

ADVANCED SUBSIDIARY GCE
CHEMISTRY B (SALTERS)
Chemistry for Life

F331

Candidates answer on the Question Paper
A calculator may be used for this paper

OCR Supplied Materials:

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

Other Materials Required:

- Scientific calculator

Friday 21 May 2010
Afternoon

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. Additional paper may be used if necessary but you must clearly show your Candidate Number, Centre Number and question number(s).

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 **12** pages. Any blank pages are indicated.

Answer **all** the questions.

1 Nitrogen forms several gaseous oxides, including nitrogen monoxide, NO, and dinitrogen oxide, N₂O.

(a) Nitrogen monoxide is a pollutant gas found in car exhaust emissions.

(i) Explain how nitrogen monoxide is formed in a car engine.

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..... [3]

(ii) State **one** polluting effect of nitrogen monoxide and its consequence.

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

(iii) Cars can be fitted with catalytic converters which convert pollutant gases such as nitrogen monoxide to harmless gases.

Name the harmless gas to which nitrogen monoxide is converted when passed over an appropriate catalytic converter.

..... [1]

- (iv) Precious metals such as rhodium are used as heterogeneous catalysts in catalytic converters.

A simple model of heterogeneous catalysis describes four main stages in the process.

List the four stages, in order, below.



Your answer should include the appropriate technical terms, spelled correctly.

Stage 1

.....

Stage 2

.....

Stage 3

.....

Stage 4

..... [4]

- (b) Another oxide of nitrogen, dinitrogen oxide, N_2O , is used in some racing cars. N_2O decomposes readily on heating. The equation for the decomposition is:



The standard enthalpy change of formation, ΔH_f^\ominus , for N_2O is $+82.0 \text{ kJ mol}^{-1}$.

Use the information above to calculate the enthalpy change, under standard conditions, for the reaction represented by **equation 1.1**.

enthalpy change of reaction = kJ mol^{-1} [2]

[Total: 12]

- 2 Information on how the composition of the Earth's atmosphere has changed over thousands of years can be obtained by drilling 3 kilometre deep ice cores in the Antarctic.

Significant changes in concentrations of lead-207 and lead-208 isotopes over the last hundred years have been identified from the analysis of polar ice cores.

- (a) Complete the table below to give the atomic structure of the lead-207 isotope.

isotope	protons	neutrons	electrons
lead-207			

[1]

- (b) A small amount of the element lead that originates from natural sources is always found in the atmosphere. Ice cores analysed using a 'time-of-flight' mass spectrometer show changes in the concentration of this atmospheric lead over time.

In the 'time-of-flight' mass spectrometer

- (i) what causes lead atoms to lose electrons and become cations in the ionisation area?

.....
 [1]

- (ii) what causes the acceleration of lead ions in the acceleration area?

.....
 [1]

- (iii) what property of different isotopes causes their ions to take different times to cross the drift region?

.....
 [1]

- (c) Data from ice core measurements show that the concentration of the lead-208 isotope rose sharply between 1930 and 1960 but has now fallen back again.

- (i) How would the appearance of a mass spectrum of a sample taken from a 1950 core differ from the mass spectrum of a sample from a 1930 core?

.....

 [1]

- (ii) The likely reason for the increase in atmospheric lead levels was the use of volatile lead compounds as 'anti-knock' agents in petrol during the mid 1900s.

Explain the cause of 'knocking' in a car engine and suggest why it is undesirable.

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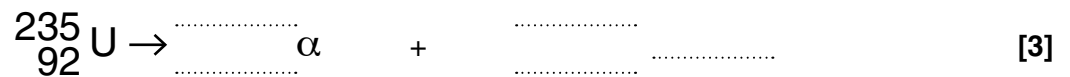
 [2]

- (d) Stable lead-207 atoms are the final product in a series of steps starting with the unstable uranium-235 isotope which is found in some rocks.

- (i) What term is used to describe unstable isotopes of elements?

..... [1]

- (ii) Complete the following nuclear equation for the first step of the breakdown of uranium-235 by alpha decay.



- (iii) The ratio of uranium-235 atoms to lead-207 atoms can be used to determine an approximate age for some rocks.
 The dating relies on the fact that the half-life of any given unstable isotope is fixed.

Explain the term *half-life*.

.....
 [2]

(e) The arrangement of water molecules in ice is very regular. The shape of individual water molecules is important in building up this regular structure.

(i) Draw a 'dot-and-cross' diagram for a water molecule.

[2]

(ii) Use the electron pair repulsion principle to describe and explain the shape of a water molecule **and** suggest the bond angle.

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..... [4]

[Total: 19]

(b) Another compound of barium, barium sulfate, BaSO_4 , is used when medical X-rays of the digestive system are taken. Barium sulfate can be swallowed by patients and causes no harm because it is insoluble.

A data book gives the solubility of barium sulfate as 2.20×10^{-4} g per 100g of water.

Calculate the solubility of barium sulfate in **mol** per 100g of water.

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

solubility of barium sulfate = mol per 100g water [3]

(c) The position of barium in the Periodic Table is related to its electronic structure.

Explain how the electronic structure of barium is related to the group **and** period of the Periodic Table in which it is found.

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

[Total: 13]

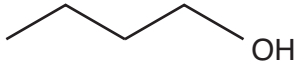
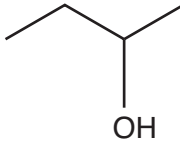
- 4 Bioethanol is a well known 'biofuel'. Biobutanol, which is produced from sugar beet, can also be used as a fuel in some combustion engines.

(a) Name the homologous series to which ethanol and butanol belong.

..... [1]

(b) Butanol has the molecular formula, $C_4H_{10}O$. There are four structural isomers with this formula that contain the $-OH$ functional group.

Complete the table below to show one other isomer of $C_4H_{10}O$ that contains an $-OH$ group.

skeletal formula			
name	butan-1-ol	butan-2-ol	

[2]

(c) Butan-1-ol has several advantages over ethanol as a fuel.

(i) One advantage is that butan-1-ol has a higher energy density (energy per kilogram of fuel).

Calculate the energy density of butan-1-ol in kJ kg^{-1} .

Standard enthalpy change of combustion of butan-1-ol, $\Delta H_c^\ominus = -2676 \text{ kJ mol}^{-1}$

M_r butan-1-ol = 74

energy density = kJ kg^{-1} [2]

- (ii) Explain why many reactions are exothermic, using ideas of bond making and bond breaking.

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..... [3]

- (iii) An advantage of biobutanol is that it mixes well with petrol over a wide range of composition.

Describe and explain the entropy change that occurs when biobutanol mixes with petrol.

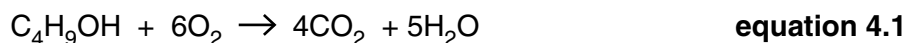
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..... [2]

- (d) A disadvantage of biobutanol is that the air to fuel ratio needed for complete combustion is greater than that of bioethanol.

The equation for the complete combustion of biobutanol vapour in the combustion chamber is given below:



- (i) Write an equation for the complete combustion of bioethanol, $\text{C}_2\text{H}_5\text{OH}$.

[2]

- (ii) Use your equation in (i) and **equation 4.1** to explain why bioethanol requires a lower air to fuel ratio than biobutanol for complete combustion.

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..... [1]

(e) The use of biofuels as replacements for petroleum based fuels involves benefits and disadvantages.

Other than financial cost, suggest:

(i) **two** benefits of using biofuels.

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..... [2]

(ii) **one** disadvantage of using biofuels.

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..... [1]

[Total: 16]

END OF QUESTION PAPER

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