4.1 Structure of the atom

videos

The atom is composed of protons, neutrons and electrons. These are referred to as 'subatomic particles'.

Electrons are fundamental particles. This means that, as far as we can tell, they can't be divided into smaller particles.

Protons are neutrons are not fundamental particles, but are composed of particles called quarks. (At GCSE you are not expected to know this.)

Properties of subatomic particles

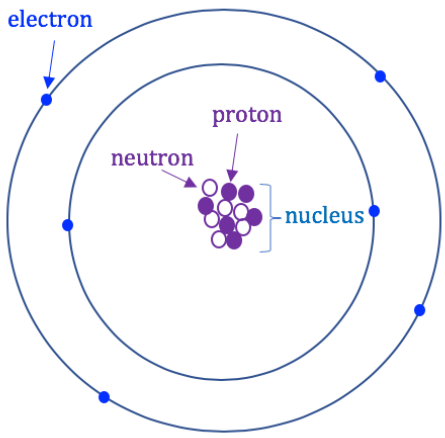
Particle	Relative charge (relative to proton)	Relative mass (relative to proton)
proton	+1	1
neutron	0	1
electron	-1	1/1800

The terms 'relative charge' and 'relative mass' are used to show how the charge and mass compares to that of the proton. For example, the electron has a relative charge of minus one. This means that the electron has the same charge as the proton, but the opposite polarity.

(1) In a neutral atom, there are the same number of electrons as protons. Explain why.

(2) The 'atomic mass number' is the number of protons + neutrons in an atom. Why do electrons not contribute to the atomic mass number?

Particle arrangement



Protons and neutrons are found in the nucleus of the atom. Electrons are arranged in shells around the nucleus. There is an electrostatic attraction between electrons and protons. Electrons in shells closer to the nucleus are in lower energy positions compared to electrons further out.

The number of protons determines the position of the atom in the periodic table. In nuclear physics the number of protons is called the 'proton number'. In chemistry it is referred to as the 'atomic number'.

(3) What is the proton number of the atom shown in the diagram?

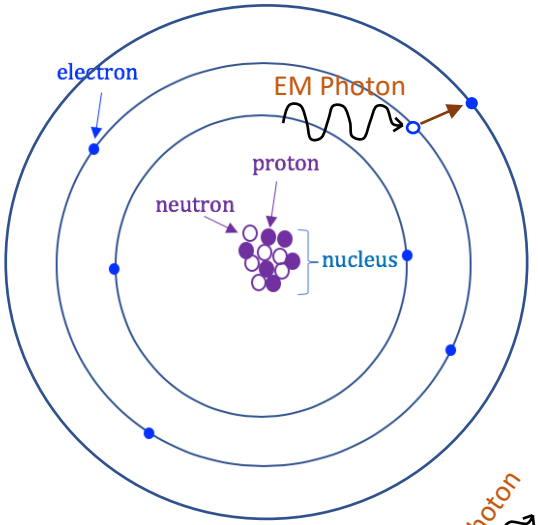
(4) What element is the atom shown. (Hint: Look up the position in the periodic table.)

Atoms range in size from 1×10^{-10} to $5 \times 10^{-10} m$. The nucleus is very tiny in comparison. The nucleus ranges in size from 2×10^{-15} to $15 \times 10^{-15} m$.

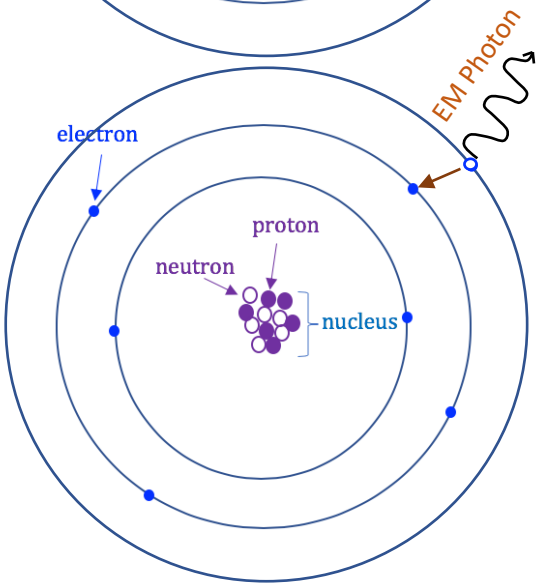
(5) In order of magnitude, how much smaller is the diameter of the nucleus compared to the diameter of the atom?

Absorption and emission of electromagnetic radiation

Electrons usually reside in the lowest energy positions in an atom. This means that electron shells closest to the nucleus fill up first. However, if electrons acquire additional energy, they can move outwards to a higher energy shell. They can acquire energy by absorbing a small packet of electromagnetic wave energy (called a 'photon').



In the diagram (left), an electron absorbs the energy from a photon of electromagnetic radiation (e.g. light). This moves the electron to a higher energy level. We say that the electron is in an 'excited state'.



The opposite thing can happen. An electron in a higher energy level can drop to lower energy level by losing energy. It loses energy by emitting an electromagnetic (EM) wave photon.

(6) Depending on the energy drop, these emitted electromagnetic waves can be X-rays, ultraviolet, visible or infrared. Which of these would involve the biggest drop in energy? (Hint: Think about which EM waves carry the most energy.)