**3.3 Trends in Properties**

The periodic variation in the properties of elements reflects the periodic variation in their electronic configurations.

This variation is most obvious if we look at how their properties change as we move from left to right across a period. Such trends reflect the effect of adding an electron as we move from one element to the next.

There are similarities between elements in a group but significant differences also occur. Elements in the same group have the same number electrons in their outer shell, but the atoms become larger as we move down a group and this effects the properties of the elements.

**Atomic Properties**

The properties of radius, ionisation energy and electronegativity all depend on the strength of the attraction between the outer-shell electrons and the nucleus. In general the attraction will depend on:

* The positive charge that attracts the outer-shell electrons
* The distance of the electrons from the nucleus

**Radius:**

**Ionisation Energy:**

**Electronegativity:**

Page 43 summarises the relevant data for these three trends.

The electrons in atoms of elements in the same period are located in the same outer-shell. As you move across the period the number of protons increase and hence the number of electrons increase.

We will consider the elements for two of the periods.

**Example 1: Period 2 elements Lithium and Fluorine**

**Example 2: Period 3 elements Sodium and Chlorine**

|  |  |
| --- | --- |
| Trend | Trend |
| Atomic radius increases down a group | Electrons occupy most of the volume of an atom. Potassium (1s22s22p63s23p64s1) is much larger than lithium (1s22s1) |
| Atomic radius decreases across a period | The size of atoms decrease. The increasing positive charge of the nucleus pulls the outer-shell electrons closer, causing the volume to decrease |
| First ionisation energy decreases down a group | As the atoms become larger, their outer electrons are further from the nucleus therefore the energy required to extract the outermost electron decreases. |
| First ionisation increases across a period | As the strength of attraction between the outer electrons and the nucleus increases, the energy required to remove the outer electron increases. |
| Electronegativity decreases down a group | As the outer electrons become more distant, electrons are more weakly attracted to the atom. |
| Electronegativity increases across a period | The electron-attracting ability of atoms increases as the pull on the outer electrons increases. |

**Metallic and Non-metallic character**

Elements on the right side of the table are non-metals, other elements are metals. As you move from left to right across a period the elements become less metallic.

There is also a variation in metallic character within groups. In group 14, carbon the first element in the group is a non-metal whereas tin and lead are metals.

Some elements, such as germanium silicon, arsenic and tellurium are located partway across the periods, display both metallic and non-metallic properties. Such elements are called metalloids.

**Reactivity of Elements**

The way metals react with water can give us an indication of their relative reactivity. See table 3.2 page 45.

In general the reactivity of metals increases down a group and decreases across a period.

The non-metal halogens (group 17) are also very reactive. Experimental data shows that the reactivity of the halogens decreases down the group.

**The Noble Gases**

The elements in group 18 are known as the noble gases and are all very unreactive. They have low melting and boiling temperatures and are all gases at normal temperatures. Helium boils at -269oC.

The lack of reactivity arises from there arrangement of electrons in their atoms. They all have a filled outer-shell and this confers stability to the elements.

**Text Questions 8 – 10**

**Workbook: 6**