

# The Periodic Table: Chemical Periodicity

## Question Paper 2

<b>Level</b>	International A Level
<b>Subject</b>	Chemistry
<b>Exam Board</b>	CIE
<b>Topic</b>	The Periodic Table: Chemical Periodicity
<b>Sub-Topic</b>	
<b>Paper Type</b>	Theory
<b>Booklet</b>	Question Paper 2

**Time Allowed:** 62 minutes

**Score:** /51

**Percentage:** /100

**Grade Boundaries:**

A*	A	B	C	D	E	U
>85%	77.5%	70%	62.5%	57.5%	45%	<45%

- 1 (a) (i) Describe and explain the trend in the volatilities of the Group IV chlorides  $\text{CCl}_4$ ,  $\text{GeCl}_4$  and  $\text{PbCl}_4$ .

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- (ii) Describe and explain the reactions, if any, of these chlorides with water. Write equations for any reactions that occur.

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[7]

(b)  $\text{SnO}_2$  and  $\text{PbO}_2$  react with acids in different ways.

- $\text{SnO}_2$  reacts with concentrated sulfuric acid to form a colourless solution with no evolution of gas.
- $\text{PbO}_2$  reacts with concentrated sulfuric acid to give a white solid, **B**, and oxygen gas.
- $\text{PbO}_2$  reacts with cold concentrated hydrochloric acid to give a yellow solution containing the  $[\text{PbCl}_6]^{2-}$  ion, with no evolution of gas.
- Warming this yellow solution causes the evolution of  $\text{Cl}_2$  gas, leaving a colourless solution which on cooling in ice precipitates a white solid, **C**.

(i) Identify the two white solids, **B** and **C**, mentioned above.

**B** .....

**C** .....

(ii) Suggest an equation for **each** of the four reactions described above.

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[4]

[Total: 11]

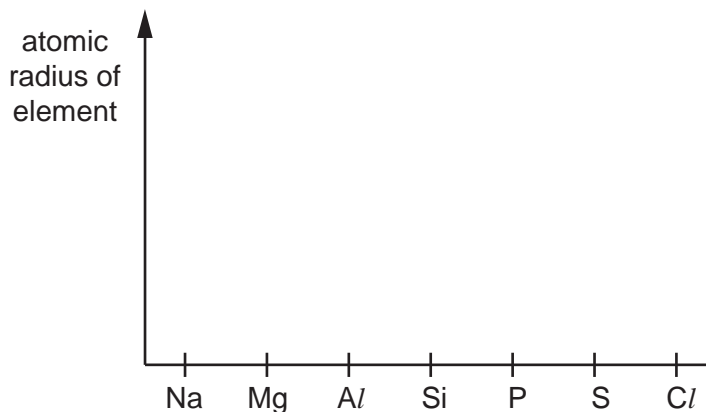
2 Elements in the same period of the Periodic Table show trends in physical and chemical properties. The grids on this page and on the opposite page refer to the elements of the third period, Na to Cl.

On **each** of these grids, draw a clear sketch to show the variation of the stated property.

Below **each** grid, briefly explain the variation you have described in your sketch.

For each explanation you should refer to the important factors that cause the differences in the property you are describing.

(a)



explanation .....

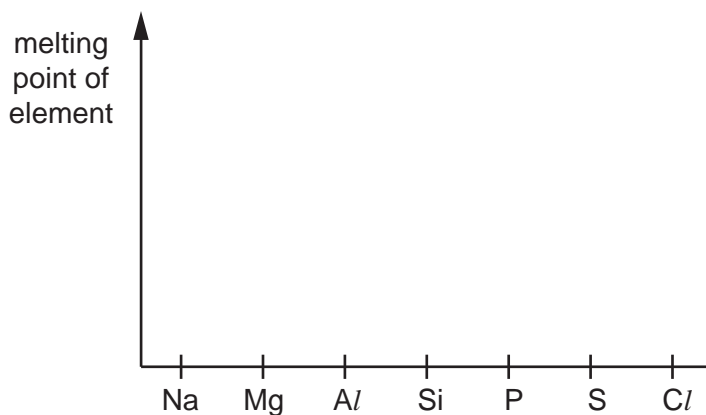
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[3]

(b)



explanation .....

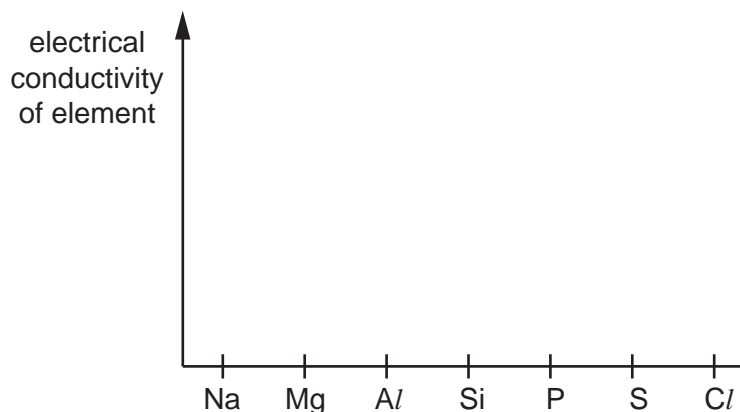
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[4]

(c)



explanation .....

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[4]

(d) The melting points of some of the oxides of the elements sodium to sulfur are given in the table below.

compound	Na <sub>2</sub> O	MgO	Al <sub>2</sub> O <sub>3</sub>	SiO <sub>2</sub>	P <sub>4</sub> O <sub>6</sub>	SO <sub>2</sub>
mp/K	1193	3173	2313	1883	297	198

(i) What type of bond is broken when **each** of the following compounds is melted?

Na<sub>2</sub>O .....

SiO<sub>2</sub> .....

P<sub>4</sub>O<sub>6</sub> .....

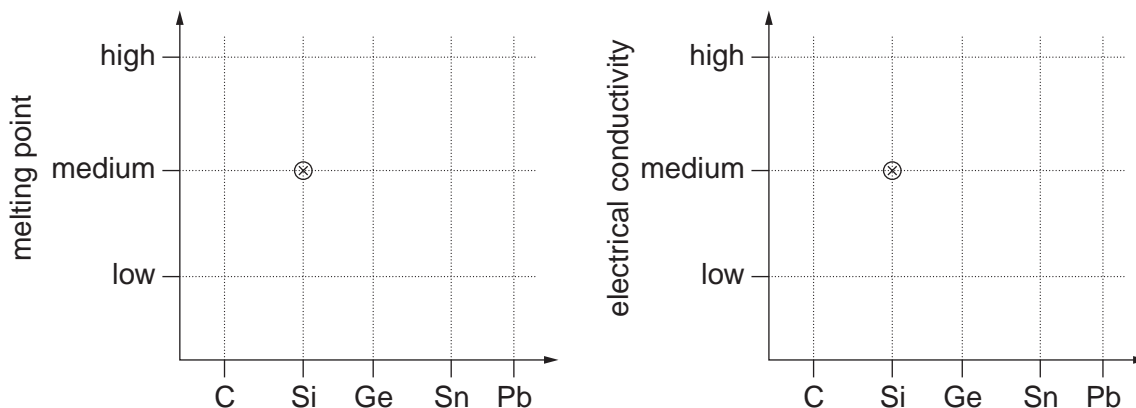
(ii) Identify **one** of these six oxides that has no reaction at all with water.

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[4]

[Total: 15]

- 3 (a) (i) On the following grids, plot points showing the variation in the named property of the Group IV elements. Your points should show for each element, whether the melting point/electrical conductivity is 'high', 'medium' or 'low'. The point for silicon has already been plotted in each case.



- (ii) Suggest explanations of these trends in terms of the structure and bonding of the Group IV elements.

melting point

.....  
 .....

electrical conductivity

.....  
 .....

[6]

- (b) Choose **one** reaction to illustrate **each** of the following statements. Write an equation for each of your chosen reactions, and describe what you would see as the reaction is carried out.

- (i) PbO is more stable than PbO<sub>2</sub>.

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 .....

- (ii) CO is easily oxidised to CO<sub>2</sub>.

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 .....

- (iii) Aqueous SnCl<sub>2</sub> is a useful reducing agent.

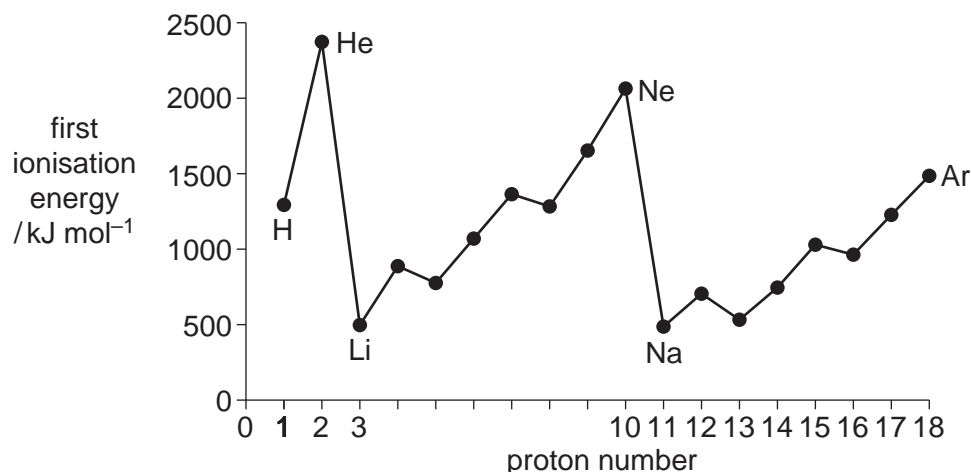
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[4]

[Total: 10]

- 4 The Periodic Table we currently use is derived directly from that proposed in 1869 by Mendeleev who had noticed patterns in the physical and chemical properties of the elements he had studied.

The diagram below shows the first ionisation energies of the first 18 elements of the Periodic Table.



- (a) Give the equation, including state symbols, for the first ionisation energy of sulfur. .... [2]
- (b) Explain why there is a **general** increase in first ionisation energies across the Period from sodium to argon. .... [3]
- (c) (i) Explain why the first ionisation energy of magnesium is greater than that of aluminium. ....
- (ii) Explain why the first ionisation energy of phosphorus is greater than that of sulfur. .... [4]

The table below refers to the elements of the third Period sodium to sulfur and is incomplete.

element	Na	Mg	Al	Si	P	S
conductivity			high			
melting point			high			

(d) (i) Complete the ‘conductivity’ row by using **only** the words ‘high’, ‘moderate’ or ‘low’.

(ii) Complete the ‘melting point’ row by using **only** the words ‘high’ or ‘low’. [5]

When Mendeleev published his first Periodic Table, he left gaps for elements that had yet to be discovered. He also predicted some of the physical and chemical properties of these undiscovered elements.

For one element, **E**, he correctly predicted the following properties.

melting point of the element      high

melting point of the oxide      high

boiling point of the chloride      low

The element **E** was in the fourth Period and was one of the elements from gallium, proton number 31, to bromine, proton number 35.

(e) By considering the properties of the third Period elements aluminium to chlorine, suggest the identity of the fourth Period element **E**.

..... [1]

[Total: 15]