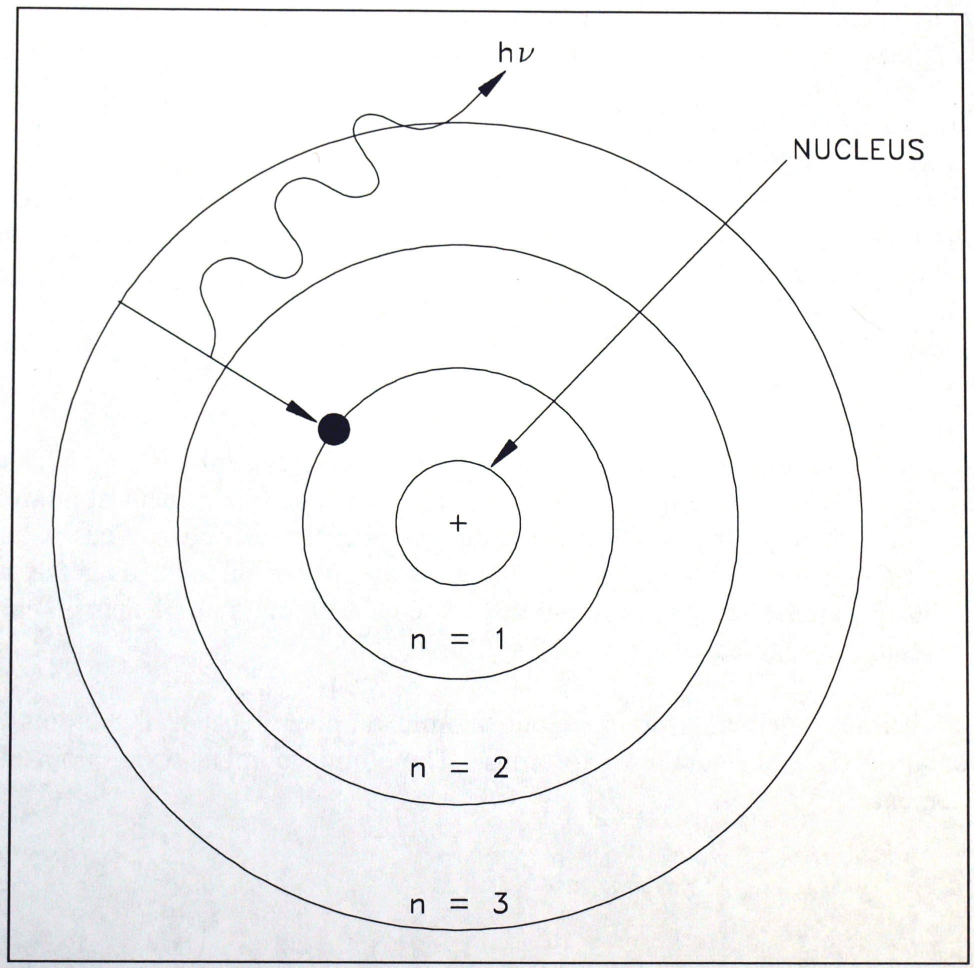
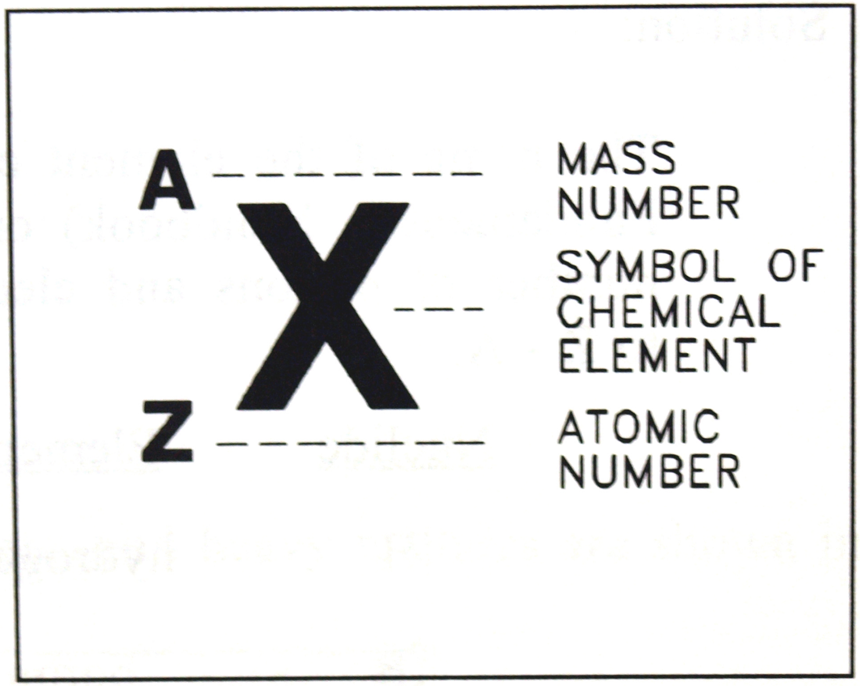
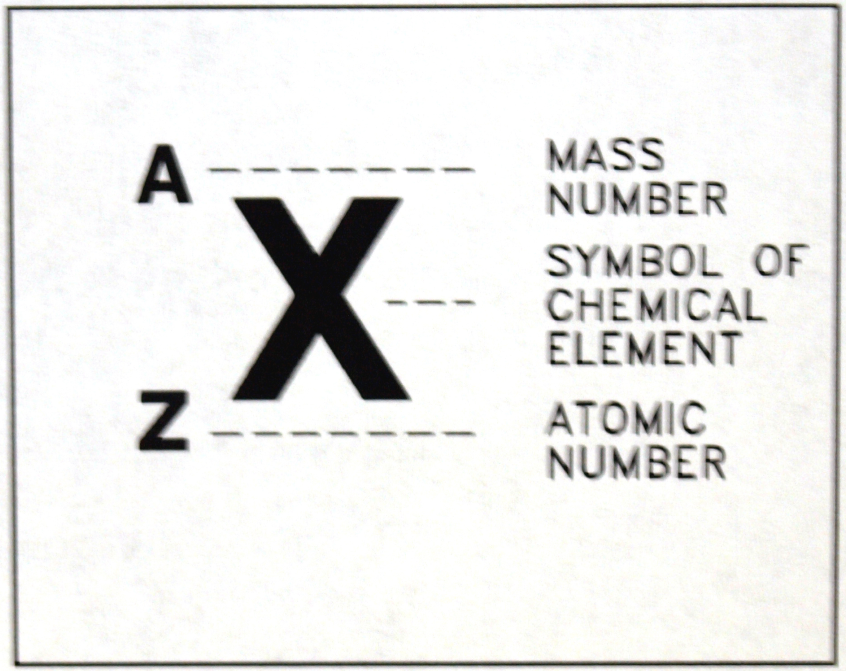


Figure 1 Bohr's Model of the Hydrogen Atom

Properties of Subatomic Particles			
Particle	Location	Charge	Mass
Neutron	Nucleus	none	1.008665 amu
Proton	Nucleus	+1	1.007277 amu
Electron	Shells around nucleus	-1	0.0005486 amu



Nomenclature for Identifying Nuclides



Nomenclature for Identifying Nuclides

Nuclide	Element	Protons	Electrons	Neutrons
$^{1}_{1}H$	hydrogen	1	1	0
$^{10}_{5}B$	boron	5	5	5
$^{14}_{7}N$	nitrogen	7	7	7
$^{114}_{48}Cd$	cadmium	48	48	66
$^{239}_{94}Pu$	plutonium	94	94	145

Calculated Values for Nuclear Radii	
Nuclide	Radius of Nucleus
$^{1}_{1}H$	1.25×10^{-13} cm
$^{10}_{5}B$	2.69×10^{-13} cm
$^{56}_{26}Fe$	4.78×10^{-13} cm
$^{178}_{72}Hf$	7.01×10^{-13} cm
$^{238}_{92}U$	7.74×10^{-13} cm
$^{252}_{98}Cf$	7.89×10^{-13} cm

$$F_g = \frac{G\ m_1\ m_2}{r^2}$$

where:

F_g	=	gravitational force (newtons)
m_1	=	mass of first body (kilograms)
m_2	=	mass of second body (kilograms)
G	=	gravitational constant (6.67×10^{-11} N-m^2/kg^2)
r	=	distance between particles (meters)

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Regional Center for
Nuclear Education & Training

$$F_e = \frac{K\ Q_1\ Q_2}{r^2}$$

where:

- F_e = electrostatic force (newtons)
- K = electrostatic constant (9.0×10^9 N-m^2/C^2)
- Q_1 = charge of first particle (coulombs)
- Q_2 = charge of second particle (coulombs)
- r = distance between particles (meters)

$$F_g = \frac{G\, m_1\, m_2}{r^2}$$

where:

F_g	=	gravitational force (newtons)
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Q_1	=	charge of first particle (coulombs)
Q_2	=	charge of second particle (coulombs)
r	=	distance between particles (meters)

Forces Acting in the Nucleus

Force	Interaction	Range
Gravitational	Very weak attractive force between all nucleons	Relatively long
Electrostatic	Strong repulsive force between like charged particles (protons)	Relatively long
Nuclear Force	Strong attractive force between all nucleons	Extremely short

Atomic Nature of Matter Summary

- Atoms consist of three basic subatomic particles. These particles are the proton, the neutron, and the electron.
- Protons are particles that have a positive charge, have about the same mass as a hydrogen atom, and exist in the nucleus of an atom.
- Neutrons are particles that have no electrical charge, have about the same mass as a hydrogen atom, and exist in the nucleus of an atom.
- Electrons are particles that have a negative charge, have a mass about eighteen hundred times smaller than the mass of a hydrogen atom, and exist in orbital shells around the nucleus of an atom.

- The Bohr model of the atom consists of a dense nucleus of protons and neutrons (nucleons) surrounded by electrons traveling in discrete orbits at fixed distances from the nucleus.

- Nuclides are atoms that contain a particular number of protons and neutrons.

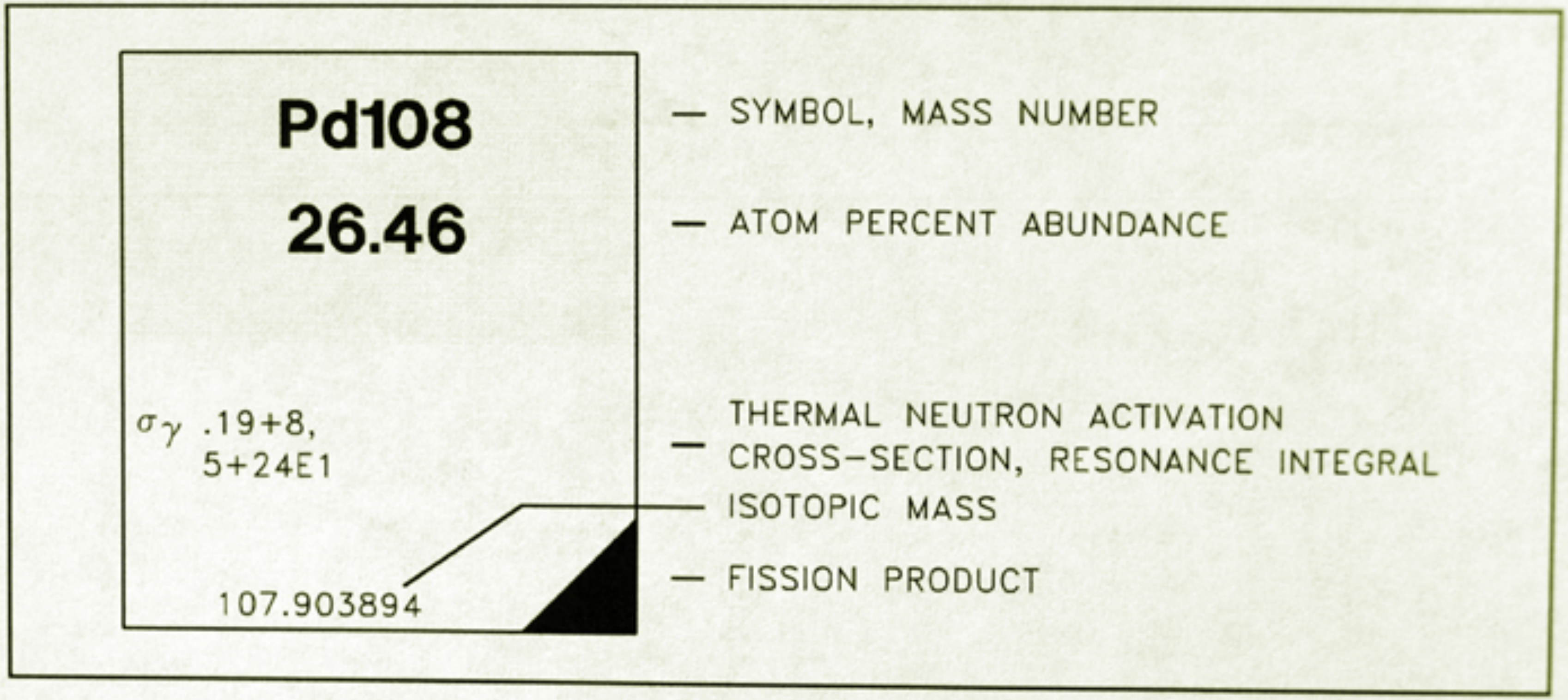
- Isotopes are nuclides that have the same atomic number and are therefore the same element, but differ in the number of neutrons.

- The atomic number of an atom is the number of protons in the nucleus.

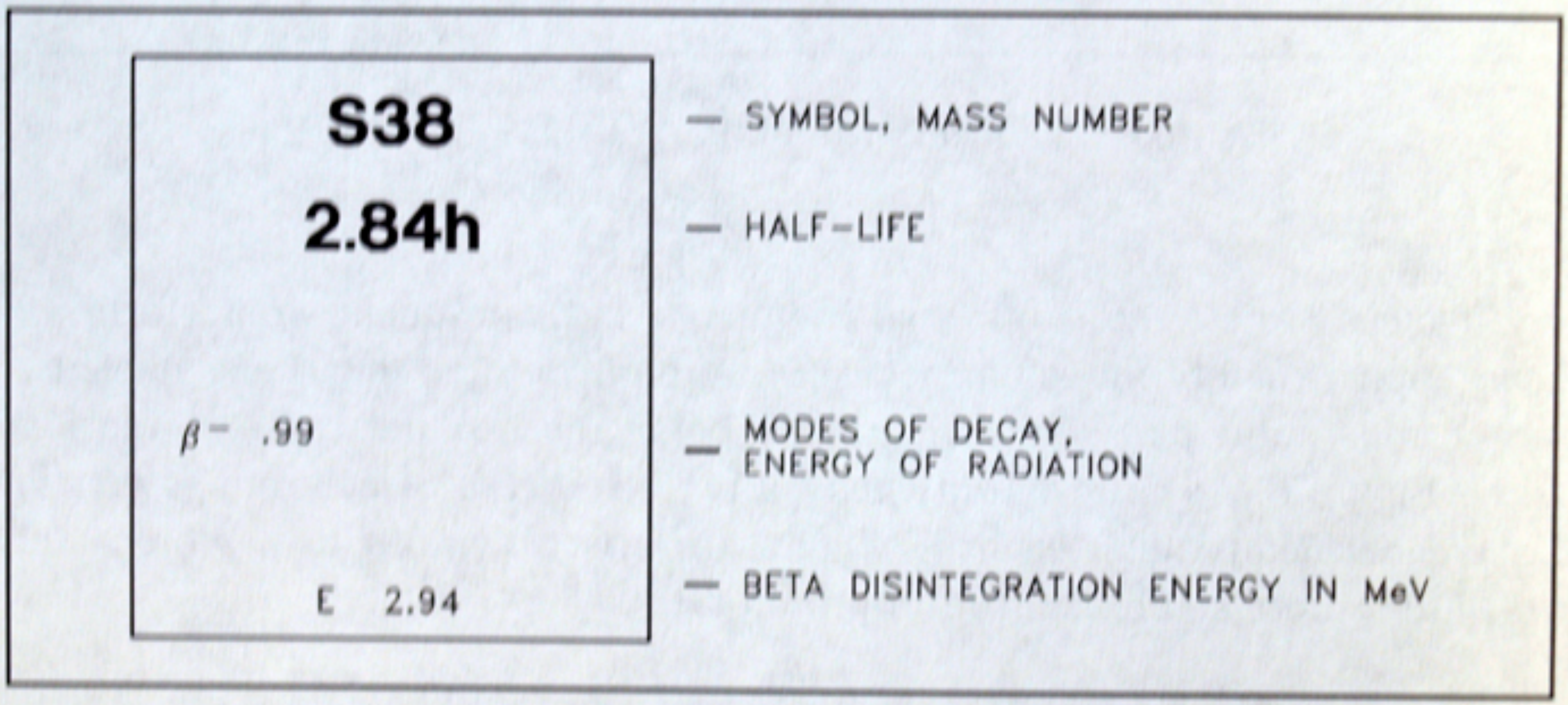
- The mass number of an atom is the total number of nucleons (protons and neutrons) in the nucleus.

- The notation ${}^{A}_{Z}X$ is used to identify a specific nuclide. "Z" represents the atomic number, which is equal to the number of protons. "A" represents the mass number, which is equal to the number of nucleons. "X" represents the chemical symbol of the element.

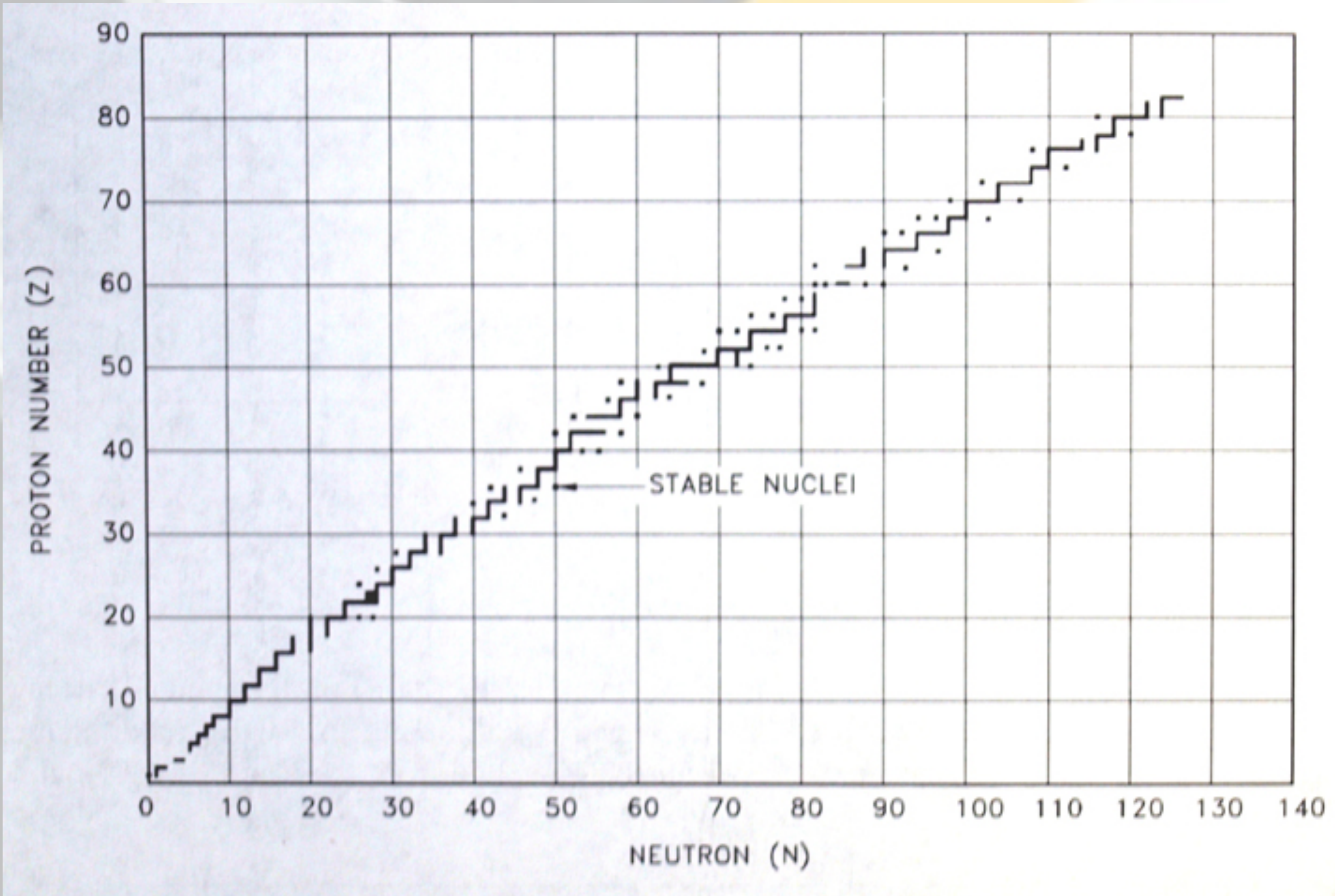
  Number of protons = Z
  Number of electrons = Z
  Number of neutrons = A - Z



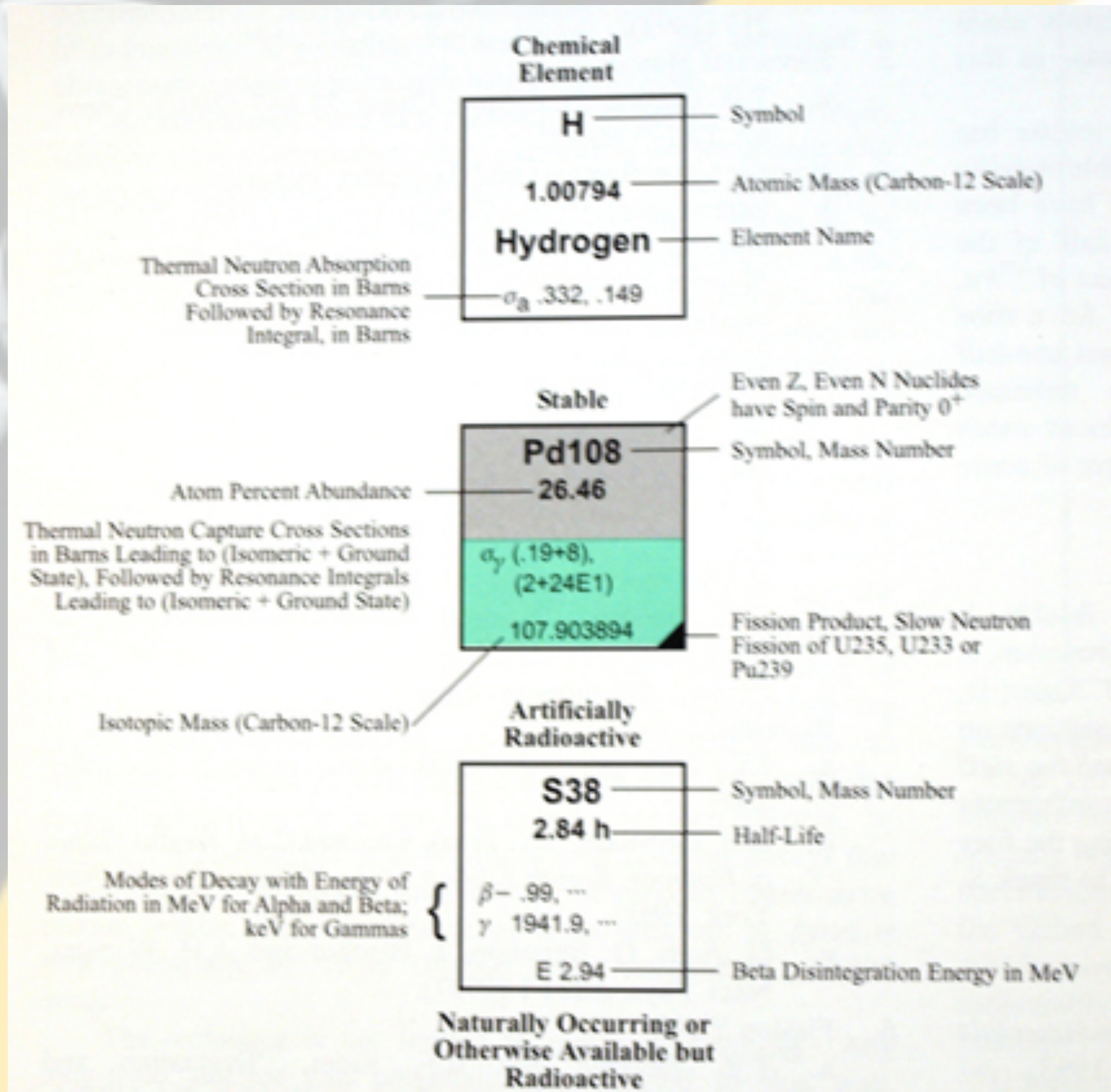
Stable Nuclides



Unstable Nuclides



PROTON NUMBER (Z)
NEUTRON (N)
STABLE NUCLEI
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140


Chemical Element
H
Symbol
1.00794
Atomic Mass (Carbon-12 Scale)
Hydrogen
Element Name
Thermal Neutron Absorption Cross Section in Barns Followed by Resonance Integral, in Barns
σa .332, .149
Stable
Even Z, Even N Nuclides have Spin and Parity 0+
Pd108
Symbol, Mass Number
Atom Percent Abundance
26.46
Thermal Neutron Capture Cross Sections in Barns Leading to (Isomeric + Ground State), Followed by Resonance Integrals Leading to (Isomeric + Ground State)
σγ (.19+8),
(2+24E1)
107.903894
Fission Product, Slow Neutron Fission of U235, U233 or Pu239
Isotopic Mass (Carbon-12 Scale)
Artificially Radioactive
S38
Symbol, Mass Number
2.84 h
Half-Life
Modes of Decay with Energy of Radiation in MeV for Alpha and Beta; keV for Gammas
β− .99, ···
γ 1941.9, ···
E 2.94
Beta Disintegration Energy in MeV
Naturally Occurring or Otherwise Available but Radioactive

The atomic weight for an element is defined as the average atomic weight of the isotopes of the element. The atomic weight for an element can be calculated by summing the products of the isotopic abundance of the isotope with the atomic mass of the isotope.

Example:

Calculate the atomic weight for the element lithium. Lithium-6 has an atom percent abundance of 7.5% and an atomic mass of 6.015122 amu. Lithium-7 has an atomic abundance of 92.5% and an atomic mass of 7.016003 amu.

Solution:

$$\text{Atomic Mass Lithium} = (0.075)\ (6.015122\ \text{amu}) + (0.925)\ (7.016003\ \text{amu})$$
$$= 6.9409\ \text{amu}$$

Summary

The important information in this chapter is summarized below.

Chart of the Nuclides Summary

- Enriched uranium is uranium in which the isotope uranium-235 has a concentration <u>greater</u> than its natural value of 0.7%.
- Depleted uranium is uranium in which the isotope uranium-235 has a concentration <u>less</u> than its natural value of 0.7%.