

# The Periodic Table: Chemical Periodicity

## Question Paper 3

<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 3

**Time Allowed:** 66 minutes

**Score:** /55

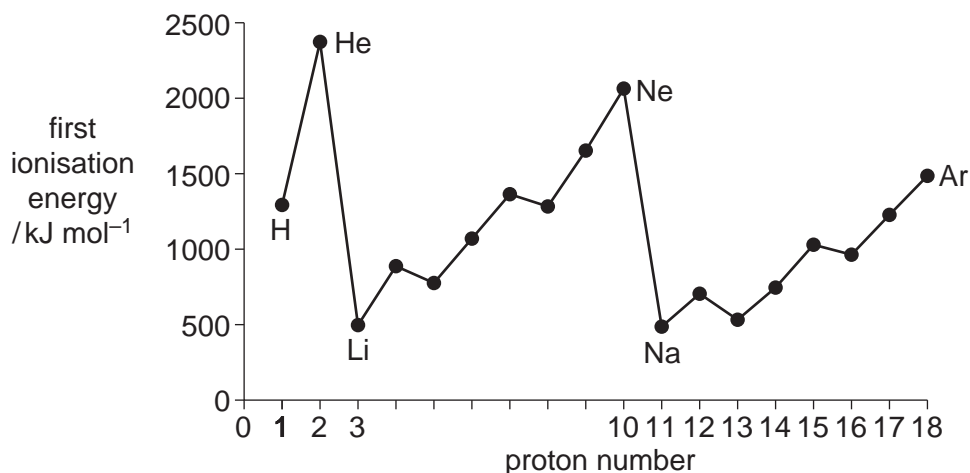
**Percentage:** /100

**Grade Boundaries:**

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

- 1 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 carbon.

..... [2]

- (b) (i) Explain why sodium has a lower first ionisation energy than magnesium.

.....  
 .....

- (ii) Explain why magnesium has a higher first ionisation energy than aluminium.

.....  
 .....

- (iii) Explain why helium, He, and neon, Ne, occupy the two highest positions on the diagram.

.....  
 .....

- (iv) Explain why the first ionisation energy of argon, Ar, is lower than that of neon, which is lower than that of helium.

.....  
 .....  
 .....

- (c) (i) The first ionisation energies of the elements Na to Ar show a variation. Some physical properties show similar variations.

The atomic radius of the elements decreases from Na to Cl.

Give a brief explanation of this variation.

.....

.....

- (ii) The cations formed by the elements Na to Al are smaller than the corresponding atoms.

Give a brief explanation of this change.

.....

.....

[3]

- (d) The oxides of the elements of the third Period behave differently with NaOH(aq) and HCl (aq). In some cases, no reaction occurs.

Complete the table below by writing a balanced equation for any reaction that occurs, with heating if necessary. If you think no reaction takes place write 'no reaction'.

You do not need to include state symbols in your answers.

.....MgO(s)	..... NaOH (aq)	→
.....MgO(s)	..... HCl (aq)	→
.....Al <sub>2</sub> O <sub>3</sub> (s)	..... NaOH (aq)	+ .....H <sub>2</sub> O (l) →
.....Al <sub>2</sub> O <sub>3</sub> (s)	..... HCl (aq)	→
.....SO <sub>2</sub> (g)	+ ..... NaOH (aq)	→
.....SO <sub>2</sub> (g)	+ ..... HCl (aq)	→

[6]

[Total: 19]

2 This question refers to the elements shown in the portion of the Periodic Table given below.

									H										He
Li	Be											B	C	N	O	F		Ne	
Na	Mg											Al	Si	P	S	Cl		Ar	
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br		Kr	

(a) From this table, identify in **each** case **one** element that has the property described. Give the **symbol** of the element in each case.

(i) The element that has a molecule which contains exactly eight atoms.

.....

(ii) The element that forms the largest cation.

.....

(iii) An element that floats on water and reacts with it.

.....

(iv) An element that reacts with water to give a solution that can behave as an oxidising agent.

.....

(v) An element whose nitrate gives a brown gas on thermal decomposition.

.....

[5]

(b) (i) Give the formula of the oxide of the most electronegative element.

.....

(ii) Several of these elements form more than one acidic oxide.  
Give the formulae of **two** such oxides formed by the **same** element.

..... and .....

[3]

The formulae and melting points of the fluorides of the elements in Period 3, Na to Cl, are given in the table.

formula of fluoride	NaF	MgF <sub>2</sub>	AlF <sub>3</sub>	SiF <sub>4</sub>	PF <sub>5</sub>	SF <sub>6</sub>	ClF <sub>5</sub>
m.p./K	1268	990	1017	183	189	223	170

(c) (i) Suggest the formulae of **two** fluorides that could possibly be ionic.

.....

(ii) What is the shape of the SF<sub>6</sub> molecule?

.....

(iii) In the sequence of fluorides above, the oxidation number of the elements increases from NaF to SF<sub>6</sub> and then falls at ClF<sub>5</sub>.  
Attempts to make ClF<sub>7</sub> have failed but IF<sub>7</sub> has been prepared.  
Suggest an explanation for the existence of IF<sub>7</sub> and for the non-existence of ClF<sub>7</sub>.

.....

.....

.....

[4]

[Total: 12]

3 The table below gives data for some of the oxides of Period 3 elements.

oxide	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>
melting point/°C	1275	2827	2017	1607	24	-75
bonding						
structure						

(a) Complete the table by filling in

(i) the 'bonding' row by using **only** the words 'ionic' **or** 'covalent',

(ii) the 'structure' row by using **only** the words 'simple' **or** 'giant'.

[2]

(b) From the table of oxides above, suggest the formula of **one** oxide that is **completely** insoluble in water.

.....

[1]

(c) Separate samples of Na<sub>2</sub>O and SO<sub>2</sub> were added to water.

(i) For **each** oxide, write a balanced equation for its reaction with water and suggest a numerical value for the pH of the resulting solution.

Na<sub>2</sub>O

equation .....

pH .....

SO<sub>2</sub>

equation .....

pH .....

(ii) Construct a balanced equation for the reaction that occurs when a solution of Na<sub>2</sub>O in water reacts with a solution of SO<sub>2</sub> in water.

.....

[5]

- (d) Separate samples of the oxides MgO and SiO<sub>2</sub> are melted.  
Each molten sample is then tested to see whether or not it conducts electricity.

Suggest what would be the results in **each** case. Explain your answers.

MgO .....

.....

.....

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

.....

.....

[4]

[Total: 12]





(c) Use the elements in Period 3 (Na to Ar) in the section of the Periodic Table opposite to identify the oxide(s) referred to below.

In **each** case, give the formula of the oxide(s).

(i) an oxide which has no reaction with water

.....

(ii) **two** acidic oxides formed by the same element

..... and .....

(iii) an oxide which dissolves readily in water to give a strongly alkaline solution

.....

(iv) an oxide which is amphoteric

.....

[5]

[Total: 12]