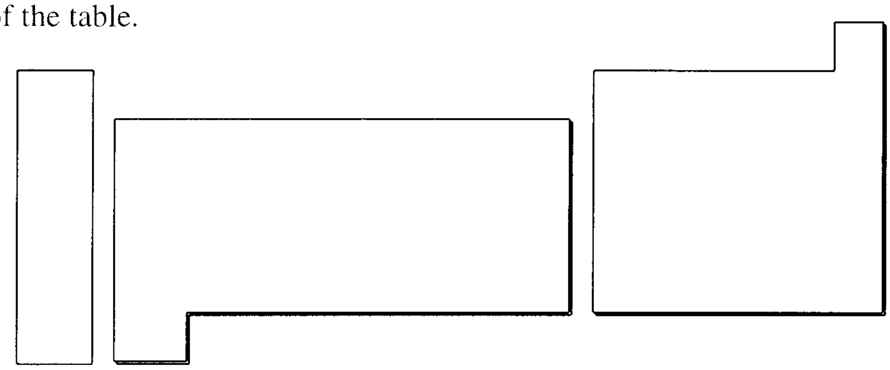
Energy Levels 1.3

1. Copy the drawing below which represents the periodic table (excluding hydrogen) and mark on it "s", "p", and "d" to represent the type of orbital which is being filled in each part of the table.



2. Ionisation energies , show regular changes as we descend a group in the periodic table. The table below shows the ionisation energies for some of the alkali metals

	Ionisation Energies / kJ mol^{-1}			
Element	1st	2nd	3rd	4th
Lithium	526	7310	11800	-
Sodium	502	4560	6920	9450
Potassium	425	3060	4440	5880

(a) (i) Write equations for the first ionisations of lithium and sodium.
(ii) Explain why the first ionisation energy of sodium is less than that of lithium.

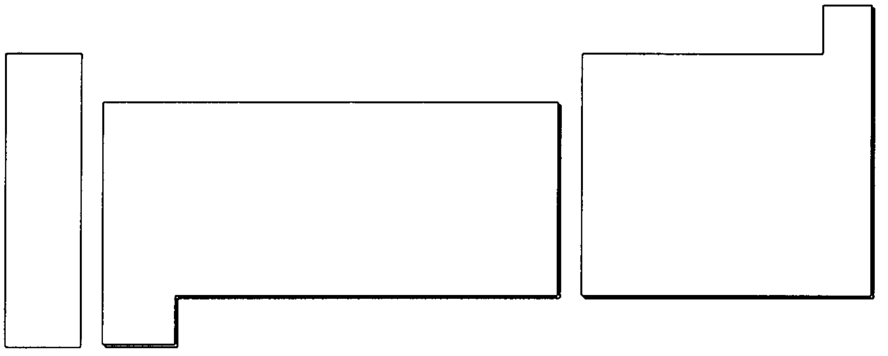
(b) (i) Write equations for the first and second ionisations of potassium.
(ii) Explain why the second ionisation energy of potassium is so much greater than the first ionisation energy.

3. The table below shows some data for some of the elements in period three

Element	Na	Mg	Al	S	Cl
Atomic radius (pm)	156	136	125	104	99
1st Ionisation Energy / kJ mol^{-1}	492	743	579	1003	1254

(a) Explain why the ionisation energies tend to increase as we move across a period.
(b) Within any period it is the noble gas which has the highest first ionisation energy. Explain why this is so.
(c) Explain the drop in first ionisation energy from magnesium to aluminium.

1.



(2) (a) (i) $Li_{(g)} \rightarrow Li^{+}_{(g)} + e^-$

$Na_{(g)} \rightarrow Na^{+}_{(g)} + e^-$

(ii) Li - $1s^2, 2s^1$ Na - $1s^2\ 2s^2\ 2p^6\ 3s^1$

2, (1) 2, 8, (1)

The 'Shielding effect' of the 2s and 2p electrons makes it easier to remove the 3s electron from the sodium atom than the 2s electron from the lithium atom. (even although the Na atom has a greater nuclear charge). The $1s^2\ 2s^1$ arrangement is more stable $1s^2 2s^2 2p^6 3s^1$

(b) (i) $K_{(g)} \rightarrow K^{+}_{(g)} + e^-$ IE = +425 kJ mol^{-1}

$K^{+}_{(g)} \rightarrow K^{2+}_{(g)} + e^-$ IE = +3060 kJ mol^{-1}

(ii) K

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

2, 8, 8, 1

K^+

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

2, 8, 8.

It is relatively easy to remove the 4s electron from the K atom because the electron arrangement $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^1$ is unstable. The electron arrangement of the K^+ ion ($1s^2, 2s^2\ 2p^6\ 3s^2\ 3p^6$) is relatively more stable (even although the 3rd level is not full - no 3d electrons). The full 3p subshell seems to confer stability on the particle.

③ (a)

	Na	Mg	Al	S	Cl
AT. Radium	156	136	125	104	99
1st IE	492	743	579	1003	1254
E.A.	2,8,1	2,8,2	2,8,3	2,8,6	2,8,7

Moving across a period, the atoms get smaller. The outer electrons are therefore nearer the nucleus. The nuclear charge is also increasing so the general trend is that it is more difficult to remove an outer electron

(b) The noble gas atom in a period has the most stable electron arrangement of all the atoms in the period. This is because the filling of a 'p' subshell (with the exception of Helium) results in a very stable electronic configuration.

(c)

	Mg	Al
	2, 8, 2	2, 8, 3
	$1s^2, 2s^2 2p^6, 3s^2$	$1s^2, 2s^2 2p^6, 3s^2 3p^1$
1st IE	743 $kJ\,mol^{-1}$	579 $kJ\,mol^{-1}$

The Mg electron arrangement is clearly more stable than the Al electron arrangement. It seems that the filling up of a subshell also confers some stability on the atom. The 2 outer electrons in the Mg atom fill the 3s subshell. The outer electron in the Al atom removed in 1st IE does not come from a full subshell.