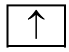
Electron configurations of transition metal elements

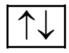
Hydrogen

$Z = 1$. Its electron configuration is $1s^1$. Its electron diagram is on the right.



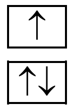
Helium

$Z = 2$. Its electron configuration is $1s^2$. Its electron diagram is on the right.



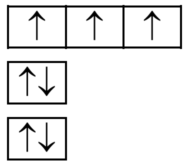
The 1s sub-level is full, so completing the first principal energy level.
The n = 2 level is used next.

Lithium



$Z = 3$. Its electron configuration is $1s^2\ 2s^1$. Its electron diagram is on the right.

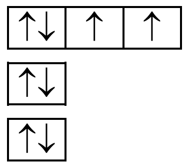
Nitrogen



$Z = 7$. Its electron configuration is $1s^2\ 2s^2\ 2p^3$. Its electron diagram is on the right.

Nitrogen obeys **Hund's multiplicity rule**, i.e. the favoured configuration is the one in which the electrons occupy different orbitals and have the same spins.

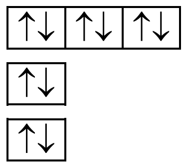
Oxygen



$Z = 8$. Its electron configuration is $1s^2\ 2s^2\ 2p^4$. Its electron diagram is on the right.

The fourth 2p electron pairs with one of the other three 2p electrons.

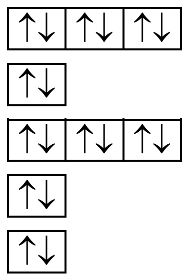
Neon



$Z = 10$. Its electron configuration is $1s^2\ 2s^2\ 2p^6$ (see electron diagram on the right).

The 2p sub-level is full, completing the n = 2 level. The n = 3 level is used next.

Argon



$Z = 18$. Its electron configuration is $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6$ (see diagram on the right).

This electron configuration can also be written as [Ne] $3s^2\ 3p^6$, which saves space.

The 3p sub-level is full, completing the n = 3 level. The n = 4 level is used next.

Potassium ($Z = 19$) is [Ar] $4s^1$, and Ca ($Z = 20$) is [Ar] $4s^2$. Once the 4s sub-level is full, the next ten elements (the **d block** elements, Sc to Zn) use the 3d orbitals.

Transition metals

The d block elements contain the **transition metals**. These are elements which form some compounds in which there is an incomplete sub-level of d electrons. This means that strictly speaking scandium and zinc ([Ar] $3d^0$ and [Ar] $3d^{10}$ in compounds), and copper to some extent, are **not** transition metals. However, they are often included as their compounds resemble those of transition metals.

Electron configurations of transition metal elements

Remember: [Ar] = $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6$

Note: The orbitals of n = 4 overlap with those of n = 3, i.e. in energy 4s below 3d, so after argon the 4s sub-level is filled first.

1. Complete the electron diagrams for potassium and calcium:

		4s
K (Z = 19), [Ar] $4s^1$	[Ar]	
Ca (Z = 20), [Ar] $4s^2$	[Ar]	

2. Now complete the electron diagrams for scandium, titanium and vanadium:

		3d	4s
Sc (Z = 21), [Ar] $3d^1\ 4s^2$	[Ar]		
Ti (Z = 22), [Ar] $3d^2\ 4s^2$	[Ar]		
V (Z = 23), [Ar] $3d^3\ 4s^2$	[Ar]		

3. As far as vanadium, everything is straightforward. However, the electron configuration of the next element (chromium) is not [Ar] $3d^4\ 4s^2$ as you might expect. A half-filled d sub-level is more energetically favourable than a half-filled s sub-level, so one of the 4s electrons is promoted to a 3d orbital. Now complete the electron diagram for chromium:

		3d	4s
Cr (Z = 24), [Ar] $3d^5\ 4s^1$	[Ar]		

4. For the next four elements, the 3d sub-level continues to fill.
Complete the electron configurations and diagrams for manganese, iron, cobalt and nickel:

		3d	4s
Mn (Z = 25), [Ar] 3d 4s	[Ar]		
Fe (Z = 26), [Ar] 3d 4s	[Ar]		
Co (Z = 27), [Ar] 3d 4s	[Ar]		
Ni (Z = 28), [Ar] 3d 4s	[Ar]		

5. When we get to copper, the situation is similar to that found with chromium. In this case, a full 3d sub-level is more energetically favourable than a full 4s sub-level.
Complete the electron configurations and diagrams for copper and zinc:

		3d	4s
Cu (Z = 29), [Ar] 3d 4s	[Ar]		
Zn (Z = 30), [Ar] 3d 4s	[Ar]		

