OCR
RECOGNISING ACHIEVEMENT

OXFORD CAMBRIDGE AND RSA EXAMINATIONS

Advanced Subsidiary GCE

CHEMISTRY (SALTERS) 2850

Chemistry for Life

Friday **9 JANUARY 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

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	**24**	
2	**16**	
3	**20**	
4	**15**	
TOTAL	**75**	

This question paper consists of 12 printed pages.

Registered Charity Number: 1066969
[Turn over

Answer **all** the questions.

1 Mexico City suffers from severe photochemical smogs. These are caused by the effect of sunlight on polluting gases from the heavy traffic and from the butane stoves widely used for cooking.

(a) Draw the **full structural formula** of butane, C_4H_{10}.

[1]

(b) Butane for stoves can be liquefied under pressure at room temperature.

(i) Suggest a reason why butane is sold as a liquid rather than as a gas.

.....

.....

.....[1]

(ii) Calculate the volume of butane gas that forms at room temperature and pressure when 2.9 g of butane vaporise.

A_r: C,12; H,1.0

1.0 mol of molecules of a gas at room temperature and pressure occupies 24 dm^3

volume = ...dm^3 [3]

(c) Propane is another hydrocarbon that is used in cooking stoves.

(i) Write the molecular formula of propane.

.....[1]

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

.....[1]

(iii) The table below gives values for the *standard enthalpy change of combustion* of propane and some other hydrocarbons in the same homologous series.

compound	$\Delta H^{\ominus}_{c,\,298}$ / kJ mol^{-1}
methane	–890
ethane	–1560
propane	–2219
butane	

Use the data to predict a value for butane and write it in the empty box.

Explain how you arrived at your answer.

.....

.....

.....

.....[2]

(d) Petrol contains two compounds of formula C_4H_{10} that are structural isomers.
Butane is one of these isomers.

(i) Draw the **skeletal** formula for the **other** isomer and give its systematic name.

skeletal formula

name .....[3]

(ii) The two isomers differ in octane rating.
Why are hydrocarbons with high *octane ratings* used in petrol?
Which isomer has the higher octane rating and why?

.....

.....

.....

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.....

.....

.....[4]

(e) Petrol engines produce nitrogen monoxide. Explain how they do this.

.....

.....

.....[3]

(f) **(i)** Petrol engines produce carbon monoxide as well as nitrogen monoxide. Catalytic converters speed up the reaction of CO with NO to form much less harmful gases. Write a balanced chemical equation for this reaction.

[2]

(ii) Catalytic converters contain heterogeneous catalysts. An explanation of how such catalysts work has four steps. The first step is given below.
Describe the next three steps.

1. The gas molecules are adsorbed onto the catalyst surface.

2. .....

.....

3. .....

.....

4. .....

.....[3]

[Total: 24]

2 Tracers can be injected into the bloodstream to follow blood flow and locate clots and other obstructions in the blood vessels. Sodium chloride containing sodium–24 is a tracer used in this way.

(a) (i) Give the number of protons, neutrons and electrons in an atom of $^{24}_{11}Na$.

protons .....

neutrons .....

electrons ..... [3]

(ii) Two of these particles have similar **masses**. Which are they?

.....[1]

(b) $^{24}_{11}Na$ gives off β-particles and γ-rays.

(i) Circle **two** words in the list below that can be used to describe this effect.

atom **radioactive** **isotope** **decay** **fusion** [2]

(ii) Complete the nuclear equation for the process that occurs when a $^{24}_{11}Na$ atom gives off a β-particle.

$$^{24}_{11}Na \longrightarrow {}^{0}_{-1}e + \square$$ [2]

(c) (i) What piece of equipment would be used to measure the radiation from the $^{24}NaCl$ tracer?

.....[1]

(ii) Describe a possible hazard from using the tracer and explain how it might arise.

.....

.....

.....[2]

(iii) The half-life of the sodium-24 tracer is 15 hours. Explain why this half-life is suitable, rather than a much longer one or a much shorter one.

.....

.....

.....

.....

.....[2]

[Turn over

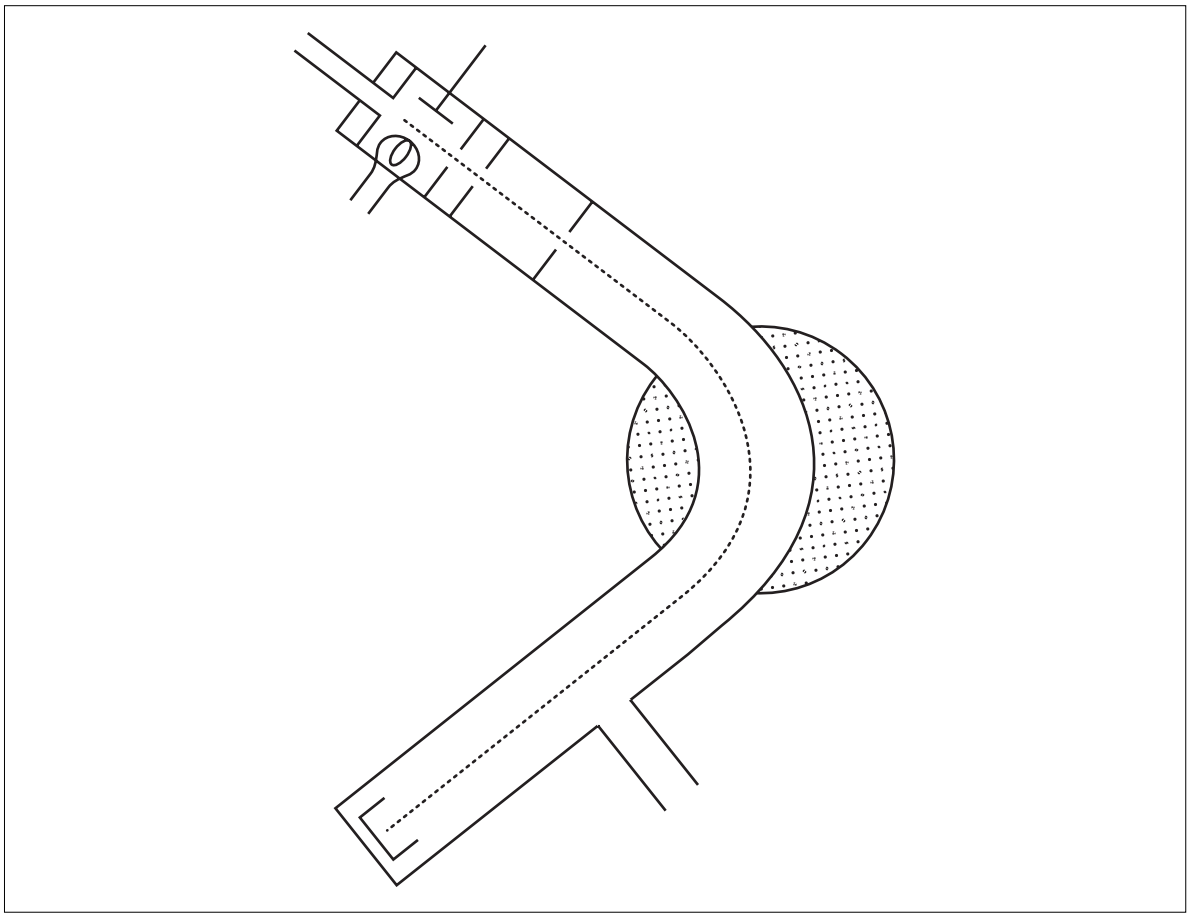
(d) The ratio of ^{24}Na to ^{23}Na in a sample of sodium can be found using a mass spectrometer. A diagram of a mass spectrometer is shown below.

The dotted line shows the path of a sodium-23 ion passing though the apparatus.

(i) Write an equation for the ionisation of a sodium atom in the mass spectrometer.

[1]

(ii) Draw the path of a **sodium-24** ion if the settings of the machine are left the same.



[2]

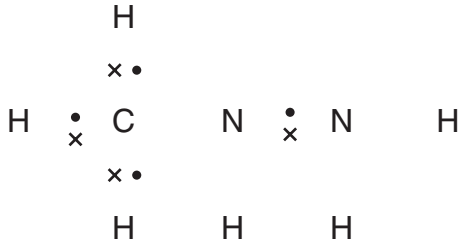
[Total: 16]

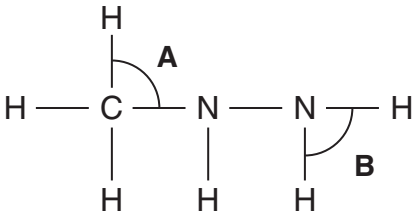
3 A rocket is powered by the reaction between methylhydrazine and dinitrogen tetroxide.

$$4CH_3NHNH_2(l) + 5N_2O_4(l) \longrightarrow 4CO_2(g) + 12H_2O(l) + 9N_2(g) \qquad \textbf{equation 3.1}$$

(a) A partially completed dot-cross diagram and a full structural formula for methylhydrazine are shown below.

(i) Complete the dot-cross diagram for methylhydrazine, showing all the outer shell electrons.





[2]

(ii) Give approximate values for the bond angles **A** and **B** in the methylhydrazine molecule.

A ..... **B** ..... [2]

(b) Use **equation 3.1** to calculate the mass of dinitrogen tetroxide that will combine with 25 g of methylhydrazine. Give your answer to **two** significant figures.

A_r: C, 12; N, 14; H, 1.0; O, 16

$$4CH_3NHNH_2(l) + 5N_2O_4(l) \longrightarrow 4CO_2(g) + 12H_2O(l) + 9N_2(g) \qquad \textbf{equation 3.1}$$

mass = ...[4]

(c) Some standard enthalpy changes of formation are given below.

compound	$\Delta H^{\ominus}_{f,\,298}$ / kJ mol^{-1}
$CH_3NHNH_2(l)$	+54.0
$N_2O_4(l)$	–20.0
$CO_2(g)$	–393
$H_2O(l)$	–286

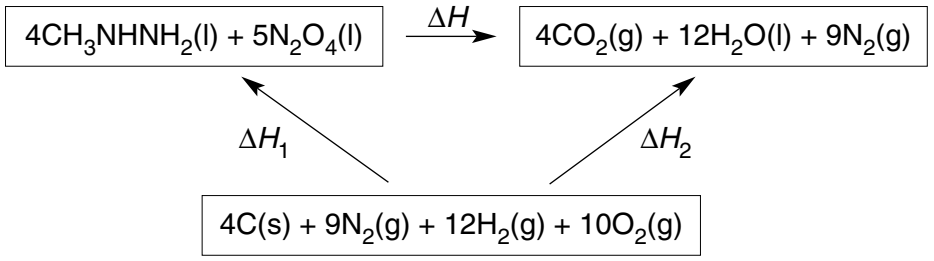
(i) Give the formula of **one** compound from this table that is formed by an **endothermic** reaction.

.....[1]

(ii) Write the equation, with state symbols, that corresponds to the standard enthalpy change of formation of $N_2O_4(l)$.

[3]

(d) Use the cycle below to calculate the standard enthalpy change of the reaction of methylhydrazine and dinitrogen tetroxide. Follow the steps given.



equation 3.1

(i) Use the data in the table in **(c)** to calculate values for ΔH_1 and ΔH_2.

ΔH_1 = ...kJ mol^{-1} ΔH_2 = ...kJ mol^{-1} [3]

(ii) Use Hess's law to write down an equation for ΔH in terms of ΔH_1 and ΔH_2.

ΔH = ...[1]

(iii) Substitute your values from **(i)** into your equation in **(ii)** to find a value for ΔH.

ΔH = ...kJ mol^{-1} [1]

(e) $4CH_3NHNH_2(l) + 5N_2O_4(l) \longrightarrow 4CO_2(g) + 12H_2O(l) + 9N_2(g)$ **equation 3.1**

(i) When the reaction in **equation 3.1** occurs in the rocket engine it is **not** under *standard conditions*. Give **one** reason for this.

.....

.....

.....[1]

(ii) The reaction represented by **equation 3.1** has a positive **entropy** change. Give **two** reasons why this is so.

1 .....

.....

2 .....

.....[2]

[Total: 20]

4 Magnesium hydroxide and calcium hydroxide can both be used by farmers and gardeners to neutralise the acidity of soils.

(a) (i) State the property of these hydroxides that is important in neutralising soils.

.....[1]

(ii) Write a balanced chemical equation for the reaction of magnesium hydroxide, $Mg(OH)_2$, with hydrochloric acid to form magnesium chloride.

[3]

(b) Use your knowledge of the chemistry of Group 2 to answer the questions below.

(i) How many electrons are there in the outer shell of a magnesium atom?

.....[1]

(ii) What is the formula of calcium carbonate?

.....[1]

(iii) Circle the name of the carbonate which decomposes at **lowest** temperature.

barium carbonate **calcium carbonate** **magnesium carbonate** **strontium carbonate** [1]

(iv) Name the gas formed when barium reacts with water.

.....[1]

(c) The reactivities of the elements of this group are related to their ionisation enthalpies.

(i) Calcium has lower first and second ionisation enthalpies than magnesium.

Explain why this is so.

How does the difference in ionisation enthalpies of calcium and magnesium affect

- the relative ease of ion formation
- the reactivities of the elements?

.....

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.....

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.....

.....

.....[4]

(ii) Write the equation, including state symbols, for the **second** ionisation enthalpy of magnesium.

[3]

[Total: 15]

END OF QUESTION PAPER