Chem With Com

Ions, Periodic Properties, and Moles

- Chapter 2.3 (Atomic Structure and Symbolism)
- Chapter 3.6 (The Periodic Table)
- Chapter 3.7 (Ionic and Molecular Compounds)
- Chapter 2.4 (Chemical Formulas)
- Appendix B (Essential Mathematics)

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

Ions

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Ions

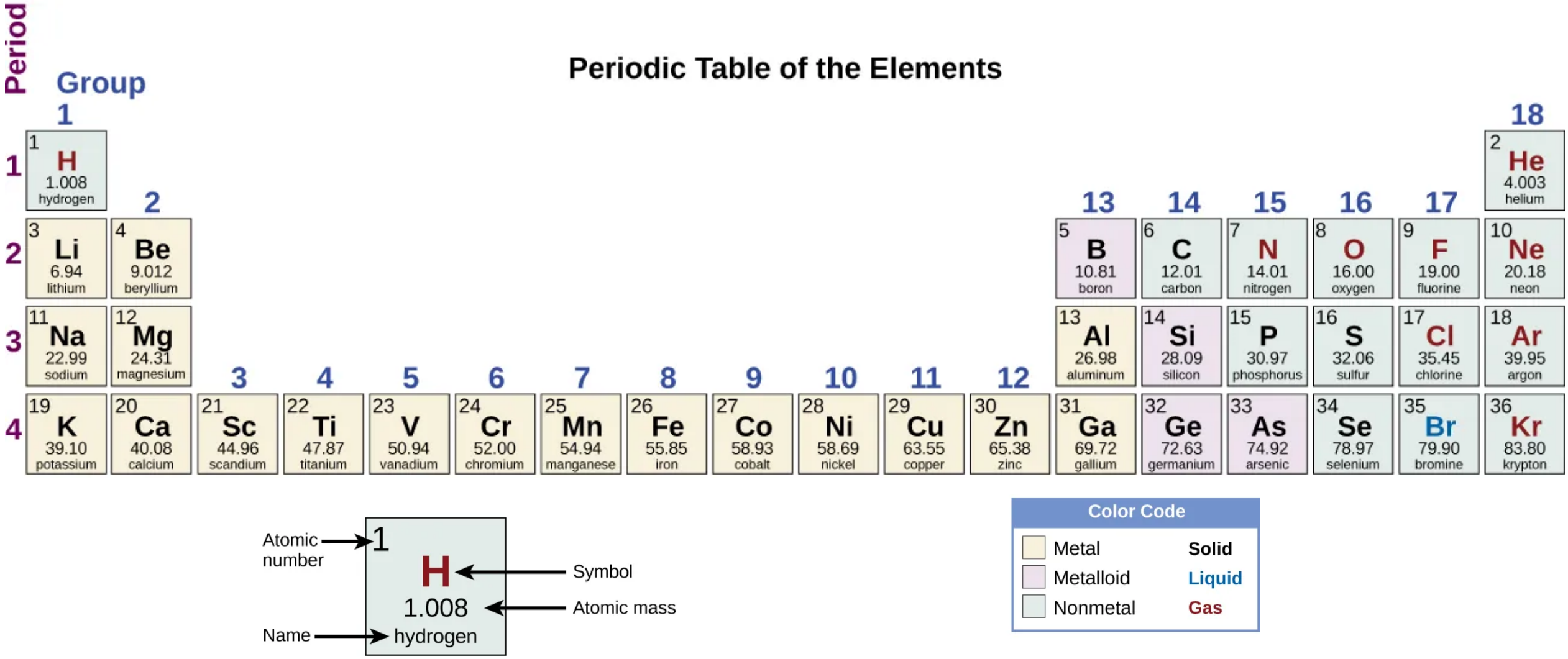
Properties of Subatomic Particles

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

- Neutral Atoms: protons (+) = electrons (-)

The Periodic Table



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Ions

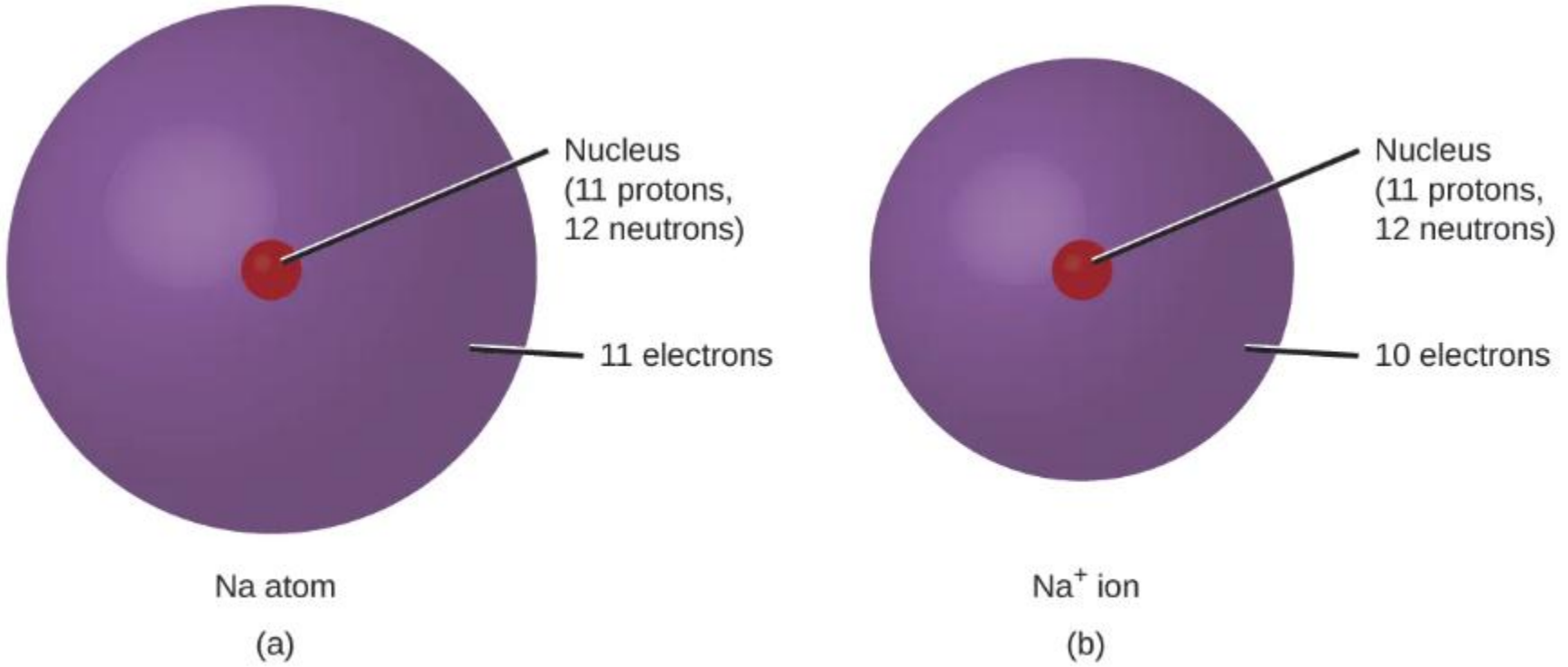

Figure 3.39 (a) A sodium atom (Na) has equal numbers of protons and electrons (11) and is uncharged. (b) A sodium cation (Na^+) has lost an electron, so it has one more proton (11) than electrons (10), giving it an overall positive charge, signified by a superscripted plus sign.

Ions

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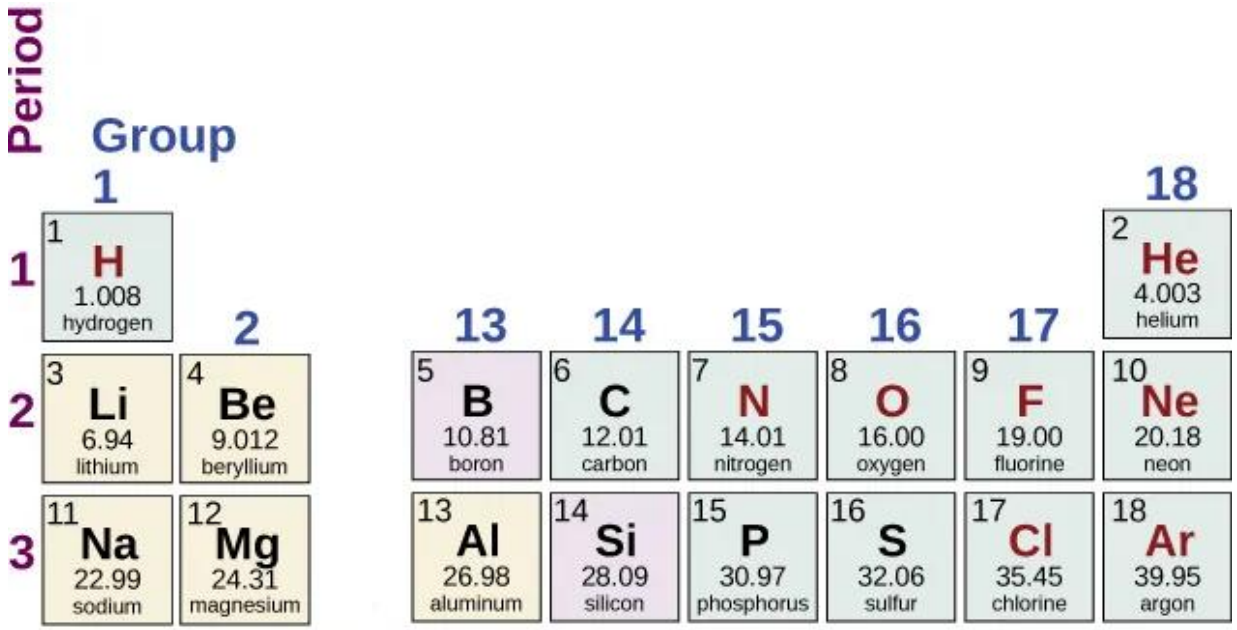
Table 2.2

- Neutral Atoms: protons (+) = electrons (-)
- Cations (+)
- Anions (-)

Questions

- True/False – A neutral atom has the same amount of electrons and protons
- An atom with more electrons than protons is called a(n) _____?
- An atom with more protons than electrons is called a(n) _____?
- How many electrons in H^{1+}?
- How many electrons in Cl^{1-}?
- How many electrons in Al^{3+}?
- How many electrons in OH^{1-}?
- How many electrons in NH_4^{1+}?



Ions

Check Your Learning

Give the symbol and name for the ion with 34 protons and 36 electrons.

Ions

Check Your Learning

An ion of platinum has a mass number of 195 and contains 74 electrons. How many protons and neutrons does it contain, and what is its charge?

Periodic Table

- Chapter 2.3 (Atomic Structure and Symbolism)
- Chapter 3.6 (The Periodic Table)
- Chapter 3.7 (Ionic and Molecular Compounds)

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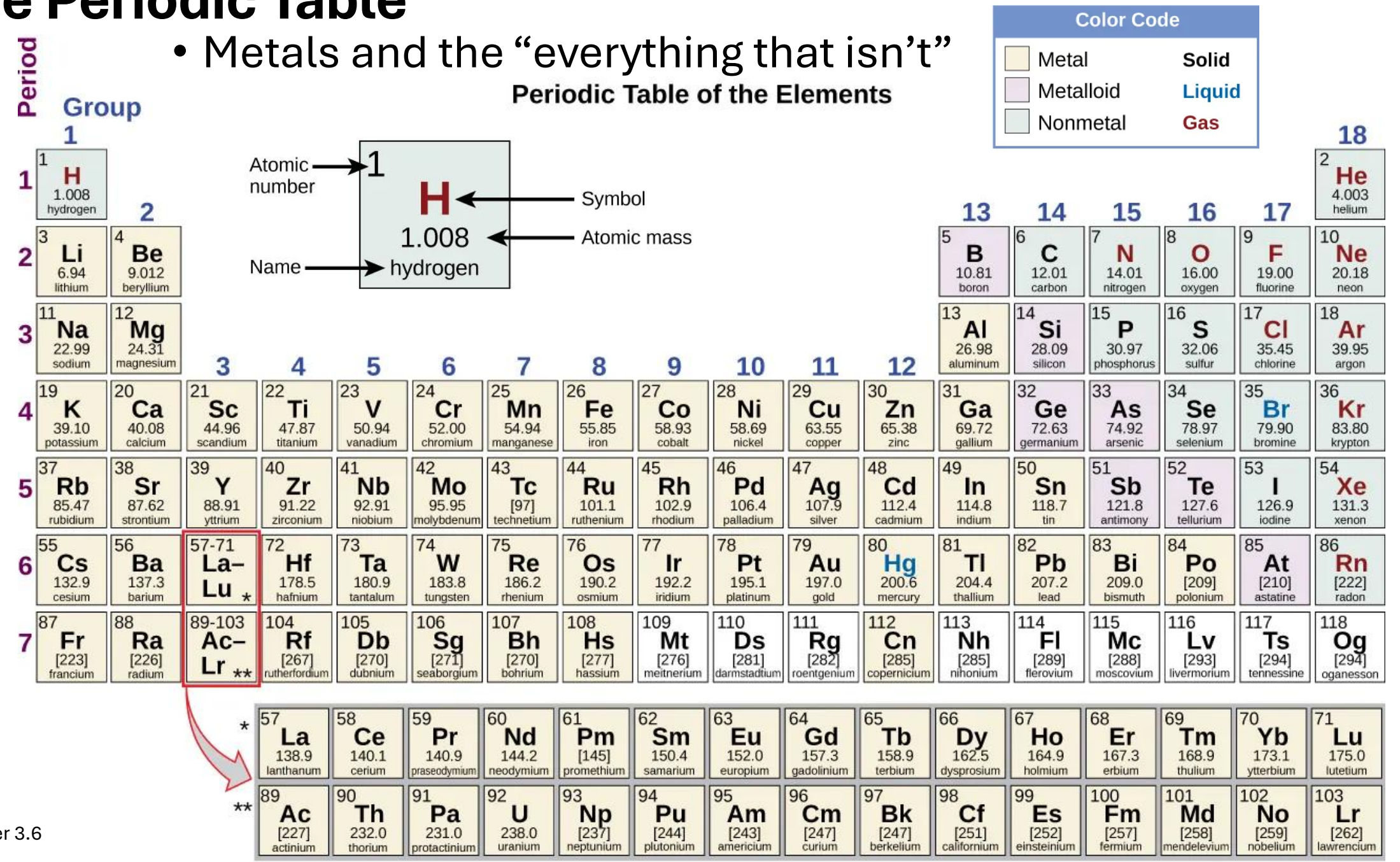
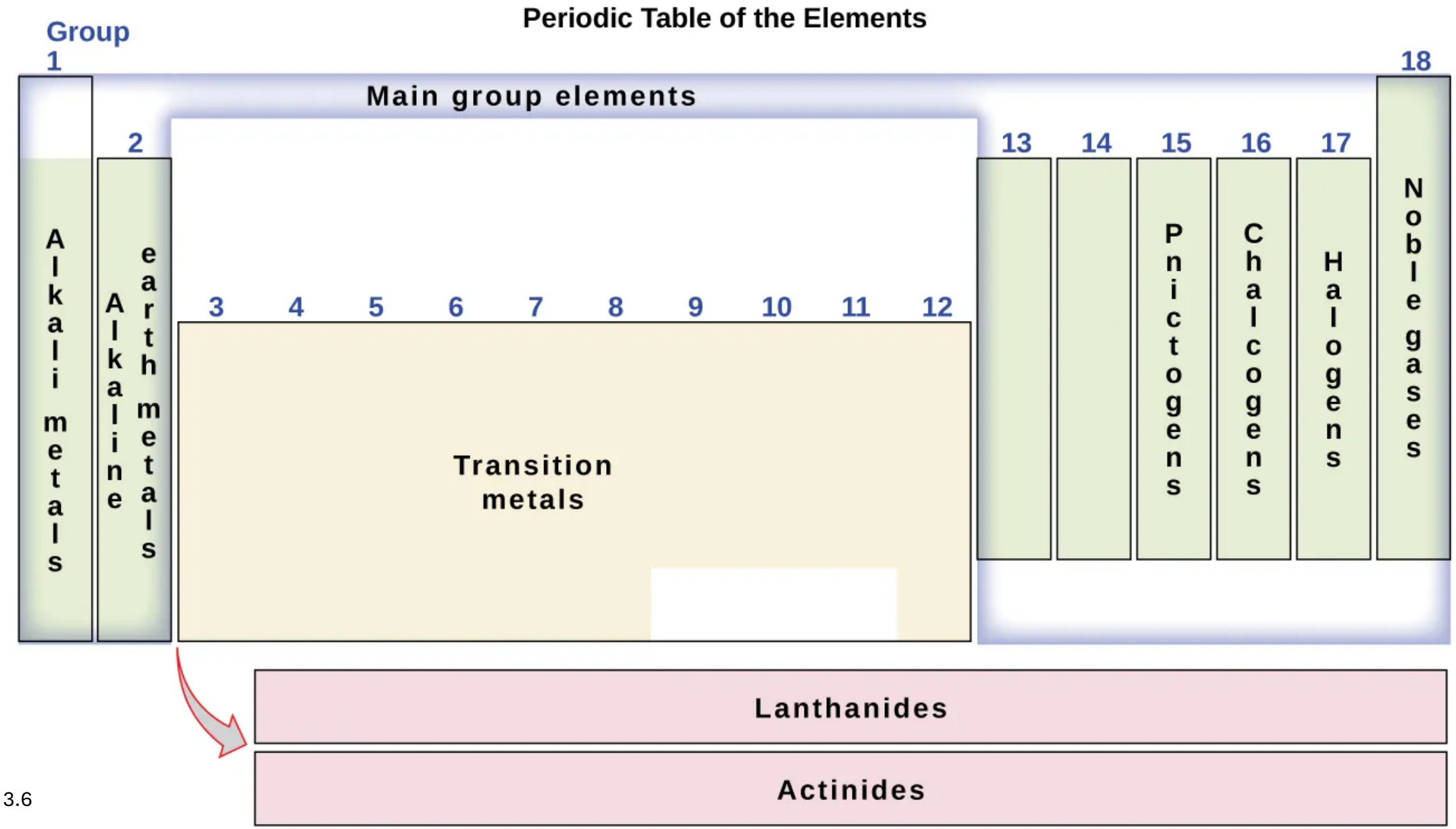
The Periodic Table

- Metals and the “everything that isn’t”



The Periodic Table



The Periodic Table

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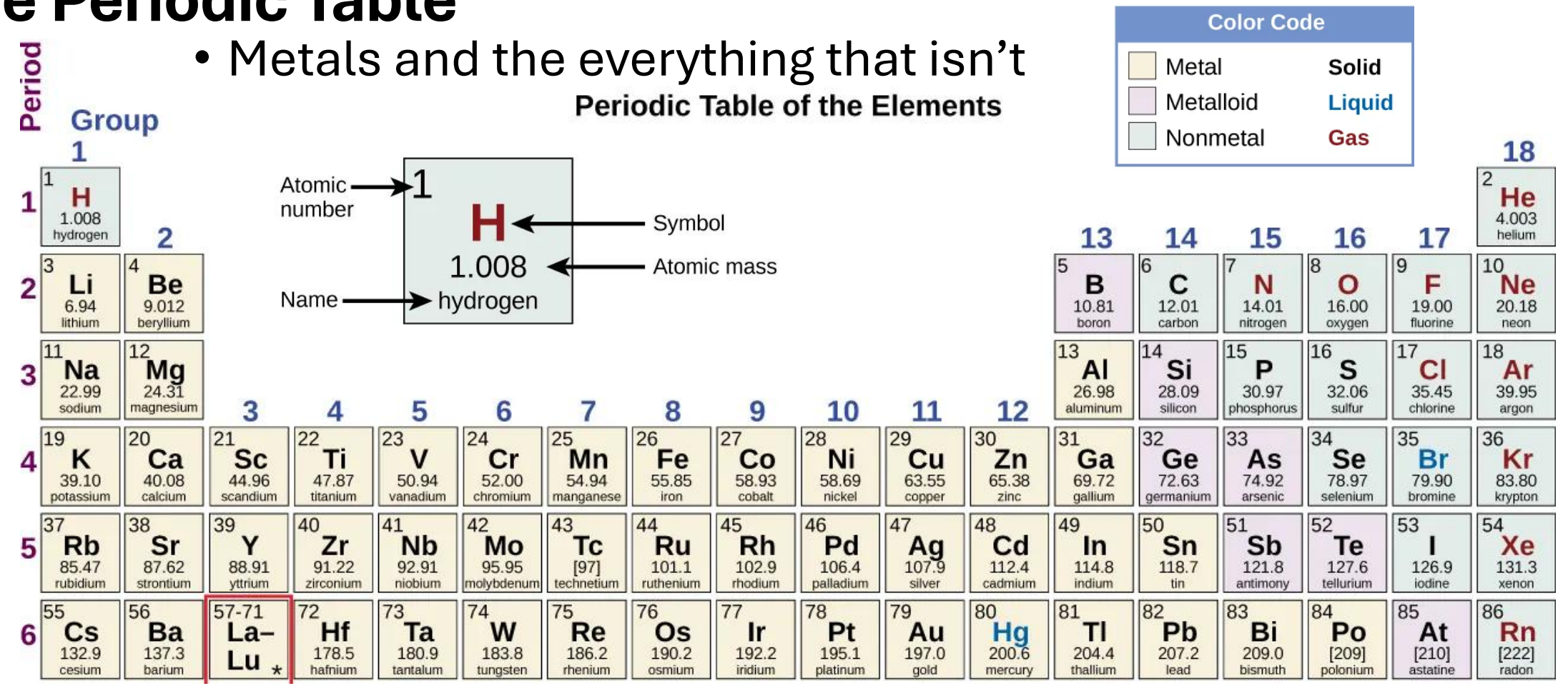
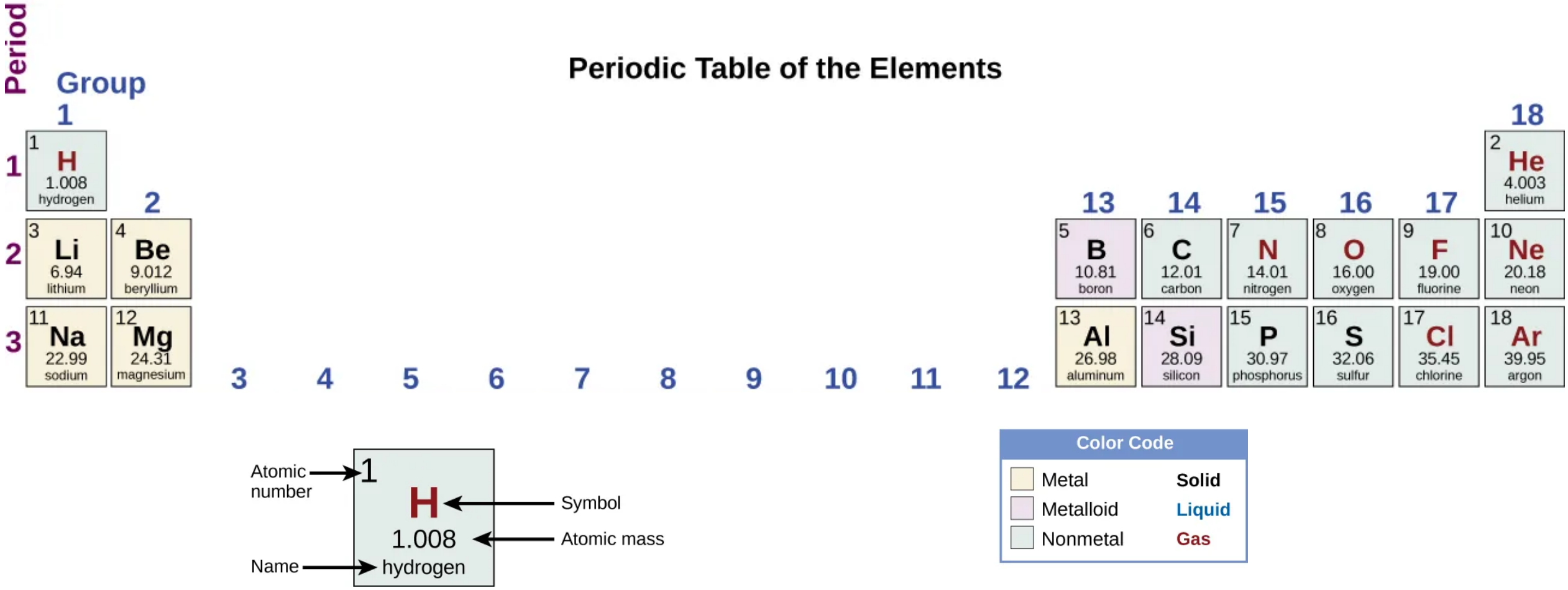
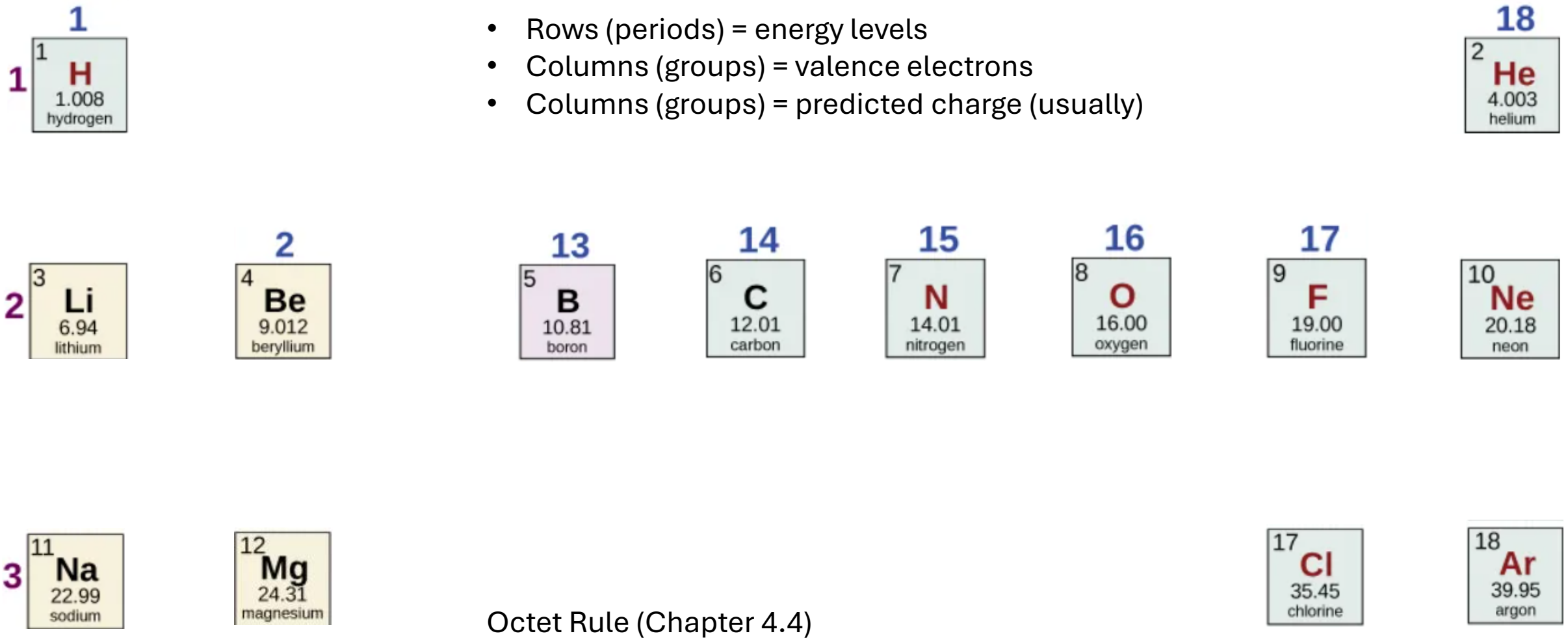


1. Is lithium a metal or nonmetal?
2. Is chlorine a metal or nonmetal?
3. Is hydrogen a metal or nonmetal?
4. Is silicon a metal or nonmetal?

The Periodic Table



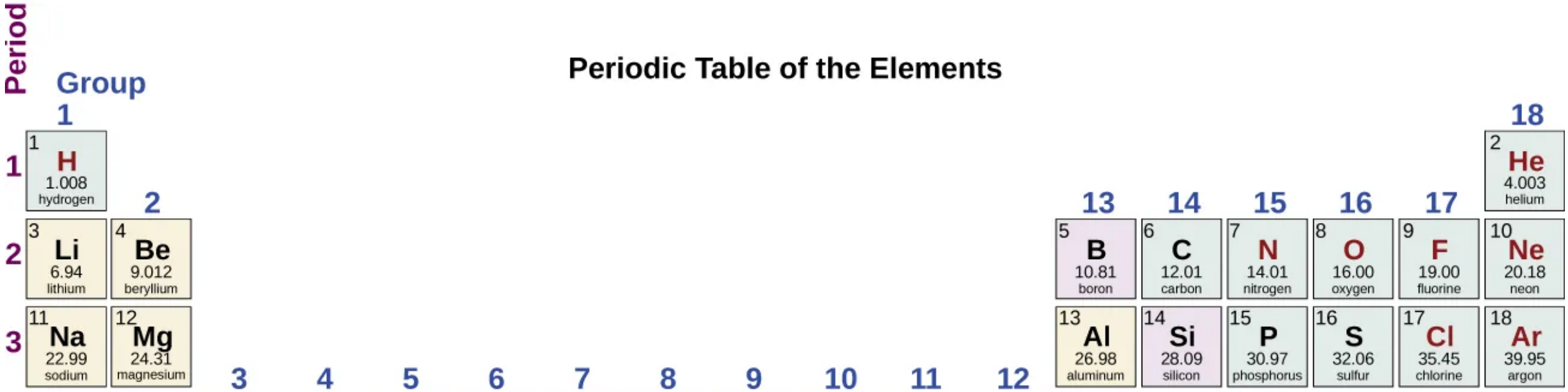
Ions



- Rows (periods) = energy levels
- Columns (groups) = valence electrons
- Columns (groups) = predicted charge (usually)

Octet Rule (Chapter 4.4)
Guideline that states that main group atoms will "want" 8 electrons

The Periodic Table



Chemical Symbols and Annotations

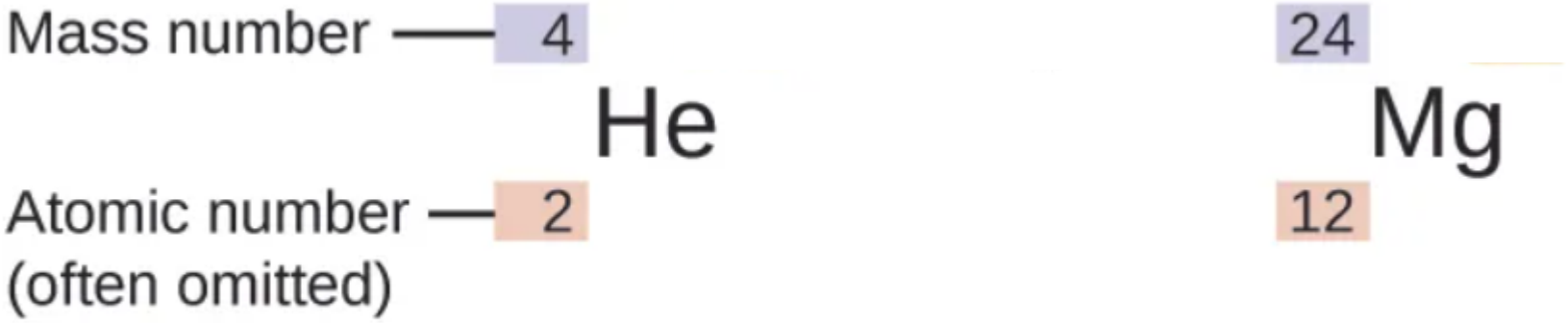


Figure 2.14 The symbol for an atom indicates the element via its usual two-letter symbol, the mass number as a left superscript, the atomic number as a left subscript (sometimes omitted),

Annotations for Ions

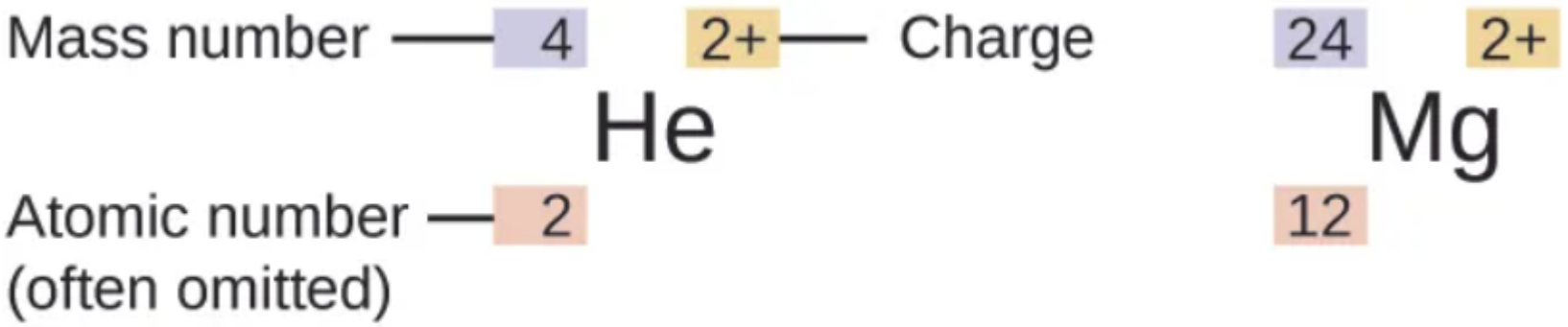
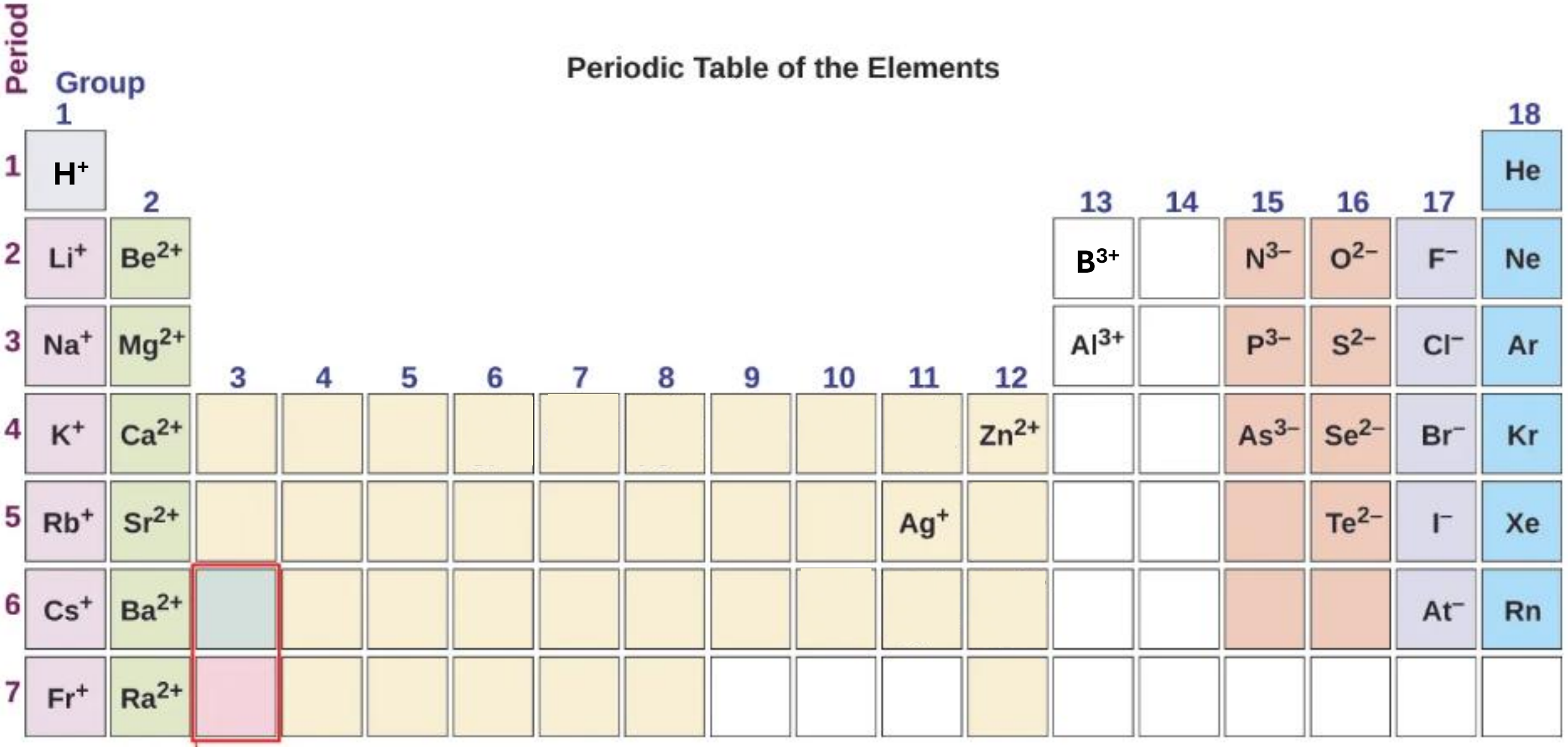


Figure 2.14 The symbol for an atom indicates the element via its usual two-letter symbol, the mass number as a left superscript, the atomic number as a left subscript (sometimes omitted), and the charge as a right superscript.

- Write the symbol, atomic number, mass number, and charge for calcium with 18 electrons.

- Write the symbol, atomic number, mass number, and charge for nitrogen with 10 electrons.

Ions and the Periodic Table



Practice/Review

- Predict the charge of Mg
- Predict the charge of F
- Predict the charge of Kr
- Combine atoms of Mg and F to make a neutral compound (the charges added together equal 0)

Polyatomic Ions

Name	Formula
ammonium	NH_4^+
hydronium	H_3O^+
peroxide	O_2^{2-}
hydroxide	OH^-
acetate	CH_3COO^-
cyanide	CN^-
azide	N_3^-
carbonate	CO_3^{2-}
bicarbonate	HCO_3^-
nitrate	NO_3^-
nitrite	NO_2^-
sulfate	SO_4^{2-}

Name	Formula
hydrogen sulfate	HSO_4^-
sulfite	SO_3^{2-}
hydrogen sulfite	HSO_3^-
phosphate	PO_4^{3-}
hydrogen phosphate	HPO_4^{2-}
dihydrogen phosphate	$H_2PO_4^-$
perchlorate	ClO_4^-
chlorate	ClO_3^-
chlorite	ClO_2^-
hypochlorite	ClO^-
chromate	CrO_4^{2-}
dichromate	$Cr_2O_7^{2-}$
permanganate	MnO_4^-

Moles and Exponential Notation

- Chapter 2.4 (Chemical Formulas)
- Appendix B (Essential Mathematics)

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Grams Per Mole?

- The atomic masses on the periodic table are in the units of grams per mole (g/mol) and sometimes atomic mass units (amu)
- Grams (g) = unit of mass
  - mass is how much matter something has
  - weight is the effect of gravity on mass, on earth mass is the same as weight
- Moles = a specific number of things (6.022×10^{23})
  - dozen = 12, tetra = 4, pair = 2, cent = 100

Element	Average Atomic Mass (amu)	Molar Mass (g/mol)	Atoms/Mole
C	12.01	12.01	6.022×10^{23}
H	1.008	1.008	6.022×10^{23}
O	16.00	16.00	6.022×10^{23}
Na	22.99	22.99	6.022×10^{23}
Cl	35.45	35.45	6.022×10^{23}

What is a mole? (The Chemist’s Dozen)

Exponential Notation

#.#### x $10^{\#}$

- A number followed by a decimal and then however many significant figures there are
- The things in red are in every exponential notation number
- The things in black are optional (but there most of the time)

- 3.14×10^{6}
- 2×10^{-6}
- 6.022×10^{23}

Exponential Notation

$$
\begin{aligned}
1000 &= 1 \times 10^{3} \\
100 &= 1 \times 10^{2} \\
10 &= 1 \times 10^{1} \\
1 &= 1 \times 10^{0} \\
0.1 &= 1 \times 10^{-1} \\
0.001 &= 1 \times 10^{-3} \\
2386 &= 2.386 \times 1000 = 2.386 \times 10^{3} \\
0.123 &= 1.23 \times 0.1 = 1.23 \times 10^{-1}
\end{aligned}
$$

Exponential Notation and Standard Notation

Exponential Notation	Standard Notation
• 3.14×10^{6}	= 3,140,000
• 2×10^{-6}	= 0.000002
• 6.022×10^{23}	= 602,200,000,000,000,000,000,000

Exponential Notation

- The decimal moves amount of times as the number in the exponent.
  - For something like 3.05×10^{4}, you would move the decimal 4 places, since the exponent is positive, you know the final number will be greater than 1.
  - For something like 2.1×10^{-3}, you would move the decimal 3 place, since the exponent is negative, you know the final number will be less than 1.
  - For 0.0078077, you would move the decimal 3 places to get to the first non-zero digit. If the number started as a number less than 1, it is a negative exponent.
  - For 97,105,000 you would move the decimal 7 places to get to the first non-zero digit. If the number started as a number greater than 1, it is a positive exponent.

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Exponential Notation to Standard Notation

Exponential Notation	Standard Notation
•	= 70,602,020,000
• 2×10^{6}	=
•	= 0.000197345
• 9.27542×10^{-7}	=

Grams Per Mole?

Element	Average Atomic Mass (amu)	Molar Mass (g/mol)	Atoms/Mole
C	12.01	12.01	6.022×10^{23}
H	1.008	1.008	6.022×10^{23}
O	16.00	16.00	6.022×10^{23}
Na	22.99	22.99	6.022×10^{23}
Cl	35.45	35.45	6.022×10^{23}

Grams Per Mole!

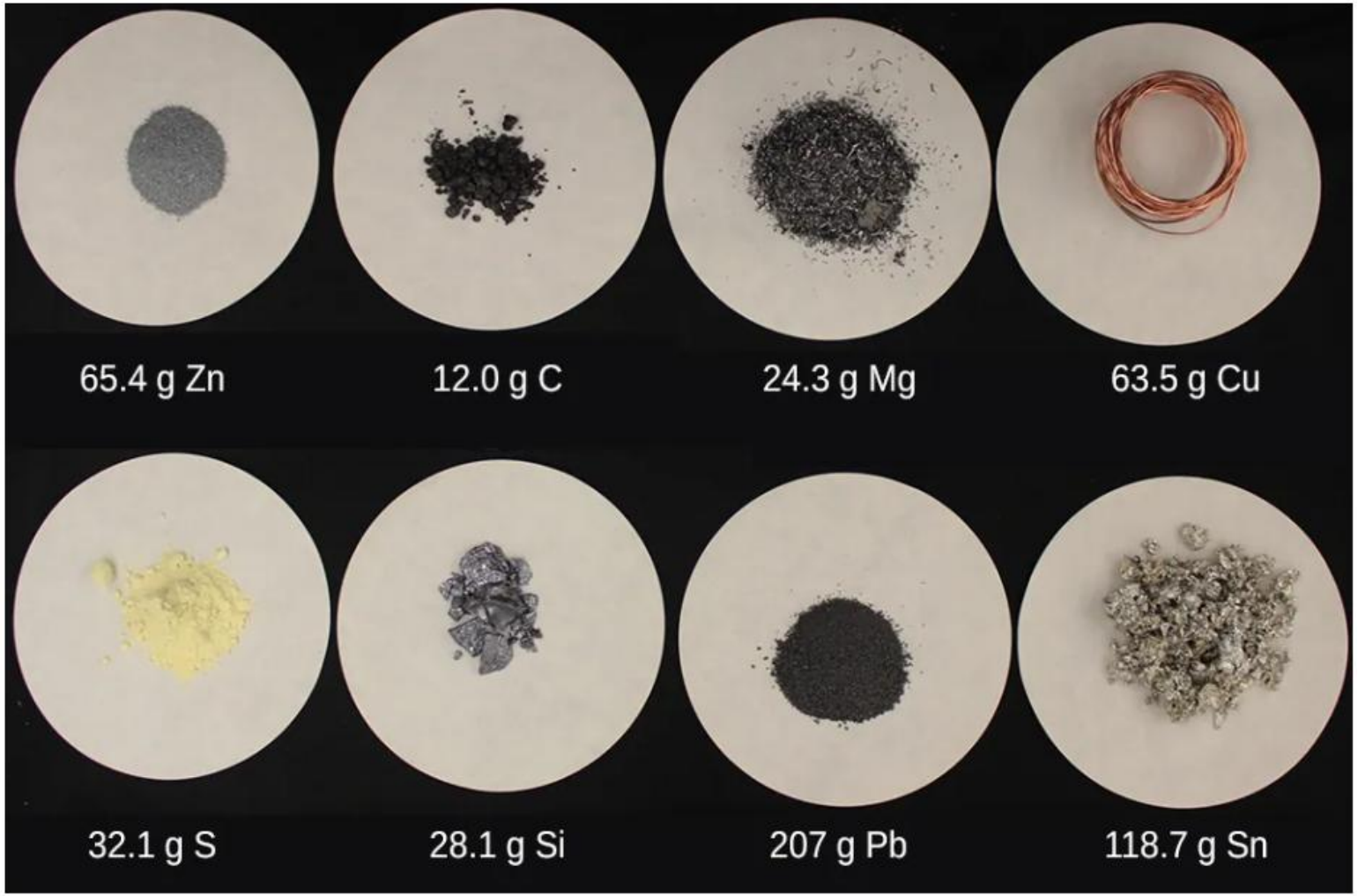


Figure 2.25 Each sample contains 6.022×10^{23} atoms —1.00 mol of atoms. From left to right (top row): 65.4 g zinc, 12.0 g carbon, 24.3 g magnesium, and 63.5 g copper. From left to right (bottom row): 32.1 g sulfur, 28.1 g silicon, 207 g lead, and 118.7 g tin. (credit: modification of work by Mark Ott)

Grams Per Mole!

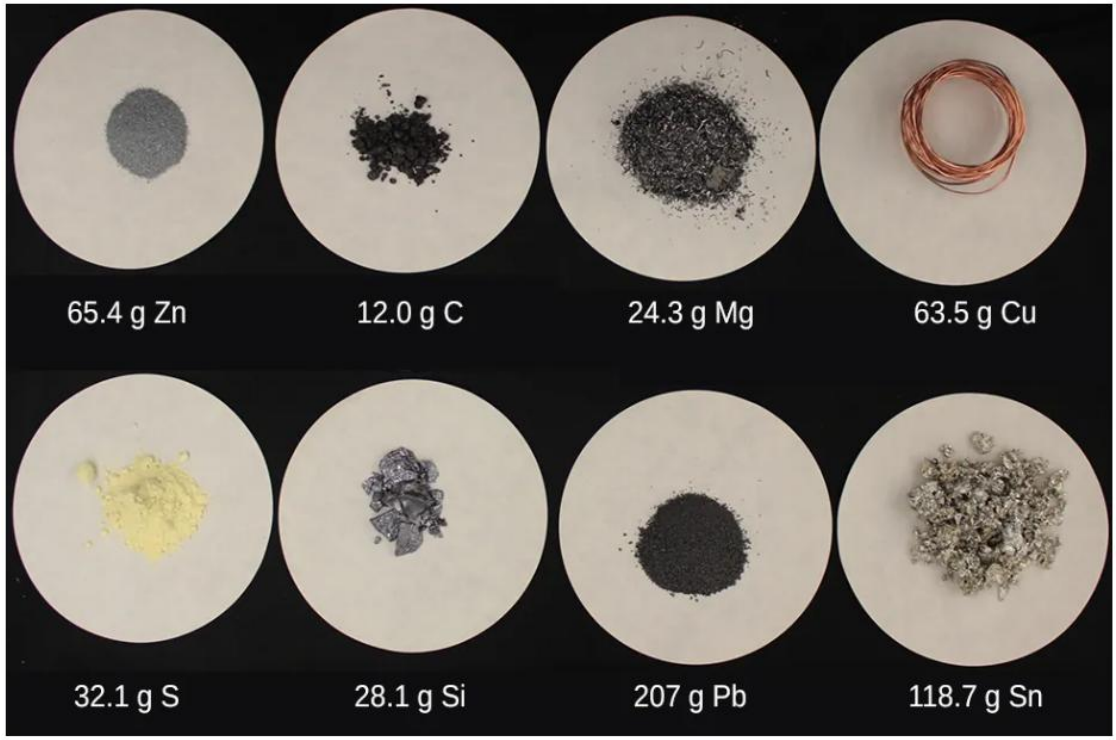
What is a mole?

12 g C. How many moles?

6 g C. How many moles?

1 mol Si. How many grams?

2 mols C. How many grams?



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