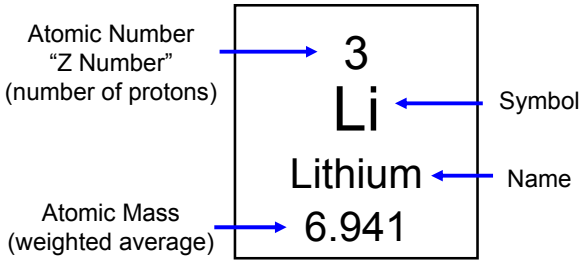
Subatomic Particles

	Symbol	Charge	Mass
Electron	e^-	-1	0
Proton	p^+	+1	1
Neutron	n^0	0	1

Reading a Periodic Table



Basics of Atoms

1) A neutral atom has the same number of electrons as it has protons.
2) Atoms of the same element can have different masses due to different numbers of neutrons.
3) Elements with different masses are called isotopes. **Nuclide** is a term for an isotope.

Designating Isotopes

Mass Number = Protons + Neutrons

→ Mass Number – Protons = Neutrons

Example: an isotope of uranium has a mass of 235 and an atomic number of 92. How many neutrons?

235 – 92 = 143
mass protons neutrons

Designating Isotopes

There are two common ways to present isotopes

Example: an isotope of uranium has a mass of 235 and an atomic number of 92.

Nuclear Symbol	Hyphen Notation
mass → 235 U Z → 92	Uranium-235

How to remember Nuclear Symbol

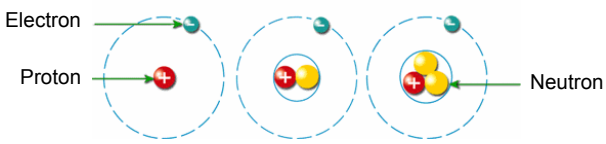
Correct: $^{235}_{92}U$

Incorrect: $^{92}_{235}U$

The nuclear symbol should look like an easy subtraction problem to calculate neutrons.

$$\begin{array}{r} {}^{235}_{92}U \\ \hline 143 \end{array}$$

Isotopes of hydrogen

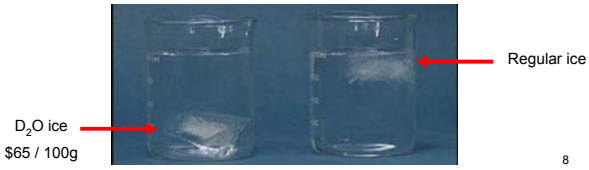


Protium	Deuterium	Tritium
mass = 1	mass = 2	mass = 3
$^{1}_{1}H$	$^{2}_{1}H$	$^{3}_{1}H$
99.985%	0.015%	Rare & radioactive

Heavy Water

Water composed of deuterium hydrogen is often labeled D_2O rather than H_2O. Because each molecule is heavier but still the same size, D_2O is more dense.

Ice cubes of D_2O in liquid H_2O will sink!!



Relative Atomic Mass – a separate unit of measurement is used for mass of individual atoms.

amu – Atomic Mass Unit

1 amu = 1.660540×10^{-27} kg

The amu is based off $^{1}/_{12}^{th}$ the mass of Carbon-12

Periodic Table Masses

This is not the same as the Mass Number!!

Masses on the periodic table are weighted averages based on the percentage of each nuclide found in nature. (Just like GPA)

Mass of Copper

Nuclide	% Occurring	Mass (amu)	% x Mass
Cu-63	69.15%	62.93	43.52
Cu-65	30.85%	64.93	20.03
			63.55

Average Mass

Dry air has 0.002% neon.

Each breath has 5×10^{17} neon atoms.
That is 500 000 000 000 000 000 atoms!!

In chemistry, we frequently work with huge quantities of atoms. Is this an easy way to count atoms?

The Mole (Mol for short)

The mole is defined as the quantity of atoms in a sample of exactly 12 g of pure carbon-12.

This count is called **Avogadro's Number**…
602,213,670,000,000,000,000,000
→ 6.0221367×10^{23}

To make things easy to remember…

1 mole = 6.02×10^{23}

The Mole is a Quantity

1 dozen = 12

How many donuts in 3.5 dozen?

$$3.5 \text{ dozen donuts} \left[\frac{12}{1 \text{ dozen}}\right] = 42 \text{ donuts}$$

1 mole = 6.02×10^{23}

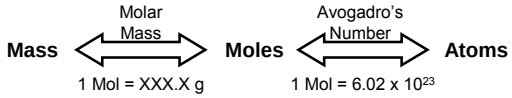
How many donuts in 3.5 moles?

$$3.5 \text{ mole donuts} \left[\frac{6.02 \times 10^{23}}{1 \text{ mole}}\right] = 2.1 \times 10^{24} \text{ donuts}$$

Converting Mass / Moles / Atoms:

Mass/Moles
"Mass to Moles or Moles to Mass… Use Molar Mass"

Moles/Atoms
1 mole atoms = 6.02×10^{23} atoms



Using Molar Mass

The Molar Mass of an element is equal to its atomic mass

Li = 6.94 g/mol → 1 mole of lithium atoms = 6.94 g

How many grams are in 2.0 moles?

$$2.0 \text{ mol Li} \left[\frac{6.94 \text{ g Li}}{1 \text{ mol Li}}\right] = 14 \text{ g Li}$$

Using Avogadro's Number

The Molar Mass of an element is equal to its atomic mass

1 mole = 6.02×10^{23}

How many atoms are in 2.0 moles of Li?

$$2.0 \text{ mole Li} \left[\frac{6.02 \times 10^{23} \text{ atoms}}{1 \text{ mole Li}}\right] = 1.2 \times 10^{24} \text{ atoms Li}$$

Atoms to Mass…. Or Mass to Atoms
This is a two step process

How many grams are in 9.03×10^{23} atoms of oxygen?

$$9.03 \times 10^{23} \text{ atoms O} \left[\frac{1 \text{ mole}}{6.02 \times 10^{23} \text{ atoms}}\right]\left[\frac{16.0 \text{ g}}{\text{mol}}\right] = 24.0 \text{ g O}$$

How many atoms are in 7.0 grams of N?

$$7.0 \text{ g N} \left[\frac{\text{mol}}{14.0 \text{ g}}\right]\left[\frac{6.02 \times 10^{23} \text{ atoms}}{1 \text{ mole}}\right] = 3.0 \times 10^{23} \text{ atoms N}$$