

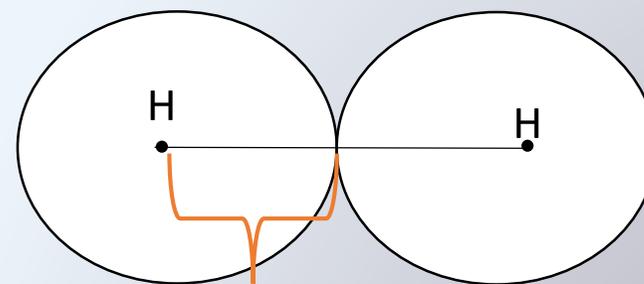
Trends in the Periodic Table



Atomic Radius

- Atomic Radius is defined as half the distance between the nuclei of 2 atoms of the same element that are joined together by a single covalent bond.

- Another name for atomic radius is covalent radius.



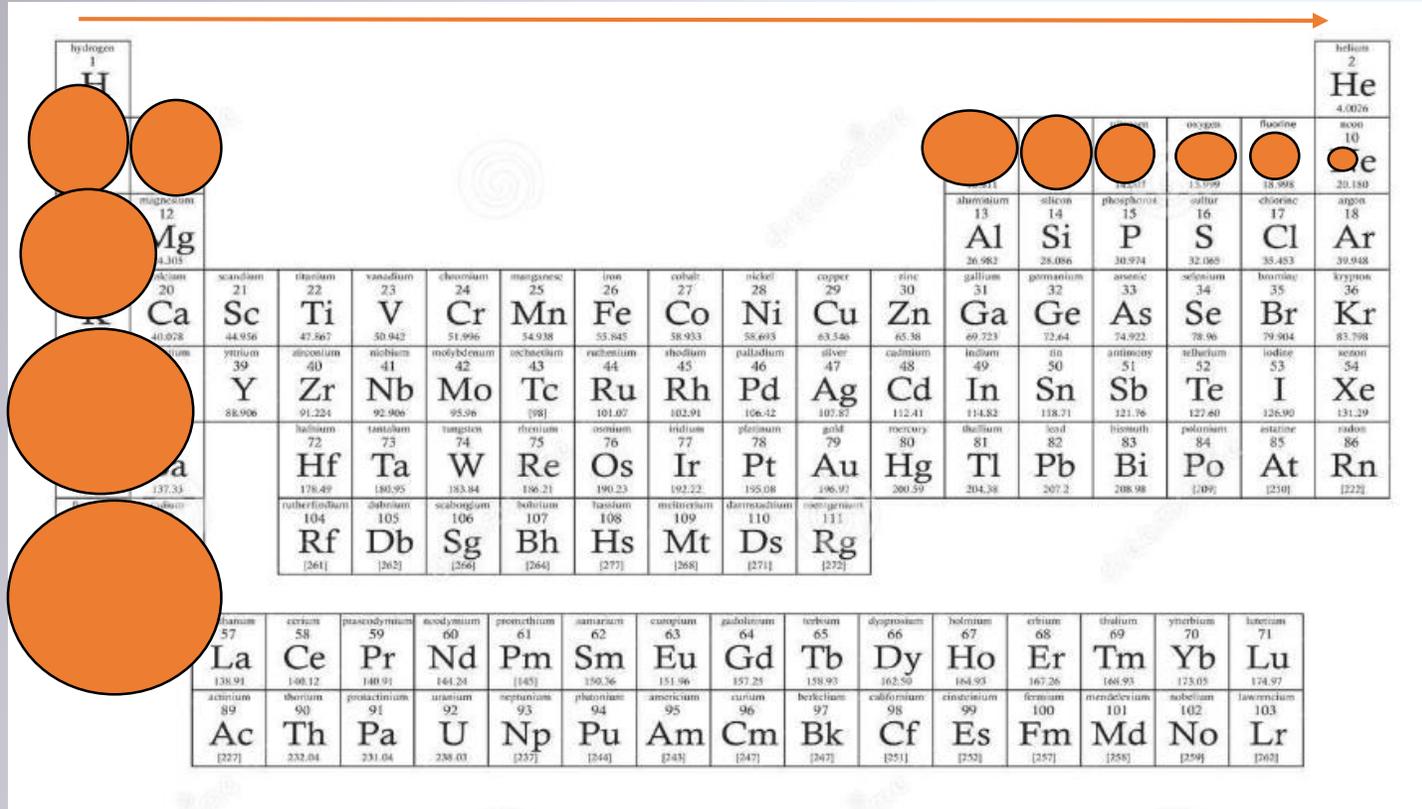
Half the distance of the bond



Trends in Atomic Radius

Atomic radius decreases across period

Atomic radius increases down the group

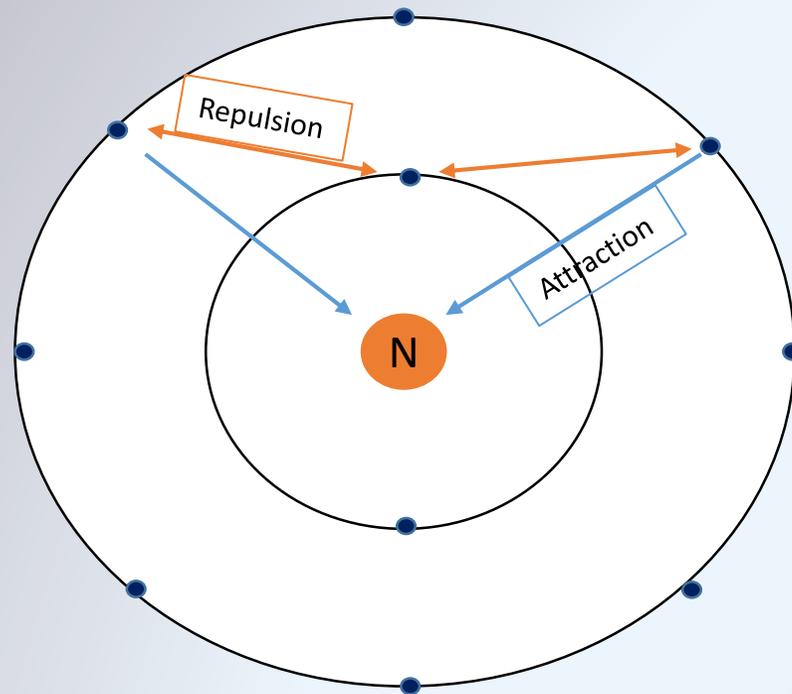


Atomic Radius increases down the group due to:

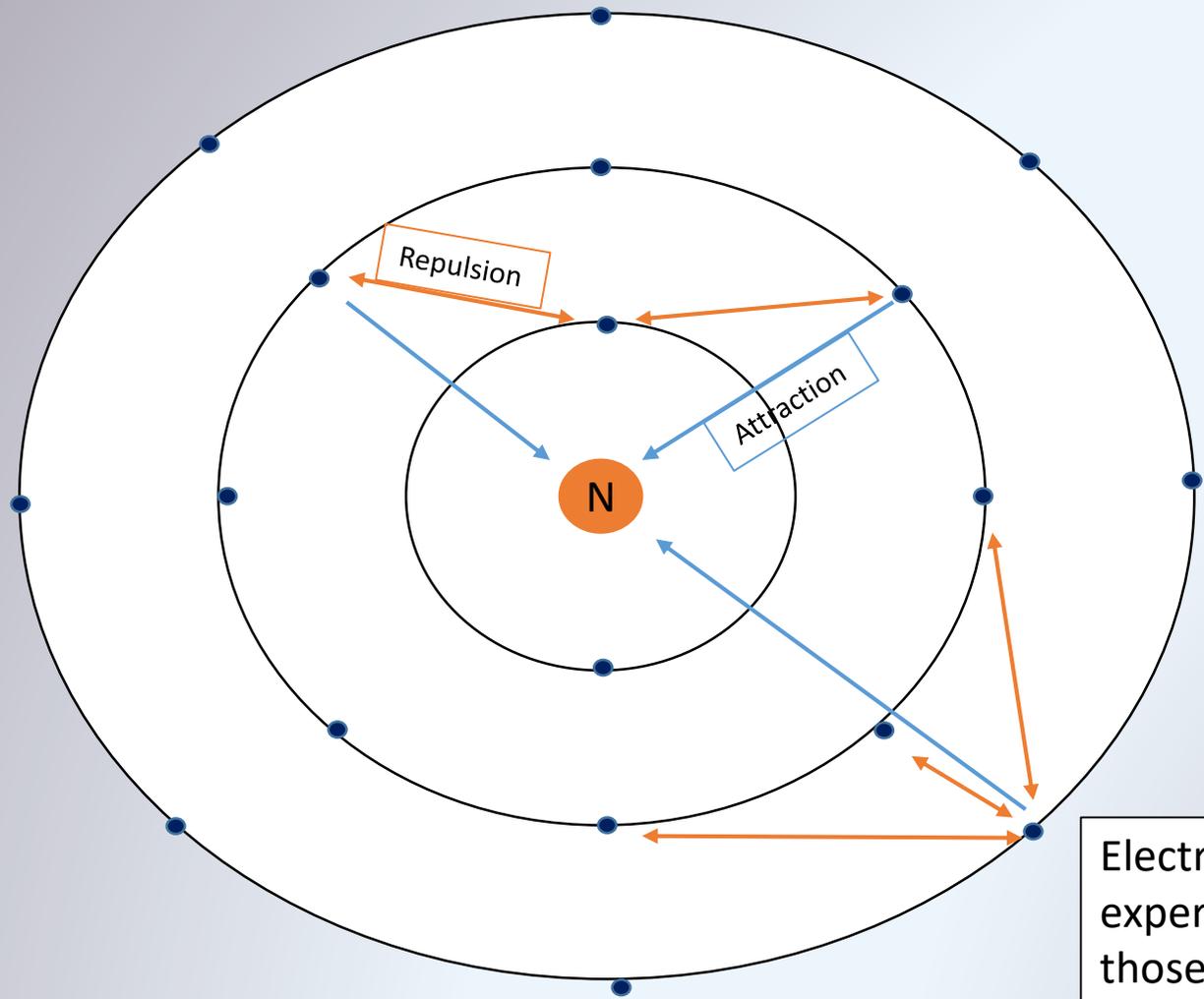
1. **A new shell of electrons** which is further away from the nucleus.
2. **The increase of the screening effect** of inner shells of electrons.



The Shielding (Screening) Effect



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Electrons in the outer shells experience more repulsion than those in the inner shells



Atomic Radius decreases across a period due to:

1. Increase in nuclear charge

- The more protons that are in the nucleus, then the stronger the attraction between the nucleus and the outer electrons

2. No increase in the screening effect

- The extra electron is being added to the same outer shell.



Decreasing Atomic Size

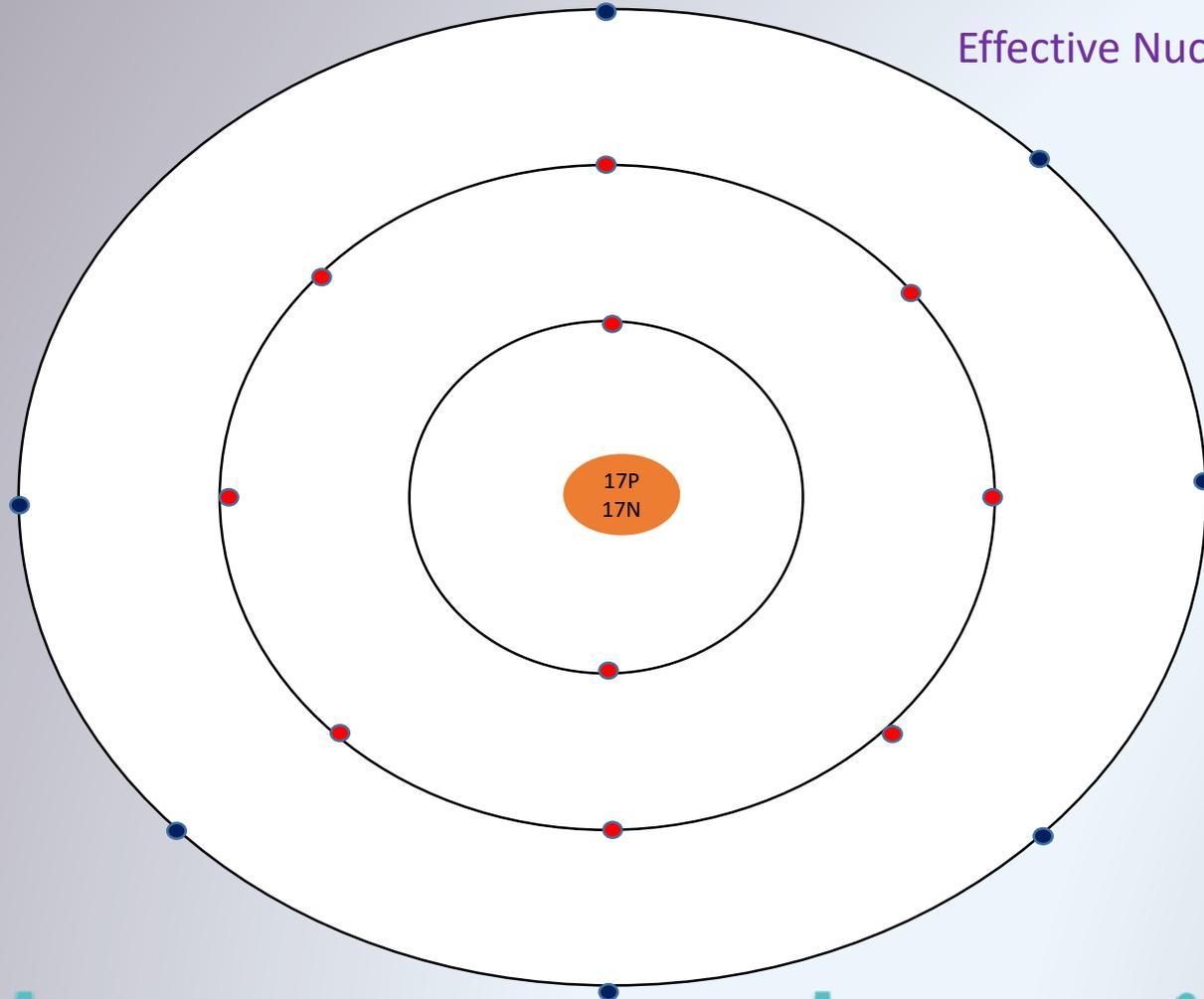
(Across a Period)

- As the attraction between the (+) nucleus and the (-) valence electrons increases, the atomic size decreases.
- From left to right, size decreases because there is an increase in nuclear charge and Effective Nuclear Charge (# protons - # core electrons).
- Each valence electron is pulled by the full Effective Nuclear Charge



Effective Nuclear Charge

Effective Nuclear Charge = total electrons – inner electrons



Chlorine = 17 total electrons
10 inner electrons

E.N.C. = $17 - 10 = +7$ charge



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D-Block elements

- As the difference in electron structure in the d-block elements occur in the 2nd last energy level, there is very little change in the size of their atoms across any period.
- The increased nuclear charge is effectively cancelled by the increase in the screening effect.

Why does little change occur in the size of D-block atoms?



First Ionization Energy

- The first ionisation energy is the **energy required** to remove the **most loosely bound electron** from a **neutral atom** in the **gaseous ground state**.



Second Ionization Energy

- Is the energy required to remove the **most loosely bound electron** from the **ion**, the first electron already having been removed.



Trends in Ionisation Energy

Ionisation energy increases across period

Ionisation energy decreases down the group

hydrogen 1 H 1.0079																	helium 2 He 4.0026				
lithium 3 Li 6.941	beryllium 4 Be 9.0122															boron 5 B 10.811	carbon 6 C 12.011	nitrogen 7 N 14.017	oxygen 8 O 15.999	fluorine 9 F 18.998	neon 10 Ne 20.180
sodium 11 Na 22.990	magnesium 12 Mg 24.305															aluminium 13 Al 26.982	silicon 14 Si 28.086	phosphorus 15 P 30.974	sulfur 16 S 32.065	chlorine 17 Cl 35.453	argon 18 Ar 39.948
potassium 19 K 39.098	calcium 20 Ca 40.078	scandium 21 Sc 44.956	titanium 22 Ti 47.867	vanadium 23 V 50.942	chromium 24 Cr 51.996	manganese 25 Mn 54.938	iron 26 Fe 55.845	cobalt 27 Co 58.933	nickel 28 Ni 58.693	copper 29 Cu 63.546	zinc 30 Zn 65.38	gallium 31 Ga 69.723	germanium 32 Ge 72.64	arsenic 33 As 74.922	selenium 34 Se 78.96	bromine 35 Br 79.904	krypton 36 Kr 83.798				
rubidium 37 Rb 85.468	strontium 38 Sr 87.62	yttrium 39 Y 88.906	zirconium 40 Zr 91.224	niobium 41 Nb 92.906	molybdenum 42 Mo 95.96	technetium 43 Tc [98]	ruthenium 44 Ru 101.07	rhodium 45 Rh 102.91	palladium 46 Pd 106.42	silver 47 Ag 107.87	cadmium 48 Cd 112.41	indium 49 In 114.82	tin 50 Sn 118.71	antimony 51 Sb 121.76	tellurium 52 Te 127.60	iodine 53 I 126.90	xenon 54 Xe 131.29				
caesium 55 Cs 132.91	barium 56 Ba 137.33			hafnium 72 Hf 178.49	tantalum 73 Ta 180.95	tungsten 74 W 183.84	rhenium 75 Re 186.21	osmium 76 Os 190.23	iridium 77 Ir 192.22	platinum 78 Pt 195.08	gold 79 Au 196.97	mercury 80 Hg 200.59	thallium 81 Tl 204.38	lead 82 Pb 207.2	bismuth 83 Bi 208.98	polonium 84 Po [209]	astatine 85 At [210]	radon 86 Rn [222]			
francium 87 Fr [223]	radium 88 Ra [226]			rutherfordium 104 Rf [261]	dubnium 105 Db [262]	seaborgium 106 Sg [266]	bohrium 107 Bh [264]	hassium 108 Hs [277]	meitnerium 109 Mt [268]	darmstadtium 110 Ds [271]	rosgonium 111 Rg [272]										

lanthanum 57 La 138.91	cerium 58 Ce 140.12	praseodymium 59 Pr 140.91	neodymium 60 Nd 144.24	promethium 61 Pm [145]	samarium 62 Sm 150.36	europtium 63 Eu 151.96	gadolinium 64 Gd 157.25	terbium 65 Tb 158.93	dysprosium 66 Dy 162.50	holmium 67 Ho 164.93	erbium 68 Er 167.26	thulium 69 Tm 168.93	ytterbium 70 Yb 173.05	lutetium 71 Lu 174.97
actinium 89 Ac [227]	thorium 90 Th 232.04	protactinium 91 Pa 231.04	uranium 92 U 238.03	neptunium 93 Np [237]	plutonium 94 Pu [244]	americium 95 Am [243]	curium 96 Cm [247]	berkelium 97 Bk [247]	californium 98 Cf [251]	einsteinium 99 Es [252]	fermium 100 Fm [257]	mendelevium 101 Md [258]	nobelium 102 No [259]	lawrencium 103 Lr [260]



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Trends in Ionization Energy

- **Increase across a period due to:**

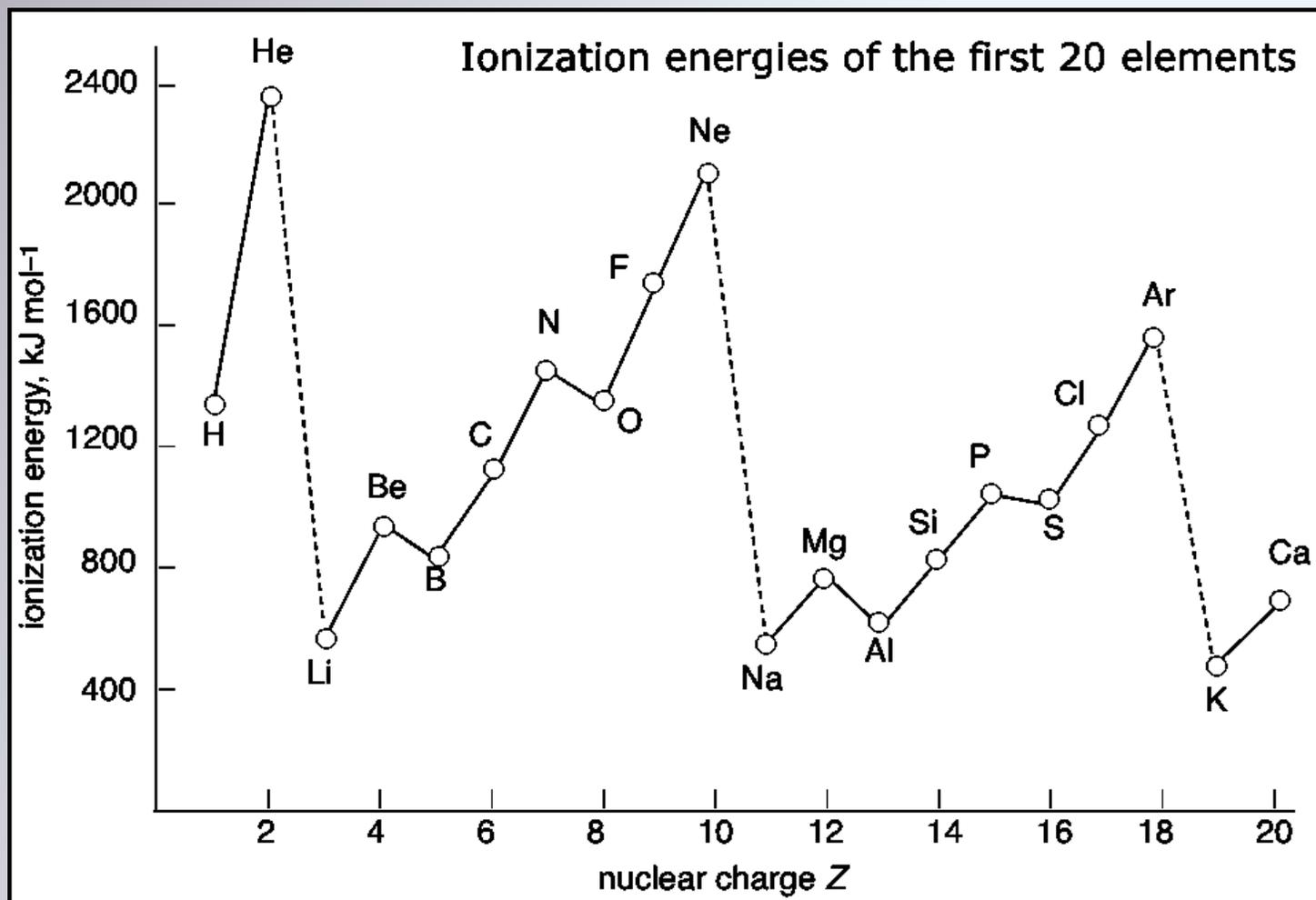
- Increase in the nuclear charge
- Decrease in atomic radius

- **Decrease down a group due to:**

- Increase in 'screening effect'
- Increase in atomic radius



Ionization Energies (*be able to explain)



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Exceptions to Ionisation Trends

- Write out the electron configuration (s, p, etc.) for the following atoms:

Be and B



Exceptions to Ionisation Trends

- Write out the electron configuration (s, p, etc.) for the following atoms:

Mg and Al



Exceptions to Ionisation Trends

- Write out the electron configuration (s, p, etc.) for the following atoms:

N and O



Exceptions to Ionisation Trends

- Write out the electron configuration (s, p, etc.) for the following atoms:

P and S



Why are these exceptions?

- Where is the outer electron being removed from in each atom?
- Which atom is more stable?



Evidence for the existence of energy levels

1. There is a steady increase in I.E. values as electrons are removed from the same shell.
2. There is a large increase in I.E. values when an electron is removed from a full shell.

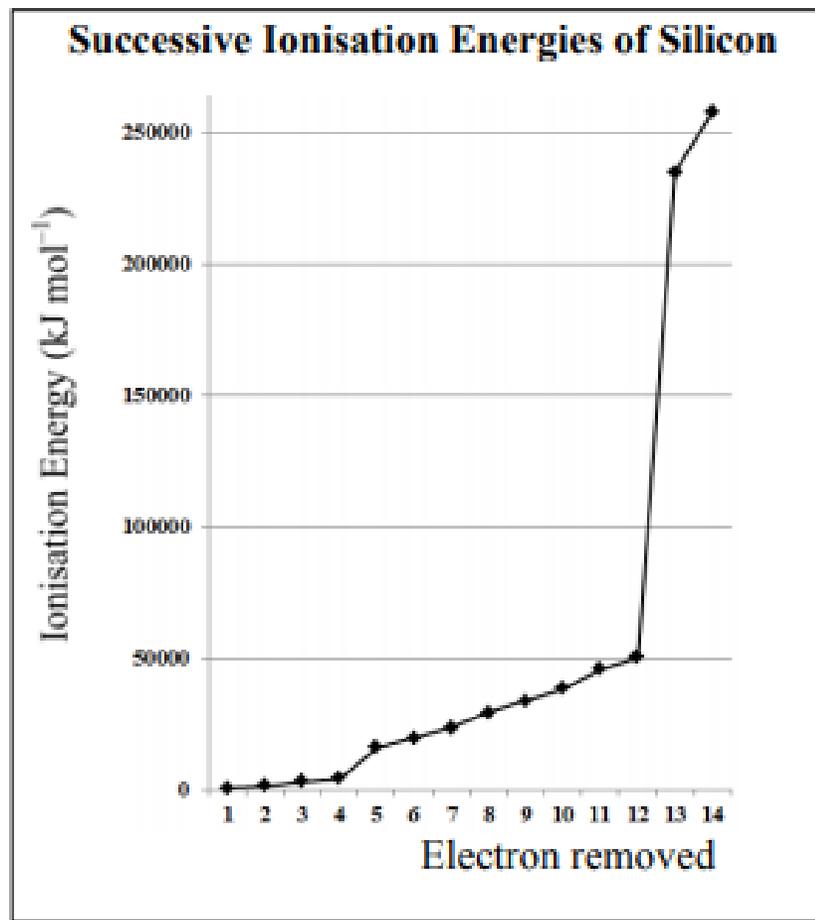
This is because the new shell is:

- Closer to the nucleus
- There is less screening effect
- Shell is full, so has extra stability



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Trends in I.E. for Silicon... Can you explain the trends?



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Electronegativity (E.N)

- Is the **relative force of attraction** atoms have for a **shared pair of electrons** in a **covalent bond**.
- Electronegativity values lay between 0.7 to 4.



Table of E.N values

1										18							
1 H 2.20	2										13	14	15	16	17	2	
3 Li 0.98	4 Be 1.57											5 B 2.04	6 C 2.55	7 N 3.04	8 O 3.44	9 F 3.98	10 Ne --
11 Na 0.93	12 Mg 1.31	3	4	5	6	7	8	9	10	11	12	13 Al 1.61	14 Si 1.90	15 P 2.19	16 S 2.58	17 Cl 3.16	18 Ar --
19 K 0.82	20 Ca 1.00	21 Sc 1.36	22 Ti 1.54	23 V 1.63	24 Cr 1.66	25 Mn 1.55	26 Fe 1.83	27 Co 1.88	28 Ni 1.91	29 Cu 1.90	30 Zn 1.65	31 Ga 1.81	32 Ge 2.01	33 As 2.18	34 Se 2.55	35 Br 2.96	36 Kr --
37 Rb 0.82	38 Sr 0.95	39 Y 1.22	40 Zr 1.33	41 Nb 1.60	42 Mo 2.16	43 Tc 2.10	44 Ru 2.20	45 Rh 2.28	46 Pd 2.20	47 Ag 1.93	48 Cd 1.69	49 In 1.78	50 Sn 1.96	51 Sb 2.05	52 Te 2.10	53 I 2.66	54 Xe 2.60
55 Cs 0.79	56 Ba 0.89	57 La 1.10	72 Hf 1.30	73 Ta 1.50	74 W 1.70	75 Re 1.90	76 Os 2.20	77 Ir 2.20	78 Pt 2.20	79 Au 2.40	80 Hg 1.90	81 Tl 1.80	82 Pb 1.80	83 Bi 1.90	84 Po 2.00	85 At 2.20	86 Rn --
87 Fr 0.70	88 Ra 0.90	89 Ac 1.10	104 Rf --	105 Db --	106 Sg --	107 Bh --	108 Hs --	109 Mt --	110 Ds --	111 Rg --	112 Uub --	113 Uut* --	114 Uuq --	115 Uup* --	116 Uuh --	117 Uus* --	118 Uuo --



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Trends in E.N

- **Increase across a period due to:**
 - Increase in nuclear charge (# protons).
 - Decrease in atomic radius.
- **Decrease down a group due to:**
 - Increase in the number of shells of electrons (shielding effect).
 - Increase in atomic radius



Uses of E.N values

- Help determine the type of bond within a molecule (intramolecular)... ionic or covalent bonds.
- Helps determine the type of force between molecules (intermolecular)...Van der Waals, Dipole-Dipole, or Hydrogen bonding.
- Helps determine the solubility in polar/non-polar solvents. “

“Like dissolves like”

