

3 properties of elements

Atomic radius

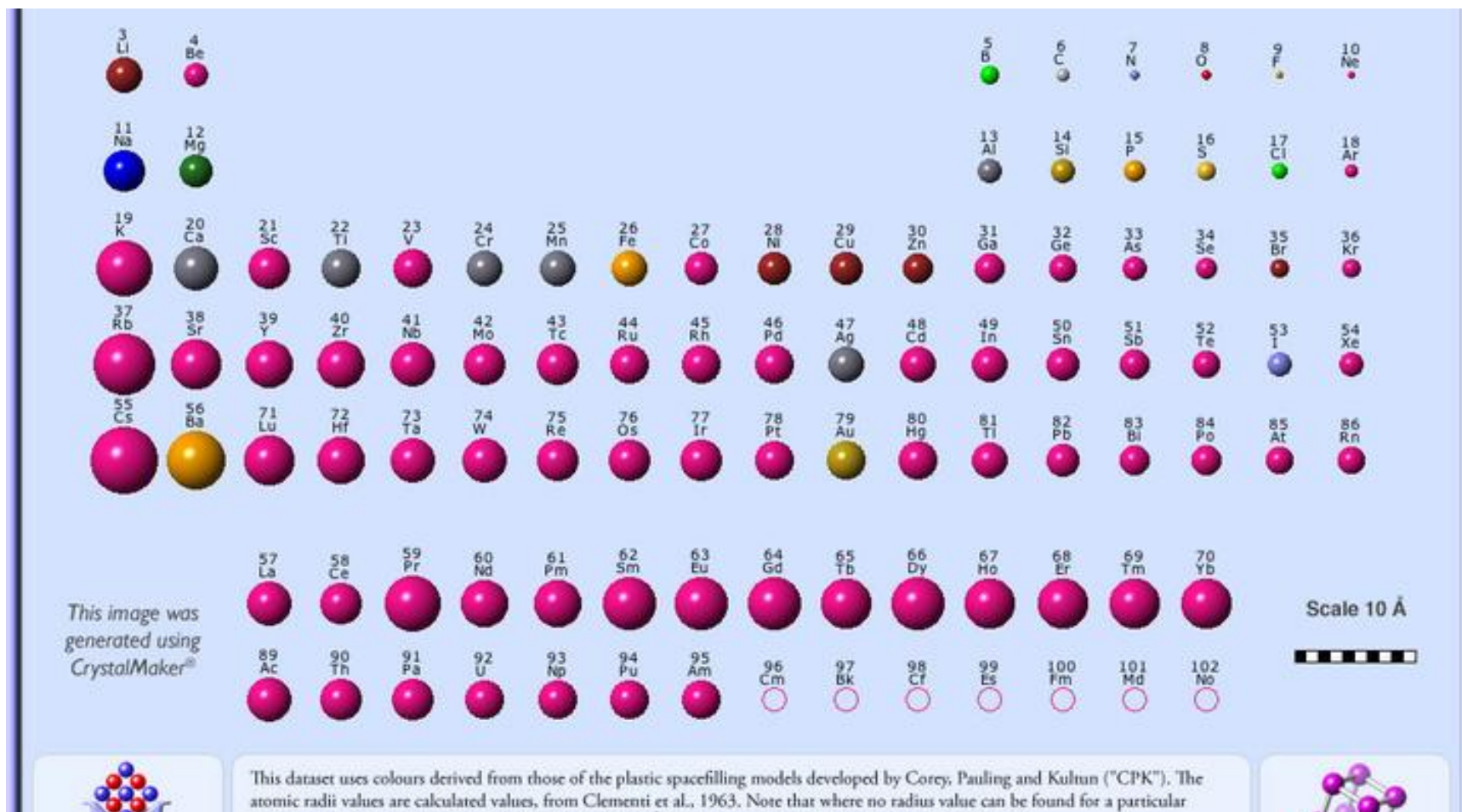
Ionisation energy

Electronegativity

Atomic radius

- $\frac{1}{2}$ distance between **2 nuclei** of two atoms of the **same element** that are joined together by a **single covalent bond**.
- It is possible for scientists to measure experimentally the distance between the nuclei of 2 atoms.
- This is known as bond length and is measured using x-ray diffraction. Usually in nanometres.
- See table On page Of your maths tables

What do we notice?



What do you notice?

IA						VIIA	VIIIA
H 0.037						H 0.037	He
Li 0.123	IIA Be 0.089				IIIA B 0.088	IVA C 0.077	Ne
Na 0.157	Mg 0.136				VA N 0.070	VIA O 0.066	Ar
K 0.203	Ca 0.174				S 0.104	Cl 0.099	Kr
Rb 0.216	Sr 0.192				As 0.121	Se 0.117	Xe
Cs 0.235	Ba 0.198				Sb 0.141	Te 0.137	Rn
Fr --	Ra --				Po 0.153	At --	

The values of atomic radii decrease going across a period. Why?

- Increase in effective nuclear charge. Increase in no. of protons in nucleus. These extra protons attract the outer electrons to draw energy levels closer to nucleus.
- No increase in screening effect. The addition of an electron going across a period is not added to a new energy level each time. There is an increase in the effective nuclear charge.

The values of atomic radii increase going down a group. Why? Must give 2 reasons

- As we go down a group there is a new energy level which is further from the nucleus.
- Screening effect. Even though nuclear charge increases this is counteracted by the shielding effect of the inner energy levels of electrons.

Trends in Ionisation energy

- 1st ionisation of an atom is minimum energy required to remove the most loosely bound electron from a neutral gaseous atom in its ground state.

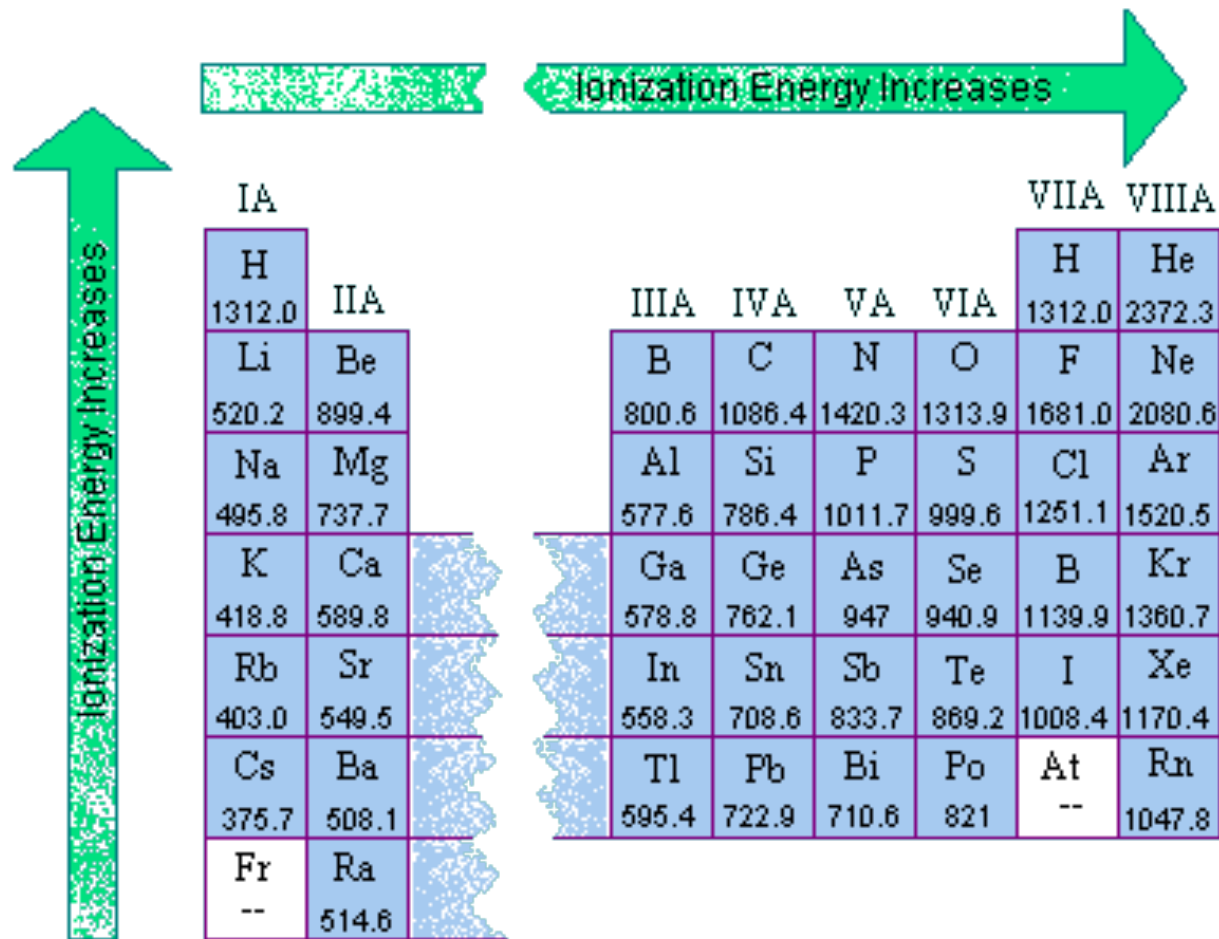
1st Ionisation energy decreases going down a group why?

- Increase in atomic radius
- Screening effect of inner electrons.

Ionisation energy increase going across a period . Why?

- decreasing atomic radius
- Increase in nuclear charge

Exceptions

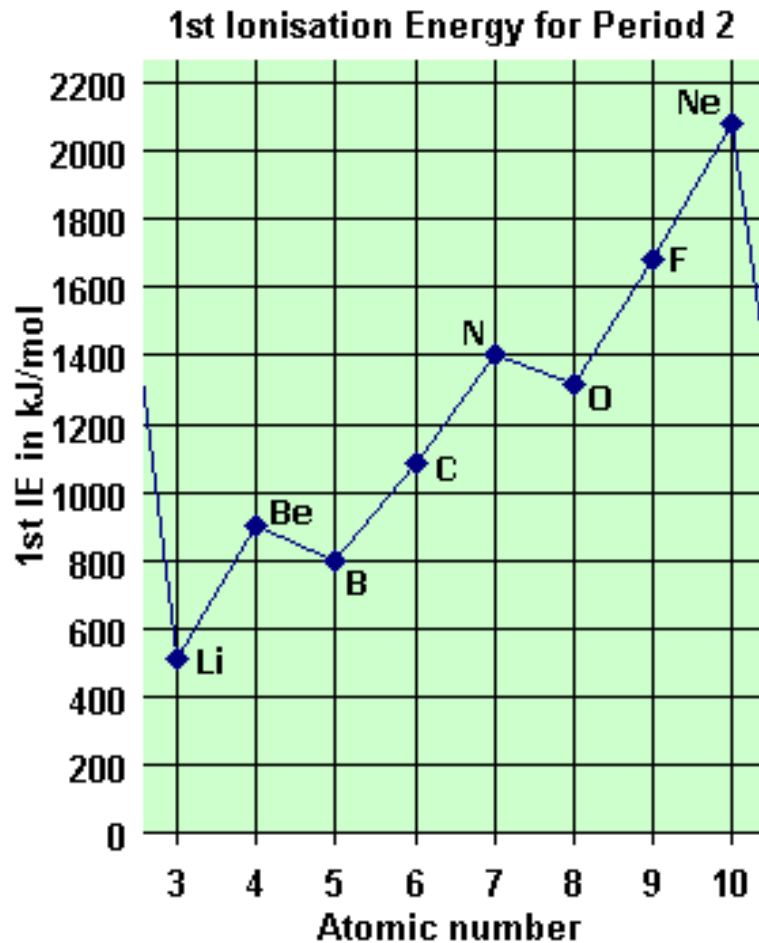


Ionization Energy Increases (Left to Right)

Ionization Energy Increases (Bottom to Top)

IA						VIIA		VIII	
H 1312.0						H 1312.0	He 2372.3		
Li 520.2	Be 899.4	IIA		III	IV	V	VI	F 1681.0	Ne 2080.6
Na 495.8	Mg 737.7			Al 577.6	Si 786.4	P 1011.7	S 999.6	Cl 1251.1	Ar 1520.5
K 418.8	Ca 589.8			Ga 578.8	Ge 762.1	As 947	Se 940.9	Br 1139.9	Kr 1360.7
Rb 403.0	Sr 549.5			In 558.3	Sn 708.6	Sb 833.7	Te 869.2	I 1008.4	Xe 1170.4
Cs 375.7	Ba 508.1			Tl 595.4	Pb 722.9	Bi 710.6	Po 821	At --	Rn 1047.8
Fr --	Ra 514.6								

Plot a Graph of 1st ionisation (y-axis
against atomic no. (x-axis) for
elements in period 2.



- Identify exceptions to this trend.

Exceptions

Be > B

- $1s^2, 2s^2$
- Beryllium has a full 2s sublevel. This gives an atom of Be extra stability so more energy than expected is needed to remove its most loosely bound electron

N > O

- $1s^2, 2s^2, 2p^3$
- Nitrogen has a half full 2p sublevel. This gives an atom of N extra stability so more energy than expected is needed to remove its most loosely bound electron

Can you explain

Mg > Al

P > S

Trends in electronegativity

Is relative force of attraction that an atom has for the shared pair of electrons in a covalent bond

Going across a period

- Electronegativity increase
- Due to increase in nuclear charge
- Decreasing atomic radius

Going down a group

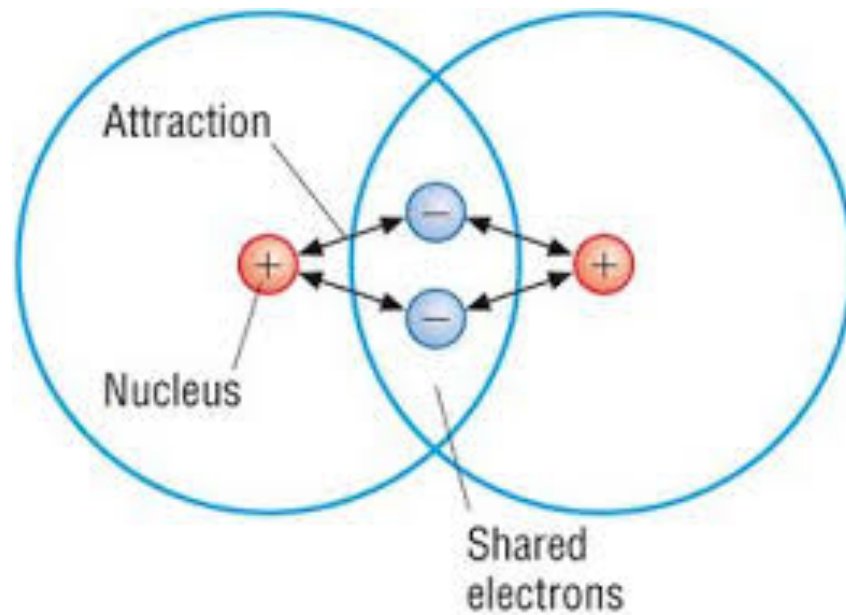
- Electronegativity decreases
- Increased atomic radius
- Screening effect

Electronegativity

Electronegativity Trend

Directions of increasing electronegativity

1A		2A												3A		4A		5A		6A		7A		0																						
1 H 1.00797		3 Li 6.941	4 Be 9.0122											5 B 10.811	6 C 12.01115	7 N 14.0067	8 O 15.9994	9 F 18.9984	10 Ne 20.179			11 Na 22.9998	12 Mg 24.305											13 Al 26.9815	14 Si 28.086	15 P 30.9738	16 S 32.06	17 Cl 35.453	18 Ar 39.948							
19 K 39.098	20 Ca 40.08	21 Sc 44.956	22 Ti 47.90	23 V 50.942	24 Cr 51.996	25 Mn 54.9380	26 Fe 55.847	27 Co 58.9332	28 Ni 58.70	29 Cu 63.546	30 Zn 65.38	31 Ga 69.723	32 Ge 72.59	33 As 74.9216	34 Se 78.96	35 Br 79.904	36 Kr 83.80											37 Rb 85.47	38 Sr 87.62	39 Y 88.906	40 Zr 91.224	41 Nb 92.906	42 Mo 95.94	(99)	43 Tc 101.07	44 Ru 102.905	45 Rh 106.4	46 Pd 107.868	47 Ag 112.41	48 Cd 114.82	49 In 118.69	50 Sn 121.75	51 Sb 127.60	52 Te 126.904	53 I 131.30	54 Xe 131.30
55 Cs 132.905	56 Ba 137.327	57 La 138.905	58 Ce 139.901	59 Pr 137.925	60 Nd 140.908	61 Pm 144.9126	62 Sm 150.36	63 Eu 151.964	64 Gd 157.25	65 Tb 158.925	66 Dy 162.50	67 Ho 164.9303	68 Er 167.259	69 Tm 168.9327	70 Yb 173.054	71 Lu 174.967	72 Hf 178.49	73 Ta 180.948	74 W 183.85	75 Re 186.207	76 Os 190.23	77 Ir 192.22	78 Pt 195.084	79 Au 196.967	80 Hg 200.59	81 Tl 204.37	82 Pb 207.19	83 Bi 208.980	84 Po (210)	85 At (210)	86 Rn (222)															
87 Fr (223)	88 Ra (226)	89 Ac (227)	90 Th (232)	91 Pa (231)	92 U (238)	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)	104 Rf (261)	105 Db (262)	106 Sg (266)	107 Bh (264)	108 Hs (277)	109 Mt (268)	110 Ds (271)	111 Rg (272)	112 Nh (285)	113 Fl (284)	114 Mc (289)	115 Lv (293)	116 Ts (294)	117 Og (294)																



Second ionisation

- E required to remove an electron from an ion with one positive charge in a gaseous state
- $X^+_{(g)} \longrightarrow X^{2+}_{(g)} + e^-$
- Make sure to include (g) symbol as def states in gaseous state

Second ionisation E

- Potassium = $1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 4s^1$
- 2nd ionisation E is much higher than 1st ionisation E as it involves removing an electron from a full 3p sublevel. The large difference in 1st and 2nd ionisation gives us evidence for existence of energy levels as the electron being removed from the 3p is closer to nucleus and experiences less shielding.

There is a steady increase in ionisation energy values as electrons are removed from an atom.

Reason 1

- For every electron that is removed the nuclear charge is increasing.

Reason 2

- Large increase in IE when an electron is being removed from a new energy level.

Classic mistakes noted when correcting questions on this topic.

- Not learning ionisation energy def. accurately.
- Not labelling axes on graphs
- Mixing energy levels/sub levels and orbitals
- Emphasize in your answer that a $\frac{1}{2}$ filled or full filled sublevel makes an atom more stable.
- Bohr diagrams being used instead of Dot and cross diagrams .
- Use specific language like going across table effective nuclear charge increase and atomic radius decreases. Don't waffle!