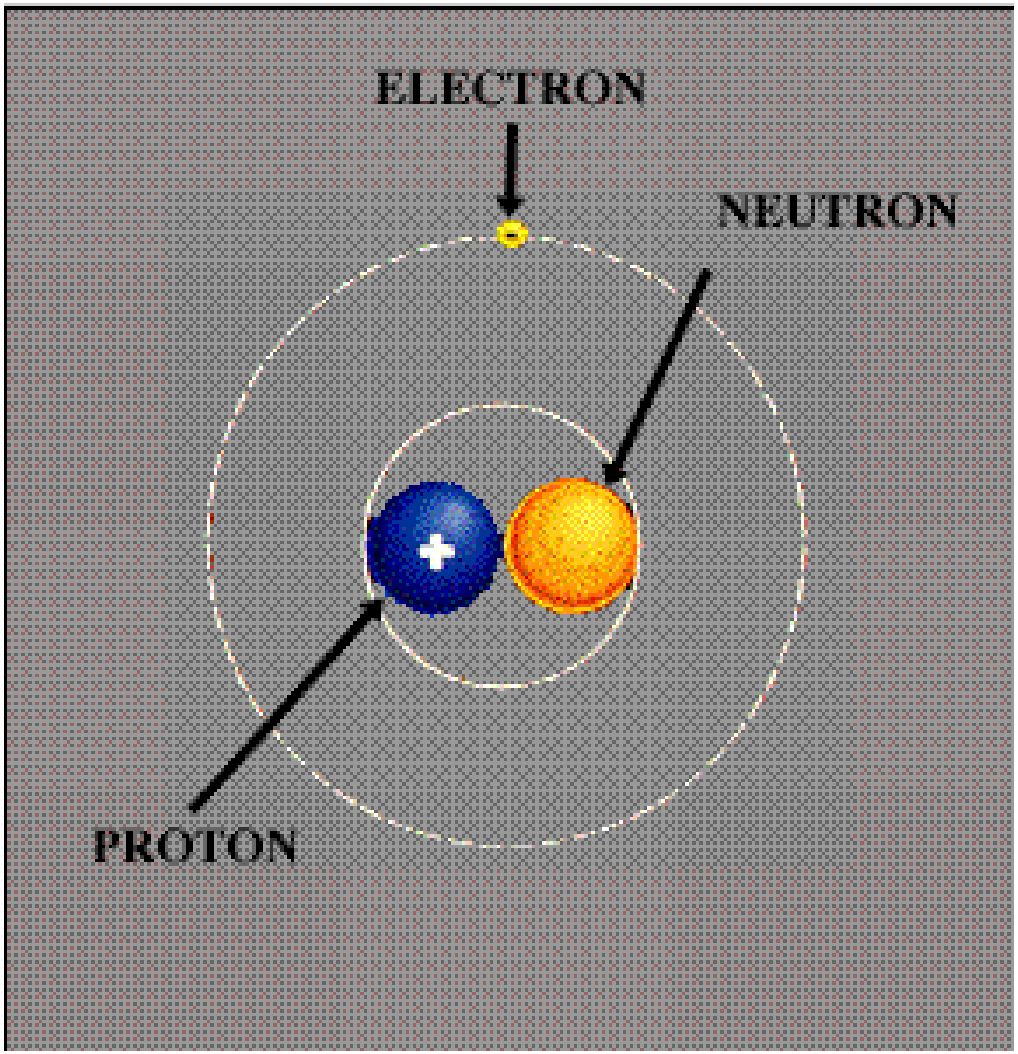
NOTES – 4.3:
Atomic Number, Mass Number, Isotopes and Atomic Mass

Summary of atomic structure:



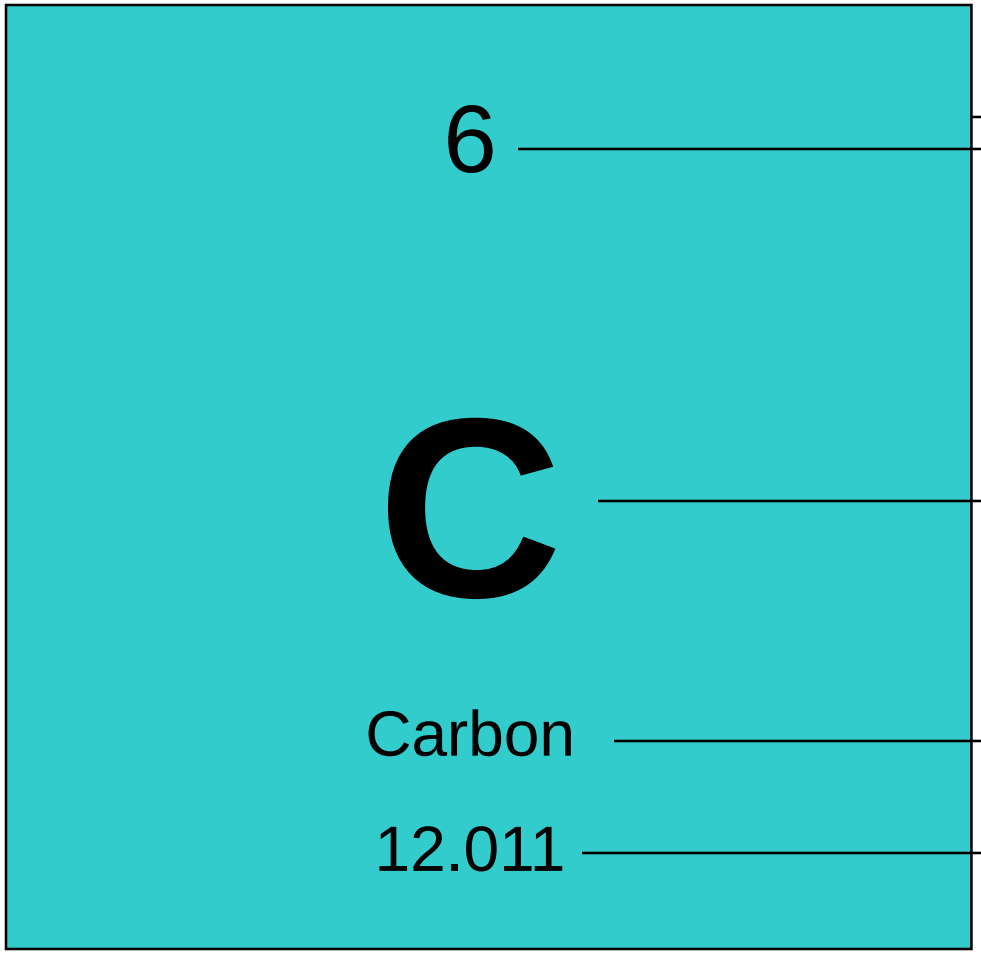
ATOMIC NUMBER:

- Designates the **number of protons** in a nucleus of an atom
- Each element has a **characteristic atomic number** (the same atomic # for ALL atoms of the same element)
- The number of electrons **equals the atomic number in a neutral atom**

MASS NUMBER:

- Designates the total number of protons + neutrons in an atom
- Number of neutrons = mass number - atomic number
- Atoms of the same element can have different mass numbers

Periodic Table Symbol Key:



Atomic number (Z)

Element's symbol

Element's name

Atomic mass (A)

# of protons = Z

# of electrons = # of protons (in a neutral atom)

# of neutrons = A - Z

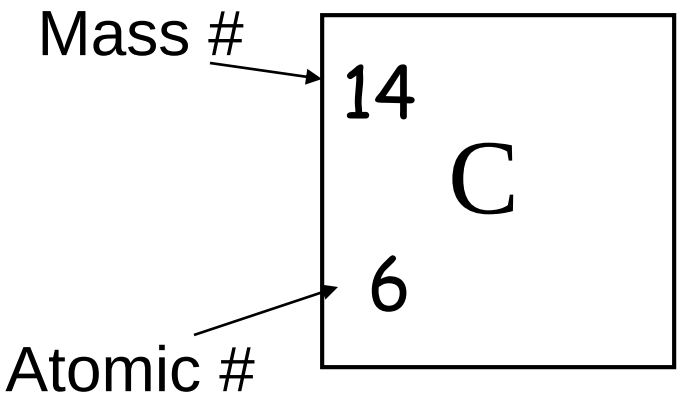
Determining # p^+, n, and e^- from chemical symbols:

- Example 1:

  # protons = 6

  # electrons= 6

  # neutrons= 14-6 = 8

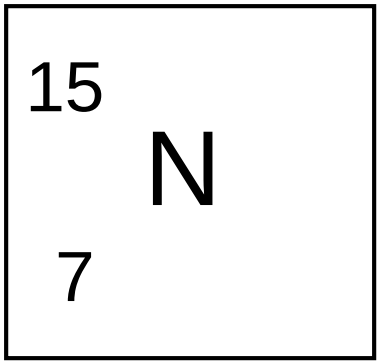


- Example 2:

  # protons = 7

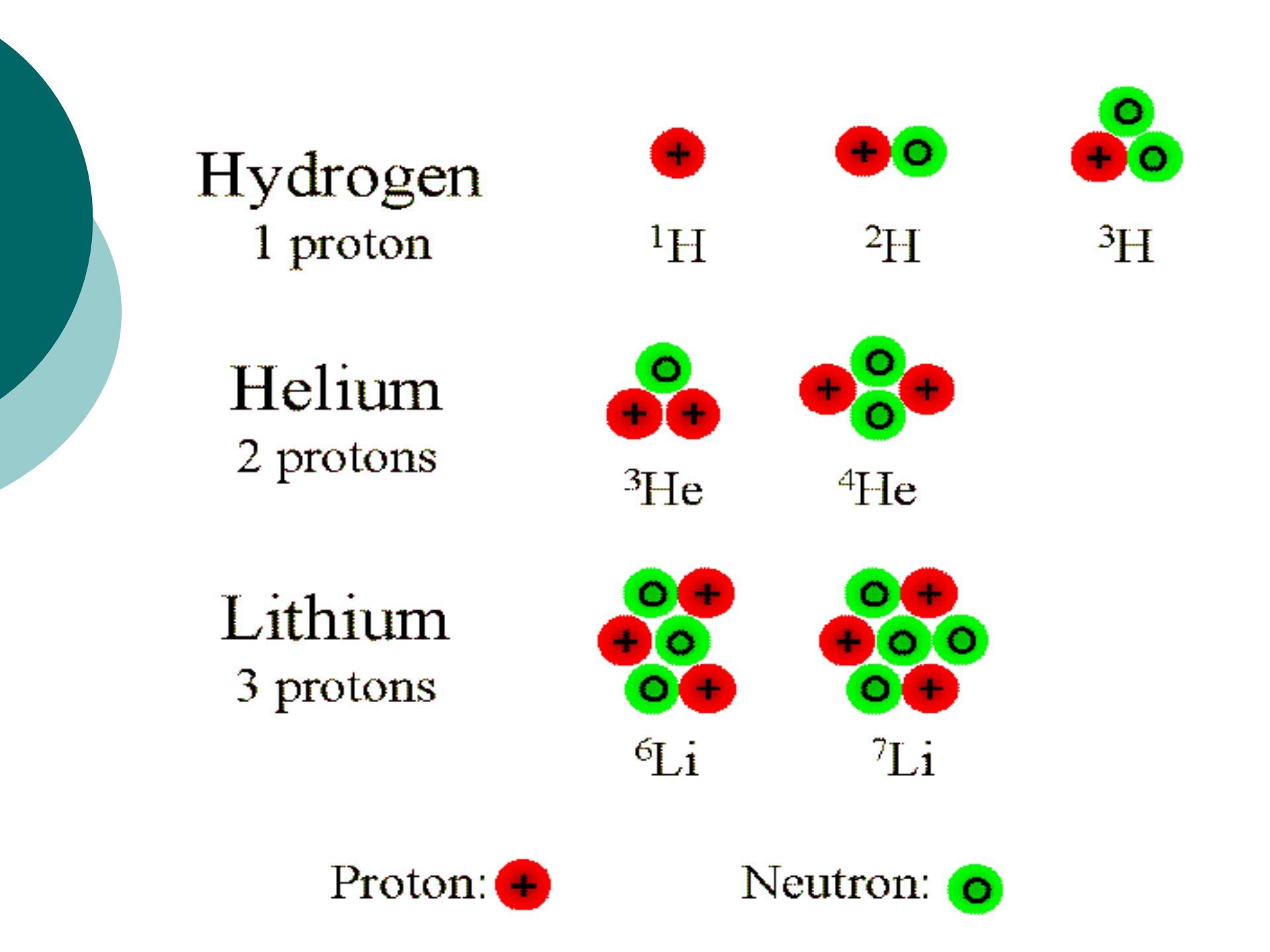
  # electrons= 7

  # neutrons= 15-7 = 8



ISOTOPES:

- Atoms with the same number of protons, but **different numbers of neutrons**
- Isotopes of an element have the same atomic number, but different mass numbers
- **Nuclear Symbol** or isotopic symbol – shows number of protons, neutrons and electrons in an atom


Hydrogen
1 proton
^{1}H
^{2}H
^{3}H
Helium
2 protons
^{3}He
^{4}He
Lithium
3 protons
^{6}Li
^{7}Li
Proton:
Neutron:

ISOTOPE CHART:

Element	Isotope symbol	# pro.	# elec.	# neu.
Boron-10	^{10}B	5	5	5
Boron-11	^{11}B	5	5	6
Chlorine-35	^{35}Cl	17	17	18
Chlorine-37	^{37}Cl	17	17	20

AVERAGE ATOMIC MASS (= Atomic Weight)

- the weighted average of the masses of the atoms (isotopes) in a naturally occurring sample of an element
- masses are based off of the atomic mass unit (amu) defined as one twelfth the mass of a carbon-12 atom
- these values can be fractions

Average Atomic Mass Example

- In nature carbon is composed of 98.890% ^{12}C atoms and 1.1100% ^{13}C atoms. ^{12}C has a mass of 12.000 amu and ^{13}C has a mass of 13.0034 amu. What is the average atomic mass of carbon?

Average Atomic Mass Example

- In nature carbon is composed of 98.890% ^{12}C atoms and 1.1100% ^{13}C atoms. ^{12}C has a mass of 12.000 amu and ^{13}C has a mass of 13.0034 amu. What is the average atomic mass of carbon?

Ave. mass = (.98890)(12.000)
+ (.011100)(13.0034)

= 12.011 amu

Example: There are 3 isotopes of magnesium that occur in nature. Their abundances and masses are listed below:

Isotope	% Abundance	Mass (amu)
^{24} Mg	78.99%	23.98504
^{25} Mg	10.00%	24.98584
^{26} Mg	11.01%	25.98259

What is the atomic weight of magnesium?

Atomic weight =

$$
\begin{aligned}
& (.7899)(23.98504) \\
+\ & (.1000)(24.98584) \\
+\ & (.1101)(25.98259)
\end{aligned}
$$

$$= \boxed{\textbf{24.31 a.m.u.}}$$

Carbon-12 and carbon-14 are

a) isomers
b) isotopes
c) radioactive elements
d) different elements

Isotopes are atoms of the same element with different numbers of neutrons, and therefore different atomic masses.

While carbon-14 is used in radioactive dating, carbon-12 has a more stable nucleus and therefore is not used in this capacity.

How many protons, electrons and neutrons are in one atom of oxygen-17?

a) 17 p, 17 e, 17 n
b) 17 p, 17 e, 1 n
c) 8 p, 8 e, 8 n
d) 8 p, 8 e, 9 n

While most oxygen atoms have a mass of 16 g/mol, oxygen-17 is an isotope with a mass of 17 g/mol.

The number of protons in an element is the same for every atom of that element.

electrons = # protons if element has no charge.