THE PERIODIC TABLE

OF THE ELEMENTS
In 1872, Dmitri Mendeleev
• created the **periodic table**
• arranged elements by increasing atomic mass
• arranged elements into groups with similar properties

**The Periodic Table**

Figure 2.5 Dmitri Mendeleev’s 1872 periodic table. The spaces marked with blank lines represent elements that Mendeleev deduced existed but were unknown at the time, so he left places for them in the table. The symbols at the top of the columns (e.g., $R^2O$ and $RH^4$) are molecular formulas written in the style of the 19th century.
In 1913, Henry Mosely

- Used x-ray diffraction to determine how many protons are in an atom of an element
- arranged elements by increasing atomic number
- arranged elements into groups with similar properties
### Periodic Table of Elements

#### Representative elements

<table>
<thead>
<tr>
<th>Period number</th>
<th>Group 1A</th>
<th>Group 2A</th>
<th>Group 3A</th>
<th>Group 4A</th>
<th>Group 5A</th>
<th>Group 6A</th>
<th>Group 7A</th>
<th>Group 8A</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>H</td>
<td>Li</td>
<td>Be</td>
<td>B</td>
<td>C</td>
<td>N</td>
<td>O</td>
<td>F</td>
</tr>
<tr>
<td>2</td>
<td>Na</td>
<td>Mg</td>
<td>Al</td>
<td>Si</td>
<td>P</td>
<td>S</td>
<td>Cl</td>
<td>Ar</td>
</tr>
<tr>
<td>3</td>
<td>K</td>
<td>Ca</td>
<td>Sc</td>
<td>Ti</td>
<td>V</td>
<td>Cr</td>
<td>Mn</td>
<td>Fe</td>
</tr>
<tr>
<td>4</td>
<td>Rb</td>
<td>Sr</td>
<td>Y</td>
<td>Zr</td>
<td>Nb</td>
<td>Mo</td>
<td>Tc</td>
<td>Ru</td>
</tr>
<tr>
<td>5</td>
<td>Cs</td>
<td>Ba</td>
<td>La</td>
<td>Hf</td>
<td>Ta</td>
<td>W</td>
<td>Re</td>
<td>Os</td>
</tr>
<tr>
<td>6</td>
<td>Fr</td>
<td>Ra</td>
<td>Ac</td>
<td>Pm</td>
<td>Sm</td>
<td>Eu</td>
<td>Gd</td>
<td>Tb</td>
</tr>
<tr>
<td>7</td>
<td>Ce</td>
<td>Pr</td>
<td>Nd</td>
<td>Pm</td>
<td>Sm</td>
<td>Eu</td>
<td>Gd</td>
<td>Tb</td>
</tr>
<tr>
<td></td>
<td>La</td>
<td>Ce</td>
<td>Pr</td>
<td>Nd</td>
<td>Pm</td>
<td>Sm</td>
<td>Eu</td>
<td>Gd</td>
</tr>
<tr>
<td></td>
<td><em>Lanthanides</em></td>
<td>†Actinides*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Transition elements

<table>
<thead>
<tr>
<th>Period number</th>
<th>Group 1A</th>
<th>Group 2A</th>
<th>Group 3A</th>
<th>Group 4A</th>
<th>Group 5A</th>
<th>Group 6A</th>
<th>Group 7A</th>
<th>Group 8A</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>He</td>
<td>Li</td>
<td>Be</td>
<td>B</td>
<td>C</td>
<td>N</td>
<td>O</td>
<td>F</td>
</tr>
<tr>
<td>2</td>
<td>Na</td>
<td>Mg</td>
<td>Al</td>
<td>Si</td>
<td>P</td>
<td>S</td>
<td>Cl</td>
<td>Ar</td>
</tr>
<tr>
<td>3</td>
<td>K</td>
<td>Ca</td>
<td>Sc</td>
<td>Ti</td>
<td>V</td>
<td>Cr</td>
<td>Mn</td>
<td>Fe</td>
</tr>
<tr>
<td>4</td>
<td>Rb</td>
<td>Sr</td>
<td>Y</td>
<td>Zr</td>
<td>Nb</td>
<td>Mo</td>
<td>Tc</td>
<td>Ru</td>
</tr>
<tr>
<td>5</td>
<td>Cs</td>
<td>Ba</td>
<td>La</td>
<td>Hf</td>
<td>Ta</td>
<td>W</td>
<td>Re</td>
<td>Os</td>
</tr>
<tr>
<td>6</td>
<td>Fr</td>
<td>Ra</td>
<td>Ac</td>
<td>Pm</td>
<td>Sm</td>
<td>Eu</td>
<td>Gd</td>
<td>Tb</td>
</tr>
</tbody>
</table>

#### Metals, Metalloids, and Nonmetals

- **Metals**
- **Metalloids**
- **Nonmetals**
THE PERIODIC TABLE

<table>
<thead>
<tr>
<th>Periodic Table of the Elements</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Atomic Number</strong></td>
</tr>
<tr>
<td><strong>Symbol</strong></td>
</tr>
<tr>
<td><strong>Name</strong></td>
</tr>
<tr>
<td><strong>Atomic Mass</strong></td>
</tr>
</tbody>
</table>

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USEFUL STUDY TECHNIQUE

Write as much relevant information on your periodic table as possible. Mark it up!

► Annotate / Add side notes

► Color code

► Organize information
PERIODS AND GROUPS

On the periodic table

• elements are arranged according to similar properties in vertical columns called **groups**

• **periods** are horizontal rows of elements

  Period 1 contains two elements: H and He
  Periods 2 and 3 each contain eight elements:
  Period 2 – Li, Be, B, C, N, O, F, He
  Period 3 – Na, Mg, Al, Si, P, S, Cl, Ar
PERIODS AND GROUPS

Group 2

Period 4

K  Ca  Sc  Ti  V  Cr  Mn  Fe  Co  Ni  Cu  Zn  Ga  Ge  As  Se  Br  Kr

Be  Mg  2A

Sr  Ba  Ra
Group Numbers, written at the top of each vertical column, are written two ways:

- The letter A is used for the representative elements 1A to 8A and the letter B for the transition elements.
- The numbers 1–18 are used for the columns from left to right.
**REPRESENTATIVE ELEMENTS**

**Group 1A (1)**  
*Alkali metals*

Lithium, sodium, and potassium are some alkali metals from Group 1A.

**Group 7A (17)**  
*Halogens*

Chlorine, bromine, and iodine are halogens from Group 7A.
The heavy zigzag line on the periodic table separates the metals from nonmetals. Metalloids (semi-metals) border the zigzag line.
### METALS, NONMETALS, AND METALLOIDS

#### TABLE 4.3 Some Characteristics of a Metal, a Metalloid, and a Nonmetal

<table>
<thead>
<tr>
<th></th>
<th>Silver (Ag)</th>
<th>Antimony (Sb)</th>
<th>Sulfur (S)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metal</td>
<td>Metal</td>
<td>Metalloid</td>
<td>Nonmetal</td>
</tr>
<tr>
<td>Shiny</td>
<td>Shiny</td>
<td>Blue-gray, shiny</td>
<td>Dull, yellow</td>
</tr>
<tr>
<td>Extremely ductile</td>
<td>Extremely ductile</td>
<td>Brittle</td>
<td>Brittle</td>
</tr>
<tr>
<td>Can be hammered into sheets (malleable)</td>
<td>Can be hammered into sheets (malleable)</td>
<td>Shatters when hammered</td>
<td>Shatters when hammered</td>
</tr>
<tr>
<td>Good conductor of heat and electricity</td>
<td>Good conductor of heat and electricity</td>
<td>Poor conductor of heat and electricity</td>
<td>Poor conductor of heat and electricity</td>
</tr>
<tr>
<td>Used in coins, jewelry, tableware</td>
<td>Used in coins, jewelry, tableware</td>
<td>Used to harden lead, color glass and plastics</td>
<td>Used in gunpowder, rubber, fungicides</td>
</tr>
<tr>
<td>Density 10.5 g/mL</td>
<td>Density 10.5 g/mL</td>
<td>Density 6.7 g/mL</td>
<td>Density 2.1 g/mL</td>
</tr>
<tr>
<td>Melting point 962 °C</td>
<td>Melting point 962 °C</td>
<td>Melting point 630 °C</td>
<td>Melting point 113 °C</td>
</tr>
</tbody>
</table>
The atomic number

- is specific for each element and the same for all atoms of that element
- is equal to the number of protons in an atom
- typically appears above the symbol of an element

**Atomic Number**

11

**Chemical Symbol**

Na
ATOMIC NUMBERS AND PROTONS

• Hydrogen has atomic number 1; every H atom has 1 proton.
• Carbon has atomic number 6; every C atom has 6 protons.
• Copper has atomic number 29; every Cu atom has 29 protons.
• Gold has atomic number 79; every Au atom has 79 protons.
ATOMIC MODELS

Lithium (Li)
- 3 protons
- 3 neutrons
- 3 electrons

Carbon (C)
- 6 protons
- 6 neutrons
- 6 electrons

Periodic Table
- Atomic number

Proton
Electron
Neutron
LEARNING CHECK

State the number of protons in each atom.

1. A nitrogen atom
   (a) 5 protons    (b) 7 protons    (c) 14 protons

2. A sulfur atom
   (a) 32 protons   (b) 16 protons   (c) 6 protons

3. A barium atom
   (a) 137 protons  (b) 81 protons   (c) 56 protons
State the number of protons in each atom.

1. A nitrogen atom  (b) 7 protons
2. A sulfur atom   (b) 16 protons
3. A barium atom   (c) 56 protons
ATOMIC MASS

Atomic mass is the average of all the naturally occurring isotopes of that element.
PERIODIC TRENDS

There are trends or patterns that can be observed on the periodic table.

• These trends include
  • Atomic Radius
  • Ionization Energy
  • Electronegativity
  • Electron Affinity
  • Metallic Character
ATOMIC RADIUS

- Atomic Radius – size of an atom (distance from nucleus to outermost electrons)
  - As you go down a column, atomic radius increases
  - As you go across a period (L to R), atomic radius decreases
IONIZATION ENERGY

- Ionization Energy – energy needed to remove outermost electron
- As you go down a column, ionization energy decreases
- As you go across a period (L to R), ionization energy increases
**ELECTRONEGATIVITY**

- **Electronegativity** – ability of an atom to attract and bind to electrons
- As you go down a column, electronegativity decreases
- As you go across a period (L to R), electronegativity increases
**ELECTRON AFFINITY ENERGY**

- **Electron Affinity** – ability of an atom to accept an electron
- Electron affinity **increases** from left to right within a period
- Electron affinity **decreases** from top to bottom within a group
METALLIC CHARACTER

- **Metallic Character** – how readily an atom can lose an electron
- Metallic characteristics **decrease** from left to right across a period
- Metallic characteristics **increase** down a group
STUDY CHECK

Compare your annotated periodic table with the side model.

Discuss your observations with a peer.

How can you apply this technique to other courses?
The Group number tells the number of valence electrons (the electrons in the outer shell).

Example: Group 1A has 1 valence electron; 2A has 2, 5A has 5, etc.
Questions

Prepared and Compiled from various sources by
D. Leonard & A. Kandefer (Learning Specialists)
The Academic Support Center @ Daytona State College
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