

Chapter 22. The Nuclear Atom

Contents:

22.1 Atomic Structure

22.2 Protons, Neutrons and Electrons

5.1.1 The atom

Core

- 1 Describe the structure of an atom in terms of a positively charged nucleus and negatively charged electrons in orbit around the nucleus
- 2 Know how atoms may form positive ions by losing electrons or form negative ions by gaining electrons

Supplement

- 3 Describe how the scattering of alpha (α) particles by a sheet of thin metal supports the nuclear model of the atom, by providing evidence for:
 - (a) a very small nucleus surrounded by mostly empty space
 - (b) a nucleus containing most of the mass of the atom
 - (c) a nucleus that is positively charged

5.1.2 The nucleus

Core

- 1 Describe the composition of the nucleus in terms of protons and neutrons
- 2 State the relative charges of protons, neutrons and electrons as +1, 0 and -1 respectively
- 3 Define the terms proton number (atomic number) Z and nucleon number (mass number) A and be able to calculate the number of neutrons in a nucleus
- 4 Use the nuclide notation ${}^A_Z X$
- 5 Explain what is meant by an isotope and state that an element may have more than one isotope

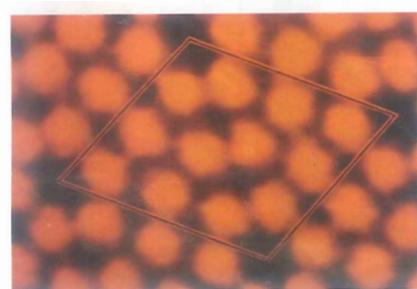
Supplement

- 6 Describe the processes of nuclear fission and nuclear fusion as the splitting or joining of nuclei, to include the nuclide equation and qualitative description of mass and energy changes without values
- 7 Know the relationship between the proton number and the relative charge on a nucleus
- 8 Know the relationship between the nucleon number and the relative mass of a nucleus

22.1 Atomic Structure

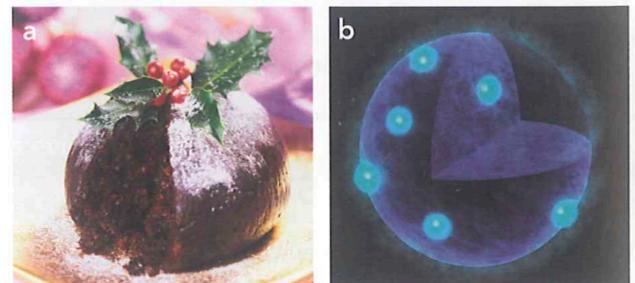
What are we/everything made of?

Atoms:



Is atom the smallest particle?

Electrons:



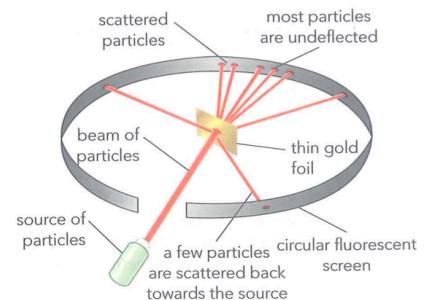
=> Plum pudding model:

Is Plum pudding model right? How can you prove it right or wrong?

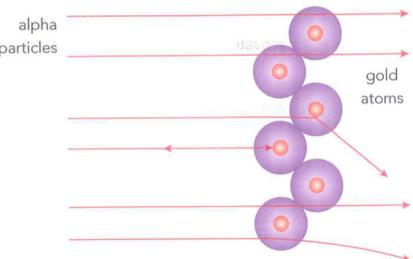
• **Alpha particle scattering experiment**

How was the experiment carried out?

Observations:



Conclusions:



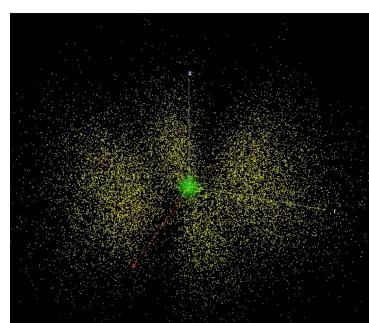
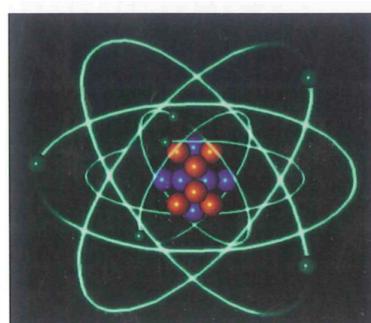
Atom structure:

A sense of scale: atom:

Ionization:

It was as if you fired a fifteen-inch artillery shell at a piece of tissue paper and it came back and hit you.
— Ernest Rutherford

More about the model



22.2 Sub-atomic particles: Protons, Neutrons and Electrons

Why does nucleus carry positive charge?

Proton:

Neutron:

Protons & Neutrons:

Electrons:

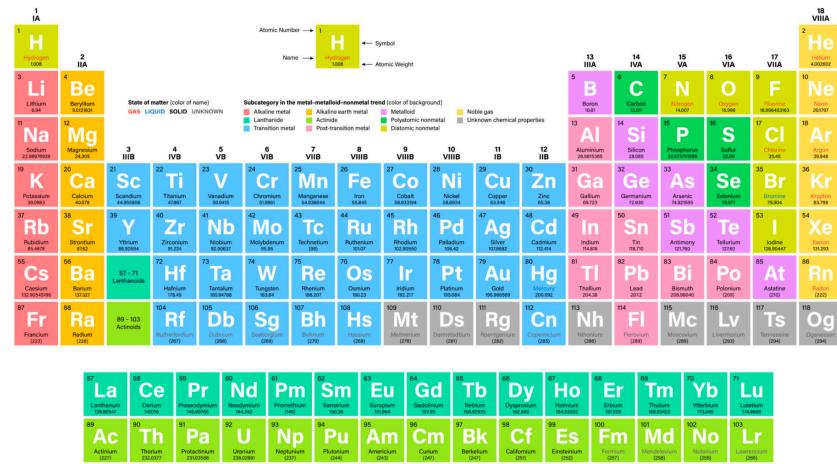
Relative mass:

Relative charge:

Particle	Position	Charge / C	Relative charge	Mass / kg	Relative mass
proton	in nucleus	$+1.6 \times 10^{-19}$	+1	1.67×10^{-27}	1
neutron	in nucleus	0	0	1.67×10^{-27}	1
electron	orbiting nucleus	-1.6×10^{-19}	-1	9.11×10^{-31}	$\frac{1}{1836}$ (practically zero)

Different atoms & different elements (== element number)

Periodic Table of the Elements



More complex particles are possible: atoms → molecules → meta materials.

Proton number(Z):

Neutron number(N):

Nucleon number(A):

Nuclide notation:

Exercise:

1. Write down the nuclide notation for hydrogen, helium.

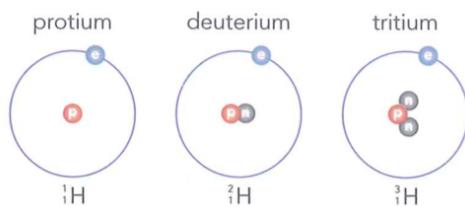
2. What are proton/neutron/nucleon number of

Charge & mass of nuclei:

Isotope

Proton number determines element number, which does not have any restriction on neutron number, how about the same element(same proton number) with different neutrons?

Isotope of an element:



Symbol for isotope	Proton number Z	Neutron number N	Nucleon number A
${}^1_1\text{H}$	1	0	1
${}^2_1\text{H}$	1	1	2
${}^3_1\text{H}$	1	2	3

Symbol for isotope	Proton number Z	Neutron number N	Nucleon number A
${}^{235}_{92}\text{U}$	92	143	235
${}^{238}_{92}\text{U}$	92	146	238

Unstable Isotope =>

Nuclear fission and fusion: