SMART EXAM RESOURCES
9701 CAMBRIDGE AS CHEMISTRY
TOPIC QUESTIONS AND MARK SCHEMES
TOPIC :ATOMIC STRUCTURE
SUB-TOPIC: VARIATION IN ATOMIC AND IONIC RADIUS
SET-1-QP-MS

1 **(a)** The table shows information about some of the elements in the third period.

element	Na	Mg	Al	P	S	Cl
atomic radius / nm	0.186	0.160	0.143	0.110	0.104	0.099
radius of most common ion / nm	0.095	0.065	0.050	0.212	0.184	0.181
maximum oxidation number of the element in its compounds	+1					+7

(i) Complete the table to show the maximum oxidation number of each element in its compounds. [1]

(ii) Explain why the atomic radius of elements in the third period decreases from Na to Cl.

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..... [3]

(iii) The radius of the most common ion of Mg is much smaller than the radius of the most common ion of S.

Identify both ions and explain the difference in their radii.

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..... [2]

Mark Scheme:

(a)(i)	max O.N. | +1 | (+)2 | (+)3 | (+)5 | (+)6 | +7	1
a)(ii)	(from Na to Cl) nuclear charge increases	1
	electrons are in the same shell / have same shielding	1
	greater / stronger attraction (of electrons to nucleus)	1
a)(iii)	Mg^{2+} **AND** S^{2-}	1
	ion of Mg / Mg^{2+} has one fewer shell (than ion of S / S^{2-})	1

2 This question is about Period 3 elements and their compounds.

(a) Give an explanation for each of the following statements.

(i) The atomic radius decreases across Period 3 (Na to Ar).

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..... [2]

Mark Scheme:

(a) (i)	greater attractive force OR greater force between nucleus and (outer) electrons proton number / atomic number / nuclear charge increases across period AND electrons occupy same shell / shielding roughly constant	[1] [1]	[2]

3 Although the actual size of an atom cannot be measured exactly, it is possible to measure the distance between the nuclei of two atoms. For example, the 'covalent radius' of the C*l* atom is assumed to be half of the distance between the nuclei in a Cl_2 molecule. Similarly, the 'metallic radius' is half of the distance between two metal atoms in the crystal lattice of a metal. These two types of radius are generally known as 'atomic radii'.
The table below contains the resulting atomic radii for the elements of period three of the Periodic Table, Na to C*l*.

element	Na	Mg	A*l*	Si	P	S	C*l*
atomic radius / nm	0.186	0.160	0.143	0.117	0.110	0.104	0.099

(a) (i) Explain qualitatively this variation in atomic radius.

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Mark Scheme:

(a) (i) from Na to Cl

nuclear charge increases	(1)
electrons are in the same shell/have the same shielding	(1)
nuclear attraction increases	(1)

4 **(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 C*l*.

Give a brief explanation of this variation.

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(ii) The cations formed by the elements Na to A*l* are smaller than the corresponding atoms.

Give a brief explanation of this change.

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[3]

Mark Scheme:

(i) Na and Mg

Mg has greater nuclear charge/more protons than Na (1)

in both atoms, the 3s electrons are in the same orbital/ same energy level/same shell (1)

(ii) Mg and A*l*

in A*l* outermost electron is in 3p rather than 3s (1)

3p electron is at higher energy **or** is further away/is more shielded from nucleus (1)

5 This question refers to the elements shown in the Periodic Table 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

The element that has the largest atomic radius.

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Mark Scheme:

K (1)