

OXFORD CAMBRIDGE AND RSA EXAMINATIONS

Advanced Subsidiary GCE

CHEMISTRY (SALTERS)

2850

Chemistry for Life

Thursday

10 JUNE 2004

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									
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TIME 1 hour 15 minutes

INSTRUCTIONS TO CANDIDATES

- Write your name in the space above.
- Write your Centre number and Candidate number in the boxes above.
- Answer **all** the questions.
- Write your answers in the spaces provided on the question paper.
- Read each question carefully and make sure you know what you have to do before starting your answer.

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 a *Data Sheet for Chemistry (Salters)*.
- You are advised to show all the steps in calculations.

FOR EXAMINER'S USE		
Qu.	Max.	Mark
1	22	
2	21	
3	21	
4	11	
TOTAL	75	

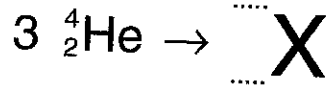
This question paper consists of 12 printed pages.

Answer **all** the questions.

1 The Sun and planets are thought to have formed from a cloud containing hydrogen and helium gases. Other elements were then produced by fusion reactions within the Sun.

(a) One of these reactions is the fusion of three helium nuclei.

(i) Complete the following nuclear equation for this reaction by filling in the atomic number and mass number of the nucleus **X** that is formed.



[2]

(ii) Name the element **X** formed in the above reaction.

.....[1]

(iii) Heavier elements tend to form at the centre of a star. Suggest **two** reasons for this.

1.

.....

2.

.....[2]

(b) Some of the fusion reactions produce unstable radioisotopes such as $^{13}_7\text{N}$. $^{13}_7\text{N}$ decays by β -particle emission and has a half-life of 10 minutes.

(i) Give the number of protons, neutrons and electrons in an atom of $^{13}_7\text{N}$.

protons

neutrons

electrons

[3]

(ii) What is a β -particle?

.....[1]

(iii) Write a nuclear equation for the decay of $^{13}_7\text{N}$.

[3]

- (c) $^{13}_7\text{N}$ has a half-life of 10 minutes.

Suggest a reason why it is difficult to study the reactions of compounds containing $^{13}_7\text{N}$.

.....
 [1]

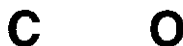
- (d) In colder parts of the universe, between stars, molecules have been identified. One such molecule is carbon monoxide, CO.

- (i) The structure of carbon monoxide is represented as $\text{C} \begin{array}{c} \longleftarrow \\ \equiv \\ \longrightarrow \end{array} \text{O}$

What type of covalent bond is represented by the arrow?

..... [1]

- (ii) Draw a dot-cross diagram for a molecule of carbon monoxide.



[3]

- (iii) Another molecule found in space is OCS, which has the same shape as CO_2 . OCS is not stable under the conditions on Earth. We can, however, predict the shape of the molecule using electron pair repulsion theory. Explain this theory and use it to predict the shape of the OCS molecule.

.....

 [5]

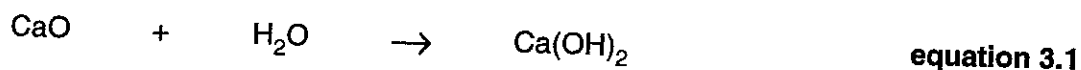
[Total: 22]

- 2 There are cans of coffee that heat themselves when a button on the outside is pressed. Inside the can, in separate compartments, are calcium oxide and water. When the button is pressed, these react together to give enough heat to warm up the coffee.

(a) What term is used to describe a reaction that gives out heat?

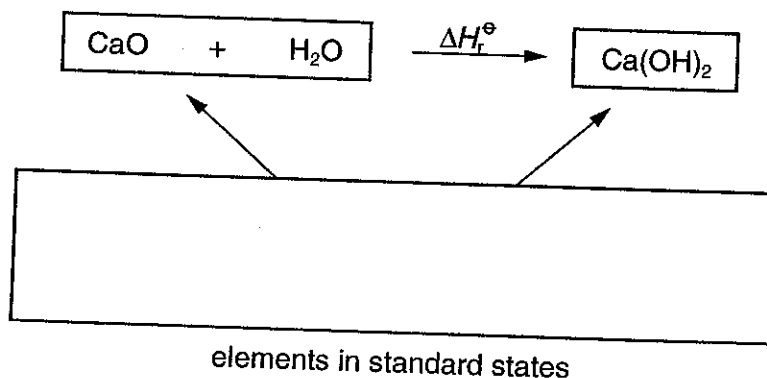
.....[1]

- (b) The equation for the reaction between calcium oxide and water to form solid calcium hydroxide is given below.



- (i) Insert state symbols in the equation above. [1]
- (ii) The value for the standard enthalpy change of the reaction can be calculated using a Hess cycle.

Complete the Hess cycle below by filling in the 'elements' box. Include state symbols.



[2]

- (iii) Use the Hess cycle and the data in the table below to calculate a value for the standard enthalpy change of the reaction, ΔH_r^\ominus .

compound	standard enthalpy change of formation $\Delta H_f^\ominus / \text{kJ mol}^{-1}$
CaO	-635
Ca(OH) ₂	-986
H ₂ O	-286

answerkJ mol⁻¹ [2]

(c) Calculate the mass of water that would be needed to react exactly with 12 g of calcium oxide. Give your answer to two significant figures.

A_r : Ca, 40; O, 16; H, 1.0

mass =g [3]

(d) Solid calcium oxide reacts with an **excess** of water to give calcium hydroxide **solution**. A group of students set out to determine the enthalpy change of this reaction.

(i) Suggest an **experimental procedure** they might use and list the **measurements** they would make.

experimental procedure
.....
.....

measurements
.....
.....
.....
.....[5]

(ii) The value of the standard enthalpy change of reaction of solid calcium oxide with excess water is different from the value you calculated in (b)(iii).

Suggest why it is very difficult to measure directly the enthalpy change you calculated in (b)(iii).

.....
.....
.....[1]

(e) The calcium hydroxide solution contains hydroxide ions.

(i) What term is used to describe a solution containing hydroxide ions?

.....[1]

(ii) How would you test the solution for the presence of aqueous hydroxide ions?

test

result[2]

(f) Magnesium oxide is a possible alternative substance to use in the self-heating cans instead of calcium oxide.

Answer the questions below using your knowledge of Group 2 chemistry.

(i) Compare the solubilities in water of magnesium hydroxide and calcium hydroxide.

.....

.....[1]

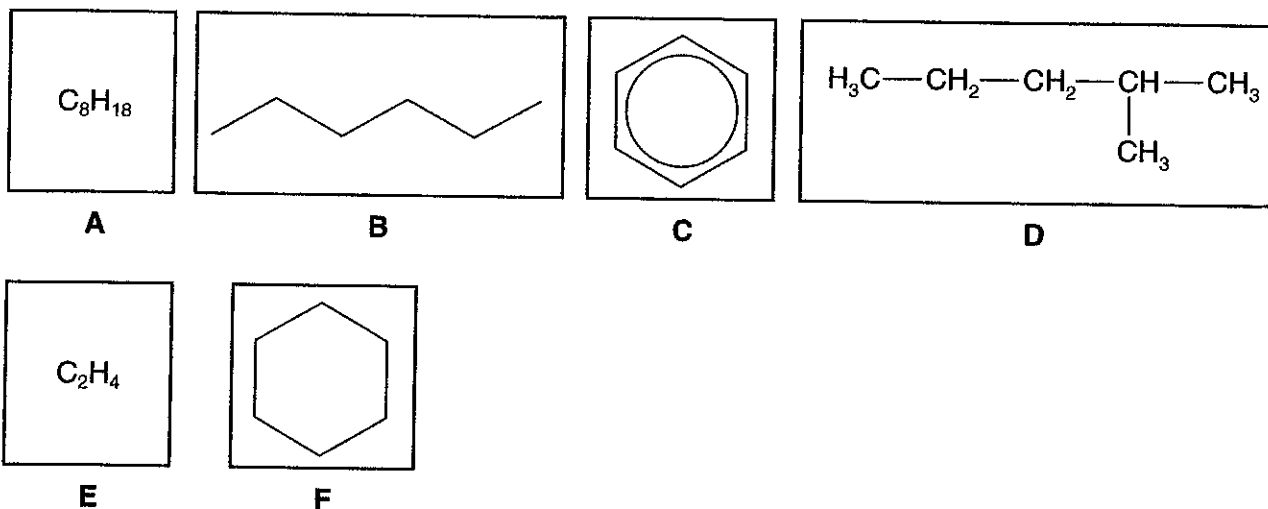
(ii) Write a balanced equation for the reaction of magnesium oxide with dilute hydrochloric acid.

[2]

[Total: 21]

3 Petrol is a complex mixture of compounds, most of which are hydrocarbons.

(a) Some examples of hydrocarbons in petrol are given below, displayed in some of the various ways that chemists use.



Use the letters **A** to **F** to answer the following questions about these hydrocarbons.

- (i) Which are alkanes?[1]
- (ii) Which are structural isomers of each other?[1]
- (iii) Which is an aromatic compound?[1]
- (iv) Which is an alkene?[1]
- (v) Which is a cycloalkane?[1]
- (b) Name **compound D**.[2]
- (c) The hydrocarbon molecules in petrol mix in a very random, disordered manner. What term is used as a measure of the **number of ways of arrangement** of molecules?
.....[1]
- (d) Governments and car manufacturers have both investigated ways of reducing the emissions from car engines. One possible way is the use of 'lean burn' technology for petrol engines.

A lean burn engine uses more air to burn a fixed mass of fuel than does a normal engine. This reduces the amount of carbon monoxide produced in the exhaust gases.

(i) Suggest why less carbon monoxide is formed.

.....

[1]

(ii) The amount of nitrogen monoxide, NO, produced is also less in lean burn engines. Suggest and explain a possible reason why this is the case.

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

(e) Catalytic converters can reduce still further the pollution from lean burn engines.

Catalytic converters use a precious metal such as platinum spread thinly over a honeycomb support. The platinum acts as a heterogeneous catalyst.

(i) What is meant by the terms *heterogeneous* and *catalyst*?

.....
.....
.....
.....
.....
.....[3]

(ii) Suggest **two** reasons why the platinum is used as a **thin** layer on a **honeycomb** support.

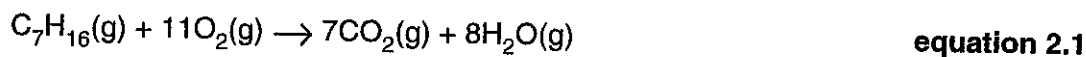
1.
2.[2]

- (f) The longer a car engine runs, the more exhaust gases are produced. Use the steps below to obtain an estimate of the volume of exhaust gases produced by a car each second.

The equation for the complete combustion of heptane vapour in the car engine is shown below.

Assume that petrol is pure heptane (C_7H_{16}).

Assume that carbon dioxide and water are the only gases present in the exhaust.



- (i) 3 g of heptane are burnt per second. Calculate the number of moles of heptane burnt per second.
 A_r : C, 12; H, 1.0

answermol s⁻¹ [2]

- (ii) Using **equation 2.1**, calculate the **total** number of moles of carbon dioxide and water produced per second.

answermol s⁻¹ [2]

- (iii) Calculate the volume of exhaust gases produced per second.

One mole of molecules of the exhaust gases occupies 60 dm³ at the high temperature in the exhaust.

answerdm³ s⁻¹ [1]

[Total: 21]

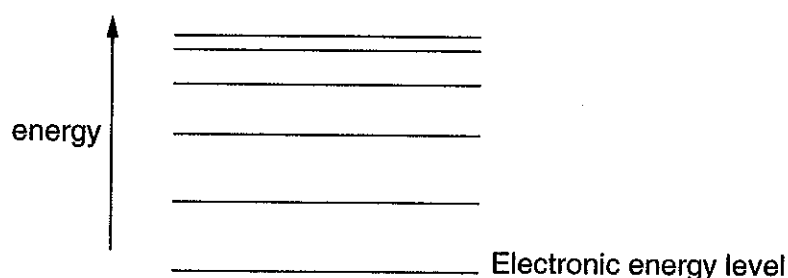
- 4 Chemical analysis has led to the discovery of contaminated goulash! Unscrupulous manufacturers have been known to contaminate the goulash with a red oxide of lead. This oxide looks like the spice paprika and improves the colour of the food. However, this practice has resulted in several deaths since lead compounds are poisonous.

A technique used to detect lead is atomic emission spectroscopy. One form of atomic emission spectroscopy bombards a sample with a stream of ions to excite the atoms.

- (a) What is an ion?

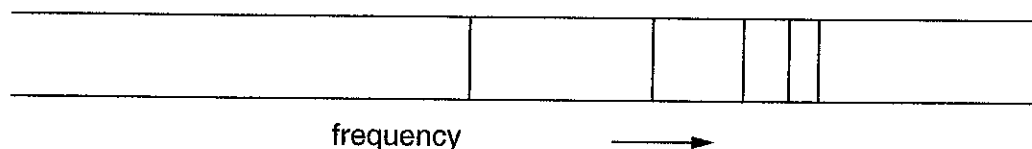
.....[1]

- (b) The diagram below represents some of the different electronic energy levels in an atom. Draw an arrow on the diagram to represent an electron being excited. Label the arrow **A**.



[2]

- (c) The atomic emission spectrum of contaminated goulash shows lines that are not present in the spectrum of normal goulash. These lines correspond to the emission spectrum for lead. Part of the emission spectrum for lead is shown below.



Each line in the spectrum corresponds to an electron changing energy levels.

- On the diagram in (b) above, draw an arrow to show one possible change in energy levels that would give rise to a line in an emission spectrum. Label this arrow **B**. [1]

(d) The full emission spectrum for lead shows more than one set of lines.

In each set, the lines get closer together at high frequencies. Use a diagram, similar to that in (b), to explain

- (i) why there is more than one set of lines in the full emission spectrum [2]
- (ii) why the lines in each set get closer together as the frequency increases. [2]

diagram

(i)

.....

.....

.....

.....

.....

(ii)

.....

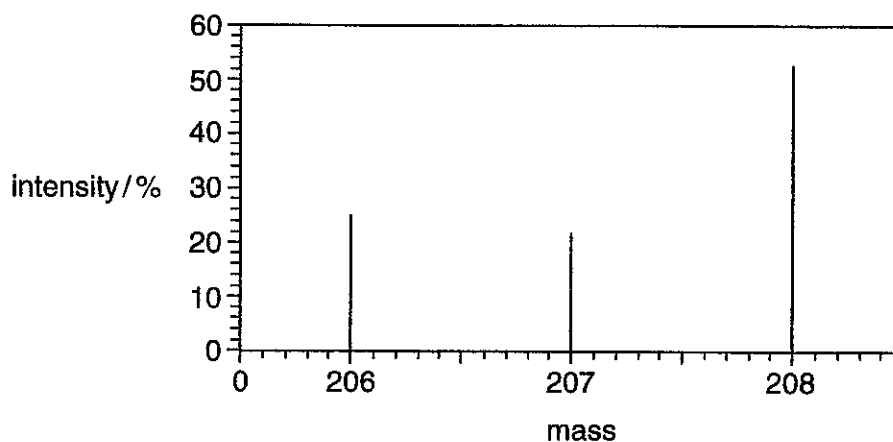
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.....

- (e) Another possible instrumental technique to detect the presence of lead compounds is mass spectrometry. A simplified mass spectrum for lead is shown below.



- (i) Explain why there is more than one peak in the mass spectrum of lead.

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

- (ii) What information is given by the relative heights of the peaks?

..... [1]

[Total: 11]

END OF QUESTION PAPER