The Periodic Table: Chemical Periodicity

Question Paper 7

Level	International A Level
Subject	Chemistry
Exam Board	CIE
Topic	The Periodic Table: Chemical Periodici
Sub-Topic	
Paper Type	Theory
Booklet	Question Paper 7

Time Allowed: 64 minutes

Score: /53

Percentage: /100

Grade Boundaries:

A*	A	B	C	D	E	U
>85%	777.5%	70%	62.5%	57.5%	45%	<45%

1 All the Group IV elements form chlorides with the formula MCl_4.

(a) Describe the bonding in, and the shape of, these chlorides.

    (i) bonding ....

   **(ii)** shape ....[2]

The boiling point of lead(IV) chloride cannot be measured directly because it decomposes on heating. The following table lists the boiling points of three Group IV chlorides.

chloride	b.p. / °C
$SiCl_4$	58
$GeCl_4$	83
$SnCl_4$	114

(b) **(i)** Plot these data on the following axes and extrapolate your graph to predict what the boiling point of $PbCl_4$ would be if it did not decompose.
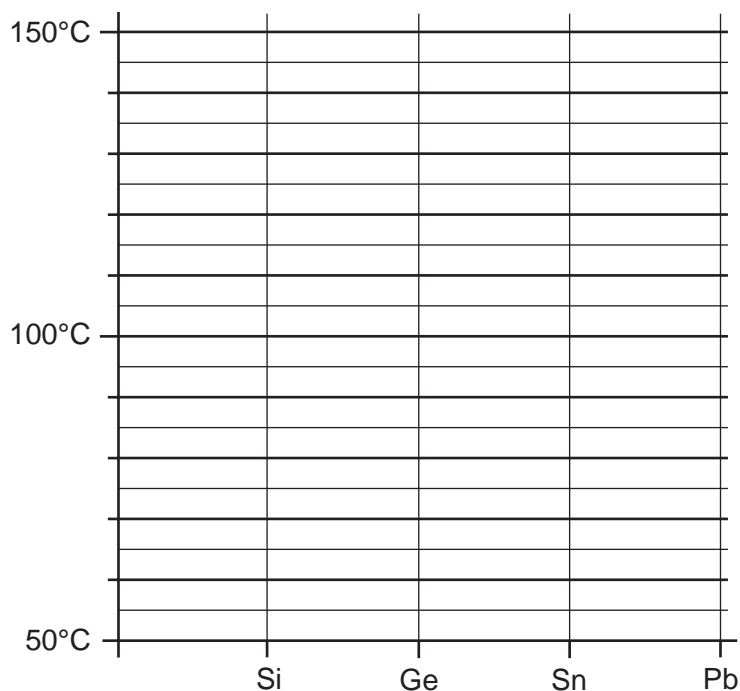
    (ii) Suggest why the boiling points vary in this way.

    ....

    ....

    ....[4]

(c) SiCl_4 reacts vigorously with water whereas CCl_4 is inert.

    (i) Suggest a reason for this difference in reactivity.

    ....

    (ii) Write an equation for the reaction between SiCl_4 and water.

    ....

    (iii) Suggest, with a reason, whether you would expect GeCl_4 to react with water.

    ....

    ....
                                                                                 [3]

(d) SiCl_4 is used to make high-purity silicon for the semiconductor industry. After it has been purified by several fractional distillations, it is reduced to silicon by heating with pure zinc.

    (i) Suggest an equation for the reduction of SiCl_4 by zinc.

    ....

    (ii) Use your equation to calculate what mass of zinc is needed to produce 250 g of pure silicon by this method.

mass of zinc = ... g [3]

[Total: 12]

2 The table below gives data on some oxides of elements in Period 3 of the Periodic Table.

oxide	Na_2O	MgO	Al_2O_3	SiO_2	P_4O_{10}	SO_3
melting point / K	1193	3125	2345	1883	853	290
boiling point / K	1548	3873	3253	2503	–	318

(a) Write an equation for the reaction of aluminium with oxygen to form aluminium oxide.

....[1]

(b) Drawing diagrams where appropriate, suggest in terms of structure and bonding, explanations for the following.

(i) the high melting point and boiling point of Al_2O_3

(ii) the low boiling point of SO_3

(iii) the melting point of SiO_2 is much higher than that of P_4O_{10}

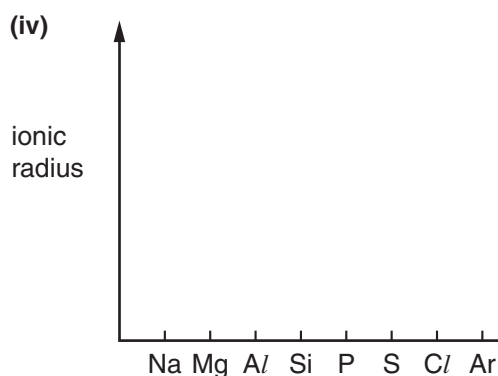**(c)** Water was added to each of the oxides in the table.

Choosing a suitable oxide in each case, write an equation for the formation of

(i) an alkaline solution, ...

(ii) an acidic solution. ....[2]

[Total : 10]

3 **(a)** The use of the *Data Booklet* is relevant to this question. Complete these sketches for elements of the third period (sodium to argon) to show how each property changes along the period.

(i)

melting point

Na Mg A*l* Si P S C*l* Ar

(ii)

electrical conductivity

Na Mg A*l* Si P S C*l* Ar

(iii)

atomic radius

Na Mg A*l* Si P S C*l* Ar

(iv)

ionic radius

Na Mg A*l* Si P S C*l* Ar
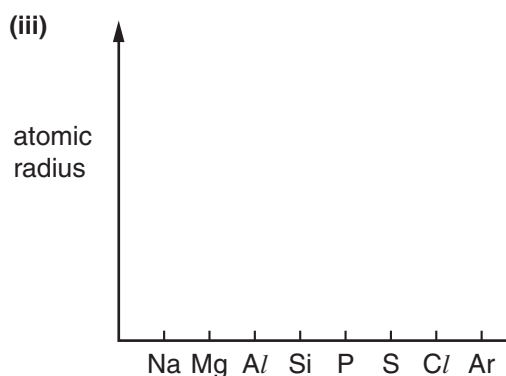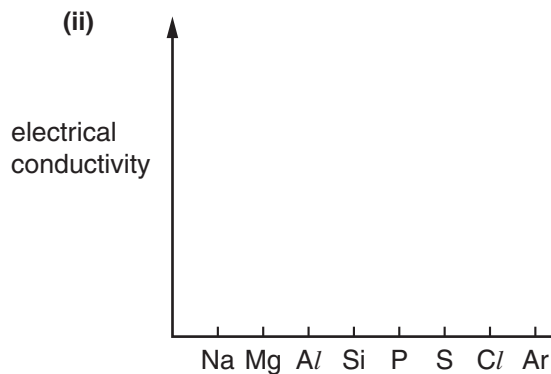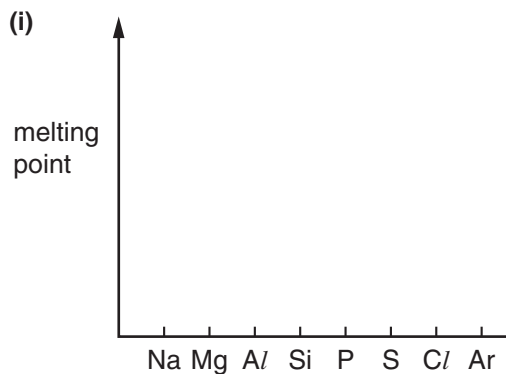
[6]

(b) **(i)** In the boxes below, write the formulae of **one** of the oxides of each of these five elements.

sodium	magnesium	aluminium	phosphorus	sulphur

(ii) Write an equation for sodium oxide reacting with water.

....

(iii) Write an equation for your chosen oxide of sulphur reacting with an alkali.

....[3]

[Total : 9]

4 **(a)** The melting points of some oxides of Group IV elements are given below.

oxide	melting point/°C
CO_2	−78
SiO_2	1610
SnO_2	1630

Describe the bonding in each oxide, and how it relates to its melting point.

(i) CO_2

....

....

....

(ii) SiO_2

....

....

....

(iii) SnO_2

....

....

....

[3]

(b) Writing balanced equations where appropriate, describe how the above three oxides differ in their reactions with

(i) NaOH(aq),

....

....

....

(ii) HC*l*(aq).

....

....

....
[4]

(c) The last oxide in Group IV, PbO_2, reacts with concentrated hydrochloric acid liberating chlorine gas.

Use the *Data Booklet* to calculate the $E^{\ominus}_{cell}$ and to write a balanced equation for this reaction.

....

....[2]

[Total : 9]

5 Crude oil is processed to give a wide variety of hydrocarbons.

(a) Give the names of one physical process and one chemical process carried out during the processing of crude oil.

physical process ....

chemical process ....

[2]

(b) Alkanes and alkenes can both be obtained from crude oil.

(i) Explain why alkanes are unreactive.

....

.... [2]

(ii) State the bond angles in a molecule of

ethane, ...

ethene. ....

[1]

(iii) State the shape of each molecule in terms of the arrangement of the atoms bonded to each carbon atom.

ethane .... ethene .... [1]

(iv) Explain why these molecules have different shapes in terms of the carbon-carbon bonds present.

....

.... [1]

(c) Use a series of equations to describe the mechanism of the reaction of ethane with chlorine to form chloroethane. Name the steps in this reaction.

....

....

....

....

.... [5]

(ii) Write an equation to show how butane could be produced as a by-product of this reaction.

.... [1]

[Total: 13]