Chem With Com

Atomic Structure and Significant Figures

- Chapter 2.1 (Early Ideas in Atomic Theory)
- Chapter 2.3 (Atomic Structure and Symbolism)
- Chapter 3.6 (The Periodic Table)
- Chapter 1.5 (Significant Figures)

Adapted From: Paul Flowers, Edward J. Neth, William R. Robinson, PhD, Klaus Theopold, Richard Langley; Chemistry: Atoms First 2e; OpenStax; Feb 14, 2019; Houston Texas; https://openstax.org/books/chemistry-atoms-first-2e/pages/1-introduction

Atomic Structure

- Chapter 2.3 (Atomic Structure and Symbolism)
- Chapter 3.6 (The Periodic Table)

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What are atoms? (and matter?)

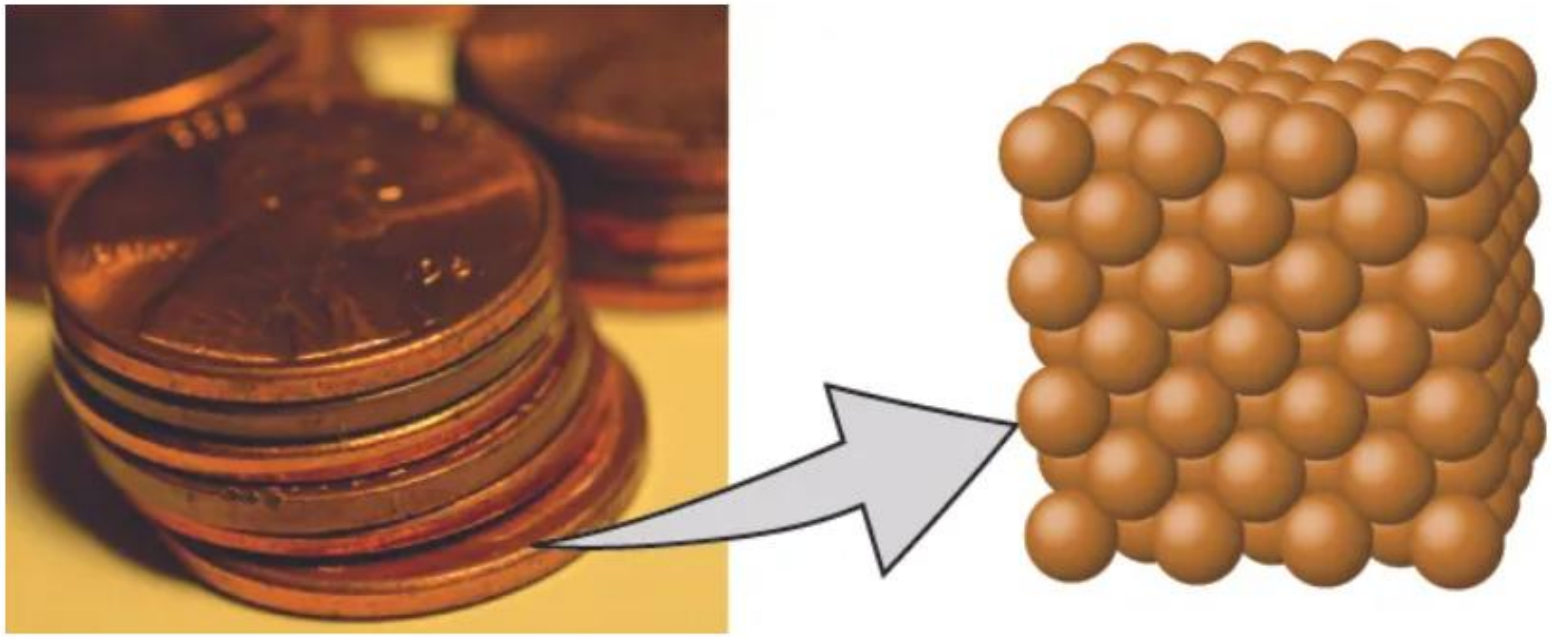


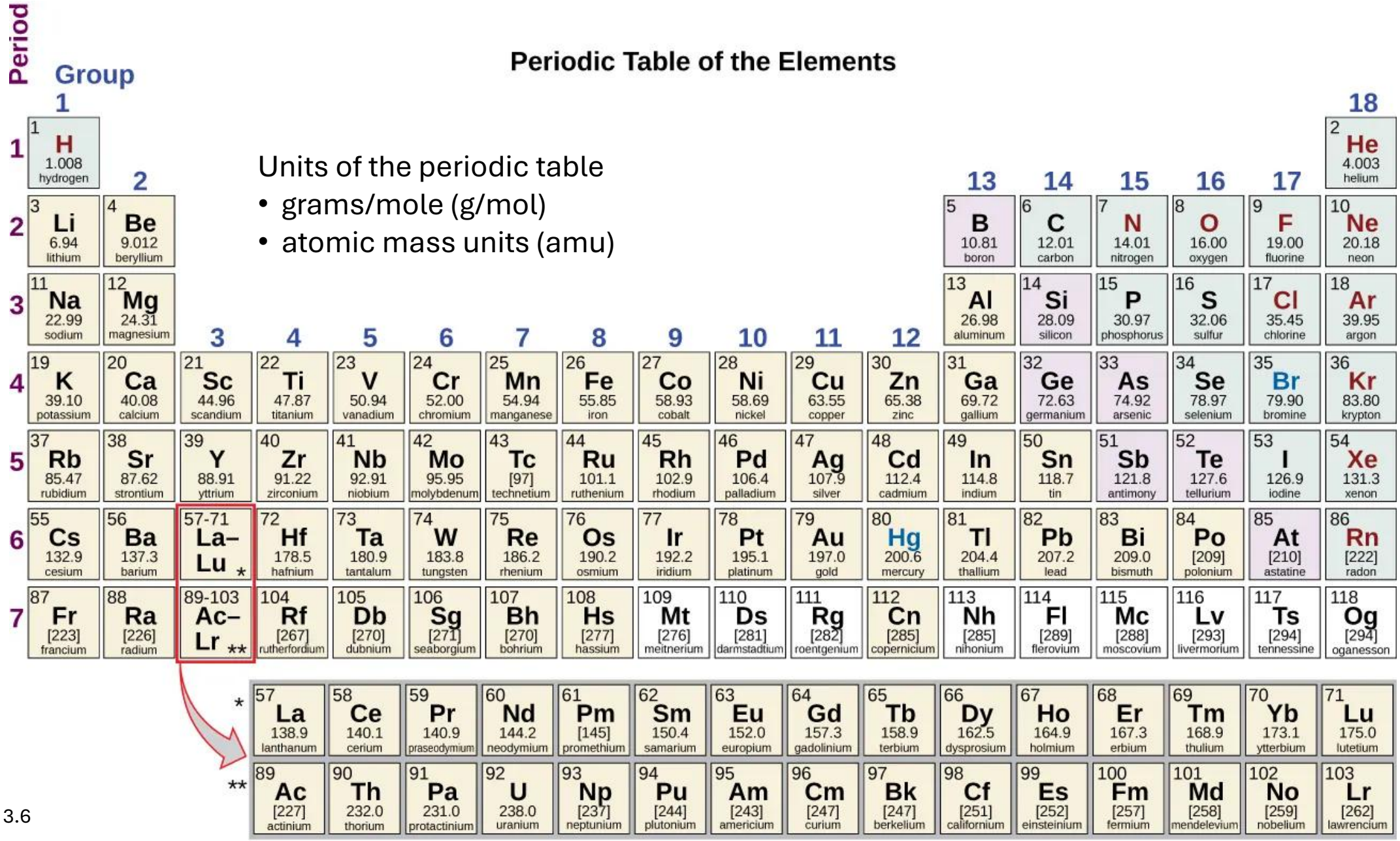
Figure 2.2 A pre-1982 copper penny (left) contains approximately 3×10^{22} copper atoms (several dozen are represented as brown spheres at the right), each of which has the same chemical properties. (credit: modification of work by "slgckgc"/Flickr)

Chemical Symbols

Figure 2.13 The symbol Hg represents the element mercury regardless of the amount; it could represent one atom of mercury or a large amount of mercury.

Element	Symbol	Element	Symbol
aluminum	Al	iron	Fe (from *ferrum*)
bromine	Br	lead	Pb (from *plumbum*)
calcium	Ca	magnesium	Mg
carbon	C	mercury	Hg (from *hydrargyrum*)
chlorine	Cl	nitrogen	N
chromium	Cr	oxygen	O
cobalt	Co	potassium	K (from *kalium*)
copper	Cu (from *cuprum*)	silicon	Si
fluorine	F	silver	Ag (from *argentum*)
gold	Au (from *aurum*)	sodium	Na (from *natrium*)
helium	He	sulfur	S
hydrogen	H	tin	Sn (from *stannum*)
iodine	I	zinc	Zn

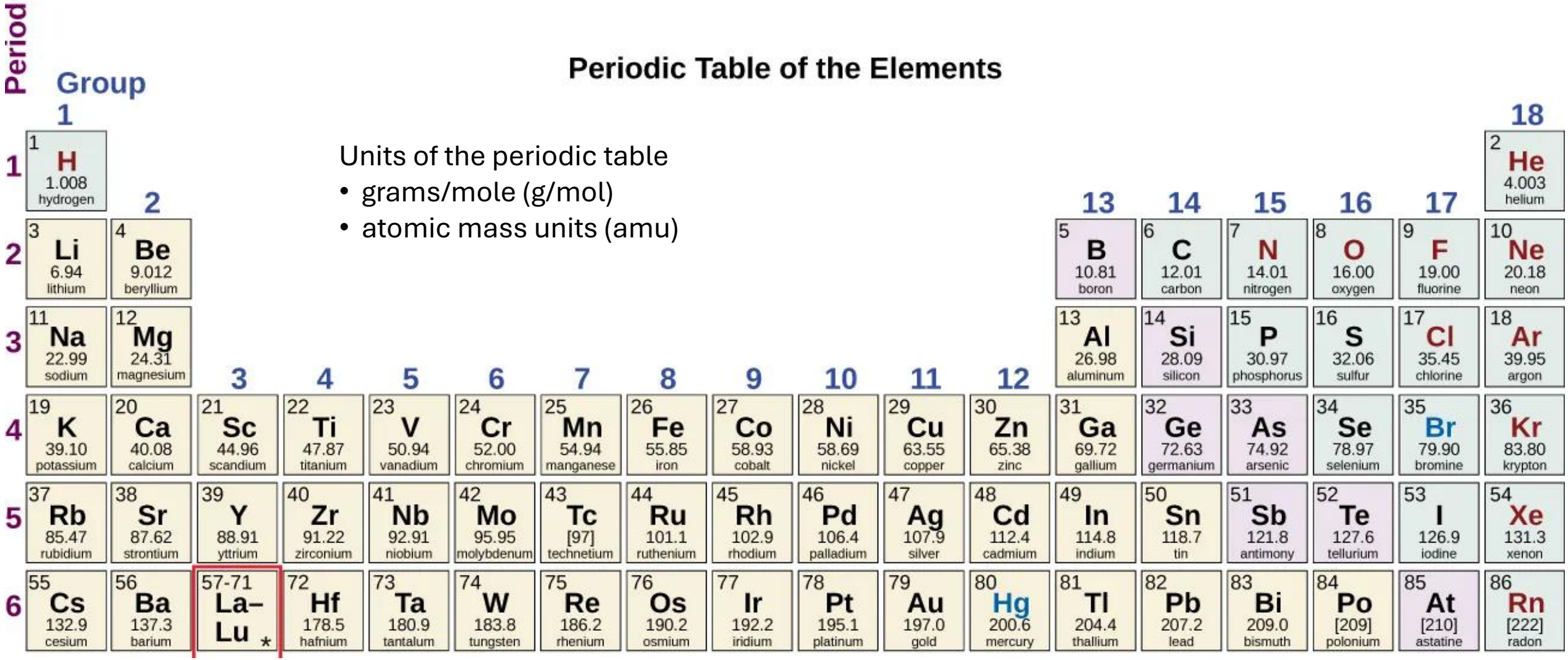
The Periodic Table



Units of the periodic table

- grams/mole (g/mol)
- atomic mass units (amu)

The Periodic Table



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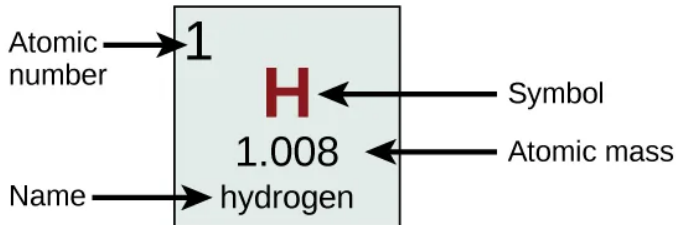
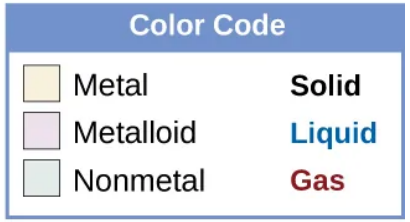
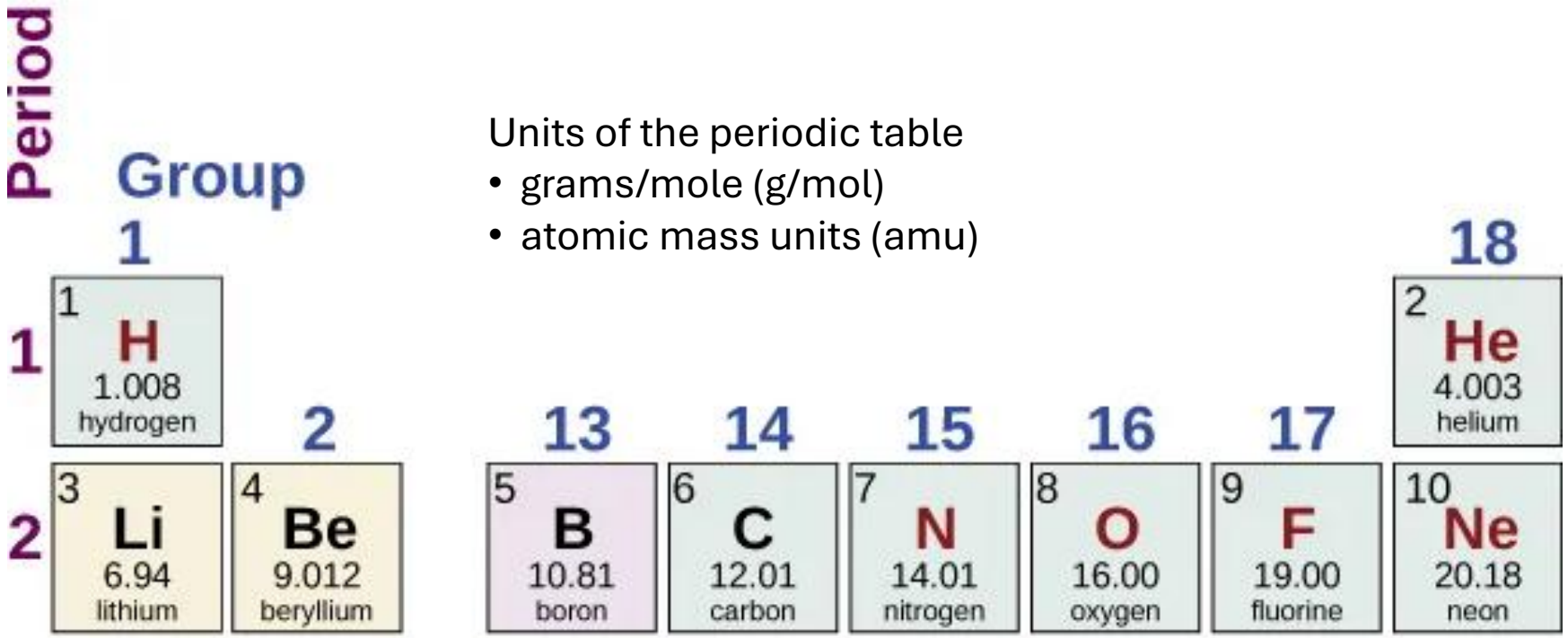




The Periodic Table



Units of the periodic table

- grams/mole (g/mol)
- atomic mass units (amu)

Atomic Structure

Figure 2.11 If an atom could be expanded to the size of a football stadium, the nucleus would be the size of a single blueberry. (credit middle: modification of work by "babyknight"/Wikimedia Commons; credit right: modification of work by Paxson Woelber)

Atomic Structure

Properties of Subatomic Particles

Name	Location	Charge (C)	Unit Charge	Mass (amu)	Mass (g)
electron	outside nucleus	-1.602×10^{-19}	1−	0.00055	0.00091×10^{-24}
proton	nucleus	1.602×10^{-19}	1+	1.00727	1.67262×10^{-24}
neutron	nucleus	0	0	1.00866	1.67493×10^{-24}

Table 2.2

grams/mole (g/mol)
atomic mass units (amu)

$$\begin{aligned} \text{atomic number (Z)} &= \text{number of protons} \\ \text{mass number (A)} &= \text{number of protons} + \text{number of neutrons} \\ \text{A} - \text{Z} &= \text{number of neutrons} \end{aligned}$$

Atomic Structure

grams/mole (g/mol)
atomic mass units (amu)

Name	Location	Unit Charge	Mass (amu)
electron	outside nucleus	1−	0.00055
proton	nucleus	1+	1.00727
neutron	nucleus	0	1.00866

Table 2.2

1. What is the charge of an electron?
2. What is the charge of a proton?
3. What is the charge of a neutron?
4. What has more mass, an electron or proton?
5. T or F, a proton is about the same size as a neutron?
6. Where are electrons located?
7. Where are protons located?
8. Where are neutrons located?
9. What particle defines the element or gives that element it's specific properties?
10. What is an atomic number?
11. What is a mass number?
12. What are the two different units of mass on the periodic table?

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Isotopes and Significant Figures

- Chapter 2.3 (Atomic Structure and Symbolism)
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Isotopes

The same element (same number of protons) with different numbers of neutrons.

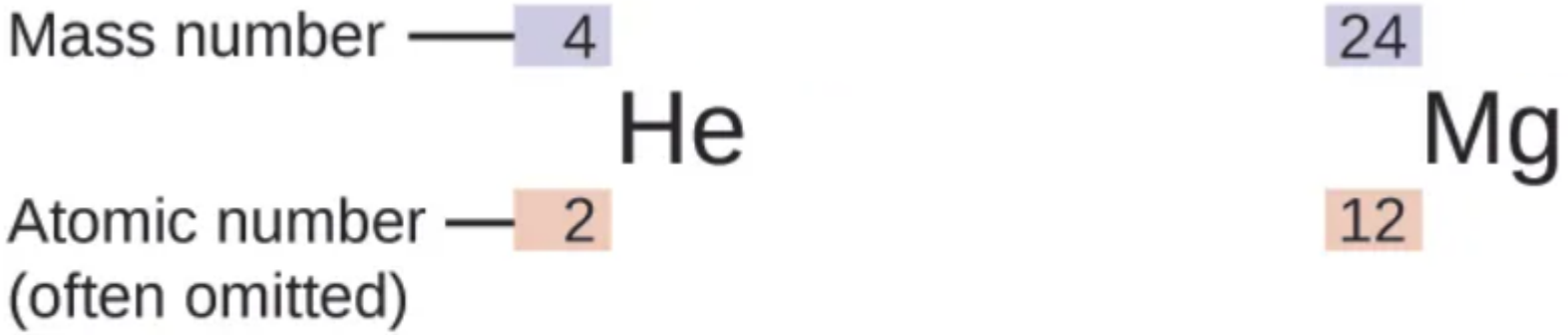
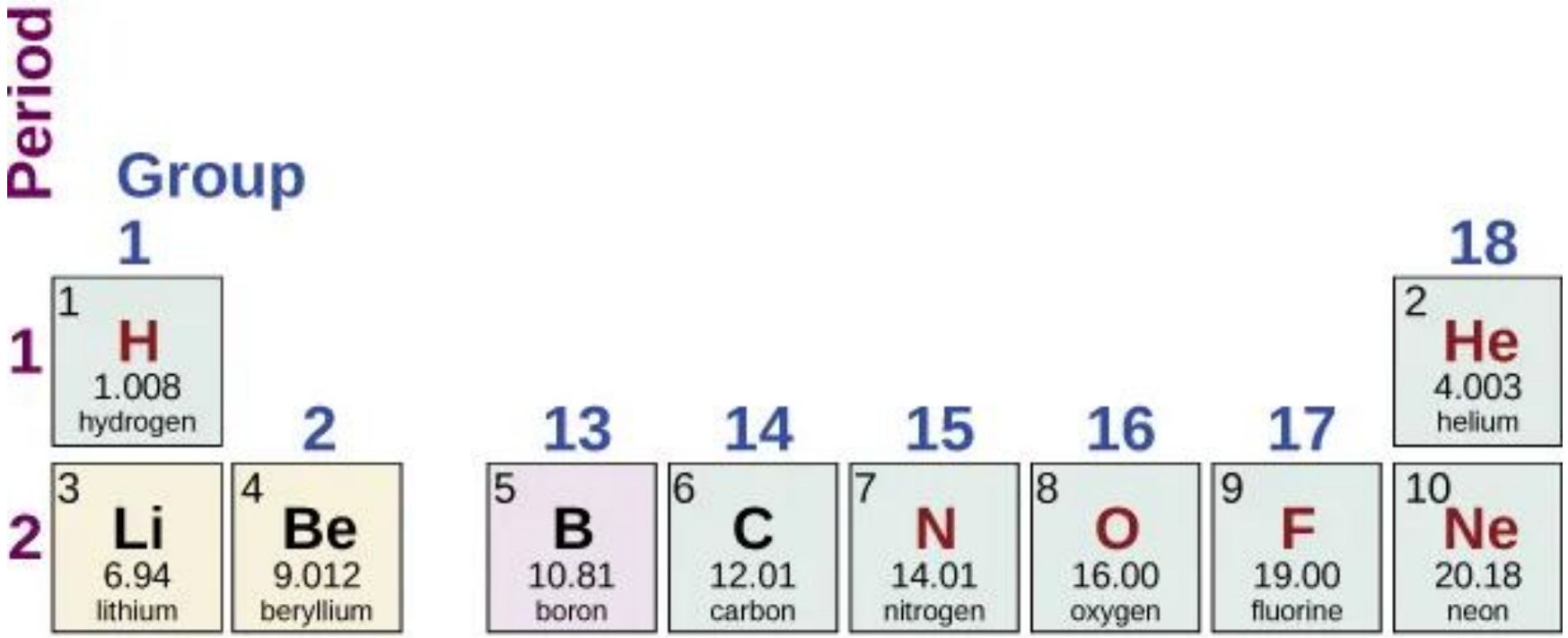


Figure 2.14 The symbol for an atom indicates the element via its usual t a left superscript, the atomic number as a left subscript (sometimes omitted), and the charge as a right superscript.

Isotope Practice

- Write the symbol, mass number, and atomic number for the following isotopes:
  - carbon with 6 neutrons
  - chlorine with 18 neutrons
  - silver with 62 neutrons

The Periodic Table



Isotopes

grams/mole (g/mol)
atomic mass units (amu)

Nuclear Compositions of Atoms of the Very Light Elements

Element	Symbol	Atomic Number	Number of Protons	Number of Neutrons	Mass (amu)	% Natural Abundance
hydrogen	$^{1}_{1}\mathrm{H}$ (protium)	1	1	0	1.0078	99.989
	$^{2}_{1}\mathrm{H}$ (deuterium)	1	1	1	2.0141	0.0115
	$^{3}_{1}\mathrm{H}$ (tritium)	1	1	2	3.01605	— (trace)
helium	$^{3}_{2}\mathrm{He}$	2	2	1	3.01603	0.00013
	$^{4}_{2}\mathrm{He}$	2	2	2	4.0026	100
lithium	$^{6}_{3}\mathrm{Li}$	3	3	3	6.0151	7.59
	$^{7}_{3}\mathrm{Li}$	3	3	4	7.0160	92.41
beryllium	$^{9}_{4}\mathrm{Be}$	4	4	5	9.0122	100

Significant Figures

Significant

- Nonzero numbers
- Zeros between nonzero numbers
- Right-end zeros only if there is a decimal anywhere in the number

Not Significant

- Everything else

Significant Figures

Significant	Examples	# of Sig Figs
• Nonzero numbers	111	3
	924.19	5
	0.3527	4
• Zeros between nonzero numbers	10000001	8
	909	3
	80980	5?
• Right-end zeros only if there is a decimal anywhere in the number	1100	2
	0.070580	5
	0.0000010	2

Significant Figures

Significant	Examples
• Nonzero numbers	
• Zeros between nonzero numbers	
• Right-end zeros only if there is a decimal anywhere in the number	

Significant Figures

Check Your Learning

Round the following to the indicated number of significant figures:

(a) 0.424 (to two significant figures)

(b) 0.0038661 (to three significant figures)

(c) 421.25 (to four significant figures)

(d) 28,683.5 (to five significant figures)

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Atomic Mass and Math with SigFigs

- Chapter 2.3 (Atomic Structure and Symbolism)
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- Chemistry can be difficult but you can do it and you will be successful if you can commit the required time to it.

- It requires time, consistent practice, repetition, and patience with yourself.


YOU CAN
DO IT!!!

Isotopes

grams/mole (g/mol)
atomic mass units (amu)

Nuclear Compositions of Atoms of the Very Light Elements

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	$^{4}_{2}\mathrm{He}$	2	2	2	4.0026	100
lithium	$^{6}_{3}\mathrm{Li}$	3	3	3	6.0151	7.59
	$^{7}_{3}\mathrm{Li}$	3	3	4	7.0160	92.41
beryllium	$^{9}_{4}\mathrm{Be}$	4	4	5	9.0122	100

Atomic Mass

The average mass of all of the isotopes of an element

grams/mole (g/mol)
atomic mass units (amu)

$$\text{average mass} = \sum (\text{fractional abundance} \times \text{isotopic mass})_i$$

Element	Symbol	Atomic Number	Number of Protons	Number of Neutrons	Mass (amu)	% Natural Abundance
boron	$^{10}_{5}\text{B}$	5	5	5	10.0129	19.9
	$^{11}_{5}\text{B}$	5	5	6	11.0093	80.1

$$\text{boron average mass} = (0.199 \times 10.0129\ \text{amu}) + (0.801 \times 11.0093\ \text{amu})$$

PEMDAS

Parentheses
Exponents
Multiplication
Division
Addition
Subtraction

$$\frac{part}{whole}\ x\ 100\% = percent$$

Significant Figures

Addition/Subtraction

- Use the least amount of DECIMALS in the problem

Multiplication/Division

- Use the least amount of SIG FIGS in the problem

Significant Figures

Addition/Subtraction

- Use the least amount of DECIMALS in the problem

Multiplication/Division

- Use the least amount of SIG FIGS in the problem

Has both?

- Use both!
- Use an overline to keep track of the significant figures and keep going
- Round – if digit to the right of the last sigfig is 5 or greater, round up, if 4 or below, round down. *other rounding rules in the future!!

Significant Figures

Addition/Subtraction

- Use the least amount of DECIMALS in the problem

Multiplication/Division

- Use the least amount of SIG FIGS in the problem

Significant Figures

Addition/Subtraction

- Use the least amount of DECIMALS in the problem

Multiplication/Division

- Use the least amount of SIG FIGS in the problem

Has both? Use both!

- Use an overline to keep track of the significant figures and keep going
- Round – if digit to the right of the last sigfig is 5 or greater, round up, if 4 or below, round down. *other rounding rules in the future!!

Significant Figures

Addition/Subtraction

- Use the least amount of DECIMALS in the problem

Multiplication/Division

- Use the least amount of SIG FIGS in the problem

Math and Sig Figs

Check Your Learning

(a) Add 2.334 mL and 0.31 mL.

(b) Subtract 55.8752 m from 56.533 m.

Math and Sig Figs

Check Your Learning

(a) Multiply 2.334 cm and 0.320 cm.

(b) Divide 55.8752 m by 56.53 s.

Math and Sig Figs

Check Your Learning

(a) 2.334 cm x(0.320 cm – 0.12 cm)

(b)(55.8752 m + 6.22 m)/ 56.53 s

Atomic Mass

grams/mole (g/mol)
atomic mass units (amu)

Element	Symbol	Atomic Number	Number of Protons	Number of Neutrons	Mass (amu)	% Natural Abundance
boron	$^{10}_{5}\mathrm{B}$	5	5	5	10.0129	19.9
	$^{11}_{5}\mathrm{B}$	5	5	6	11.0093	80.1

$$\text{boron average mass} = (0.199 \times 10.0129\ \text{amu}) + (0.801 \times 11.0093\ \text{amu})$$

$$\text{average mass} = \sum_i (\text{fractional abundance} \times \text{isotopic mass})_i$$

Atomic Mass

Check Your Learning

A sample of magnesium is found to contain 78.70% of ^{24}Mg atoms (mass 23.98 amu), 10.13% of ^{25}Mg atoms (mass 24.99 amu), and 11.17% of ^{26}Mg atoms (mass 25.98 amu). Calculate the average mass of a Mg atom.

What is atomic mass?

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