# IONIZATION ENERGY

<b>Ionisation energy:</b> Tof of	he from one mole of	required to remove	to produce o	ne mole
The symbol used to r The units are:	epresent ionization e	energy is:		
Subsequent ionizati	_		. (	<b>.</b>
The one mole of	required to remove	to produce one mole	of of	from .
Q) Why is energy re	equired to remove a	n electron from an ato	m or ion?	
There is an charged nucleus and to overcome.		force of attraction bety charged electrons.		

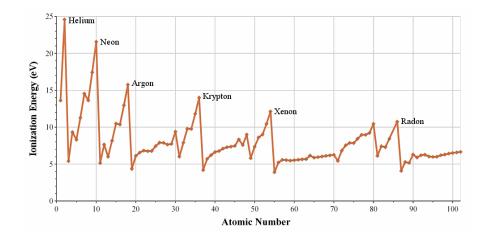
# Q) Look at the successive ionization energies of Lithium. Why do you think ionization energies increase as more electrons are removed?

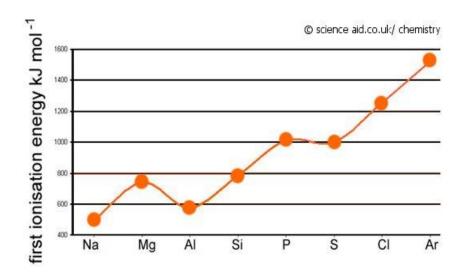
Li 1st 520 2nd 7300 3rd 11800

There are electrons in the . The (amount of ) remains the . Therefore, there is a force of attraction on the remaining electrons requiring more to remove an .

#### Factors influencing ionization energies:

Look at the graph below what patterns do you notice?

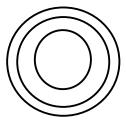




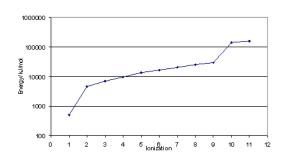
There	are three ma	in factors that affec	t ionisation ene	ergy:	
1.	Across a is added per	charge (the numbe . The nuc element e.g.	er of lear charge	in a beca	). Iuse one
2.		radius.			
	Across a in nuclear cha	the atomic arge and hence, the		, because attraction on	
	Down a an on the outer	in the number	nic radius of	. The	because there is attraction
3.		effect.			
	The shielding	effect is to do with	the number of		electrons. The greater
	the number o	of inner electrons (or	shells). The		the shielding effect. The
	inner electroi	ns create			s and 'shield' the
	attraction of		. This means		in the shielding
	effect		action on the	re	equiring
	energy to re				
	Across a Down a		g effect remain		an increase in the
	number of	the shielding (inner	electrons).	, ade 10 (	un mereuse in me
		These thre	e factors contr	ibute to the:	

## Working out an unknown element from successive ionization energies

Draw a dot and cross diagram of sodium:



Look at the successive ionization energies of sodium:



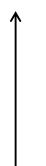
#### What do you notice?

Look back at the electronic structure of sodium can you make any links between the graph and the structure?

### A more detailed look at ionization energy values:

We have said that nuclear charge across a period. Therefore wouldn't ionisation energy increase always increase across a period? No there are some discrepancies.

Draw the **box diagram** of the electronic structure of Beryllium and Boron.



What are the 1st ionization energy values for beryllium and boron? What explanation can you give for these differences (refer to the back of the booklet)?

The outermost electron in Boron is in the energy subshell and there is slightly more from inner shell electrons meaning that energy is required to remove the electron.

Draw the electronic structure in **box diagram** of nitrogen and oxygen.



What are the 1<sup>st</sup> ionization energies for oxygen and nitrogen? Draw the electron structure box diagrams. Can you explain the ionization energy difference?

There are electrons in the 2P subshell in oxygen, this creates meaning less is required to remove the electron.

Similar patterns can be seen throughout the periodic table, e.g.

Answering question	ns on ionization energies:	
There are four types	of question that can be asked in the ex	ram.
mere are roor types	s of question that can be asked in the ex	.am:
1. Explaining the dif	ference in ionization energies of atoms	the period.
2. Explaining the dif	ference in ionization energies of atoms	a group.
3. Explaining the	in ionization energies	a period.
4. Identifying an unk	nown element from	energy data.
HINT: A	lways mention the three factors (for q	uestion one and two)
Across a	(in general).	
1) Explain why si	ilicon has a higher 1st ionization energy	than aluminium. 3marks
Silicon has a shielding effect. This	nuclear charge, a means there is a nuclear	in atomic radius and on the
electrons. Therefore,	energy is required to	an electron.
Down a		
2) Explain why m	nagnesium has a lower 1st ionization ene	ergy than beryllium. 3marks
Magnesium has a	atomic radius as it has	shells and therefore
an	in shielding effect. This offsets the	in nuclear charge. This
means there is	nuclear on the	electrons. Therefore,
energy is required to	o an electron.	
Discrepancies in I.E	a period (group c	and group ).
3a) Explain why mag	gnesium has a higher 1st ionization energ	gy than aluminium. 2marks

Discrepancies in I.E	a period (group	and aroup	).
Disciepuncies in i.E	a perioa (groop	ana groop	,.

3b) Explain why oxygen has a lower 1st ionization energy than nitrogen. 2marks

#### Determining an element from

#### ionisation energy data.

3c) Element X is in period three of the periodic table. From the successive ionisation energy data below, identify the element and explain you answer. 3 marks

I.E	Energy in KJmol <sup>-1</sup>
1st	999.6
2nd	2252
3rd	3357
4th	4556
5th	8004.3
6th	8495.8
7th	27107
8th	31719

4a) Describe the general trend in ionisation energies from sodium to argon, in terms of atomic structure.

b) State and explain the difference in 1st ionisation energy between nitrogen and arsenic.

18 He 2372.3	Ne 2080.7	<b>Ar</b> 1520.6	<b>Kr</b> 1350.8	<b>Xe</b> 1170.3	<b>Rn</b> 1037.1			
17	<b>F</b> 1681.0	<b>G</b>	<b>Br</b> 1139.9	1008.4	At		<b>Lu</b> 523.5	<b>Lr</b> 472.8
91	1313.9	<b>S</b> 9.666	<b>Se</b> 941.0	<b>Te</b> 869.3	<b>Po</b> 812.1		<b>Yb</b> 603.4	<b>No</b>
15	N 1402.3	<b>P</b>	<b>As</b> 944.5	<b>Sb</b> 830.6	<b>Bi</b> 703.0	Uup	<b>Tm</b> 596.7	Md 635
4	C 1086.5	<b>Si</b>	<b>Ge</b>	<b>Sn</b> 708.6	<b>Pb</b> 715.6	Dug	<b>Er</b> 589.3	<b>Fm</b> 627
13	<b>B</b> 800.6	<b>AI</b> 577.5	<b>Ga</b> 578.8	<b>In</b> 558.3	<b>=</b> 589.4	Uut	<b>Ho</b> 581.0	<b>Es</b> 619
		12	<b>Zn</b> 906.4	<b>Ga</b>	<b>Hg</b> 1007.1	Uub	<b>Dy</b> 573.0	<b>G</b>
		Ξ	<b>Cu</b> 745.5	<b>Ag</b> 731.0	<b>Au</b> 890.1	Rg	<b>Tb</b> 565.8	<b>BK</b> 598.0
2372.3 kJ/mol		10	<b>Ni</b> 737.1	<b>Pd</b> 804.4	<b>P</b> 864.4	Ds	<b>Gd</b> 593.4	<b>Cm</b> 578.1
237		6	<b>Co</b> 760.4	<b>Rh</b> 719.7	<b> </b>	Mt	<b>Eu</b> 547.1	<b>Am</b> 576.4
		00	<b>Fe</b> 762.5	<b>Ru</b> 710.2	<b>0s</b> 814.2	Hs	<b>Sm</b> 544.5	<b>Pu</b> 581.4
		7	Mn 717.3	<b>Tc</b> 702	<b>Re</b> 755.8	Bh	<b>Pm</b> 538.6	<b>Np</b> 604.5
lom		9	<b>Ç</b>	Mo 684.3	W 758.8	Sg	Nd 533.1	<b>U</b> 597.6
375.7 kJ/mol		2	<b>V</b> 650.9	<b>Nb</b> 652.1	<b>Ta</b> 728.4	Db	<b>Pr</b> 528.1	<b>Pa</b>
		4	<b>=</b>	<b>Zr</b> 640.1	<b>H</b>	<b>Rf</b> 580	<b>Ce</b> 534.4	<b>Th</b> 608.5
		3	<b>Sc</b> 633.1	<b>Y</b> 599.9	<b>La</b> 538.1	<b>Ac</b> 498.8	Lanthanides 6	Actinides 7
- 2	<b>Be</b> 899.5	Mg 7.7.87.7	<b>S</b>	<b>S4</b> 9.5	<b>Ba</b> 502.9	<b>Ra</b> 509.3	В	
1 1312.0	<b>Li</b> 520.2	<b>Na</b> 495.8	<b>K</b> 418.8	<b>Rb</b> 403.0	<b>Cs</b>	<b>Fr</b> 393.0		
-	7	m	4	2	9	7		