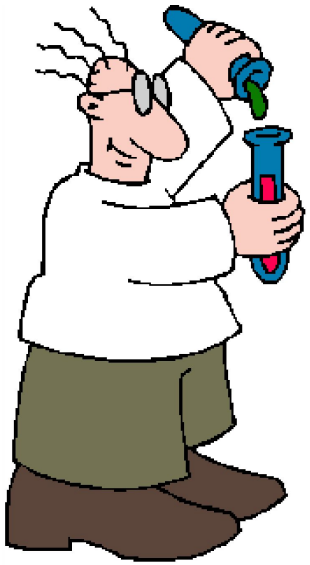
Unit F321

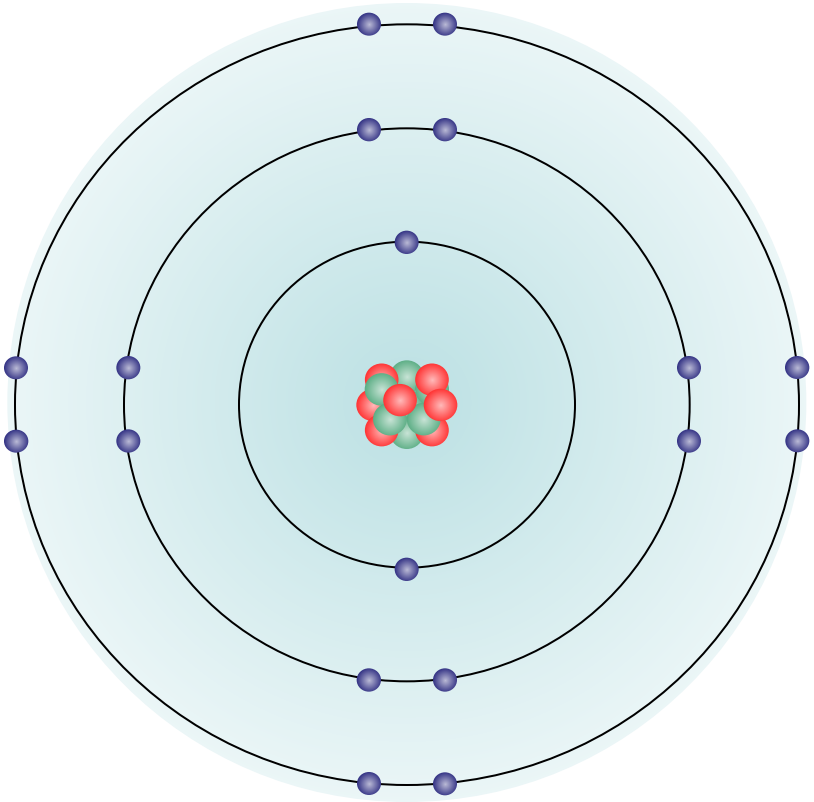
Module 1.2.1 Electron Structure



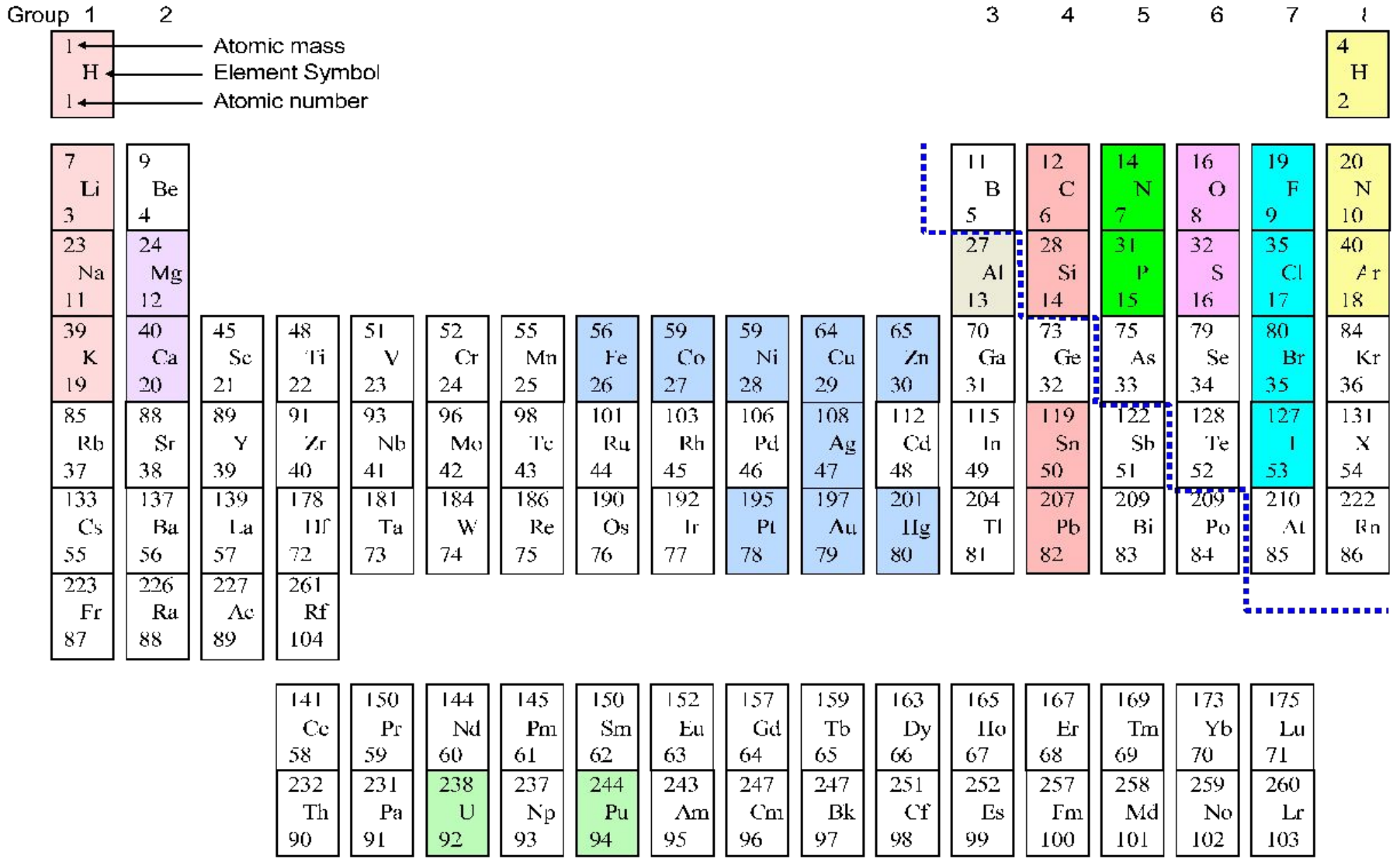
Define the terms *first ionisation energy* and *successive ionisation energy*;	
Explain that ionisation energies are influenced by nuclear charge, electron shielding and the distance of the outermost electron from the nucleus;	
predict from successive ionisation energies of an element: (i) the number of electrons in each shell of an atom, (ii) the group of the element;	
state the number of electrons that can fill the first four shells;	
describe an orbital as a region that can hold up to two electrons, with opposite spins;	
describe the shapes of s and p orbitals;	
state the number of: (i) orbitals making up s-, p- and d-sub- shells, (ii) electrons that occupy s-, p- and d-sub- shells;	
describe the relative energies of s-, p- and d- orbitals for the shells 1, 2, 3 and the 4s and 4p orbitals;	
deduce the electron configurations of: (i) atoms, given the atomic number, up to $Z = 36$, (ii) ions, given the atomic number and ionic charge, limited to s and p blocks up to $Z = 36$;	
classify the elements into s, p and d blocks.	

Atomic Structure

- Protons, neutrons, electrons
- How to make ions
- Relative atomic mass



The Periodic Table Of The Elements



N.B. Coloured squares show the elements to learn for lower secondary educati n.

Inside an atom

	Mass / kg	Charge / C	Relative mass	Relative charge
PROTON	1.672×10^{-27}	1.602×10^{-19}	**1**	**+1**
NEUTRON	1.675×10^{-27}	**0**	**1**	**0**
ELECTRON	9.109×10^{-31}	1.602×10^{-19}	$\frac{1}{2000}$	**-1**

- **Atomic number** = no. protons in nucleus
- **Mass number** = no. protons + no. neutrons
- **Ion:** a positively or negatively charged atom or group of atoms

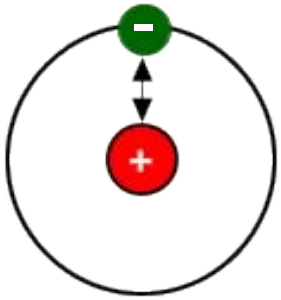
Ionisation Energy

- What is ionisation energy?
- Definitions
  - First ionisation energy
  - Successive ionisation energies
- What affects ionisation energy?

WHAT IS IONISATION ENERGY?

Ionisation Energy is a measure of the amount of energy needed to remove electrons from atoms.

As electrons are negatively charged and protons in the nucleus are positively charged, there will be an attraction between them. The greater the pull of the nucleus, the harder it will be to pull an electron away from an atom.



Attraction between the nucleus and an electron

FIRST IONISATION ENERGY - Definition

The energy required to remove ONE MOLE of electrons from each atom in ONE MOLE of gaseous atoms to form ONE MOLE of gaseous positive ions.

e.g. $Na(g) \rightarrow Na^+(g) + e^-$

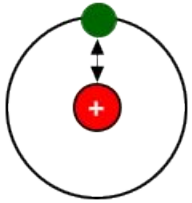
$Al(g) \rightarrow Al^+(g) + e^-$

Make sure you write in the (g)

WHAT AFFECTS IONISATION ENERGY?

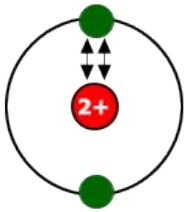
The value of the 1st Ionisation Energy depends on the electronic structure

Hydrogen



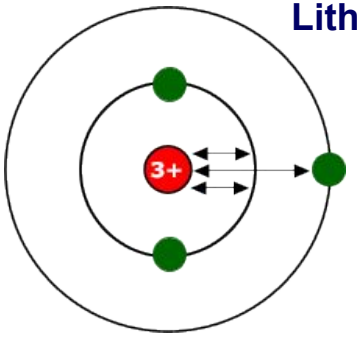
1310 kJ mol^{-1}

Helium



2370 kJ mol^{-1}

Lithium

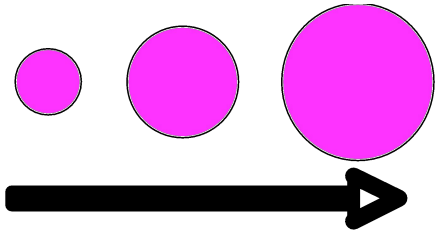


519 kJ mol^{-1}

The value for helium is higher than that for hydrogen because there are now two protons in the nucleus. The nuclear charge is greater so the pull on the outer electrons is larger. More energy will be needed to pull an electron out of the atom.

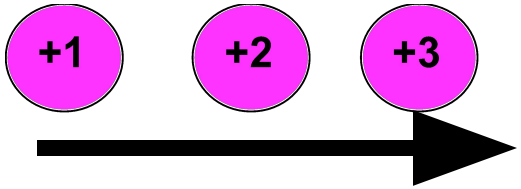
Ionisation Energy is affected by 3 things:

1. Atomic Radius



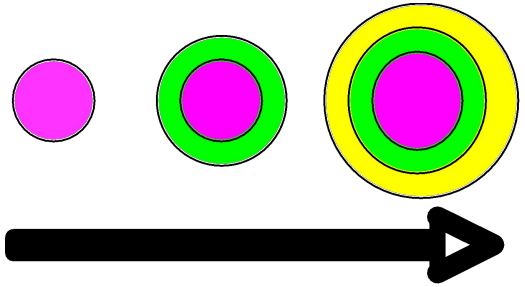
I. E. Decreases

2. Nuclear Attraction



I. E. Increases

3. Electron Shielding



I. E. Decreases

Successive Ionisation Energies

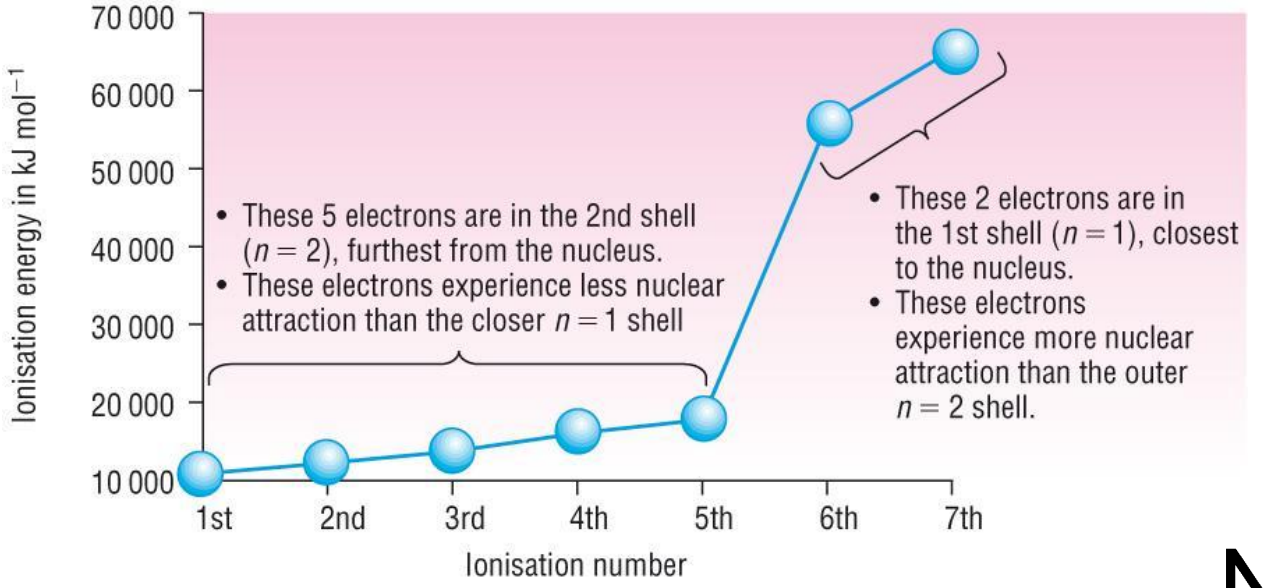
- A measure of the energy required to remove each electron in turn.

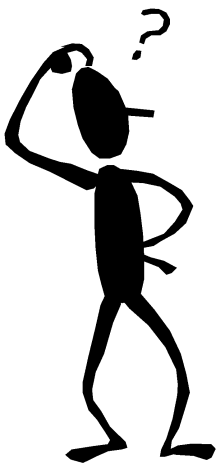
- $Mg(g) \rightarrow Mg^{+}(g) + e^{-}$ 1^{st} I.E. =+738 $kJ.mol^{-1}$

- $Mg^{+}(g) \rightarrow Mg^{2+}(g) + e^{-}$ 2^{nd} I.E.= + 1451$kJ.mol^{-1}$

- $Mg^{2+}(g) \rightarrow Mg^{3+}(g) + e^{-}$ 3^{rd} I.E.= + 7733$kJ.mol^{-1}$

- $Mg^{3+}(g) \rightarrow Mg^{4+}(g) + e^{-}$ 4^{th} I.E.= + 10541$kJ.mol^{-1}$

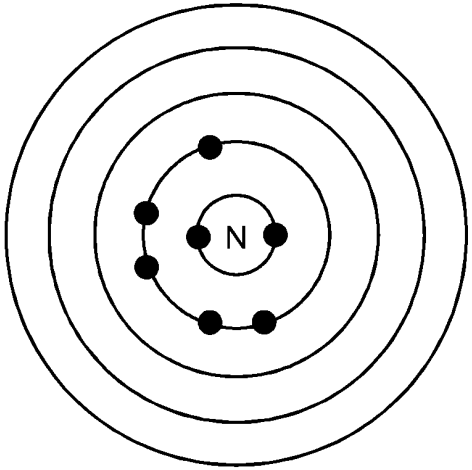




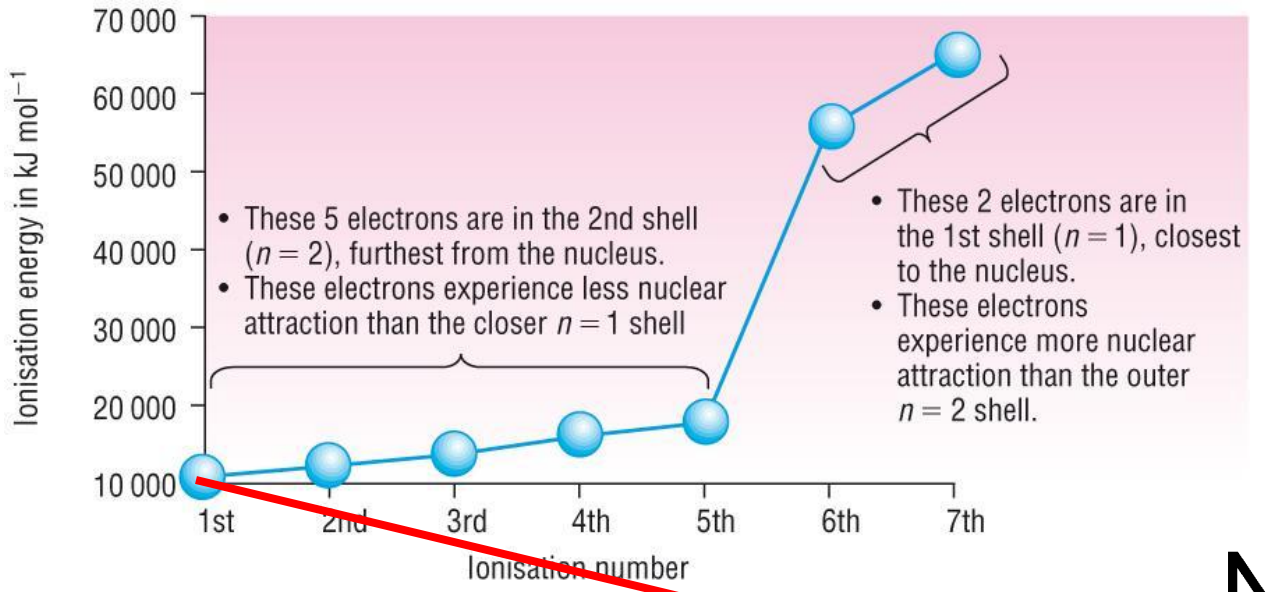
Which electron is removed first?

(First Ionisation Energy)

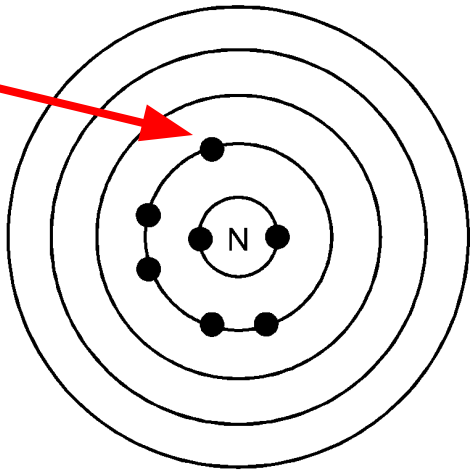
Nitrogen $_{7}N$



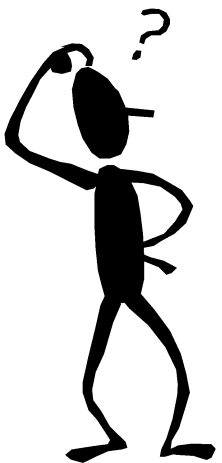
electron configuration 2,5



Nitrogen $^{N}_{7}$



electron configuration 2,5



Which electron is removed first?

(First Ionisation Energy)

Successive Ionisation Energies of Calcium

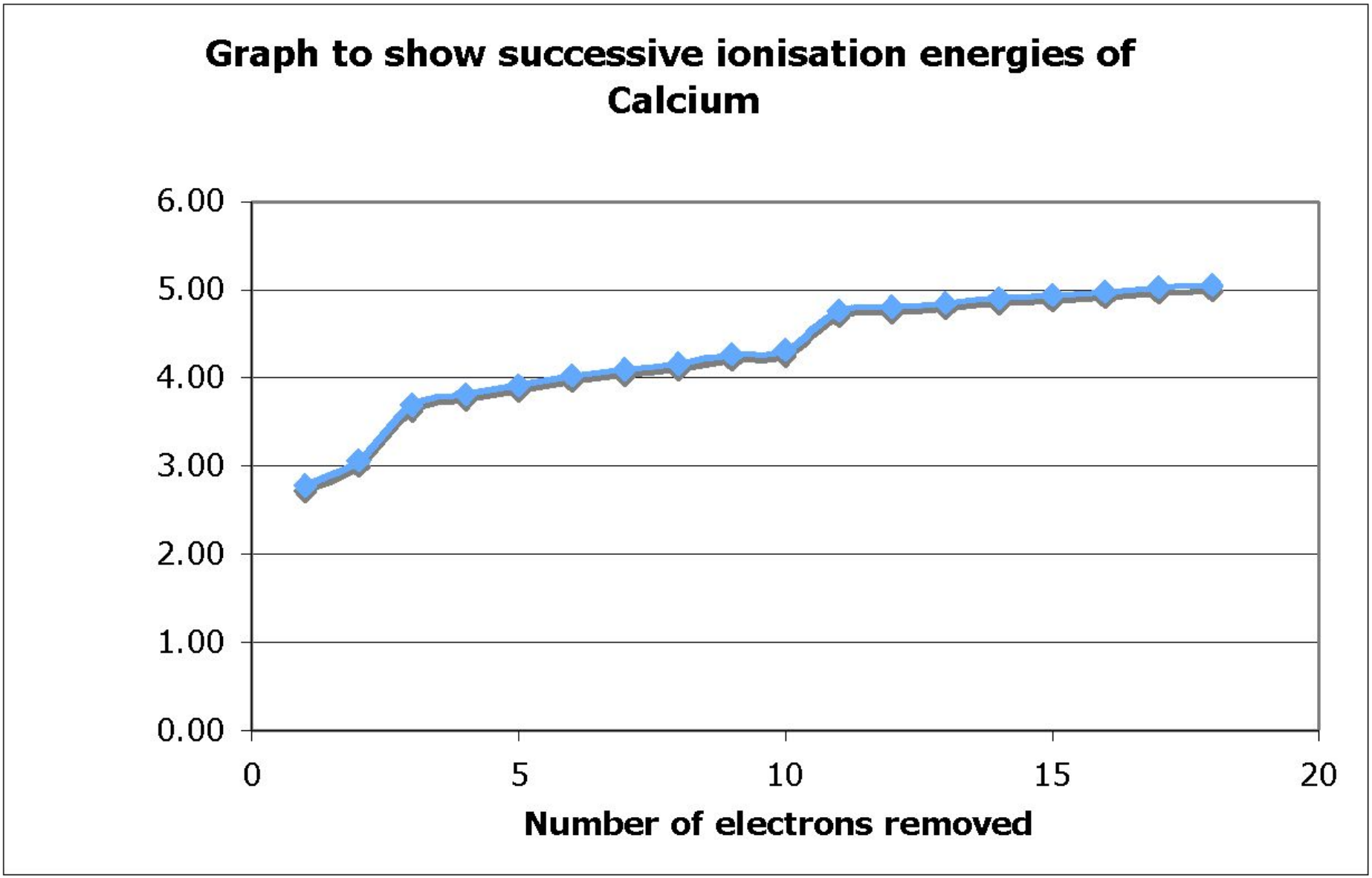
Draw a graph to show the **successive ionisation energies of calcium**, using the **$\log_{10}$** values

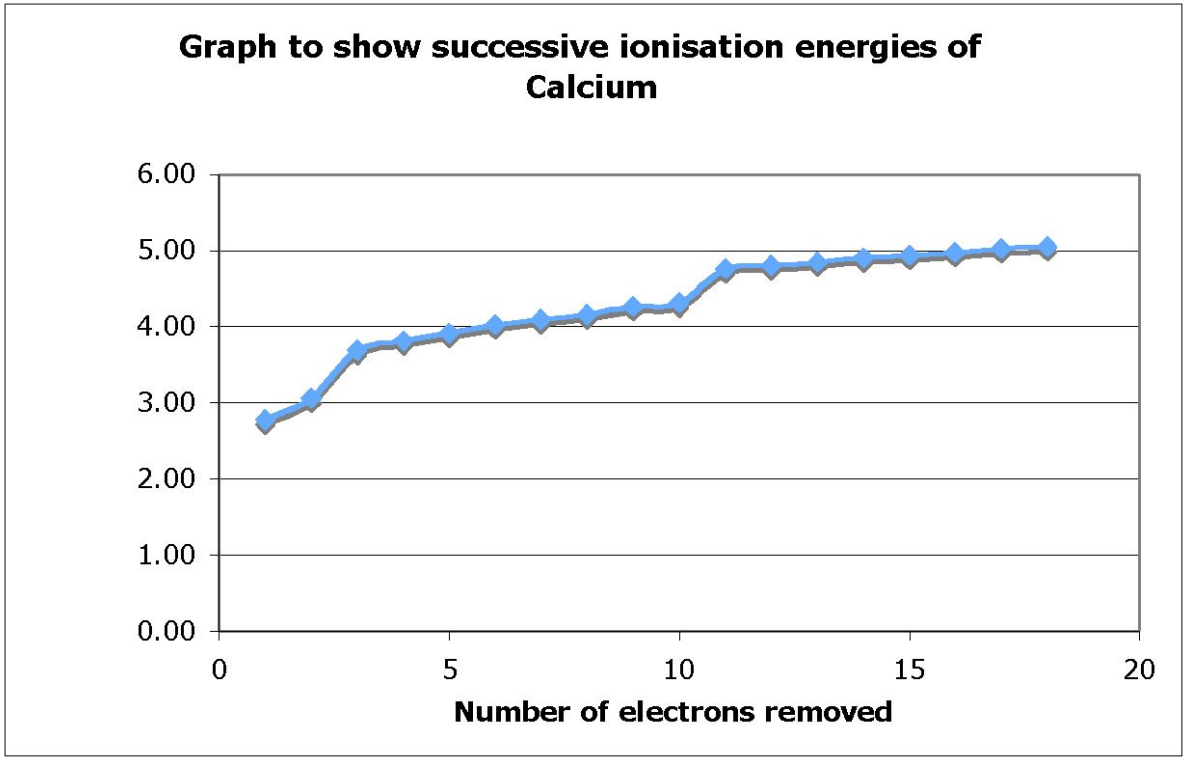
(press log, then the number, then =)

Explain all the main points about the graph that you can see (use **Pg 41** of OCR AS Chemistry to help you)

Number of electrons removed	Ionisation Energy of Calcium / $kJmol^{-1}$	$\log_{10}$ IE of Ca
1	590	
2	1145	
3	4912	
4	6474	
5	8145	
6	10496	
7	12320	
8	14207	
9	18192	
10	20385	
11	57048	
12	63333	
13	70052	
14	78792	
15	86367	
16	94000	
17	104900	
18	111600	

Number of electrons removed	Ionisation Energy of Calcium / $kJmol^{-1}$	$\log_{10}$ IE of Ca
1	590	2.77
2	1145	3.06
3	4912	3.69
4	6474	3.81
5	8145	3.91
6	10496	4.02
7	12320	4.09
8	14207	4.15
9	18192	4.26
10	20385	4.31
11	57048	4.76
12	63333	4.80
13	70052	4.85
14	78792	4.90
15	86367	4.94
16	94000	4.97
17	104900	5.02
18	111600	5.05

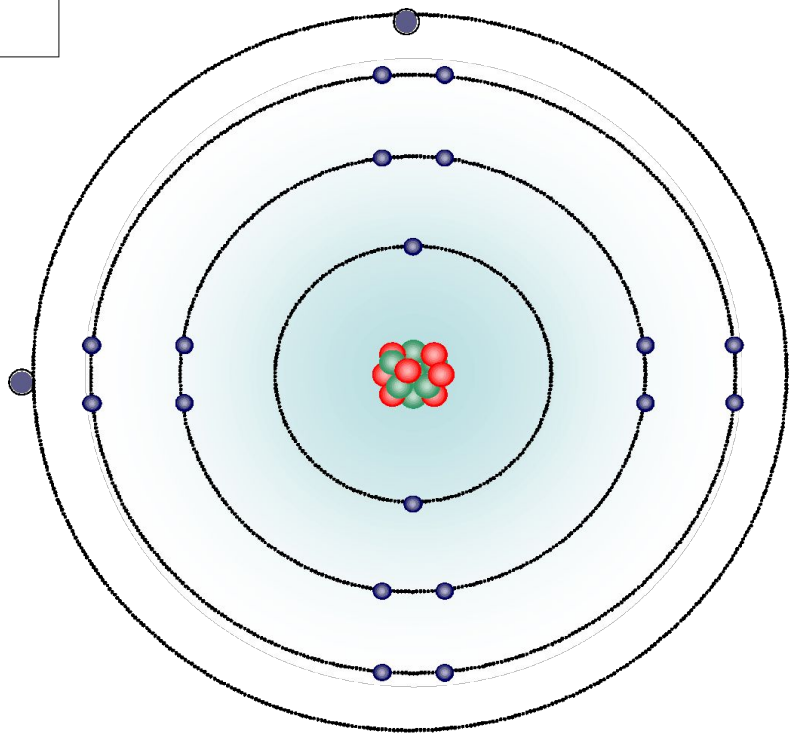

Graph to show successive ionisation energies of Calcium
6.00
5.00
4.00
3.00
2.00
1.00
0.00
0
5
10
15
20
Number of electrons removed



$^{40}_{20}Ca$

2,8,8,2

$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2$



Put these words in order of importance:

- Ionisation energy
- Atom
- Successive ionisation energy
- Ion
- Energy level

Most Important → Least Important