# WJEC (England) Physics GCSE

## 9.1: Nuclear Atom and Isotopes

### Detailed Notes

(Content in **bold** is for higher tier **only**)

# Atomic Structure

## Developing Models

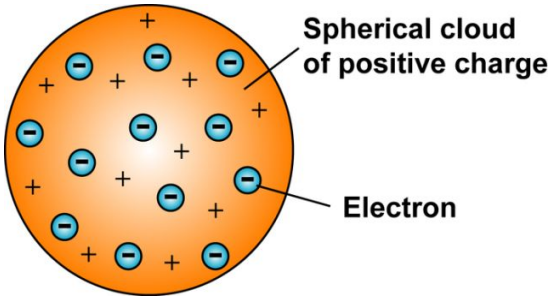
Ideas about the atom and its internal structure have developed over time as new experiments were completed and new discoveries made.

### Dalton's Model

In 1800, scientist John Dalton said everything was made of tiny spheres called **atoms**, that could not be divided further.

### The Plum Pudding Model

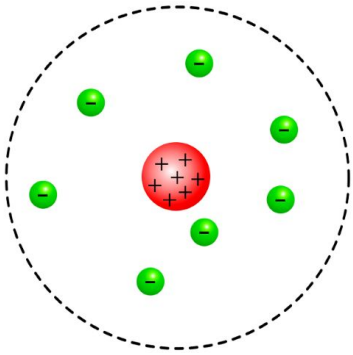
**JJ Thomson** discovered the **electron** in 1897 and hypothesised The Plum Pudding Model. In this, **negative electrons** ("plums") are dispersed through a **positive sphere** ("pudding"). Overall the charges cancel meaning the atom is **neutral**.




***The Plum Pudding Model of an atom (askeyphysics.org).***

### Rutherford's Model

In 1913, Rutherford used discoveries from his **gold foil experiment** to model the atom as a sphere with a **positive nucleus** at the **centre** and a **negative electron 'cloud'** around it.



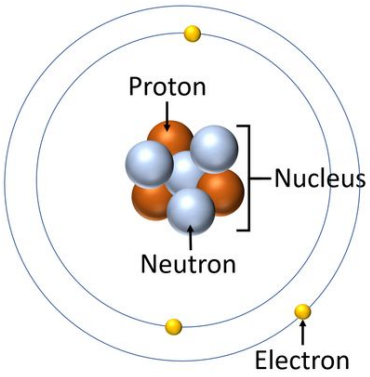
***The Rutherford model of the atom (thestargarden.co.uk).***

### Bohr Model

In 1913, Bohr produced a model that is most similar to the atomic model used today, with a **positive nucleus** and **orbiting negative electrons**.

## Nuclear Model

Today, the **nuclear model** of the atom is accepted. This describes atoms to consist of a **central nucleus** of **protons** and **neutrons** that is positively charged overall and very small compared to the size of the whole atom. **Negative orbiting electrons** surround this nucleus in various energy levels.




***Nuclear model of an atom (keystagewiki.com).***

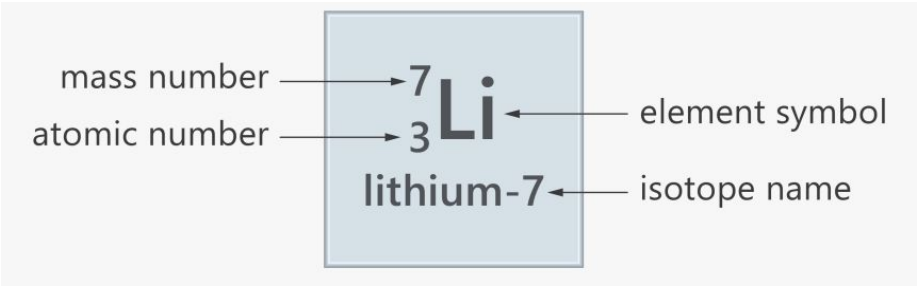
Protons, neutrons and electrons are types of **sub-atomic particle**. They each have characteristic **charges** and **relative masses**:

| Sub-atomic Particle | Relative Charge | Relative Mass |
|---|---|---|
| Proton (p) | +1 | 1 |
| Neutron (n) | 0 | 1 |
| Electron (e) | -1 | 1/1840 (negligible) |

This shows how **protons and neutrons** account for most of the **mass** in an atom, and protons and electrons contribute to the charge.

## Atomic Notation

Each atom of an element can be represented using **chemical symbols**. This shows the abbreviated name of the element, the **mass number** and the **atomic number**.




***Full atomic notation or Lithium (pngitem.com).***

### Atomic Number (Z)

Each atom has a unique **atomic number** that makes it identifiable. Atomic number is sometimes referred to as **proton number** as it is equal to the **number of protons** present in the nucleus.

### Mass Number (A)

The **mass** of an atom is the **sum of protons and neutrons** as they contribute the most. The mass of electrons is so small it is said to be negligible. Mass number can also be referred to as the **nucleon number** as it is equal to the number of sub-atomic particles in the **nucleus**.

Using these two numbers from the atomic notation, the number of each sub-atomic particle can be calculated (assuming it is neutral).

$$Atomic\ Number = Z = Protons = 3$$
$$Mass\ Number = A = Protons + Neutrons = 7$$

$$Neutrons = Mass\ Number - Atomic\ Number = 7 - 3 = 4$$

$$=> p = 3$$
$$=> n = 4$$
$$=> e = 3$$

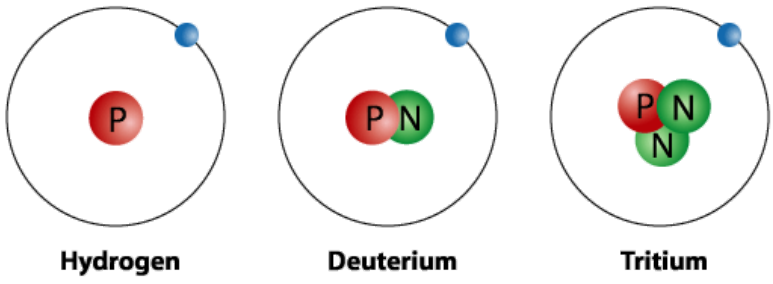
### Ions

In a **neutral** atom, the number of protons will equal the number of electrons so there is **no overall charge**. If an **electron is gained**, the atom will become a **negatively** charged ion and if an **electron is lost**, the atom will become a **positively** charged ion.

## Isotopes

An isotope forms when there is a difference in the number of **neutrons** in a nucleus. Isotopes have the **same proton number**, so are therefore atoms of the **same element** but have a **different mass** due to a different number of neutrons.

Elements can have **multiple** isotopes and some are more stable than others. **Hydrogen** has **three** main isotopes: Hydrogen (*H-1*), Deuterium (*H-2*) and Tritium (*H-3*).




***The three main isotopes of Hydrogen (memorangapp.com).***