

Atomic Radii

What is the atomic radii?

The radius of an atom, measured in nm

How do you think it changes across a period? Down a group?

Atomic radii:

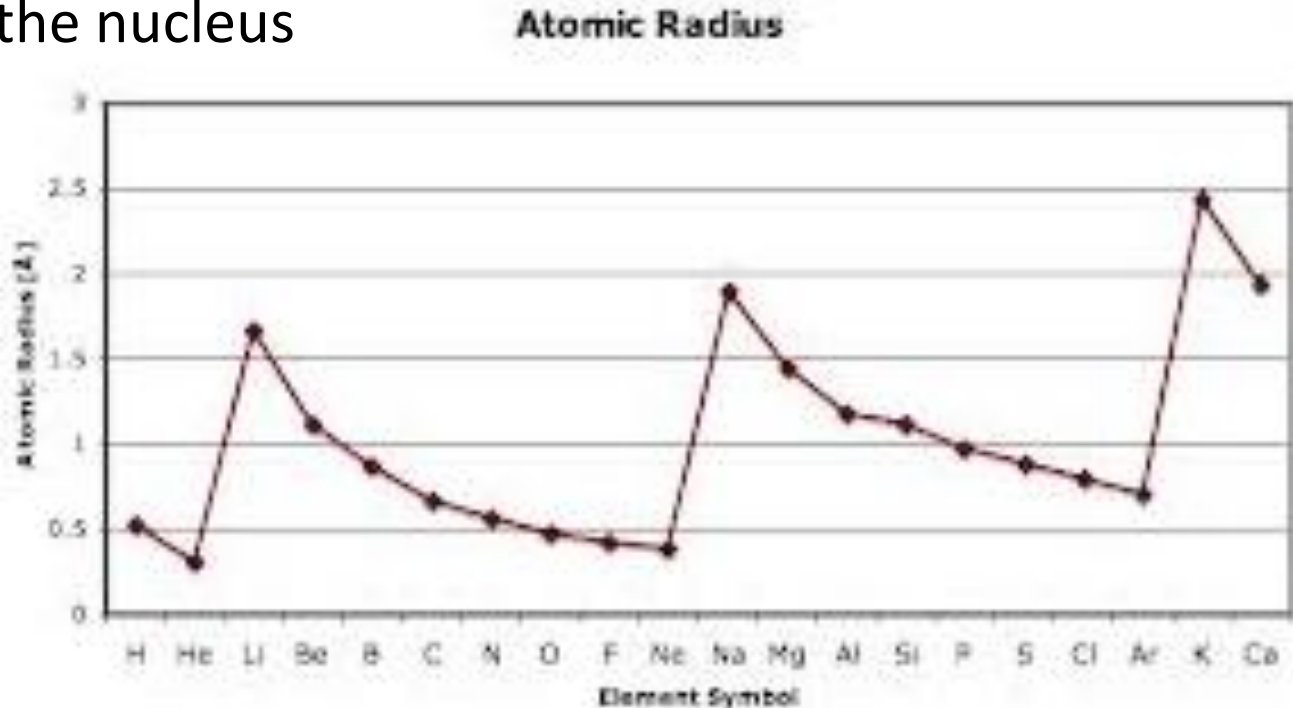
- Decreases across a period
- Increases down a group

1 H 1.0079																	18 He 4.0026
3 Li 6.941	4 Be 9.0122											5 B 10.811	6 C 12.011	7 N 14.007	8 O 15.999	9 F 18.998	10 Ne 20.180
11 Na 22.990	12 Mg 24.305	3	4	5	6	7	8	9	10	11	12	13 Al 26.982	14 Si 28.086	15 P 30.974	16 S 32.065	17 Cl 35.453	18 Ar 39.948
19 K 39.098	20 Ca 40.078	21 Sc 44.956	22 Ti 47.867	23 V 50.942	24 Cr 51.996	25 Mn 54.938	26 Fe 55.845	27 Co 58.933	28 Ni 58.693	29 Cu 63.546	30 Zn 65.409	31 Ga 69.723	32 Ge 72.64	33 As 74.922	34 Se 78.96	35 Br 79.904	36 Kr 83.798
37 Rb 85.468	38 Sr 87.62	39 Y 88.906	40 Zr 91.224	41 Nb 92.906	42 Mo 95.94	43 Tc (98)	44 Ru 101.07	45 Rh 102.91	46 Pd 106.42	47 Ag 107.87	48 Cd 112.41	49 In 114.82	50 Sn 118.71	51 Sb 121.76	52 Te 127.60	53 I 126.90	54 Xe 131.29
55 Cs 132.91	56 Ba 137.33	57-71 *	72 Hf 178.49	73 Ta 180.95	74 W 183.84	75 Re 186.21	76 Os 190.23	77 Ir 192.22	78 Pt 195.08	79 Au 196.97	80 Hg 200.59	81 Tl 204.38	82 Pb 207.2	83 Bi 208.98	84 Po (209)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra (226)	89-103 #	104 Rf (261)	105 Db (262)	106 Sg (266)	107 Bh (264)	108 Hs (270)	109 Mt (268)	110 Ds (281)	111 Rg (272)	112 Uub (285)	113 Uut (284)	114 Uuq (289)	115 Uup (288)	116 Uuh (291)		118 Uuo (294)
* Lanthanide series			57 La 138.91	58 Ce 140.12	59 Pr 140.91	60 Nd 144.24	61 Pm (145)	62 Sm 150.36	63 Eu 151.96	64 Gd 157.25	65 Tb 158.93	66 Dy 162.50	67 Ho 164.93	68 Er 167.26	69 Tm 168.93	70 Yb 173.04	71 Lu 174.97
# Actinide series			89 Ac (227)	90 Th 232.04	91 Pa 231.04	92 U 238.03	93 Np (237)	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (252)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (262)

Atomic Radii

What affects atomic radii? ie what affects the attraction between the valence electrons and the nucleus

- The energy level the electron is in (distance of orbital from the nucleus)
- Charge of the nucleus



Atomic Radii

Why does chlorine have a smaller atomic radii than sodium?

What is the definition of the term.

Where are the atoms located on the periodic table (and valence electrons).

How this affects the stated trend.

Why it affects the stated trend and relate back to question.

Atomic radii refers to the size of an atom. Both chlorine and sodium are located in the second row of the periodic table, so the valence electrons are going into the same energy level.

Chlorine atoms have more protons in the nucleus than sodium atoms so the electrons are more strongly attracted to the chlorine nucleus.

This stronger attraction **means that** the electrons will be drawn closer to the nucleus in chlorine and hence the radius will be smaller.

Ionic Radii

What is the ionic radii?

The radius of an ion, measured in nm

How do you think the size of a cation changes compared to its parent atom?

How do you think the size of an anion changes compared to its parent atom?

Ionic Radii:

- Cations are smaller than their parent atoms
- Anions are larger than their parent atoms
- Increase down a group

Ionic Radii

What affects ionic radii compared to parent atom?

Sizes of atoms and their ions in pm

Group 1		Group 2		Group 13		Group 15		Group 17	
Li ⁺ 90	Li 134	Be ²⁺ 59	Be 90	B ³⁺ 41	B 82	O 73	O ²⁻ 126	F 71	F ⁻ 119
Na ⁺ 116	Na 154	Mg ²⁺ 86	Mg 130	Al ³⁺ 68	Al 118	S 102	S ²⁻ 170	Cl 99	Cl ⁻ 167
K ⁺ 152	K 196	Ca ²⁺ 114	Ca 174	Ga ³⁺ 76	Ga 126	Se 115	Se ²⁻ 184	Br 114	Br ⁻ 182
Rb ⁺ 165	Rb 211	Sr ²⁺ 132	Sr 192	In ³⁺ 94	In 144	Te 135	Te ²⁻ 207	I 133	I ⁻ 205



- Attraction of the nucleus to the electrons in the valence shell

Ionic Radii

Why do sodium ions have a smaller radii than sodium atoms

What is the definition of the term.

Where are the atoms located on the periodic table (and valence electrons).

How this affects the stated trend.

Why it affects the stated trend and relate back to question.

Sodium atom and sodium ions have the same number of protons but the sodium ion has one less electron.

When the sodium ion loses an electron it loses an energy level, so it only has 2 electron shells. Sodium atoms have three electron shells. This loss of a shell **means that** the effective nuclear charge on the electrons is increased.

Losing an electron shell means that the electrons are now closer to the nucleus meaning the sodium ion is smaller than the sodium atom.

2013 Exam Q1 b (ii)

Complete worksheet about atomic and ionic radii and exam questions

(b) Discuss the data for each of the following pairs of particles.

(ii)

Atom or ion	Radius/pm
Cl	99
Cl ⁻	181

2013 Exam Q1 b (ii)

This table shows that Cl^- has a larger radius than Cl . This is because with an extra electron the attractive force from the nucleus is reduced, because it now has to hold another electron in place. This means all the electrons are held less tightly, and therefore are further away from the nucleus, giving ~~the~~ ~~a~~ ~~Cl~~ Cl^- a larger radius than Cl .

Answer lacks sufficient details for achievement. Chemistry 91390, 2013

2013 Exam Q1 b (ii)

^{17}Cl $1s^2 2s^2 2p^6 3s^2 3p^5$ e^- in the 3rd Energy level.

$^{17}\text{Cl}^-$ $1s^2 2s^2 2p^6 3s^2 3p^6$. Correct \rightarrow merit.

Both Cl and Cl^- have the same number of protons and hence same ~~nuclear~~ nuclear charge. There is 1 more electron for Cl^- , so Cl^- has greater e^- and e^- repulsion for Cl^- . Therefore, e^- are less tightly held by nucleus in Cl^- .
 $\therefore \text{Cl}^-$ is larger in radius than Cl .

2013 Sample Exam Q1 b (i)

(b) Give a justification for each of the following:

- (i) A chloride ion, Cl^- , is larger than a chlorine atom, Cl , whereas a sodium ion, Na^+ , is smaller than a sodium atom, Na .

When chlorine forms a Cl^- ion an extra electron is added ~~which~~ to the outer shell which increases electron-electron repulsion, therefore causing the outer electrons to spread out. ~~There~~ There are still the same number of protons but more electrons so the attractive force between outer electrons and nucleus is not as strong, the outer electrons are situated further from the nucleus and so Cl^- is larger than Cl . When Na forms an Na^+ ion, the outer energy level of electrons is removed so the new outer electrons are situated closer to the nucleus, ~~there is a stronger~~ attractive force between the outer electrons and the nucleus so the Na^+ ion is smaller than Na .