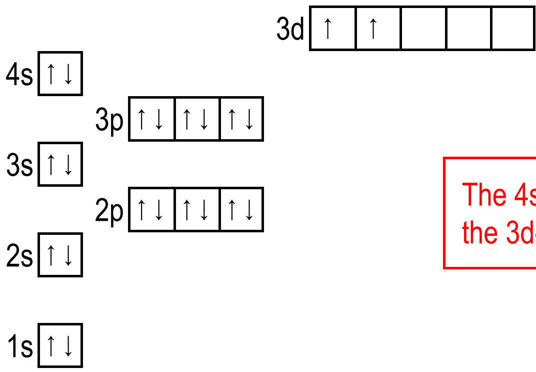
ELECTRON CONFIGURATION EXAMPLES

titanium atom

electron-energy level diagram



Ti

The 4s-subshell fills before the 3d-subshell.

full electron configuration

Ti: $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^2$

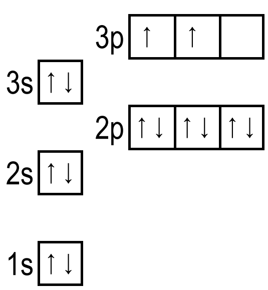
shorthand electron configuration

Ti: $[Ar]4s^2 3d^2$

$[Ar]$ = electron configuration of argon = $1s^2 2s^2 2p^6 3s^2 3p^6$

silicon atom

electron-energy level diagram



Si

full electron configuration

Si: $1s^2 2s^2 2p^6 3s^2 3p^2$

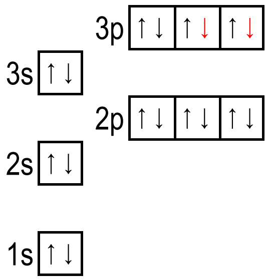
shorthand electron configuration

Si: $[Ne]3s^2 3p^2$

$[Ne]$ = electron configuration of neon = $1s^2 2s^2 2p^6$

sulfide ion

electron-energy level diagram



S^{2-}

Two more electrons added for the 2– charge.

full electron configuration

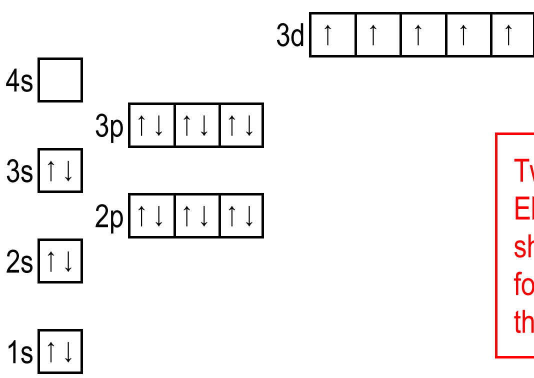
S^{2-} : $1s^2 2s^2 2p^6 3s^2 3p^6$

shorthand electron configuration

S^{2-} : [Ar]

manganese(II) ion

electron-energy level diagram



Mn^{2+}

Two electrons removed for the 2+ charge. Electrons are removed from the outermost shell. In this case, the outermost shell is the fourth shell - two electrons are removed from the 4s-subshell leaving the 4s-subshell empty.

full electron configuration

Mn^{2+} : $1s^2 2s^2 2p^6 3s^2 3p^6 3d^5$ (or Mn^{2+} : $1s^2 2s^2 2p^6 3s^2 3p^6 4s^0 3d^5$)

shorthand electron configuration

Mn^{2+} : $[Ar]3d^5$ (or Mn^{2+} : $[Ar]4s^0 3d^5$)

Example: Explain why carbon is paramagnetic but calcium is not paramagnetic.

Paramagnetic means that the atom has a magnetic field. Unpaired electrons cause paramagnetism.

2p [↑] [↑] [ ]
2s [↑↓]
1s [↑↓]

C

Carbon atoms have unpaired electrons.
Therefore, carbon is paramagnetic.

4s [↑↓]
3p [↑↓] [↑↓] [↑↓]
3s [↑↓]
2p [↑↓] [↑↓] [↑↓]
2s [↑↓]
1s [↑↓]

Ca

Calcium atoms have no unpaired electrons.
Therefore, calcium is not paramagnetic.

Example: Explain the 2+ and 3+ ionic charges for iron.

The electron configuration for iron atoms is . . .

Fe:[Ar] 4s [↑↓] 3d [↑↓] [↑] [↑] [↑] [↑]

When iron forms an ion, the atom loses its two outer-shell electrons ($4s^2$) because outer-shell electrons are most easily lost. This results in the 2+ ion.

Fe^{2+} :[Ar] 4s [ ] 3d [↑↓] [↑] [↑] [↑] [↑]

One more electron lost from the 3d-subshell will result in a half-filled 3d-subshell. A half-fill d-subshell is often associated with a more stable electron-configuration. This results in the more common 3+ ion.

Fe^{3+} :[Ar] 4s [ ] 3d [↑] [↑] [↑] [↑] [↑]

Example: Explain the anomaly in the electron configuration of chromium.

The predicted electron configuration for a chromium atom is . . .

Cr:[Ar] 4s $\boxed{\uparrow\downarrow}$ 3d $\boxed{\uparrow}\boxed{\uparrow}\boxed{\uparrow}\boxed{\uparrow}\boxed{}$

The actual configuration is . . .

Cr:[Ar] 4s $\boxed{\uparrow}$ 3d $\boxed{\uparrow}\boxed{\uparrow}\boxed{\uparrow}\boxed{\uparrow}\boxed{\uparrow}$

This is an anomaly because the actual configuration does not match the predicted configuration. One of the electrons that is expected to be in the 4s-subshell is actually in the 3d-subshell.

Explanation: The actual configuration has a half-filled 3d-subshell. A half-filled d-subshell is often associated with a more stable electron-configuration.

Example: Explain why nitrogen and boron both form 3 covalent bonds (example: NH_3 and BH_3).

Each unpaired electron in an atom allows for the formation of one covalent bond.

2p $\boxed{\uparrow}\boxed{\uparrow}\boxed{\uparrow}$

2s $\boxed{\uparrow\downarrow}$

1s $\boxed{\uparrow\downarrow}$

N

A nitrogen atom has three unpaired electrons.
Therefore, nitrogen forms three covalent bonds.

Before Electron Promotion

2p $\boxed{\uparrow}\boxed{}\boxed{}$

2s $\boxed{\uparrow\downarrow}$

1s $\boxed{\uparrow\downarrow}$

B

After Electron Promotion

2p $\boxed{\uparrow}\boxed{\uparrow}\boxed{}$

2s $\boxed{\uparrow}$

1s $\boxed{\uparrow\downarrow}$

B

A boron atom has only one unpaired electron, and should form only one covalent bond. However, boron can promote one electron from the 2s orbital into an empty 2p orbital resulting in three unpaired electrons.
Note that electron promotion can only occur between orbitals in the same shell (in this case, within the second shell; 2s to 2p).