OCR
RECOGNISING ACHIEVEMENT

OXFORD CAMBRIDGE AND RSA EXAMINATIONS
Advanced Subsidiary GCE

CHEMISTRY (SALTERS) 2850

Chemistry for Life

Wednesday **4 JUNE 2003** 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 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 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	20	
2	27	
3	12	
4	16	
TOTAL	75	

This question paper consists of 12 printed pages.

Registered Charity Number: 1066969
[Turn over

Answer **all** the questions.

1 Mass spectrometry can be used to identify ivory which has been traded illegally. The ratio of ^{12}C to ^{13}C differs in the ivory from different regions, enabling the origin of a sample to be traced.

(a) (i) Complete the table to show the numbers of particles present in atoms of ^{12}C and ^{13}C.

name of particle	^{12}C atom	^{13}C atom
protons		
neutrons		
electrons		

[4]

(ii) Write down the atomic number and the mass number of ^{12}C.

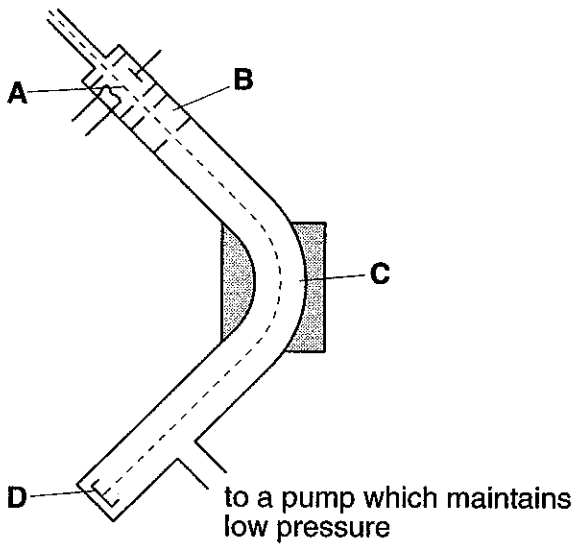
atomic number .....

mass number .....[2]

(b) What term is used to describe two forms of the same element, such as ^{12}C and ^{13}C?

.....[1]

(c) A diagram of a mass spectrometer is shown below.



Particles are ionised at **A** and then accelerated at **B**.
Explain how they are then separated at **C** so that ions of different masses can be detected at **D**.

.....

.....

.....

.....[3]

(d) A sample of ivory contains 98.89% of ^{12}C and 1.11% of ^{13}C. Calculate the relative atomic mass of carbon in the sample to **three** decimal places.

answer ..... [3]

(e) Another form of carbon is ^{15}C. This has a radioactive nucleus that decays, giving β-particles and γ-rays.

(i) Complete the nuclear equation for the decay of ^{15}C to give a β-particle.

$$^{15}_{6}C \longrightarrow$$

[3]

(ii) A sample of a solid carbon compound containing ^{15}C is to be stored safely. Explain how ^{15}C is hazardous and suggest how it should be stored, giving reasons.

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.....

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.....

.....

.....[4]

[Total: 20]

2 The tendency of a fuel to auto-ignite in a petrol engine is measured by its octane rating. The hydrocarbon 2,2,4–trimethylpentane has a low tendency to auto-ignite and is given an octane rating of 100. Heptane has a high tendency to auto-ignite and is give an octane rating of zero.

(a) (i) Name the homologous series to which both 2,2,4-trimethylpentane and heptane belong.

.....[1]

(ii) Draw the structural formula of **heptane**, which has seven carbon atoms in its molecule.

[1]

(iii) Draw the **skeletal** formula of 2,2,4-trimethylpentane.

[2]

(b) Draw the structural formula of an isomer of **heptane** and give its systematic name.

structural formula

name .....[2]

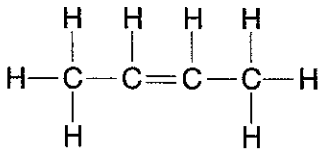
(c) To measure the octane rating of a fuel, the mixture of 2,2,4-trimethylpentane and heptane is found which auto-ignites under the same conditions as the fuel. The percentage of 2,2,4-trimethylpentane in this mixture gives the octane rating.

'Four-star petrol' has an octane rating of 97. Give the composition of a mixture of hydrocarbons that would have the same auto-ignition properties.

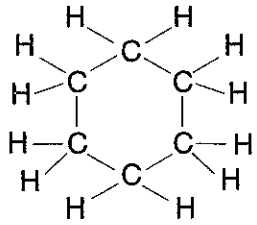
% 2,2,4–trimethylpentane .....

% heptane .....[1]

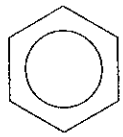
(d) Three compounds that have high octane ratings are shown below.



A



B



C

(i) To which homologous series do compounds **A** and **B** each belong?

compound A.....

compound B.....[2]

(ii) State, with a reason, which of the three compounds is/are **aromatic.**

.....

.....

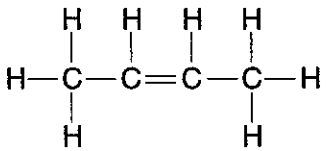
.....[2]

(e) **Compound A** can be made by cracking heptane.

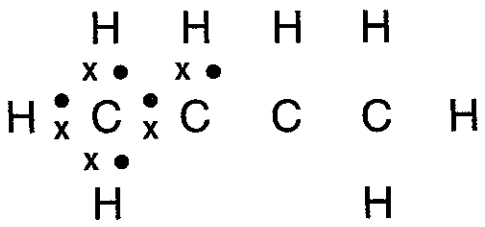
Draw a labelled diagram of the apparatus you would use to crack a sample of liquid heptane and collect the gaseous products.

[3]

(f) (i) Complete the dot-cross diagram for **compound A**.



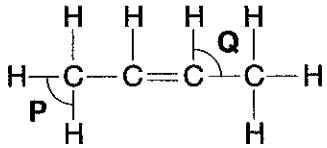
full structural formula for compound A



dot-cross diagram for compound A

[2]

(ii) Give the values of the bond angles **P** and **Q** in the molecule of **compound A**.



P .....

Q .....

[2]

(g) (i) Balance the chemical equation below for the complete combustion of **compound A**.

$$C_4H_8 + ...O_2 \longrightarrow .....CO_2 + ...H_2O$$

[2]

(ii) Use the balanced equation and the data given below to calculate a value for the enthalpy change of combustion of **compound A**.

bond	bond enthalpy /kJ mol^{-1}
C—C	+347
C—H	+413
O=O	+498
C=O	+805
O—H	+464
C=C	+612

answer ..... [4]

(iii) Give **two** reasons why the value from **(ii)**, correctly calculated, will not be the same as a value from a Data Book.

reason 1 .....

.....

reason 2 .....

.....[2]

(iv) The C—C bond is longer than the C=C bond. What evidence is there for this from the table in **(ii)**?

.....

.....[1]

[Total: 27]

3 Modern diesel cars produce less carbon dioxide per mile than petrol cars. They do, however, produce more oxides of nitrogen. They also produce more very small particles of carbon, which are harmful to human health if breathed in. The carbon particles can be removed by filters placed in the exhaust system. These filters are difficult to clean.

(a) (i) Describe how NO is formed in a vehicle engine.

.....

.....

.....[2]

(ii) Describe in detail, **two** polluting effects of oxides of nitrogen.

.....

.....

.....

.....

.....[4]

(b) Suggest how carbon is formed in a diesel engine.

.....[1]

(c) One way of removing carbon particles from the filter is by reaction with NO_2. The NO_2 is made from NO by passing the exhaust gases through a heterogeneous oxidation catalyst of platinum/rhodium.

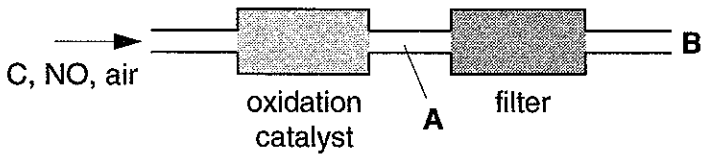
(i) Explain why the catalyst is described as *heterogeneous*.

.....[1]

(ii) Write a balanced chemical equation for the reaction of carbon with nitrogen dioxide to form nitrogen monoxide and carbon dioxide.

[2]

(iii) The diagram below shows the oxidation catalyst and the filter. Carbon particles and nitrogen monoxide (together with air) enter the system.



Assume the catalyst and filter are 100% efficient.

Choose, from the list below, **two** substances that will be present at point **A** and **two** substances that will be present at point **B**.

Substances: **C**, **CO**, **CO_2**, **NO**, **NO_2**

substances present at point **A** ..... and ..... [1]

substances present at point **B** ..... and ..... [1]

[Total: 12]

4 A chemist called Thomas Midgley discovered that lead compounds can be used as 'anti-knocking' agents in petrol. He did this by a systematic search based on the Periodic Table. He made organic compounds of lead and of several related metals and investigated the trends in their properties.

(a) The most successful lead compound, which was widely used until recently, was tetraethyl lead.

Calculate the percentage of lead by mass in tetraethyl lead, $Pb(C_2H_5)_4$.
[A_r : Pb, 207; C,12; H, 1.0]

answer ..... [2]

(b) The type of bonding in lead is called metallic bonding.

(i) Draw a labelled diagram to show how metallic bonding occurs.

[2]

(ii) Explain how the structure is held together.

.....

.....[1]

(c) **(i)** By what property are the elements arranged in the Periodic Table?

.....[1]

(ii) By what property did Mendeleev first arrange them?

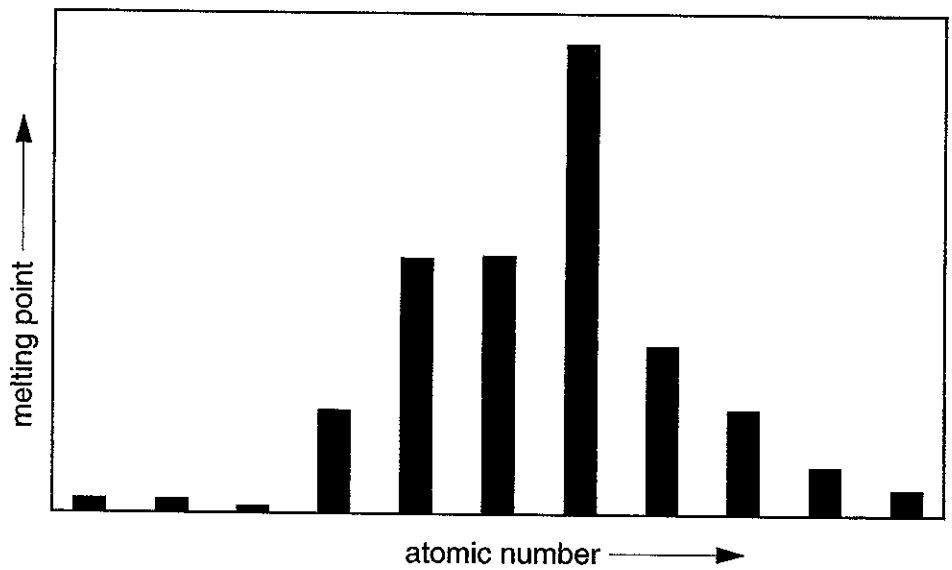
.....[1]

(d) Consider the elements Na, Mg, A*l*, Si, P, S, C*l* in Period 3.

(i) How does the electrical conductivity of these elements change on going from left to right across the period?

.....[1]

(ii) The bar-chart below shows the pattern of melting points of a series of elements arranged in order of ascending atomic number. The elements sodium to chlorine form **part** of this series.



Label the position of **sodium** on the chart.

Explain your choice.....

.....

.....[2]

(iii) Write the equation, **with state symbols**, which represents the first ionisation enthalpy of **sodium**.

[3]

(iv) Which of the elements from Na to C*l* would have the **highest** value for its first ionisation enthalpy? Explain why.

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.....[3]

[Total: 16]