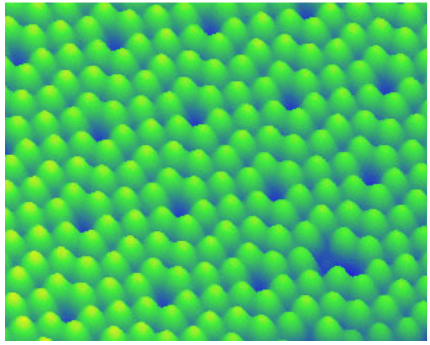
1.1 Inside the Atom

Atomic Structure

- The size of an **atom** is about 10^{-10} m (0.1 nanometre, nm).
- Rutherford's alpha particle scattering experiment showed it to be composed of a central, positively charged **nucleus** surrounded by negatively charged **electrons**.
- The nucleus is composed of **protons** and **neutrons**, which are known collectively as **nucleons**. The nucleus contains almost all of the atom's mass, since protons and neutrons each have masses of approximately 1.67×10^{-27} kg, whereas electrons have masses of only 9.11×10^{-31} kg.
- Electrons have a charge equal and opposite to the charge on a proton. Neutrons are neutral.
- The size of a nucleus is about 10^{-15} m (1 femtometre, fm). This means that an atom is almost entirely empty space.
- Electrons surround nuclei at different distances but they do **not** orbit the nucleus like little planets around a star. Chemists refer to the regions in which electrons are located as "shells".



Scanning tunnelling microscope image of silicon atoms on the surface of a crystal

Isotopes

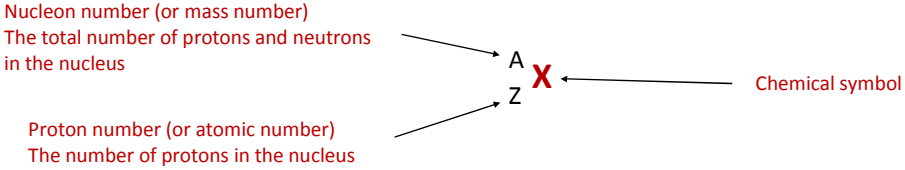
Many chemical elements exist in different forms. For example, hydrogen, deuterium and tritium are all forms of hydrogen. They are known as **isotopes** of hydrogen. Isotopes of an element have the same number of protons in their nuclei but differing numbers of neutrons, (see table overleaf). Having the same number of protons means that, for neutral atoms, they must have the same number of electrons surrounding the nucleus. This means that all isotopes of the same element have the same chemical properties.

Example: the isotopes of hydrogen

Isotope	No. of protons	No. of neutrons
hydrogen	1	1
deuterium	1	2
tritium	1	3

Nuclear Nomenclature

The following shorthand is used to describe nuclei:



- The number of neutrons in the nucleus is just A-Z
- The word **nuclide** is often used to describe each type of nucleus.

Specific Charge

The specific charge of a particle is the ratio of the charge to the mass. It is measured in coulombs per kilogram, (C kg^{-1}). Example:

particle	charge / C	mass / kg	specific charge / C kg^{-1}
proton	$+1.6 \times 10^{-19}$	1.67×10^{-27}	9.58×10^{7}
electron	-1.6×10^{-19}	9.11×10^{-31}	1.76×10^{11}
alpha particle	$+3.2 \times 10^{-19}$	6.68×10^{-27}	4.79×10^{7}