What’s an atom?

From our glossary:
“An unimaginably small particle that could not be made any smaller and still behave as a chemical system. Atoms are the smallest particles that can exist and retain an element’s identity.”

Atoms

- Atoms contain protons, neutrons, electrons
- Nucleus = protons & neutrons
- Electrons surround nucleus
- Protons: + charge
- Electrons: – charge
- Neutrons: no charge
Models of an atom

Single Atom Images: Scanning Tunneling Microscope

Atomic Theory of Matter

• Matter composed of atoms
• Atoms of a given element have identical chemical properties
• Different elements have different properties
• Atoms combine in whole number ratios
• Not created or destroyed in ordinary chemical reactions
Atomic Weights

- Atoms have measurable masses.
- "Atomic weight" of an element is average mass of an atom of the element. (Why average?)
- Units:
  - 1 amu = 1.66 x 10^{-27} kg
- Find mass of an average carbon atom in grams. (atomic weight = 12.011 amu)

<table>
<thead>
<tr>
<th>Isotope</th>
<th>Mass (amu)</th>
</tr>
</thead>
<tbody>
<tr>
<td>^{68}\text{Ga}</td>
<td>68.92558</td>
</tr>
<tr>
<td>^{71}\text{Ga}</td>
<td>70.92470</td>
</tr>
</tbody>
</table>

- Gallium has 2 stable isotopes as shown above.
- Given atomic mass of Ga is 69.723, calculate the isotopic abundances
Physical properties: Density

What's a molecule?

- Again, from our glossary:
  “The smallest particle of an element or compound that can exist and retain the chemical properties of that element or compound.”
Molecules

- Molecular formula gives composition: number of atoms of each element present
- Molecular mass = sum of masses of atoms

Representing Molecules

- Names: ethanol, ethyl alcohol
- Formulas: \( \text{C}_2\text{H}_6\text{O}, \text{C}_2\text{H}_5\text{OH}, \text{CH}_3\text{CH}_2\text{OH} \)
- Structural drawings
- Models

Ways to depict molecules

- Ethanol: \( \text{C}_2\text{H}_6\text{O}, \text{CH}_3\text{CH}_2\text{OH} \)
- Dimethyl ether: \( \text{C}_2\text{H}_6\text{O}, \text{CH}_3\text{OCH}_3 \)
Models of molecules

Line Drawings

\[ \begin{align*}
\text{H} & \quad \text{H} \\
\text{H} \quad \text{C} \quad \text{C} \quad \text{O} \quad \text{H} \\
\text{H} & \quad \text{H}
\end{align*} \]

- Shorthand notation
- Carbons & hydrogens on carbons not shown
- Each line is a bond
- Each carbon has 4 bonds

Example:

Line structure / formula

This compound has potential as a medium for holographic data storage.

- Find formula
Example

- Formula is $C_{15}H_{20}N_2O_2$

Chemistry: 3 “Representations”

- **Macroscopic or bulk:** observations
- **Symbolic:** written description
- **Microscopic/molecular:** visualize atoms & molecules
- One big “trick” to chemistry is seeing connections between these views