

OXFORD CAMBRIDGE AND RSA EXAMINATIONS

Advanced Subsidiary GCE

**CHEMISTRY (SALTERS)**

Chemistry for Life

**2850**

Friday 11 JANUARY 2002 Afternoon 1 hour 30 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 30 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 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 will be awarded marks for the quality of written communication where this is indicated in the question.
- You may use a scientific calculator.
- You are advised to show all the steps in any calculations.
- You may use the *Data Sheet for Chemistry (Salters)*.

FOR EXAMINER'S USE		
Qu.	Max.	Mark
1	18	
2	35	
3	26	
4	11	
<b>TOTAL</b>	<b>90</b>	

This question paper consists of 10 printed pages and 2 blank pages.

- 1 One of the reactions which occurs in the Sun is shown below.



- (a) (i) Name this type of reaction in which nuclei react to form heavier ones.

.....[1]

- (ii) Such reactions generate the Sun's energy.  
Give another reason why this type of reaction is significant.

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

- (b) (i) How many neutrons are there in an atom of  ${}^3_1\text{H}$ ?

.....[1]

- (ii) Explain in terms of their similarities and differences why  ${}^3_1\text{H}$  and  ${}^2_1\text{H}$  are described as *isotopes*.

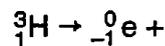
.....  
.....[2]

- (c) Nuclei of  ${}^3_1\text{H}$  are unstable. They release  $\beta$ -particles when they decay.

- (i) Write down the term that describes nuclei which are unstable and decay.

.....[1]

- (ii) Complete the nuclear equation for the decay of  ${}^3_1\text{H}$ .



[3]

- (d) Isotopes emitting  $\beta$ -particles can be used as *tracers*.

- (i) What is the purpose of a *tracer*?

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

- (ii) Name a piece of apparatus normally used to detect  $\beta$ -particles.

.....[1]

(e) Hydrogen atoms in the layers of gas surrounding a star can be detected by characteristic lines in the absorption spectrum of light from the star.

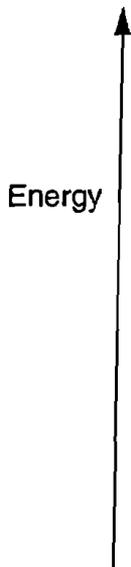
(i) Describe the appearance of an *absorption spectrum*.

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

(ii) Why do hydrogen atoms give an absorption spectrum whereas hydrogen nuclei do not?

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

(iii) Draw a diagram of the energy levels in a hydrogen atom. Draw arrows on this diagram to show the origin of two of the lines in the hydrogen absorption spectrum.



[4]

[Total : 18]

- 2 Liquefied Petroleum Gas (LPG) is used in some motor vehicles as an alternative to petrol. LPG consists mainly of propane which turns into a liquid when compressed.

(a) (i) Draw the full structural formula of propane,  $C_3H_8$ .

[1]

(ii) Write a balanced equation for the complete combustion of propane in oxygen.

[2]

(iii) Use the data below and your answers to (a) (i) and (a) (ii) to calculate a value for the enthalpy change of combustion of propane.

bond	bond enthalpy/ $\text{kJ mol}^{-1}$
C—C	+347
C—H	+413
O=O	+498
O—H	+464
C=O	+805

Answer ..... [4]

(b) Butane is an ingredient of ordinary car petrol.

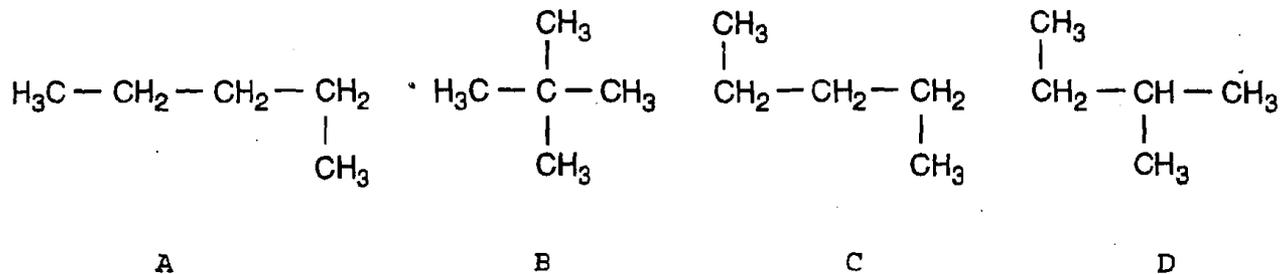
(i) Name the homologous series to which butane and propane belong.

.....[1]

(ii) An experiment shows that complete combustion of  $1.0 \text{ dm}^3$  (measured at room temperature and pressure) of butane produces 120 kJ of energy. Calculate a value for the enthalpy change of combustion of butane, giving the correct sign.  
[1.0 mol of molecules of gas at room temperature and pressure occupies  $24 \text{ dm}^3$ ]

Answer .....  $\text{kJ mol}^{-1}$  [2]

- (c)  $C_5H_{12}$  exists as several *structural isomers*. Choose, from the structures below, **two different structural isomers** which are **not pentane**.



For each structural isomer you have chosen, give the letter and the name.

Letter ..... Name .....

Letter ..... Name ..... [4]

- (d) 'The two isomers that you have chosen have similar enthalpy changes of combustion to that of pentane'.

State, with reasons, whether you think this statement is true or false.

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

- (e) Hydrocarbons used as fuels have different octane ratings.

Why are hydrocarbons with high octane ratings blended into petrol?

Which of the isomers you named in (c) would you expect to have the higher octane rating, and why?

.....  
 .....  
 .....  
 .....  
 .....  
 ..... [4]



(h) Suggest one disadvantage of using LPG compared with ordinary petrol, apart from possible pollution and octane rating.

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

(i) (i) Would you expect the entropy of the system to increase, decrease or stay the same when liquefied propane changes into propane gas?

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

(ii) Explain why the entropy of the system increases when butane gas and propane gas mix.

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

[Total : 35]

3 Calcium carbonate rocks inside the Earth's crust sometimes decompose if the surrounding temperatures are high enough. The rocks give off carbon dioxide gas, which can then dissolve in water from underground springs, making it fizzy. This water is often bottled and sold as 'naturally carbonated spring water'.

(a) (i) Write a balanced chemical equation, with state symbols, for the decomposition of calcium carbonate,  $\text{CaCO}_3$ , to carbon dioxide and calcium oxide.

[2]

(ii) When calcium oxide reacts with water, calcium hydroxide is formed. Give the chemical formula of calcium hydroxide.

.....[1]

(iii) Aqueous calcium hydroxide contains hydroxide ions. What term is used to describe an aqueous solution of hydroxide ions?

.....[1]

(iv) Give details of how you would test the solution for the presence of hydroxide ions.

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

(b) (i) Use your equation in (a) (i) to calculate the volume of carbon dioxide (measured at room temperature and pressure) which would be given off by heating 2.5 g of calcium carbonate.

[ $A_r$ : Ca, 40; C, 12; O, 16;

Volume of 1.0 mole of molecules of gas at room temperature and pressure is  $24 \text{ dm}^3$ ]

Answer ..... [3]

(ii) Draw a labelled diagram of an apparatus you could use in the laboratory to check your answer to (b) (i).

[4]

(c) Magnesium carbonate also occurs in rocks.

(i) Give the electron structures (in terms of electron shells) of magnesium and calcium.

Mg atom.....

Ca atom.....[2]

(ii) Barium carbonate is also found in rocks. In what important way are the electron structures of the Group 2 elements barium, calcium and magnesium the same?

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

(iii) The carbonates of barium, calcium and magnesium all have the formula  $MCO_3$ , where M represents the metal. Explain, in terms of ion charges, why this is so.

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

(d) (i) Which carbonate ( $BaCO_3$ ,  $CaCO_3$  or  $MgCO_3$ ) decomposes at the lowest temperature?

.....[1]

(ii) Describe the trend in the solubilities of the Group 2 hydroxides as the group is descended.

.....[1]

(e) (i) Draw a dot-cross diagram for carbon dioxide, showing the outer electron shells only.

[2]

(ii) Use your diagram in (i) to deduce a value for the bond angle in the carbon dioxide molecule and explain your reasoning.

Bond angle .....

Explanation .....

.....

.....[4]

[Total : 26]

- 4 Catalytic cracking of hydrocarbons is carried out by feeding hot vaporised hydrocarbons and solid catalyst into the bottom of a tube and forcing them upwards by steam. The cracking reactions take place in the few seconds during which the hydrocarbons are in contact with the catalyst.

(a) (i) State what the term *catalyst* means.

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

(ii) What **type** of catalyst is described here?

.....[1]

(b) (i) Write a balanced chemical equation (using molecular formulae) for the cracking of decane (an alkane with ten carbon atoms) to an **alkene** with **three carbon atoms** and another alkane.

[3]

(ii) Draw the **skeletal** formula for the **alkene** from your equation in (b) (i).

[2]

(c) Explain why the **alkanes** produced by cracking are important.

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

[Total : 11]