OCR
RECOGNISING ACHIEVEMENT

OXFORD CAMBRIDGE AND RSA EXAMINATIONS
Advanced Subsidiary GCE

CHEMISTRY (SALTERS)

Chemistry for Life

2850

Wednesday **11 JANUARY 2006** 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, Centre number and candidate number in the boxes above.
- Answer **all** the questions.
- Read each question carefully and make sure you know what you have to do before starting your answer.
- Write your answers, in blue or black ink, in the spaces provided on the question paper. Pencils may be used for diagrams and graphs **only**.
- Do not write in the bar code. Do not write in the grey area between the pages.
- **DO NOT** WRITE IN THE AREA **OUTSIDE** THE BOX BORDERING EACH PAGE. ANY WRITING IN THIS AREA WILL NOT BE MARKED.

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	**16**	
2	**17**	
3	**19**	
4	**23**	
TOTAL	**75**	

This question paper consists of 14 printed pages and 2 blank pages.

[Turn over

Answer **all** the questions.

1 Nuclear fusion reactions readily occur in the Sun. However, in 1989 two scientists claimed to have fused atoms of the hydrogen isotope $^{2}_{1}H$ using only simple laboratory apparatus. This experiment was described as 'cold fusion'.

(a) **(i)** Give **one** similarity and **one** difference between $^{2}_{1}H$ and the usual isotope of hydrogen.

similarity .....

difference ..... [2]

(ii) Complete the following equation to show the fusion of two atoms of the hydrogen isotope $^{2}_{1}\mathbf{H}$.

$$2\,^{2}_{1}H \longrightarrow$$ [2]

(iii) What happens in a nuclear **fusion** reaction?

.....

..... [2]

(b) Many other scientists were doubtful about the cold fusion experiment.

(i) Explain, in terms of charges, why it is difficult to get two nuclei to fuse together.

.....

..... [2]

(ii) What conditions in the Sun make fusion possible?

.....

..... [2]

(c) A mass spectrum of hydrogen gas showed a peak at mass 2.

(i) Identify the **two** possible particles that would give rise to this peak.

.....

..... [3]

(ii) Other peaks occur at mass 3 and mass 4. Suggest possible explanations for these peaks.

mass 3 .....

mass 4 ..... [2]

(iii) What information does the **height** of a peak in a mass spectrum give you?

..... [1]

[Total: 16]

2 The Group 2 metal magnesium and its compounds are used in a variety of situations.

One of the main sources of magnesium metal is from magnesium ions (Mg^{2+}) in sea water. The first stage in the production of magnesium is to mix the sea water with a slurry of calcium hydroxide. This precipitates magnesium hydroxide.

(a) This reaction can be represented as follows.

$$Mg^{2+}(aq) + Ca(OH)_2(aq) \longrightarrow Mg(OH)_2(.....) + Ca^{2+}(.....)$$ **equation 2.1** [1]

Complete the state symbols on the product side of the equation.

(b) The above reaction relies on the fact that the solubility of the Group 2 hydroxides increases down the group.

Give **one** other chemical property of the Group 2 elements or their compounds that shows an increase down the group.

..... [1]

(c) The magnesium hydroxide produced in **equation 2.1** above can be heated to produce magnesium oxide or reacted with hydrochloric acid to make magnesium chloride.

(i) Draw an electron 'dot-cross' diagram, in the space below, to show the ions present in magnesium chloride. Show outer electron shells only.

[4]

(ii) What **type** of reaction is the reaction of magnesium hydroxide with hydrochloric acid?

..... [1]

(d) The magnesium chloride is electrolysed to form magnesium metal.

Magnesium metal is an excellent conductor of electricity. Use your knowledge of bonding in metals to suggest why metals are good conductors of electricity.

.....

.....

.....

..... [2]

(e) Sea water contains about 0.13% by mass of magnesium (as the magnesium ion).

Calculate the **number of moles** of magnesium in 1.0 dm^3 of sea water.

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

Assume the density of sea water is 1.0 g cm^{-3}.

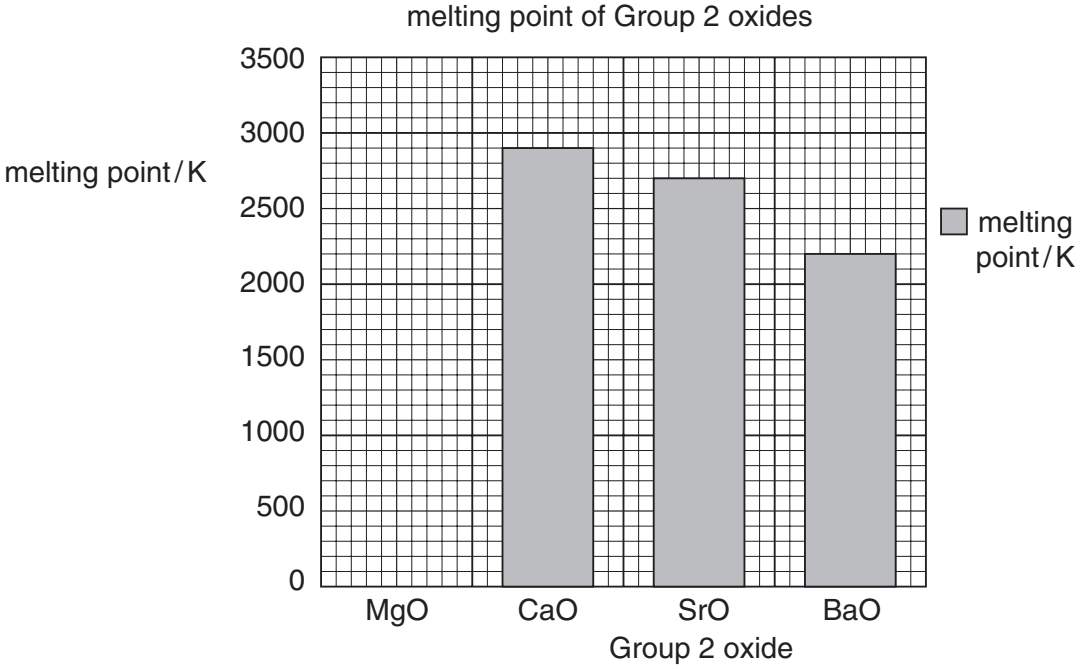
1.0 dm^3 = 1000 cm^3; A_r: Mg, 24

number of moles ..... mol [4]

(f) Magnesium oxide is used as a furnace lining because of its very high melting point.

Below is a bar chart showing the melting point of some Group 2 metal oxides.

Suggest the temperature at which magnesium oxide melts.

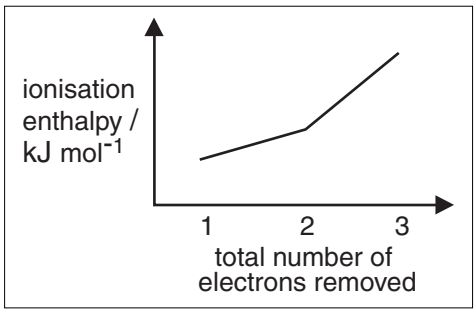


melting point of magnesium oxide = ... K [1]

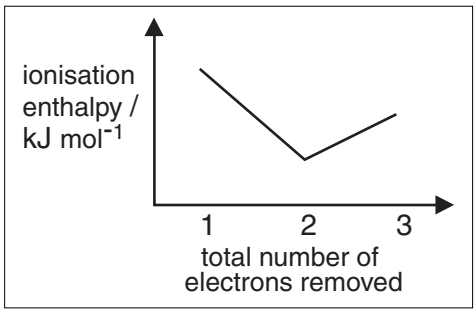
(g) Group 2 metals form 2+ ions by losing electrons.

Ionisation enthalpies are a measure of how easy it is to remove successive electrons from an atom.

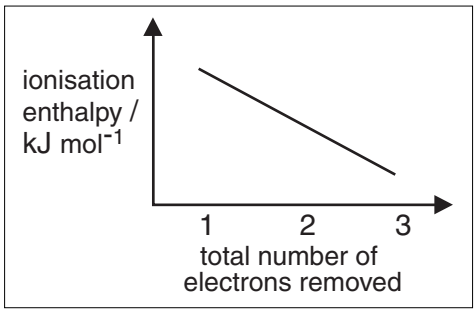
Which of the following graphs best represents the pattern in the first **three** ionisation energies for a Group 2 element? Explain your choice.



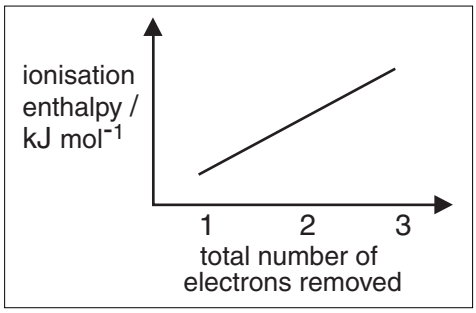
graph A



graph B



graph C



graph D

The pattern in the first three ionisation enthalpies is best represented by graph .....

explanation .....

.....

.....

.....

..... [3]

[Total: 17]

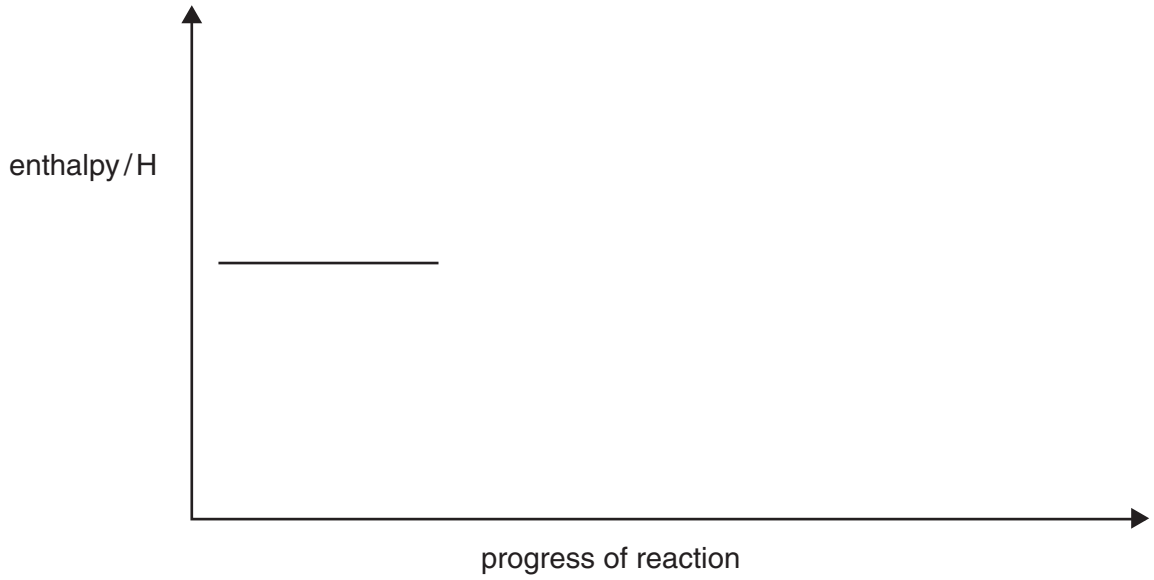
3 Athletes suffering from stiff or injured muscles often make use of cold or hot packs, depending on the nature of the problem.

(a) Cold packs can reduce inflammation. Some packs contain water and solid ammonium nitrate in separate compartments.

Breaking the divide between the two compartments and shaking leads to a considerable drop in temperature as the ammonium nitrate dissolves.

(i) Complete and label the enthalpy level diagram below to represent a reaction that causes a temperature **decrease** in the surroundings.

Use the following labels: **reactants**; **products**; **enthalpy change of reaction**



[3]

(ii) What name is given to a reaction or process causing a temperature decrease in the surroundings?

..... [1]

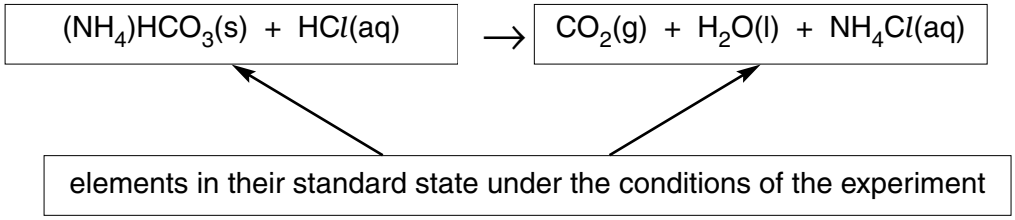
(b) A chemical reaction involving the ammonium compound ammonium bicarbonate, $(NH_4)HCO_3$, and causing a large decrease in temperature is given below.

$$(NH_4)HCO_3(s) + HCl(aq) \longrightarrow CO_2(g) + H_2O(l) + NH_4Cl(aq) \qquad \textbf{equation 3.1}$$

(i) The enthalpy change for this reaction can be determined indirectly using an energy cycle.

A suitable energy cycle for this reaction is given below. Use this and the enthalpy changes of formation given in the table to calculate the enthalpy change for the reaction, ΔH_r.

Give an appropriate sign with your answer.



compound	enthalpy change of formation ΔH_f / kJ mol^{-1}
$(NH_4)HCO_3(s)$	–849
$HCl(aq)$	–165
$CO_2(g)$	–394
$H_2O(l)$	–286
$NH_4Cl(aq)$	–300

ΔH_r = ... kJ mol^{-1} [4]

$(NH_4)HCO_3(s) + HCl(aq) \longrightarrow CO_2(g) + H_2O(l) + NH_4Cl(aq)$ **equation 3.1**

(ii) The enthalpy change for this reaction could be measured directly from experiment by adding solid ammonium bicarbonate to dilute hydrochloric acid in an appropriate container.

Describe the essential measurements that would need to be taken in order to determine this enthalpy change.

.....

.....

.....

.....

.....

..... [4]

(iii) This reaction is accompanied by an increase in **entropy**.

There are differences in the magnitude of the entropy of solids, liquids and gases.

- describe and explain these differences
- account for the increase in entropy in the reaction in **equation 3.1**.

.....

.....

.....

.....

.....

..... [4]

(c) One type of **hot** pack that is on the market contains a moist mixture of finely divided iron, common salt and charcoal sealed in a plastic cover inside an outer cloth bag.

On breaking the plastic inner seal, the iron oxidises rapidly in air causing the temperature to rise markedly. The iron oxide Fe_2O_3 is formed.

(i) Write a balanced equation for this oxidation reaction. Include the state symbols.

[2]

(ii) Suggest a purpose for the charcoal/salt mixture.

..... [1]

[Total: 19]

4 Liquefied petroleum gas is a general term used for liquefied C_3 or C_4 alkanes. It can be used as an automobile fuel, when it is usually called 'autogas'. Well over 100 000 cars in the UK run on autogas and the number is increasing.

(a) In the UK, autogas consists almost entirely of the C_3 alkane, propane.

(i) The alkanes are a homologous series of hydrocarbons and can be represented by a general formula. Give the **general** formula for alkanes.

..... [1]

(ii) Suggest **one** reason why propane is liquefied.

..... [1]

(b) In Europe, most autogas is a mixture of C_3 and C_4 alkanes.

(i) There are two C_4 alkanes. Draw **skeletal** formulae and give the name of each of these alkanes in the boxes below.

name	name .....

[3]

(ii) What name is given to molecules with different structures but the same molecular formula?

..... [1]

(c) Autogas produces considerably less carbon monoxide and unburnt hydrocarbons than ordinary petrol. One reason suggested for this is that autogas mixes much more thoroughly with air in the combustion chamber and therefore combustion is more complete.

(i) The equation for the complete combustion of the C_3 alkane, propane, is written below.

$$C_3H_8(g) + 5O_2(g) \longrightarrow 3CO_2(g) + 4H_2O(g)$$

Calculate the volume of **air** that would be needed to exactly react with 1.0 dm^3 of propane gas.

Assume that air contains 20% by volume of oxygen and that all measurements are made under the same conditions of temperature and pressure.

volume of air = ... dm^3 [2]

(ii) Why must the measurements all be conducted under the same conditions of temperature and pressure?

.....

..... [1]

(iii) Give **one** reason why it is desirable to reduce carbon monoxide emissions.

..... [1]

(iv) Give a **different** reason why hydrocarbon emissions should also be reduced.

.....

..... [1]

(v) Explain, in terms of bond breaking and bond making, why the combustion of a fuel gives out heat.

.....

.....

.....

.....

.....

.....

..... [3]

(d) Autogas has a higher octane number than ordinary petrol.

- Explain in terms of the molecules involved why the octane number is higher for autogas.
- Why is a fuel with a high octane number an advantage?

.....

.....

.....

.....

..... [4]

(e) Energy density is the energy transferred on burning 1.0 kg of fuel.

The energy density for petrol is about 48 000 kJ kg^{-1}. It is higher for autogas.

(i) Calculate the energy density for autogas assuming it to be 100% propane.

Show your working.

ΔH_c propane = –2 220 kJ mol^{-1}; M_r: C_3H_8 = 44

energy density of autogas = ... kJ kg^{-1} [3]

(ii) Why is the energy density of autogas higher than that of petrol?

.....

.....

..... [2]

[Total: 23]

END OF QUESTION PAPER

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