## **Periodicity**

**1.** This question is about magnesium, bromine and magnesium bromide.

Table 16.1 shows some physical properties of magnesium, bromine and magnesium bromide.

Substance	Molting point / °C	Electrical c	onductivity
Substance	Melting point / °C	Solid	Liquid
Magnesium	711	Good	Good
Bromine	-7	Poor	Poor
Magnesium bromide	650	Poor	Good

**Table 16.1** 

Explain the physical properties shown in <b>Table 16.1</b> using your knowledge of structure and bonding.				

2(a).

s question is about some elements in Period 4 of the periodic table.  It table shows the melting point and electrical conductivity of two elements in Period 4.  Element Melting Point / °C Electrical conductivity  Calcium 842 Good  Bromine -7 Poor  It your knowledge of structure and bonding to explain the properties in the table.				
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Element     Melting Point / °C     Electrical conductivity       Calcium     842     Good       Bromine     -7     Poor       your knowledge of structure and bonding to explain the properties in the table.				
Calcium 842 Good  Bromine -7 Poor  your knowledge of structure and bonding to explain the properties in the table.	table shows the melti	ng point and electrical condu	ctivity of two elements in Perio	od 4.
Calcium 842 Good  Bromine -7 Poor  your knowledge of structure and bonding to explain the properties in the table.				
Bromine —7 Poor  your knowledge of structure and bonding to explain the properties in the table.	Element	Melting Point / °C	Electrical conductivity	
your knowledge of structure and bonding to explain the properties in the table.				
	Calcium	842	Good	
	Bromine	-7	Poor	
	Bromine	-7	Poor	
	Bromine your knowledge of str	−7 ucture and bonding to explai	Poor  the properties in the table.	
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[5]

ii.	The reaction of barium with bromine is more vigorous than the reaction of calcium with bromine.
	Explain why.
	•

(b). Calcium reacts with bromine to form calcium bromide, CaBr<sub>2</sub>.

Show **outer** electrons only.

Draw a 'dot-and-cross' diagram to show the bonding in CaBr<sub>2</sub>.

**3.** The table below shows two physical properties of the element strontium.

Melting point	high
Electrical conductivity	very good

Explain these physical properties of strontium, in terms of bonding and structure. Include a labelled diagram in your answer.

Diagram

4.

	[1]
Explain which block in the Periodic Table sodium and magnesium belong to.	
calcium and strontium.	
Sir Humphry Davy discovered several elements including sodium, potassium, magnesi	um,
	[5]
Explanation	

5.	SiO <sub>2</sub> and CO <sub>2</sub> are oxides of Group 14 (Group 4) elements.	
	Solid SiO₂ melts at 2156 °C. Solid CO₂ melts at −56 °C.	
	Suggest the type of lattice structure in solid $SiO_2$ and in solid $CO_2$ and explain the difference is melting points in terms of the types of force within each lattice structure.	n
	Structure in SiO <sub>2</sub> (s)	
	Structure in CO <sub>2</sub> (s)	
	Explanation	
		-151
6.	Why are silicon, carbon, oxygen and chlorine all classified as p-block elements?	
		_[1]
7(a).	This question refers to the elements in the first three periods (H $\rightarrow$ Ar) of the Periodic Table.	
	Select an element from the first three periods that fits each of the following descriptions.	
	i. The element that forms a 1- ion with the same electron configuration as helium.	
		[1]
	ii. The element with the highest first ionisation energy.	
		[1]

iii. The element in Period 3 which has the successive ionisation energies shown below.

Ionisation number	1st	2nd	3rd	4th
lonisation energy/kJ mol⁻¹	738	1451	7733	10541

		[1]
iv.	The element which forms a compound with fluorine that has octahedral molecules.	
		[1]
٧.	An element which reacts with water to form an acidic solution.	
		[1]
vi.	The element $\mathbf{X}$ , which forms a compound with hydrogen, $\mathbf{X}H_3$ , with a molar mass of g mol <sup>-1</sup> .	34.0
		[1]
vii.	An element which forms a compound with hydrogen in which the element has an oxidation number of $\neg 4$ .	
		[1]
viii.	The element which has a density of $1.33 \times 10^{-3}$ g cm <sup>-3</sup> at room temperature and pressure.	
		[1]

(b). Table 1.1 shows some properties of Period 3 chlorides.

Group		1	2	14 (4)	15 (5)	16 (6)
Chloride	NaC/	MgCI <sub>2</sub>	SiC/4	PC/3	SCI <sub>2</sub>	
Electrical	Solid	poor	poor	poor	poor	poor
conductivity	Liquid	good	good	poor	poor	poor
Melting point	•	high	high	low	low	low

Table 1.1				
Explain the properties shown in <b>Table 1.1</b> in terms of bonding and structure.				
15				

9.

8. The table below compares the properties of sodium sulfide, sodium and sulfur.
Complete the table.

The reactivity of the Group 2 elements Mg–Ba increases down the group.

		Sodium sulfide	Sodium	Sulfur
Melting point / °C		1180	98	113
Type of structure (giant or simple)				
	solid			
Electrical conductivity (good or poor)	liquid			

[3]

Explain why.	
	[3

**10. B** and **C** are ionic compounds of two different Group 1 elements. The molar masses of **B** and **C** are both approximately 140 g mol<sup>-1</sup>.

A student dissolves **B** and **C** in water in separate test tubes and analyses the solutions.

Use this information and the observations to identify the formulae of  ${\bf B}$  and  ${\bf C}.$ 

The observations are shown below.

Test	Observation			
rest	B(aq)	C(aq)		
Addition of HNO <sub>3</sub> (aq) followed by BaCl <sub>2</sub> (aq)	bubbles no change	no change white precipitate		

Explain your reasoning.	
	[5]

- 11. Ionisation energies have been used to develop a model for electron configuration.
  - i. Fig. 16.1 shows the first ionisation energies for Li, Be, F and Ne.

Add points for the missing elements across Period 2.

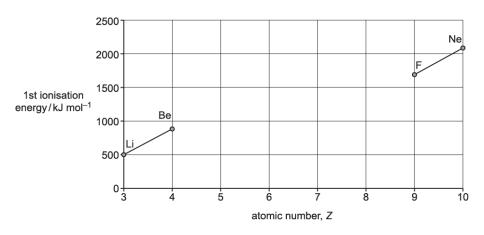


Fig. 16.1

[2]

ii. First ionisation energies decrease down groups in the Periodic Table.

Explain this trend and the effect on the reactivity of groups containing metals.

12(a). The elements of Period 2 and Period 3 of the Periodic Table are shown in Table 3.1.

Group	1	2	3	4	5	6	7	0
Period 2	Li	Ве	В	С	N	0	F	Ne
Period 3	Na	Mg	A/	Si	Р	S	C/	Ar

Table 3.1

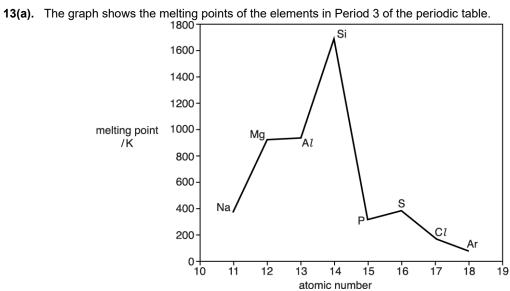
		ments in these two periods show a repeating pattern in chemical and physical prope	erties.
	What is	the name given to this repeating pattern of properties?	
			[1]
(b).	State th	ne element in <b>Table 3.1</b> with:	
	•	the lowest first ionisation energy	
	•	the lowest fourth ionisation energy	
	•	the lowest boiling point	
			[3]

(c). The melting points of the Period 3 metals sodium and magnesium are shown below.

Metal	Melting point / °C		
sodium	98		
magnesium	649		

Explain the differences in the melting points of sodium and magnesium, using the model of metallic bonding.
In your answer you should use appropriate technical terms spelled correctly.

[3]
[4]



Phosphorus and chlorine have simple molecular structures. More information about phosphorus and chlorine is given in the table below.

Element	Molecular formula
phosphorus	P <sub>4</sub>
chlorine	C <sub>l2</sub>

Explain the differences in the melting points of phosphorus and chlorine.
ro

14.

clude the names of	the particles and describe the forces	between the particles in the stru
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rease in chemical r	eactivity down the group.  onisation energies of calcium and st  First ionisation energy /	rontium are given in the table.  Second ionisation energy /
e first and second in	reactivity down the group.  onisation energies of calcium and st  First ionisation energy /  kJmol <sup>-1</sup>	rontium are given in the table.  Second ionisation energy / kJmol <sup>-1</sup>
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e first and second in Element  Ca  Sr	First ionisation energy / kJmol <sup>-1</sup> 590  550  ation, including state symbols, to reg	Second ionisation energy / kJmol <sup>-1</sup> 1145 1064 present the second ionisation energy
Element  Ca Sr  i. Write an equastrontium.	First ionisation energy / kJmol <sup>-1</sup> 590  550  ation, including state symbols, to reg	Second ionisation energy / kJmol <sup>-1</sup> 1145 1064  present the second ionisation energy ionisation energy / i
Element Ca Sr  i. Write an equastrontium.	First ionisation energy / kJmol <sup>-1</sup> 590 550 ation, including state symbols, to rep	Second ionisation energy / kJmol <sup>-1</sup> 1145 1064  present the second ionisation energy ionisation energy / i
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**(b).** Magnesium and silicon have different types of giant structures.

15.	This q	uestion	is about	the a	attraction	between	particles.
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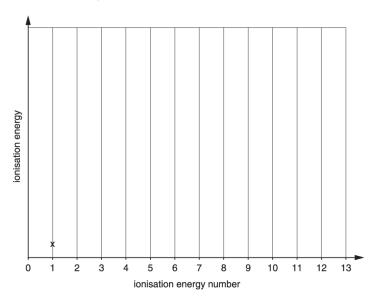
tate how and explain why the attraction between nuclei and outermost electrons in gaseous toms varies across Period 3.	
	[2]

- **16.** Aluminium has 13 successive ionisation energies.
  - i. Write the equation for the **third** ionisation energy of aluminium.
     Include state symbols.

ii. On the axes below, add crosses to show the 13 successive ionisation energies of aluminium.

The value for the first ionisation energy has been completed for you.

You do not have to join the crosses.



17(a).	Silicon dioxide, SiO <sub>2</sub> , has the same structure and bonding as diamond.	
	State the structure and bonding in SiO <sub>2</sub> .	
		 _[1]
(b).	Describe and explain the electrical conductivity of sodium oxide, Na <sub>2</sub> O, and sodium in their so and molten states.  In your answer you should use appropriate technical terms, spelled correctly.	lid
	In your answer you should use appropriate technical terms, spelled correctly.	
		[5]
18.	The Periodic Table is arranged in periods and groups.	
	Elements in the Periodic Table show a periodic trend in atomic radius.	
	State and explain the trend in atomic radius from Li to F.	
	In your answer you should use appropriate technical terms, spelled correctly.	
	trend	

Give chemical ex	xplanations for the fo	llowing statements		
Potassium is pla	ced immediately afte	r argon in the perio	odic table.	
•	•			
Bromine and me	rcury are the only two pressure. Some phy	o naturally occurrin	ng elements that ar	e liquids at room
Bromine and me	rcury are the only two	o naturally occurrin sical properties of	ng elements that ar these two element	e liquids at room s are given belo Electrical
Bromine and me	rcury are the only two pressure. Some phy	o naturally occurrin	ng elements that ar	e liquids at room s are given belo Electrical
Bromine and me	rcury are the only two pressure. Some phy  Appearance at room temperature dark orange	o naturally occurring sical properties of	ng elements that ar these two element	e liquids at room s are given belo Electrical conductivity o
Bromine and me temperature and	rcury are the only two pressure. Some phy  Appearance at room temperature	o naturally occurring value of the second of	ng elements that ar these two element Boiling point / °C	e liquids at room s are given belo Electrical conductivity o the liquid
Bromine and me temperature and Bromine	rcury are the only two pressure. Some phy  Appearance at room temperature dark orange liquid	o naturally occurring value of the second of	ng elements that ar these two element Boiling point / °C 58.8	e liquids at rooms are given below
Bromine and me temperature and Bromine Mercury	rcury are the only two pressure. Some phy  Appearance at room temperature dark orange liquid	o naturally occurringsical properties of  Melting point /  °C  -7.2  -38.8	Boiling point / °C 58.8 356.7	e liquids at rooms are given below
Bromine and me temperature and Bromine Mercury	Appearance at room temperature dark orange liquid shiny silver liquid	o naturally occurring raical properties of Melting point / °C -7.2 -38.8	Boiling point / °C 58.8 356.7 bromide, HgBr <sub>2</sub> .	e liquids at rooms are given belo  Electrical conductivity the liquid very low good
Bromine and me temperature and Bromine Mercury	Appearance at room temperature dark orange liquid shiny silver liquid mine react together to plain how electrical contents.	o naturally occurring raical properties of Melting point / °C -7.2 -38.8	Boiling point / °C 58.8 356.7 bromide, HgBr <sub>2</sub> .	e liquids at rooms are given belo  Electrical conductivity the liquid very low good
Bromine and me temperature and Bromine Mercury	Appearance at room temperature dark orange liquid shiny silver liquid mine react together to plain how electrical contents.	o naturally occurring raical properties of Melting point / °C -7.2 -38.8	Boiling point / °C 58.8 356.7 bromide, HgBr <sub>2</sub> .	e liquids at rooms are given below  Electrical conductivity of the liquid very low good
Bromine and me temperature and Bromine Mercury	Appearance at room temperature dark orange liquid shiny silver liquid mine react together to plain how electrical contents.	o naturally occurring raical properties of Melting point / °C -7.2 -38.8	Boiling point / °C 58.8 356.7 bromide, HgBr <sub>2</sub> .	e liquids at rooms are given below  Electrical conductivity of the liquid very low good
Bromine and me temperature and Bromine Mercury	Appearance at room temperature dark orange liquid shiny silver liquid mine react together to plain how electrical contents.	o naturally occurring raical properties of Melting point / °C -7.2 -38.8	Boiling point / °C 58.8 356.7 bromide, HgBr <sub>2</sub> .	e liquids at rooms are given below  Electrical conductivity of the liquid very low good
Bromine and me temperature and Bromine Mercury	Appearance at room temperature dark orange liquid shiny silver liquid mine react together to plain how electrical contents.	o naturally occurring raical properties of Melting point / °C -7.2 -38.8	Boiling point / °C 58.8 356.7 bromide, HgBr <sub>2</sub> .	e liquids at rooms are given below  Electrical conductivity of the liquid very low good
Bromine and me temperature and Bromine Mercury	Appearance at room temperature dark orange liquid shiny silver liquid mine react together to plain how electrical contents.	o naturally occurring raical properties of Melting point / °C -7.2 -38.8	Boiling point / °C 58.8 356.7 bromide, HgBr <sub>2</sub> .	e liquids at rooms are given below  Electrical conductivity of the liquid very low good

**21.** \* This question is about elements in Periods 3 – 4 of the periodic table.

The table shows the melting points of elements in Groups 14 - 17.

Phosphorus and sulfur exist as  $P_4$  and  $S_8$  molecules respectively.

	Group	14	15	16	17
Period 3	Element	Si	P	S	C <i>I</i>
	Melting point / °C	1414	44	115	-102
Period 4	Element	Ge	As	Se	Br
	Melting point / °C	938	817	221	-7

- Explain the trend in melting point from Si to Cl across Period 3.
- Comment, with reasons, on the similarities and differences in the trends across Period 3 and Period 4.

Use the information in the table in your answer.	
	[6]

The felle	wing data show	o the fir	ot oight	0110000	nivo ion	ication a	porgio	of on	olomont	
THE IOIIO	wing data show	is the in	si eigili	succes:	SIVE IOII	isation 6	anergie:	s or arr	element.	
	lonisation energy	1st	2nd	3rd	4th	5th	6th	7th	8th	
	Energy / kJ mol <sup>-1</sup>	590	1145	4912	6474	8144	10 496	12 320	14 207	
justificati										
	on:									
	on:									
	on:									
justificati	on:									

lonisation number	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th
lonisation energy / kJ mol <sup>-1</sup>	496	4562	6910	9543	13354	16613	20117	25496	28932	141362	159075

**Table 16.1** 

	ncrease with ionisation nu	
		mber?
		,
successive ionisation en sodium atoms.		ride evidence for the
ionisation energies acro	oss periods gives further d	letails of electron
lement	Mg	Al
n energy / kJ mol <sup>-1</sup>	738	578
	t ionisation energies acrorst ionisation energies of	t ionisation energies across periods gives further drst ionisation energies of magnesium and aluminium lement Mg

**END OF QUESTION PAPER**