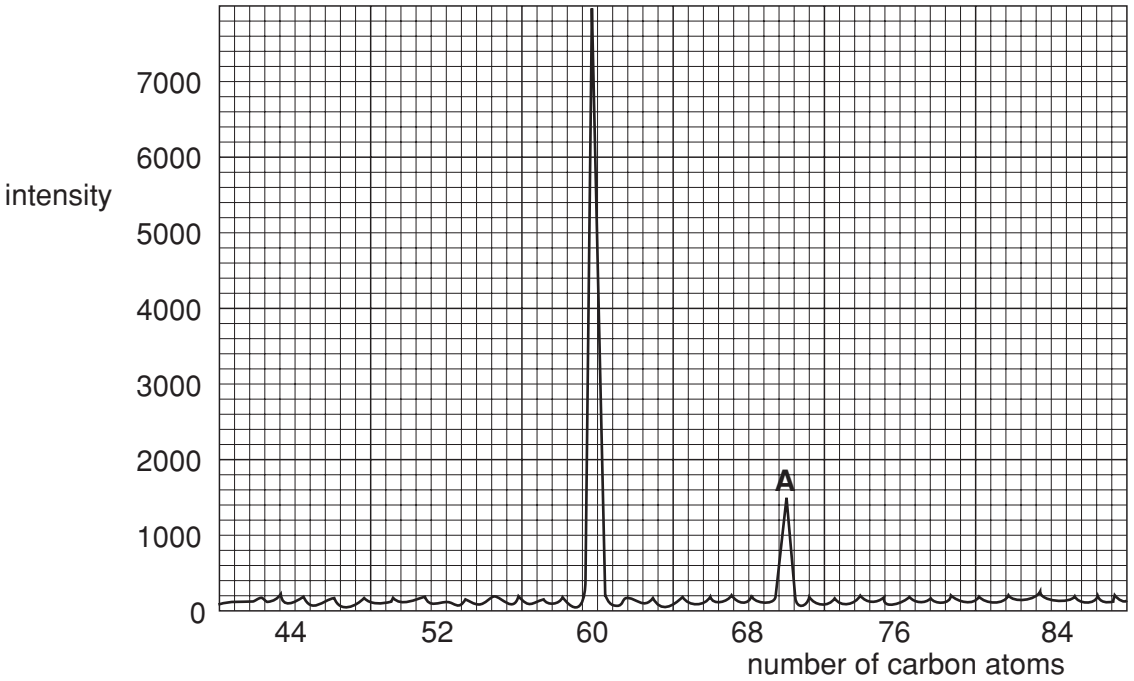
There are two scientific mistakes in the student's explanation. For **each** mistake, put a ring around the word which is incorrect, and give the correct wording below.

.....

..... [4]

(ii) A simplified mass spectrum which shows the presence of a carbon molecule is shown below.

What is the formula of the carbon molecule that gives rise to peak '**A**'?



answer ..... [1]

(b) The age of carbon-containing materials can be measured using radiocarbon dating.

The radioactive carbon-14 isotope is found in small amounts in all living organisms, and the proportion of this isotope remains constant until the organism dies.

(i) How does the atomic structure of carbon-14 differ from that of the more common carbon-12 atom?

.....

.....

..... [2]

(ii) When a carbon-containing organism dies, the radioactivity due to the carbon-14 atoms present halves approximately every 6000 years as these atoms undergo radioactive decay.

Cheap ethanol, C_2H_5OH, manufactured from crude oil, can be used in fake wines instead of ethanol derived from the fermentation of grapes.

This fake wine, however, shows very little radioactivity compared to genuine wine.

Using the information above, suggest why fake wine shows very little radioactivity.

.....

.....

.....

..... [3]

(c) The presence of atoms or ions of individual elements in the gas surrounding stars is shown by atomic emission spectroscopy.

Describe the appearance of an atomic emission spectrum.

.....

.....

..... [3]

[Total: 13]

3 Satellites are sometimes propelled by 'ion engines' rather than conventional fuels.

In an ion engine, atoms of a heavy element, typically caesium or xenon, are ionised in a vacuum chamber. The ions are then accelerated through an electric field and ejected out of a nozzle providing the thrust.

(a) **(i)** Write an equation below to represent the first ionisation enthalpy of caesium (Cs). Show state symbols.

[3]

(ii) The value of the first ionisation enthalpy for caesium is less than that of sodium.

Explain, using your knowledge of atomic structure, why this is the case.

.....

.....

.....

.....

..... [3]

(b) Caesium is stored under oil because it reacts rapidly with oxygen to form a highly dangerous 'superoxide'.

Analysis of a sample of the superoxide showed the compound to contain 80.6% caesium by mass, the rest being oxygen.

Calculate the empirical formula for the superoxide. Show your working.

A_r: Cs, 133; O, 16

empirical formula ..... [3]

(c) Ion propulsion systems using xenon propel the space probe, 'Deep Space 1'.

(i) Xenon is found in Group 0 of the Periodic Table. Explain, in simple terms, how the electronic structure of an element is related to its group.

.....

.....

..... [2]

(ii) There are nine naturally occurring isotopes of xenon.

Explain the term *isotopes*.

.....

.....

..... [2]

(d) Higher than expected levels of the xenon isotope, xenon-129, are found in some stony meteorites. This is thought to be because of the radioactive decay of iodine-129.

Write a nuclear equation in the space below to represent the radioactive decay of iodine-129 to xenon-129.

[3]

[Total: 16]

4 Nitrous oxide, N_2O, can be injected into an internal combustion engine in order to significantly increase power output.

Nitrous injection has been used in high performance cars such as dragsters and even in aircraft engines.

(a) The bonding in nitrous oxide can be represented as follows.

$$N{\equiv}N{\rightarrow}O$$

Draw an electron 'dot-cross' diagram for this molecule. Use the outline below.

N N O

[4]

(b) At the high temperature of the engine's combustion chamber, nitrous oxide decomposes into nitrogen gas and oxygen gas. This means more oxygen is available during combustion and therefore more fuel can be burnt.

(i) The equation for the decomposition is given below.

$$2N_2O(g) \longrightarrow 2N_2(g) + O_2(g) \qquad \textbf{equation 4.1}$$

Use the following bond enthalpy data to calculate the enthalpy change for this reaction.

bond	bond enthalpy / kJ mol^{-1}
N≡N (in N_2O)	+481
N≡N (in N_2 gas)	+945
O=O (O_2)	+498
N→O (in N_2O)	+167

enthalpy change = ... kJ mol^{-1} [4]

(ii) Another oxide of nitrogen, nitrogen monoxide, NO, does **not** decompose completely under the conditions present in the combustion chamber. This is because the bond enthalpy of the nitrogen–oxygen bond in this molecule is much greater than that in nitrous oxide.

What can you conclude from the above information about the N–O bond length in nitrogen monoxide compared to that in nitrous oxide?

.....

..... [1]

(c) The decomposition of nitrous oxide, as shown in **equation 4.1**, is accompanied by an increase in **entropy**.

$$2N_2O(g) \longrightarrow 2N_2(g) + O_2(g) \qquad \textbf{equation 4.1}$$

Explain why there is an increase in entropy for this decomposition.

.....

..... [1]

(d) Another way to increase the power of an engine is to change the fuel. Petrol can be replaced by a mixture of methanol, CH_3OH, and nitromethane, CH_3NO_2, in drag car racing.

(i) What name in general is given to compounds in fuels which have oxygen atoms in their molecules?

..... [1]

(ii) Of which homologous series is methanol a member?

..... [1]

(iii) The addition of nitromethane to methanol significantly increases power but also increases the tendency of the engine to 'knock'.

What causes 'knock' in a car engine and what term is used to indicate the tendency of a fuel to cause knocking?

.....

.....

..... [2]

(e) Nitromethane, CH_3NO_2, does not burn as quickly as petrol.

One of the more spectacular pollutants in drag car racing is flames of burning nitromethane being emitted from the exhaust.

The products formed from this burning 'nitro' are carbon dioxide, water and nitrogen gas.

(i) Write a balanced equation for the burning of nitromethane.

[3]

(ii) Exhaust gases from petrol fuelled cars may be less spectacular, but toxic pollutants such as nitrogen monoxide, NO, are present in the exhaust emitted.

Explain the origin of nitrogen monoxide emitted by **petrol** engines.

.....

.....

..... [3]

[Total: 20]

END OF QUESTION PAPER

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