Atomic Mass

- **One atomic mass unit (amu)**: the mass exactly equal to one-twelfth the mass of one carbon-12 atom that has six protons and six neutrons.

  1 atom of carbon-12 = 12 amu

  $$1 \text{ amu} = \frac{\text{mass of one C-12 atom}}{12}$$

  1 amu = 1.66054×10^{-24} g and 1 g = 6.02214×10^{23} amu

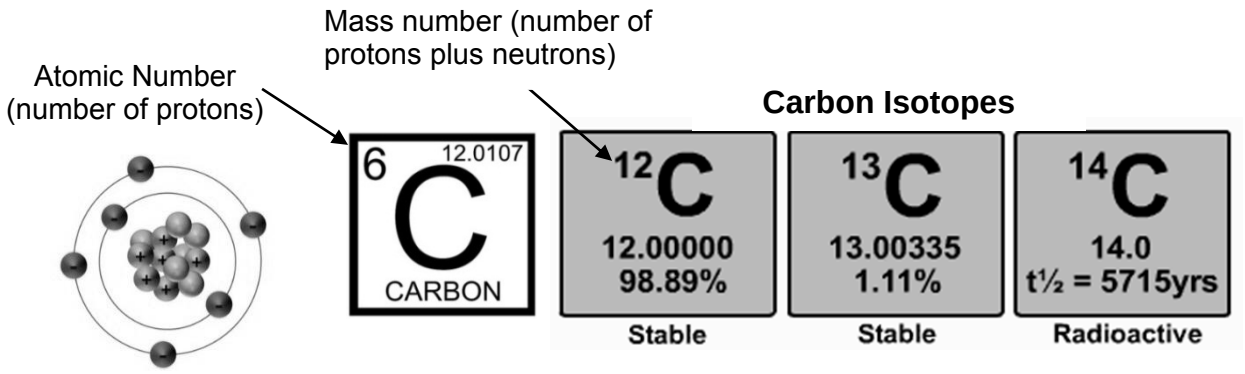
- **Average Atomic Mass**: the weighted average of the masses of the naturally occurring isotopes of the element; the mass of the atom in atomic mass units

  Average Atomic Mass = ∑ (fractional abundance of isotope n) × (mass of isotope n)

- ***Isotopes****: atoms with identical atomic numbers but different mass numbers (that is, same number of protons but different numbers of neutrons)*

  Average atomic mass of carbon = (0.09890)(12.00000 amu) + (0.0110)(13.00335 amu)

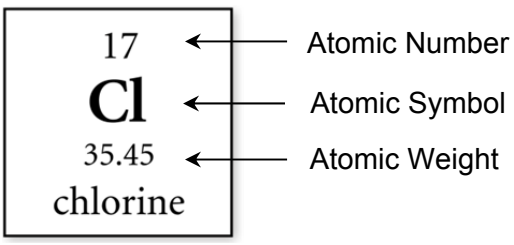
  = 12.0107 amu

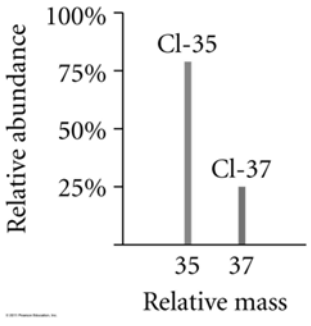


Example

If chlorine is 75.78 % Cl-35 with a mass of 34.9689 *amu and the rest Cl-37 with a mass of* 36.9659 amu*, find chlorine's atomic mass.*

Cl atomic mass = 0.7578 x 34.9689 + (1 - 0.7578) × 36.9659 = 35.45 amu





Atomic mass = (Fraction of isotope 1 x Mass of isotope 1) +
(Fraction of isotope 2 x Mass of isotope 2) +
(Fraction of isotope 3 x Mass of isotope 3) + ……

Practice Problems

1. Three isotopes of silicon occur in nature. ^{28}Si (92.23%), which has an atomic mass of 27.97693 amu; ^{29}Si (4.68%), which has an atomic mass of 28.97649 amu; and ^{30}Si (3.09%), which has an atomic mass of 29.97377 amu. Calculate the atomic weight of silicon.

2. Gallium has two naturally occurring isotopes: Ga-69 with mass 68.9256 amu and a natural abundance of 60.11%, and Ga-71 with mass 70.9247 amu and a natural abundance of 39.89%. Calculate the atomic mass of gallium.

3. Bromine has two naturally occurring isotopes (Br-79 and Br-81) and an atomic mass of 79.904 amu.
   (a) If the natural abundance of Br-79 is 50.69%, what is the natural abundance of Br-81?
   (b) If the mass of Br-81 is 80.9163 amu, what is the mass of Br-79?

4. Titanium has five common isotopes: ^{46}Ti (8.25%), ^{47}Ti (7.44%). ^{48}Ti (73.72%), ^{49}Ti (5.41%), ^{50}Ti (5.18%). What is the average atomic mass of titanium?

Isotope	Aundance (fraction)	Atomic mass (amu)
^{46}Ti	0.0825	45.953
^{47}Ti	0.0744	46.952
^{48}Ti	0.7372	47.948
^{49}Ti	0.0541	48.948
^{50}Ti	0.0518	49.945

References:
Tro, Chemistry: A Molecular Approach 2nd ed., Pearson
Brown/LeMay/Bursten, Chemistry: The Central Science, 12th ed., Pearson

Answers

1. *28.09 amu* ***2.*** *69.72 amu* ***3.*** *(a) 49.31% (b) 78.91 amu* ***4.*** *47.7 amu*