Periodicity

N Goalby

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Blocks

•An s-block element will always have an electronic structure where the outer electron is filling a s-sublevel.

• Likewise the outer electron of a p-block element will be in a p sublevel.

S block

p block

d block

1	H	He																
2	Li	Be											B	C	N	O	F	Ne
3	Na	Mg											Al	Si	P	S	Cl	Ar
4	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
5	Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe
6	Cs	Ba	La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn
7	Fr	Ra	Ac	Rf	Db	Sg	Bh	Hs	Mt	Ds	Rg	Cn	Uut	Fl	Uup	Lv	Uus	Uuo

f block

Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr

Periodic Trends in Properties of Elements

Various Elemental Properties change fairly smoothly going across a period.

Properties include:

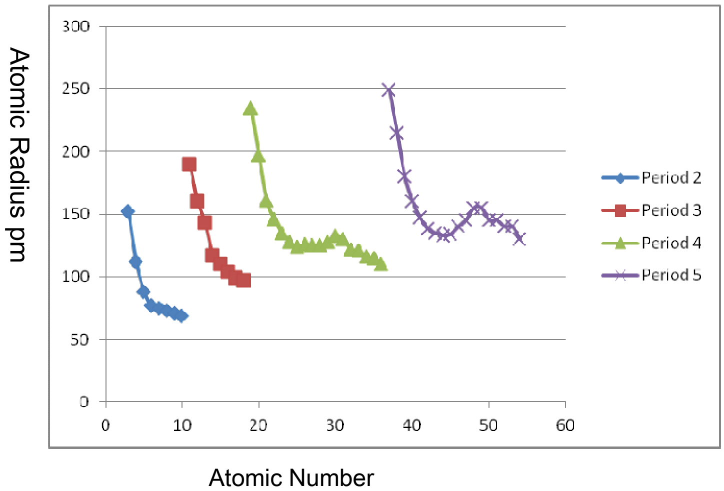
- Atomic and Ionic Radius
- Ionisation Energy
- Melting Points and Boiling Points
- Density and Conductivity

Definition
Periodicity is the pattern in the change in the properties of a row of elements. Repeated from one row to the next row

KEY

Trends in Atomic Radius

–Atomic radii decrease as you move from left to right across a period.



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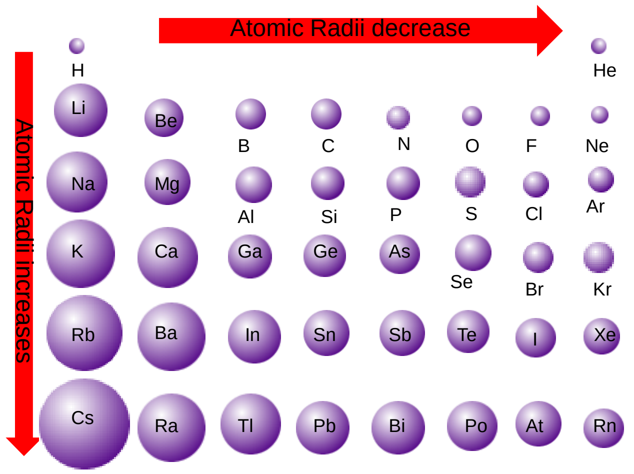
Relative atomic radii



Atomic radii decrease as you move from left to right across a period, because the increased number of protons create more positive charge attraction for electrons in the same shell .

Melting Points of Elements

1	H -259																	He -273
2	Li 181	Be 1279											B 2300	C 3827	N -210	O -218	F -219	Ne -249
3	Na 98	Mg 649											Al 660	Si 1410	P 44	S 119	Cl -101	Ar -189
4	K 64	Ca 843	Sc 1541	Ti 1660	V 1700	Cr 1903	Mn 1245	Fe 1536	Co 1495	Ni 1453	Cu 1083	Zn 420	Ga 30	Ge 938	As 817	Se 217	Br -7	Kr -157
5	Rb 39	Sr 769	Y 1507	Zr 1852	Nb 2468	Mo 2617	Tc 2172	Ru 2310	Rh 1966	Pd 1554	Ag 962	Cd 321	In 156	Sn 232	Sb 631	Te 450	I 114	Xe -112
6	Cs 28	Ba 710	La 921	Hf 2230	Ta 2996	W 3407	Re 3180	Os 3054	Ir 2407	Pt 1772	Au 1064	Hg -39	Tl 304	Pb 324.6	Bi 272	Po 254	At 302	Rn -71

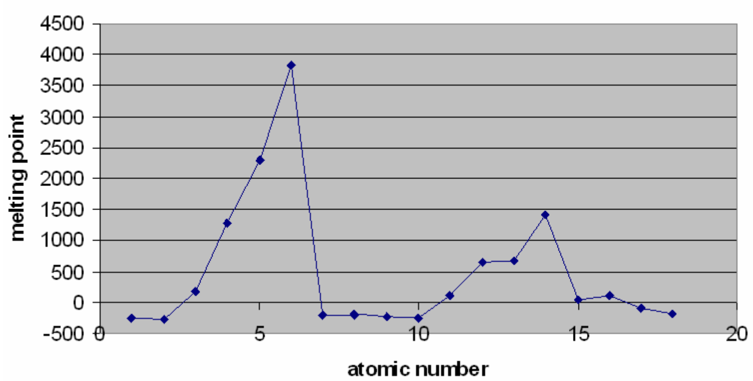
MP's tend to increase then decrease moving across periods
Highest m.p. carbon, then W and area around it

KEY

Moving left to right in a period, melting points increase as the attractive forces change from metallic bonds with loosely held electrons to solids like carbon and silicon where the atoms are arranged in giant structures.

Melting points then drop off sharply for non-metals, which have very weak forces of attraction.

Melting points in periods 2+3



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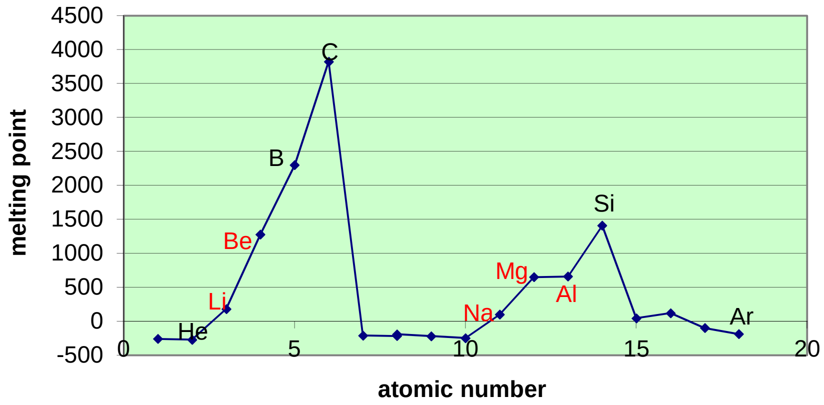
Melting points in periods 2+3 : metallic bonding



Metallic bonding : strong bonding – gets stronger the more electrons there are in the outer shell that are released to the sea of electrons. A smaller positive centre also makes the bonding stronger. High energy is needed to break bonds.

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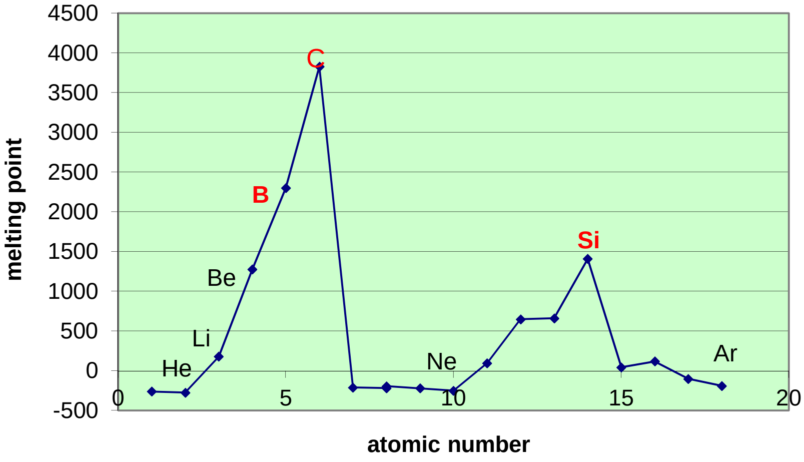
Melting points in periods 2+3 : Macromolecular



C and Si are Macromolecular: very strong covalent bonds between atoms high energy needed to break covalent bonds– very high mp +bp

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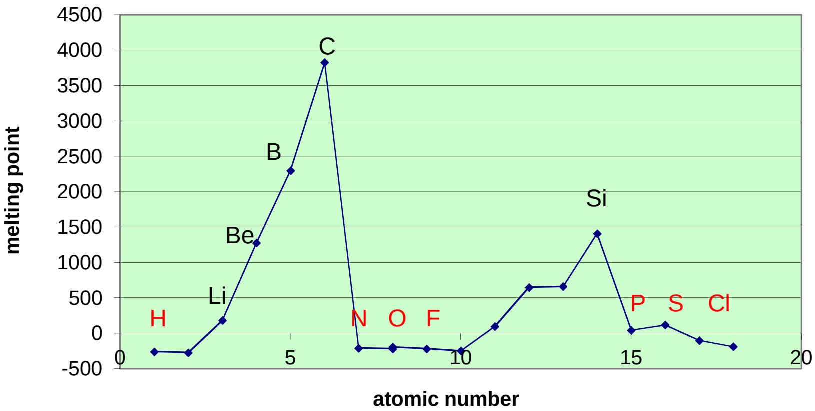
Melting points in periods 2+3 : simple molecular



Molecular (Simple covalent Cl_2, S_8, P_4): weak van der waals between molecules, so little energy is needed to break them – low mp+ bp

S_8 has a higher mp than P_4 because it has more electrons (S_8 =128)(P_4=60) so has stronger v der w

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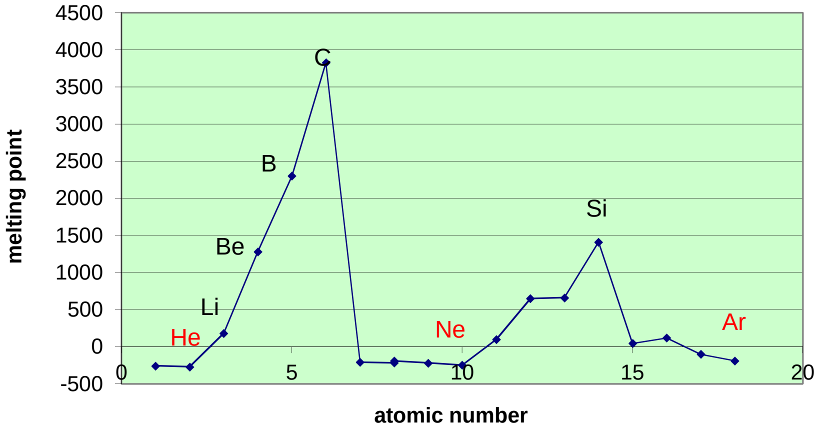
Melting points in periods 2+3 : monoatomic



The noble gases are monoatomic : weak van der waals between atoms so little energy is needed to break them – leads to very low mp+ bp

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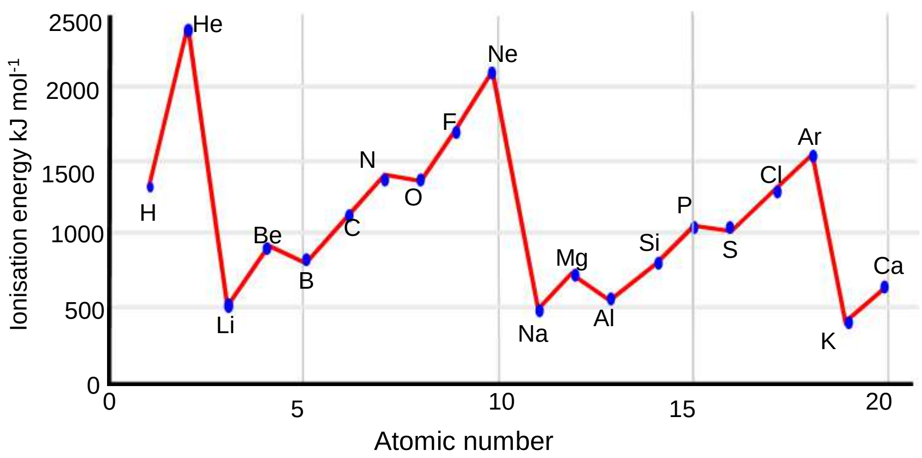
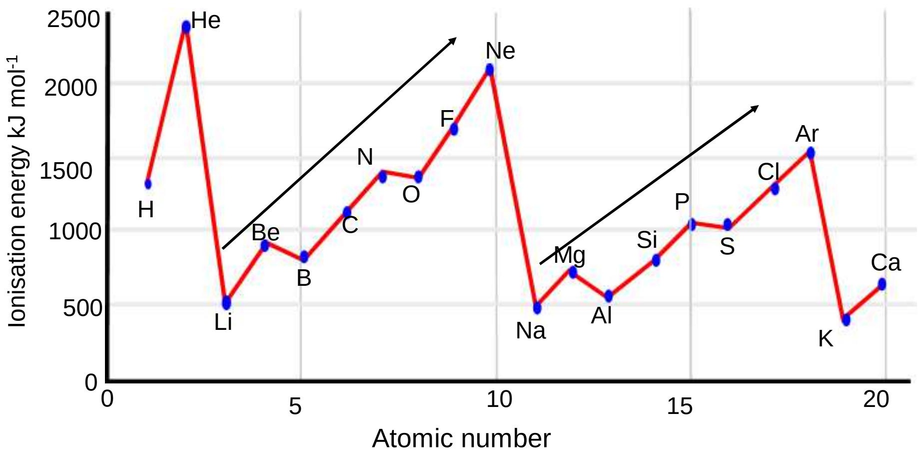
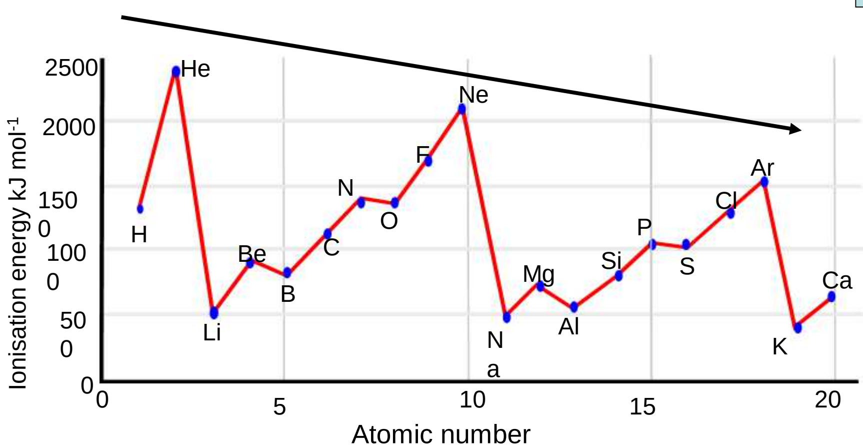
Periodicity in Ionisation Energy



The shape of the graph for periods two and three is similar. A repeating pattern across a period is called periodicity.

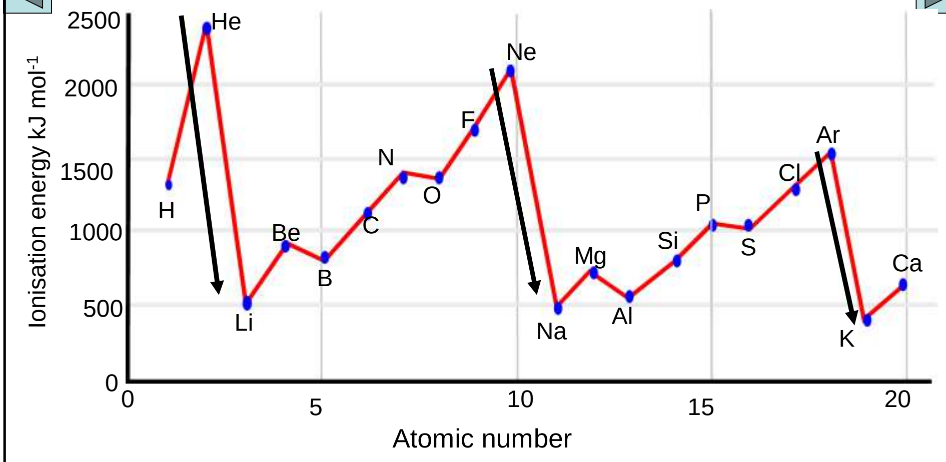


There is a general trend across each period for the ionisation energy to increase. This is due to increasing number of protons in successive elements, which means the electrons are more strongly held to the nucleus.



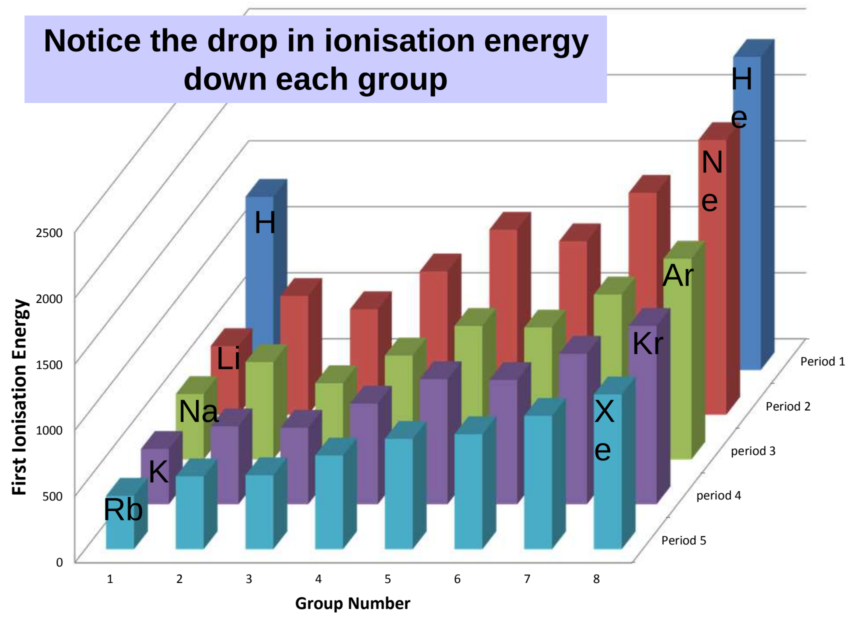
The noble gases are always at the maximum peak for each period, but there is a decrease in ionisation energy down the group. (true of all groups).

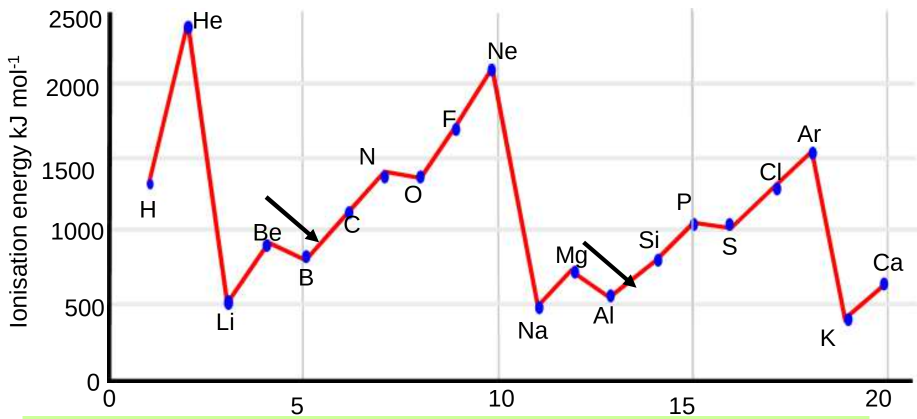
This is because as one goes down the group the outer electrons become further from the nucleus and become more shielded from the nuclear pull.



There is a large drop each time between the group 0 elements and the group1 elements.
This is because the element in group 1 will have its outer electron in a new shell further from the nucleus and is more shielded. So the group 1 element is easier to remove and has a lower ionisation energy.

Notice the drop in ionisation energy down each group





There is a small drop between Be + B , Mg + Al.
B and Al are starting to fill a p sub shell, whereas Be and Mg have their outer electrons in the s sub shell. The electrons in the p subshell are slightly easier to remove because the 2p electrons are higher in energy.

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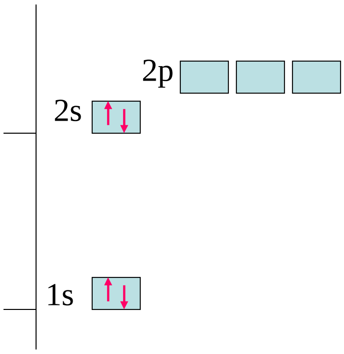
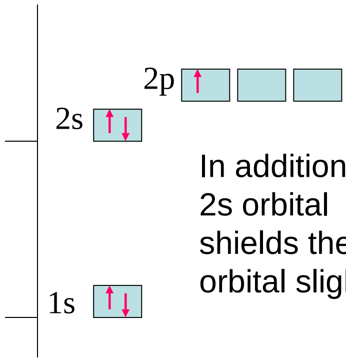
Beryllium

Electronic configuration : $1s^2 2s^2$

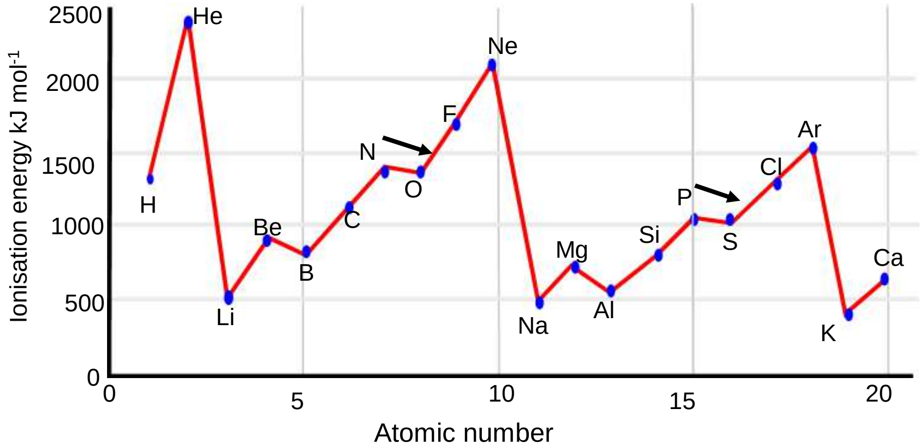


Boron

Electronic configuration : $1s^2 2s^2 2p^1$



In addition, the 2s orbital shields the 2p orbital slightly



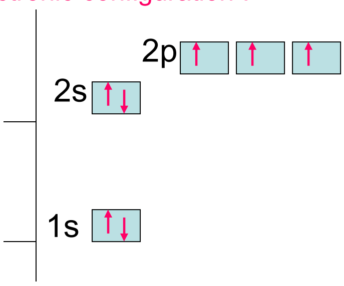
There is a small drop between nitrogen and oxygen and also phosphorous and sulphur.

When the second electron is added to an orbital there is a slight repulsion between the two negatively charged electrons which makes the second electron easier to remove.

For example with oxygen there are 4 p electrons and the 4th is starting to doubly fill the orbitals.

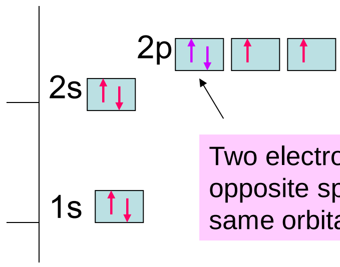
Nitrogen

Electronic configuration : $1s^2 2s^2 2p^3$



Oxygen

Electronic configuration : $1s^2 2s^2 2p^4$



Two electrons of opposite spin in same orbital