Structure of the atom

To know the constituents of the atom with their masses and charges
To be able to calculate the specific charge of the constituents
To be able to explain what isotopes and ions are

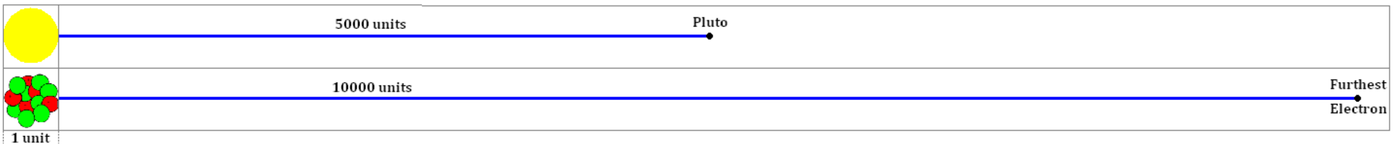
The Nuclear Model

Constituent	Charge (C)	Mass (kg)
Proton	1.6×10^{-19}	1.673×10^{-27}
Neutron	0	1.675×10^{-27}
Electron	$- 1.6 \times 10^{-19}$	9.1×10^{-31}

We know from Rutherford's experiment that the structure of an atom consists of positively charged protons and neutral neutrons in one place called the nucleus. The nucleus sits in the middle of the atom and has negatively charged electrons orbiting it. At GCSE we used charges and masses for the constituents relative to each other, the table above shows the actual charges and masses.

Almost all of the mass of the atom is in the tiny nucleus which takes up practically no space when compared to the size of the atom. If we shrunk the Solar System so that the Sun was the size of a gold nucleus the furthest electron would be twice the distance to Pluto.

If the nucleus was a full stop it would be 25 m to the first electron shell, 100 to the second and 225 to the third.



Notation

We can represent an atom of element X in the following way: $^{A}_{Z}X$

Z is the proton number. This is the number of protons in the nucleus. In an uncharged atom the number of electrons orbiting the nucleus is equal to the number of protons.

In Chemistry it is called the atomic number

A is the nucleon number. This is the total number of nucleons in the nucleus (protons + neutrons) which can be written as A = Z + N.

In Chemistry it is called the atomic mass number

N is the neutron number. This is the number of neutrons in the nucleus.

Isotopes

Isotopes are different forms of an element. They always have the same number of protons but have a different number of neutrons. Since they have the same number of protons (and electrons) they behave in the same way chemically.

Chlorine If we look at Chlorine in the periodic table we see that it is represented by $^{35.5}_{17}Cl$. How can it have 18.5 neutrons? It can't! There are two stable isotopes of Chlorine, $^{35}_{17}Cl$ which accounts for ~75% and $^{37}_{17}Cl$ which accounts for ~25%. So the average of a large amount of Chlorine atoms is $^{35.5}_{17}Cl$.

Specific Charge

Specific charge is another title for the charge-mass ratio. This is a measure of the charge per unit mass and is simply worked out by worked out by dividing the charge of a particle by its mass.

You can think of it as a how much charge (in Coulombs) you get per kilogram of the 'stuff'.

Constituent	Charge (C)	Mass (kg)	Charge-Mass Ratio (C kg^{-1}) or (C/kg)	
Proton	1.6×10^{-19}	1.673×10^{-27}	$1.6 \times 10^{-19} \div 1.673 \times 10^{-27}$	9.58×10^{7}
Neutron	0	1.675×10^{-27}	$0 \div 1.675 \times 10^{-27}$	0
Electron	(-) 1.6×10^{-19}	9.1×10^{-31}	$1.6 \times 10^{-19} \div 9.11 \times 10^{-31}$	(-) 1.76×10^{11}

We can see that the electron has the highest charge-mass ratio and the neutron has the lowest.

Ions

An atom may gain or lose electrons. When this happens the atoms becomes electrically charged (positively or negatively). We call this an ion.

If the atom gains an electron there are more negative charges than positive, so the atom is a negative ion.

Gaining one electron would mean it has an overall charge of -1, which actually means -1.6×10^{-19}C.

Gaining two electrons would mean it has an overall charge of -2, which actually means -3.2×10^{-19}C.

If the atom loses an electron there are more positive charges than negative, so the atom is a positive ion.

Losing one electron would mean it has an overall charge of +1, which actually means $+1.6 \times 10^{-19}$C.

Losing two electrons would mean it has an overall charge of +2, which actually means $+3.2 \times 10^{-19}$C.