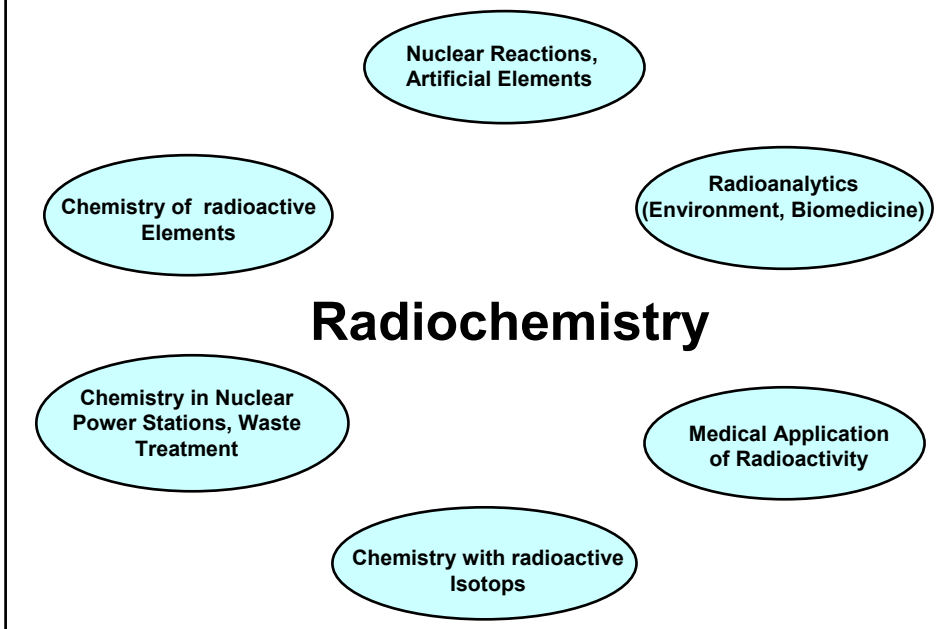


Content of the Radiochemistry Course at Freie University

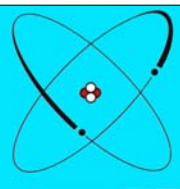
(Prof. Ulrich Abram, Institute of Chemistry)

1) Composition of atoms and elemental particles
2) Nuclear stability and nuclear radiation
3) Natural and artificial radioactivity
4) Interactions between radiation and matter
5) Measurement of nuclear radiation
6) Interactions of nuclear radiation with biological materials, Radiation protection
7) Applications of nuclear radiation in analytical chemistry
8) Radiochemical labeling procedures
9) Radioactive nuclides in nuclearmedical therapy
10) Radioactive nuclides in nuclearmedical diagnostics (PET, SPECT)
11) The chemistry of selected radioactive elements
12) Transuranium elements and the synthesis of superheavy elements
10) Nuclear fission
11) Nuclear Power and waste treatment

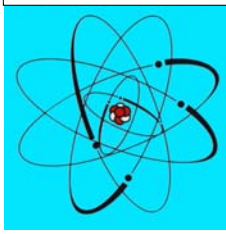
1) Composition of Atoms and elemental particles (1)

Simplified model of a hydrogen atom

Simplified model of a helium atom



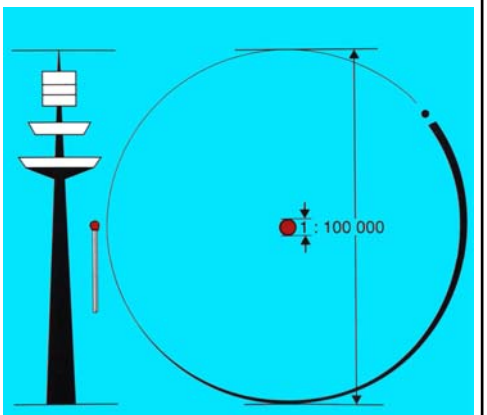
Simplified model of a carbon atom



Atomic nucleus:
protons + neutrons
number of protons = atomic number

Moseleys Law:

$$\sqrt{\nu} = a(Z - b)$$



Please Note! An atom consists of a small nucleus and a comparatively huge electron shell

1) Composition of Atoms and elemental particles (2)

Masses and charges inside an atom

Particle	Mass		Charge	
	in kg	in electron masses	in C	sign
Electron	$9{,}1091 \times 10^{-31}$	1	$1{,}6021 \times 10^{-19}$	-1
Proton	$1{,}67252 \times 10^{-27}$	1836,10	$1{,}6021 \times 10^{-19}$	+1
Neutron	$1{,}67482 \times 10^{-27}$	1838,62	0	0

The Atomic Nucleus:

number of protons = atomic number

- number of protons is essential for the atom type (determines chemical element)
- number of neutrons can vary without producing a new element
- a distinct number of neutrons is required to maintain the stability of atoms

The different number of neutrons in the atomic nuclei allows the classification of nuclei into different groups:

Isotopes having the same number of protons but different neutron numbers
Isobars having the same number nucleons (N+Z)
Isotones having the same number of neutrons

1) Composition of Atoms and elemental particles (3)

Isotopes

Isotopes are nuclides having the same number of protons, but different numbers of neutrons

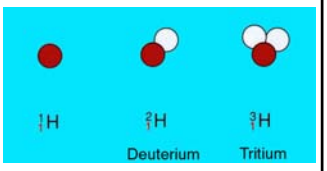
- Isotopes belong to the same chemical element
- Isotopes have different mass numbers

Examples: $^{235}_{92}U$: 92 protons (atomic number), 143 neutrons
$^{239}_{92}U$: 92 protons, 147 neutrons

Many natural elements are mixtures of different isotopes:

e.g.: carbon: $^{12}_{6}C$ (ca. 99%), $^{13}_{6}C$ (ca. 1%), M = 12.011
chlorine $^{35}_{17}Cl$ (ca. 75%), $^{37}_{17}Cl$ (ca.25%) M = 35,453
bromine $^{79}_{35}Br$ (ca. 50%), $^{81}_{35}Br$ (ca.50%) M = 79,904

Isotopes cannot easily be separated by chemical procedures



1) Composition of Atoms and elemental particles (4)

Isobars

Isobars are nuclides having the same number of nucleons (sum of protons and neutrons), but different numbers protons

- Isobars belong to different chemical elements
- Isobars have (almost) equal mass numbers

Examples: $^{40}_{18}Ar$, $^{40}_{19}K$, $^{40}_{20}Ca$

Isotones

Isotones are nuclides having the same number of neutrons but different numbers protons

- Isotones belong to different chemical elements

Examples: $^{37}_{17}Cl$, $^{38}_{18}Ar$, $^{39}_{19}K$, $^{40}_{20}Ca$