

Average Atomic Mass

Natural Distribution of Isotopes

Where do those numbers on the Periodic Table come from?

Isotopes

- Atoms that have the same number of protons, but different number of neutrons
- They are the same element with a different mass
 - Same atomic number
 - Different mass numbers

Mass Number vs. Atomic Mass

- The mass number tells the number of protons and the number of neutrons
- The atomic mass is measured in Atomic Mass Units (a.m.u.)
 - a.m.u is a relative scale
 - The mass of Carbon-12 = 12.0000... amu

Carbon-12 vs. Magnesium-24

Isotope	Atomic mass (m_a/u)	Natural abundance (atom %)	Nuclear spin (I)	Magnetic moment (μ/μ_N)
^{12}C	12.000 000 0 0 (0)*		0	
^{13}C	13.003 354 8378(10)	1.07 (8)	$1/2$	0.702411

Isotope	Atomic mass (m_a/u)	Natural abundance (atom %)	Nuclear spin (I)	Magnetic moment (μ/μ_N)
^{24}Mg	23.9850423 (8)	78.99 (4)	0	0
^{25}Mg	24.9858374 (8)	10.00 (1)	$5/2$	-0.85546
^{26}Mg	25.9825937 (8)	11.01 (3)	0	0

Average Atomic Mass

- Not all isotopes occur naturally in the same proportions
 - Some isotopes occur more often than others
- The Average Atomic Mass takes into account the distribution of the different isotopes for each element and the atomic mass of each

Calculating Average Atomic Mass

Atomic masses (in amu) of atoms in sample

81
79
79
81
79
79
81
81

640 amu = total mass of sample

$$\text{Average mass} = \frac{640 \text{ amu}}{8 \text{ atoms}}$$

$$= 80 \text{ amu}$$

= atomic mass



Sample
of bromine

Atomic masses (in amu) of atoms in sample

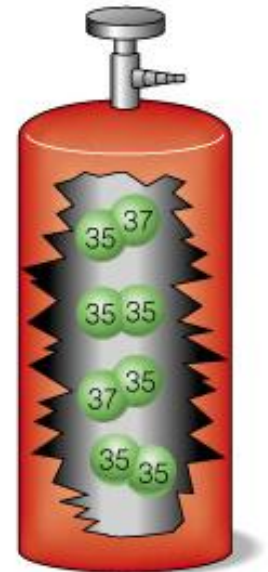
35
37
35
35
35
37
35
35

284 amu = total mass of sample

$$\text{Average mass} = \frac{284 \text{ amu}}{8 \text{ atoms}}$$

$$= 35.5 \text{ amu}$$

= atomic mass



Sample
of chlorine

Calculating Average Atomic Mass

$$\text{Mass (in a.m.u.)} \times \frac{\text{Abundance}}{100} = \text{Contribution}$$

- Perform this calculation for all naturally occurring isotopes and add the contributions
- The sum will be the **average atomic mass**

Calculating Average Atomic Mass Chlorine

Isotope	Atomic Mass	Abundance
Chlorine-35	34.96885 amu	75.53 %
Chlorine-37	36.97790 amu	24.47 %

$$34.96885 \times 0.7553 = 26.41$$

$$36.97790 \times 0.2447 = 9.048$$

35.46 a.m.u.

Calculating Average Atomic Mass

Zinc

Isotope	Atomic mass	Natural abundance
^{64}Zn	63.9291448	48.63
^{66}Zn	65.9260347	27.90
^{67}Zn	66.9271291	4.10
^{68}Zn	67.9248459	18.75
^{70}Zn	69.925325	0.62