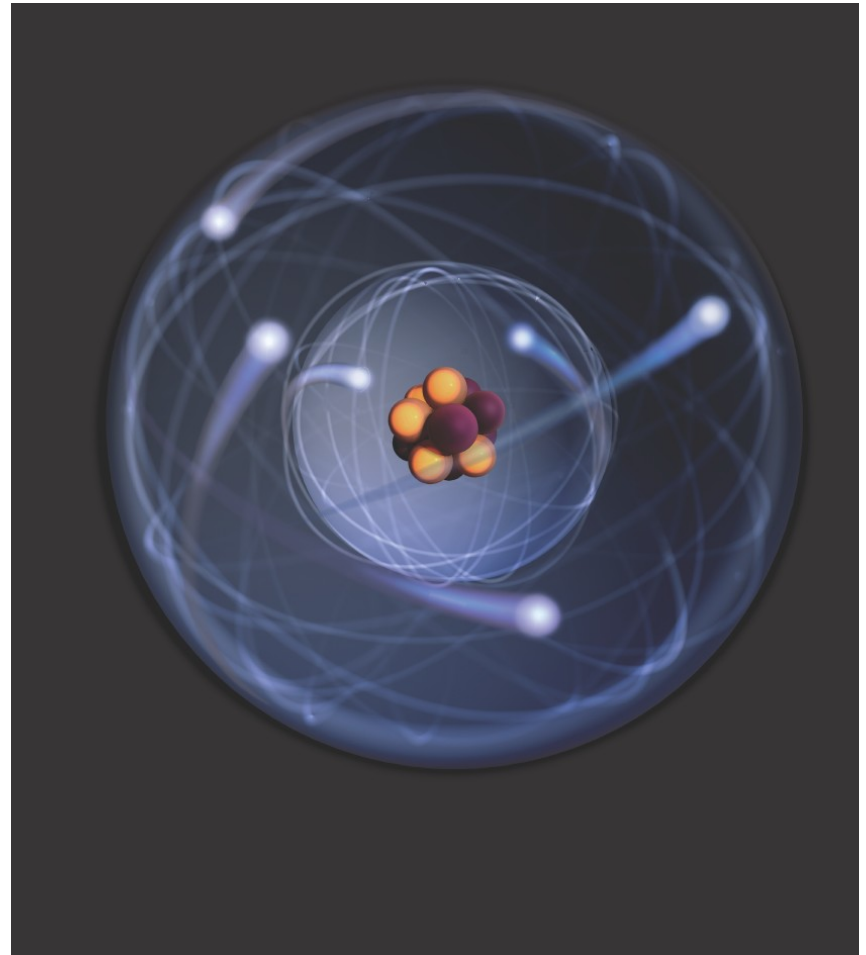

Isotopes

Chemistry 2019
Unit 4 Module 3

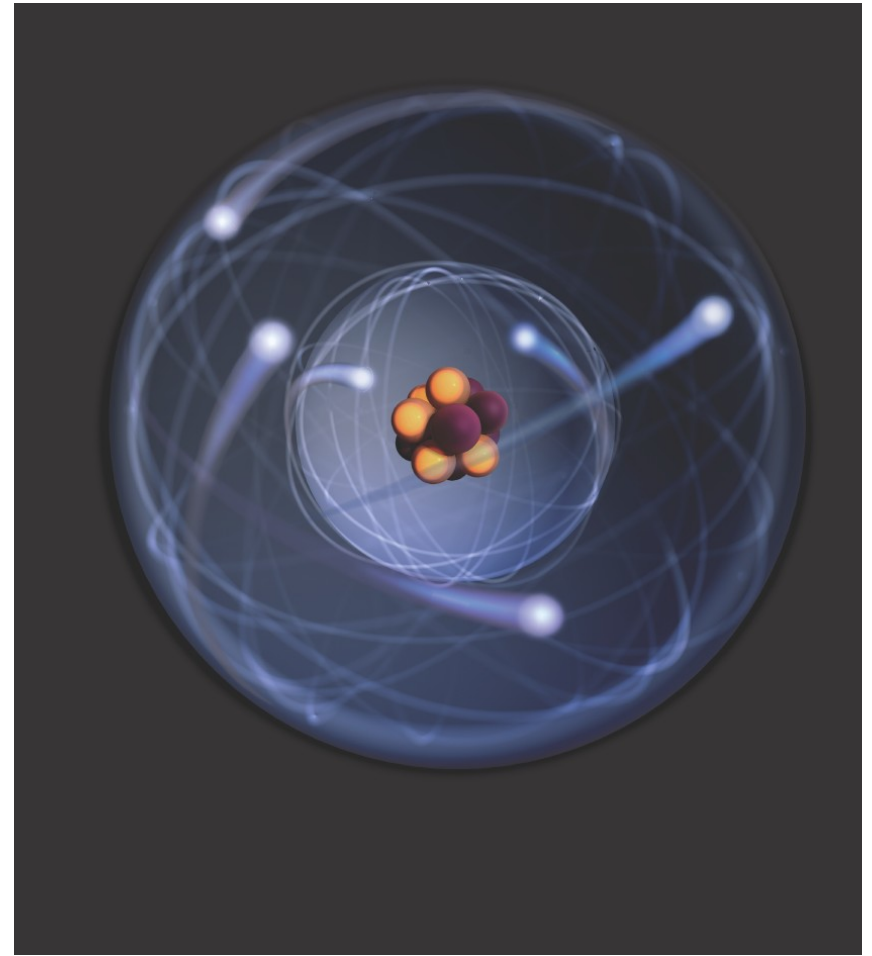
Review: Basics of Atomic Structure

- What are the three major subatomic particles?
- What charge does each one have?
- Where is each one located?

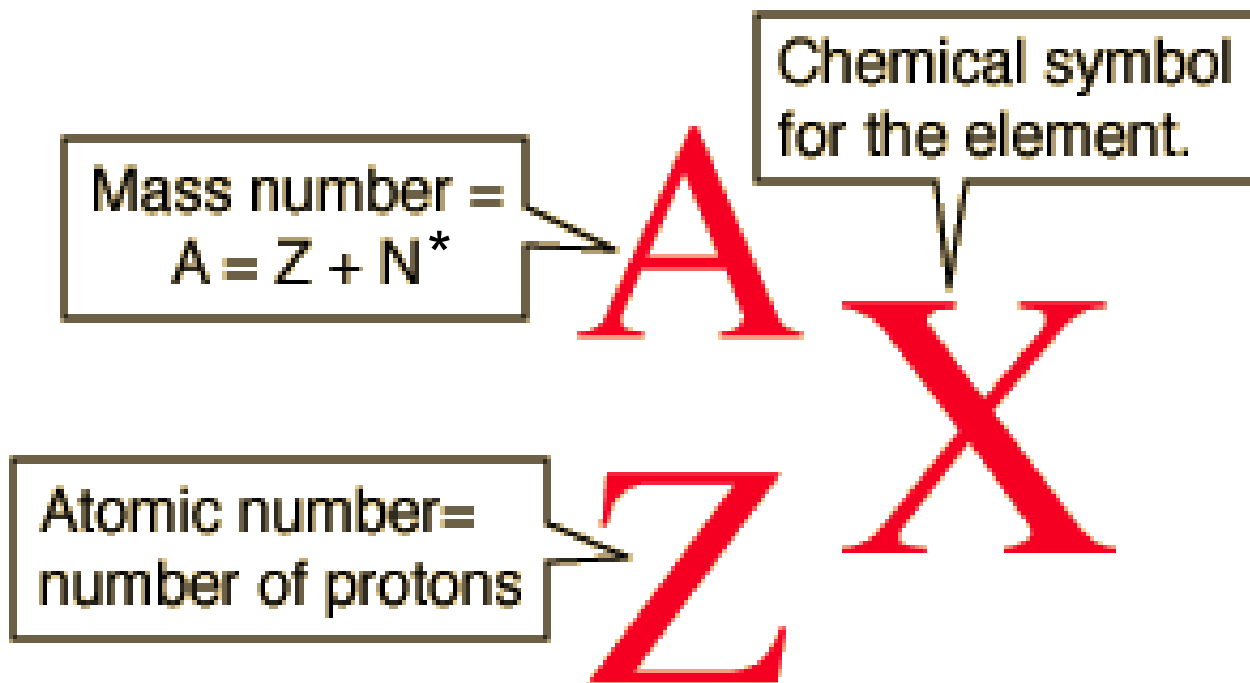


Review: Basics of Atomic Structure

- There are three major sub-atomic particles located within two regions of the atom
- Regions
 - Nucleus
 - Electron Cloud
- Particles
 - Proton (+)
 - Neutron
 - Electron (-)

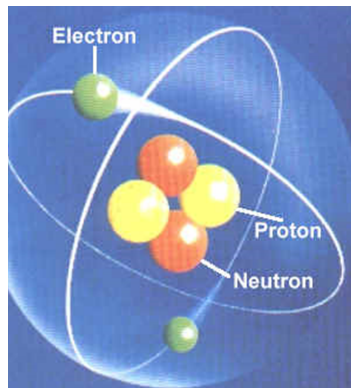


Nuclear Symbols for Neutral Atoms



*N = number of neutrons

Nuclear Symbols for Neutral Atoms



In this notation, the A and Z represent the number of particles in an atom or a population of atoms. It's not a mass.

Mass number =
 $A = Z + N^*$

A

Chemical symbol
for the element.

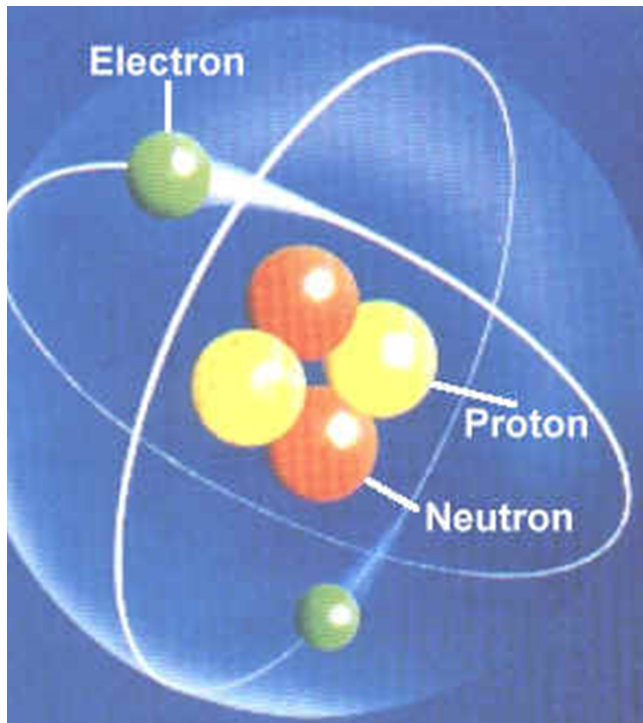
X

Atomic number =
number of protons

Z

*N = number of neutrons

What Element Is This?



Mass number =
 $A = Z + N$

4

Chemical symbol
for the element.

Atomic number =
number of protons

2

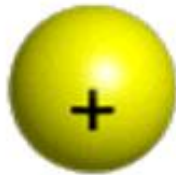
He

- There are 2 protons, so the *atomic number* is 2.
- The elemental *identity* of the atom depends only on the atomic number. It is helium, represented by He.
- There are 2 neutrons, so the *mass number* is $2+2=4$.
- There are 2 electrons, so there is no charge.

The Isotopes of Hydrogen

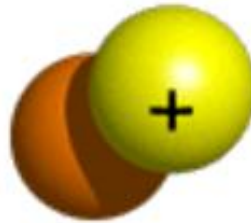
The Nuclei of the Three Isotopes of Hydrogen

Protium



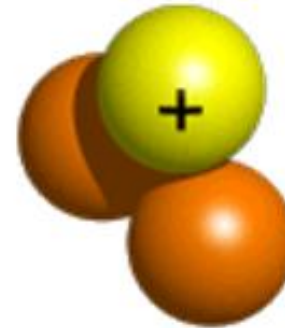
1 proton

Deuterium



1 proton
1 neutron

Tritium

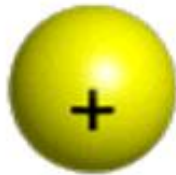


1 proton
2 neutrons

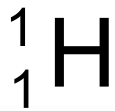
The Isotopes of Hydrogen

The Nuclei of the Three Isotopes of Hydrogen

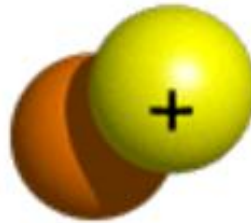
Protium



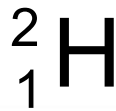
1 proton



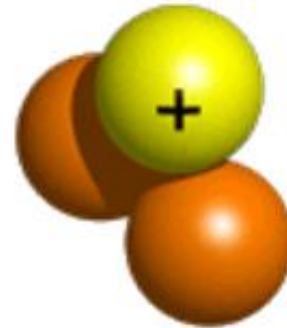
Deuterium



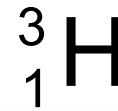
1 proton
1 neutron



Tritium



1 proton
2 neutrons



If $m_{\text{proton}} = m_{\text{neutron}} = 1\text{amu}$, what is the mass of each atom in amu?

The Isotopes of Hydrogen

Remind me...

$$1 \text{ mole H} = \boxed{1.01} \text{ g} = \boxed{6.02 \times 10^{23}} \text{ atoms}$$

There are a LOT of atoms in any lab-scale sample of a substance.

If I have 1 mole of H atoms, some of them will weigh 1 amu, some will weigh 2 amu, and some will weigh 3 amu.

So how do we come up with 1 mol H = 1.01g?

Average Atomic Mass

- The atomic mass given for an element on the periodic table is an average, which takes into account the various isotopes of an element and their relative abundance.
 - Example: The mass of hydrogen found on the periodic table is 1.00794. Hydrogen has three isotopes, as shown in the previous module notes.
-

Average Atomic Mass

- So, the atomic mass of 1.00794 reflects a “weighted” average of all three of these isotopes. Which of the three isotopes of hydrogen must be the most abundant?
- Analogy - Your grades in this class are calculated using weighted percentages. The highest weighted category toward the calculation of your grade is tests. So, your overall average is most affected by your test performance.
- Apply this concept to average atomic mass. The “average” is close to the number one. Which of the three isotopes of hydrogen must be the most abundant? Hydrogen – 1 (Protium), Hydrogen – 2 (Deuterium) or Hydrogen – 3 (Tritium)?

Calculating Average Atomic Mass

$$\text{average atomic mass} = \left(\begin{array}{l} \text{mass of} \\ \text{isotope 1} \end{array} \right) \left(\begin{array}{l} \text{abundance} \\ \text{of isotope 1} \end{array} \right) + \left(\begin{array}{l} \text{mass of} \\ \text{isotope 2} \end{array} \right) \left(\begin{array}{l} \text{abundance} \\ \text{of isotope 2} \end{array} \right) + [\text{and so on}]$$

Average Atomic Mass – Example #1

- Calculate the average atomic mass for magnesium which has three naturally occurring isotopes, Magnesium – 24 which is 78.70% abundant, Magnesium – 25 which is 10.13% abundant, and Magnesium – 26 which is 11.17% abundant.

Average Atomic Mass – Example #2

- Element X has two isotopes. One is X-10 and has a mass of 10.012 amu and an abundance of 19.91%. The other is X-11, the average atomic mass for element X is 10.810 amu. What is the actual mass of X-11? What element is this?