Journey to the Center of the Atom!

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Structure of the Atom

**Nucleus**
Protons - Charge = +1
Mass = 1 amu (Atomic Mass Unit)

Neutrons - No Charge
Mass = 1 amu

**Electron Cloud**
Electrons - Charge = -1
Mass = 1/1836 amu
Periodic Table

Periodic Table of the Elements

- alkali metals
- alkaline earth metals
- transitional metals
- other metals
- nonmetals
- noble gases

Atomic number
Atomic weight
Symbol

Solid
Liquid
Gas
Synthetically prepared
Most stable isotope

H
Lithium
Beryllium
Boron
Carbon
Nitrogen
Oxygen
Fluorine
Neon

Hydrogen
Lithium
Beryllium
Boron
Carbon
Nitrogen
Oxygen
Fluorine
Neon

K
Ca
Sc
Ti
V
Cr
Mn
Fe
Co
Ni
Cu
Zn
Ga
Ge
As
Se
Br
Kr

Potassium
Calcium
Scandium
Titanium
Vanadium
Chromium
Manganese
Iron
Cobalt
Nickel
Copper
Zinc
Gallium
Germanium
Arsenic
Selenium
Bromine
Krypton

Rb
Sr
Y
Zr
Nb
Mo
Tc
Ru
Rh
Pd
Ag
Cd
In
Sn
Sb
Te
I
Xe

Rubidium
Strontium
Yttrium
Zirconium
Niobium
Molybdenum
Technetium
Ruthenium
Rhodium
Palladium
Silver
Cadmium
Indium
Tin
Antimony
Tellurium
Iodine
Xenon

Cs
Ba
La
Ce
Pr
Nd
Pm
Sm
Eu
Gd
 Tb
Dy
Ho
Er
Tm
Yb
Lu

Cesium
Barium
Lanthanum
Cerium
Praseodymium
Neodymium
Promethium
Samarium
Europium
Gadolinium
Terbium
Dysprosium
Holmium
Erbium
Thulium
Ytterbium
Lutetium

Fr
Ra
Ac
Fm
Md
No
Lr

Francium
Radium
Actinium
Fermium
Mendelevium
Nobelium
Lawrencium

Lanthanide series
Actinide series

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Isotopes

THREE ISOTOPES OF HYDROGEN

Hydrogen
H-1

Deuterium
H-2

Tritium
H-3

Proton

Neutron
**IUPAC Periodic Table of the Isotopes**

### Element Background Color Key

- **Red** indicates that the standard atomic weight has been determined using all stable isotopes and selected radioactive isotopes having a relatively long half-life and characteristic isotopic abundances in natural terrestrial substances. Isotopes are considered stable if radioactive decay has not been detected experimentally.
- **Yellow** indicates that the element has two or more isotopes that are used to determine its standard atomic weight. The isotopic abundances and atomic weights of these isotopes are known, and the standard atomic weight is given as lower and upper bounds within square brackets, e.g., [1.00782(19), 1.00784(19)].
- **Light yellow** indicates that the element has two or more stable isotopes that are used to determine its standard atomic weight. However, the isotopic abundances and atomic weights of these isotopes may vary in natural terrestrial substances, but upper and lower bounds of the standard atomic weight have not been assigned by IUPAC or the variations may be too small to affect the standard atomic weight value. Thus, the standard atomic weight is given as a single value with an uncertainty that includes both measurement uncertainty and uncertainty due to isotopic abundance variations.
- **Green** indicates that the element has only one isotope that is used to determine its standard atomic weight. Thus, the standard atomic weight is invariant and is given as a single value with an IUPAC evaluated measurement uncertainty.
- **Light green** indicates that the element has no standard atomic weight because all of its isotopes are radioactive, and in natural terrestrial substances, no isotope occurs with a characteristic isotopic abundance from which a standard atomic weight can be determined.

### Isotopic Abundance

- **Black** indicates that the isotope is stable.
- **Red** indicates that the isotope is radioactive.
Standard Nuclear Notation

Mass Number
$A = Z + N$
(N = # of Neutrons)

Atomic Number
# of Protons

Chemical Symbol

$\begin{array}{ccc}
12 & C & 13 & C & 14 & C \\
6 & C & 6 & C & 6 & C \\
\end{array}$

or

$\begin{array}{cccc}
12 & C & 13 & C & 14 & C \\
C & C & C & C \\
\end{array}$
## Let’s Practice using Standard Nuclear Notation

Let’s practice using standard nuclear notation. We’ll start by identifying the number of protons and neutrons in various atomic species.

### Examples:

1. **Hydrogen (H)**
   - **One Proton**: $^{1}_1$H
   - **Zero Neutrons**: $^{1}_1$H

2. **Lithium (Li)**
   - **Four Protons**: $^{7}_3$Li
   - **Three Neutrons**: $^{7}_3$Li

3. **Oxygen (O)**
   - **Eight Protons**: $^{17}_8$O
   - **Seven Neutrons**: $^{17}_8$O

### Key Formulas

- **Mass Number** ($A$): $A = Z + N$
  - Where $Z$ is the number of protons (atomic number)
  - $N$ is the number of neutrons

- **Chemical Symbol**

### Calculation

Let’s use the formula $A = Z + N$ to calculate the mass number for each of the atomic species.

$$A = Z + N$$

- **Hydrogen (H)**
  - $A = 1 + 0 = 1$

- **Lithium (Li)**
  - $A = 3 + 4 = 7$

- **Oxygen (O)**
  - $A = 8 + 7 = 15$

### Conclusion

By applying the standard nuclear notation and using the formula $A = Z + N$, we can accurately determine the mass number for any atomic species.
Building a 3D Periodic Table
Chart of the Nuclides
Interactive Nucleus at the Ruth Patrick Science Education Center at the University of South Carolina- Aiken
Ne
Neon
You have made: **Neon-18**

This form of Neon is **Radioactive**.

It emits both **Beta** ($\beta^+$) and **Gamma** ($\gamma$) radiations.
Questions?