science 10

unit 2: chemistry

book 1: atomic theory & bonding

name: ___________  block: _____
Review: The Classification of Matter

We currently classify everything in the physical world as either a form of energy or a form of matter. Matter can be further classified as shown:

- Pure Substances
  - Element
  - Compound
- Mixture

<table>
<thead>
<tr>
<th>Material</th>
<th>Definition</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>pure substance</td>
<td><em>all of the sample has the same properties</em></td>
<td>water (H₂O), sugar (C₆H₁₂O₆), any element, copper (Cu)</td>
</tr>
<tr>
<td>mixture</td>
<td><em>made of 2+ substances (amounts can vary)</em></td>
<td>salt water, air, trail mix, silver is made up of only Ag atoms</td>
</tr>
<tr>
<td>atom</td>
<td>The smallest possible unit of an element</td>
<td></td>
</tr>
<tr>
<td>Molecule</td>
<td><em>cluster of 2+ atoms held together by bonds</em></td>
<td>H₂O</td>
</tr>
<tr>
<td>Ion</td>
<td>can be called a molecule with a charge</td>
<td>sodium ion (Na⁺), nitrate ion (NO₃⁻), chloride ion (Cl⁻)</td>
</tr>
<tr>
<td>element</td>
<td><em>substance that cannot be separated into simpler substances</em></td>
<td>hydrogen gas, only H atoms</td>
</tr>
<tr>
<td>Compound</td>
<td><em>made of 2+ atoms</em></td>
<td>salt = NaCl, sugar = C₆H₁₂O₆ (ionic), C₆H₁₂O₁₈ (covalent)</td>
</tr>
<tr>
<td>Particle</td>
<td>The particles that make up materials are chemical species.</td>
<td>general term to describe a piece of something any of above</td>
</tr>
</tbody>
</table>

Chemists refer to all the particles of matter collectively as chemical species.

Just as materials are classified, so are chemical species. Chemical species can be classified as neutral atoms, molecules, or ions.

Atoms are composed of particles that can be classified as well.
The elements are further classified as metals, non-metals, and metalloids.

About 80% of the elements are metals.

Hydrogen has properties that are in-between those of the metals and the non-metals. Although it has some chemical properties of metals, it has more in common with non-metals and is classified as a non-metal for most purposes.

Hydrogen is such a unique element that it is usually considered to be in a group of its own.

Metals are good conductors of both heat and electricity. They are also ductile (can be pounded into thin sheet) and malleable (can be drawn into wires), and forming alloys, mixtures containing metals, which are hard.

Non-metals are poor conductors of both heat and electricity. Many are gases at room temperature but is the solid phase their crystals are white and shiny.

Moving up and to the right in the periodic table, there is a general trend toward less metallic character from one element to the next. As a result, there is no sharp divide between the metals and non-metals.

Instead, there is a group of elements called metalloids that exhibit some metallic properties (albeit weakly) and some non-metallic properties. For example, Si is a semiconductor meaning it conducts electricity but poorly.

Compounds

A compound of matter is a pure substance composed of more than one type of atom. A compound is a chemical combination of elements and its properties are different from its elements.

Decomposition is a type of chemical reaction in which a single compound reacts to produce two or more new substances.

They resemble two or more new groupings or patterns of the atoms.

Compounds are classified in several ways.

An ion is a charged atom or group of atoms. Because ions are more stable than their corresponding neutral atoms, the atoms of many elements exist almost exclusively in nature as ions. Ionic compounds consist of positively and negatively charged ions held together by their opposite electrical charges into long-range intermolecular attractions called ion-ion crystal lattices (Figure 2.2.4). The bond or attraction between oppositely charged ions is appropriately called an ionic bond.

Non-metal atoms can also become more stable by sharing valence electrons with each other, called a covalent bond.

A neutral group of covalently bonded atoms is called a molecule, and compounds consisting of molecules are called molecular compounds.
Any compound containing a metal is an ionic compound.
Any compound containing poly non-metals is a covalent compound, except compounds containing the ammonium ion \( \text{NH}_4^+ \) which are ionic.

Polyatomic ions (\( \text{NH}_4^+, \text{SO}_4^{2-} \)) have a charge, made of many atoms.

**Sample Problem — Classifying a Compound as Ionic or Molecular**

| (a) \( \text{NaCl} \) | Ionic (IC) |
| (b) \( \text{Cu(NO}_3^2\) | Ionic (IC) |
| (c) \( \text{P}_2\text{O}_5 \) | Covalent (CC) |

**Practice Problems — Classifying a Compound as Ionic or Molecular**

1. State whether each of the following is an ionic compound or a molecular compound:
   - (a) \( \text{CO}_2 \) __Covalent__
   - (b) \( \text{CaF}_2 \) __Ionic__
   - (c) \( \text{C}_6\text{H}_6 \) __Covalent__
   - (d) \( \text{Mg}_2\text{Cl}_2 \) __Ionic__
   - (e) \( \text{H}_2\text{O} \) __Molecular__
   - (f) \( \text{HCl} \) __Ionic__

**Atomic Structure, Isotopes & Atomic Mass**

Each element is made up of very tiny particles called **atoms**, and each element is made up of just one particular type of atom, which is different to the atoms in any other element.

J.J. Thomson discovered **electrons** and proposed the existence of a (**) particle. It wasn’t until Rutherford’s famous gold foil experiment that the **proton** was discovered, and atoms were thought to me mostly empty space. He named the centre of atoms the **nucleus**.

Bohr improved on this model proposing that electrons move around the nucleus in specific layers called **electron shells**.

It was James Chadwick who discovered particles with no charge, which he named **neutrons**.

**How many electrons?**

Atoms have no overall electrical charge and are **neutral**. This means atoms must have an **equal** number of positive protons and negative electrons.

The **number of electrons** is therefore the same as the atomic __number__ __number__

**Atomic number** \( Z \) is the number of **protons** rather than the number of electrons, because atoms can lose or gain electrons but do not normally lose or gain **protons**.

**Number of protons is always the same**.
Organization of the Periodic Table

Russian chemist ____________ confidently predicted the properties of the chemical element germanium 15 years before it was discovered. He was able to do this because all known elements had been arranged into a set of rows (______ ) and columns (______ ) called the periodic table.

The periodic table below shows 112 elements. Scientists have reported the discovery of elements with atomic numbers up to 118. However, some of the discoveries have not been confirmed by the International Union of Pure and Applied Chemistry (IUPAC). Until they are, their existence is "unofficial." The properties of new elements are predicted before their discovery, just as they were in Mendeleev's time.

The observation that the physical and chemical properties of the elements recur at regular intervals when elements are listed in order of atomic weight is known as the P__________ !

PERIODIC TABLE GROUPS (FAMILIES) LEGEND
- ALKALI METALS
- ALKALI EARTH METALS
- TRANSITION METALS
- NON-METALS
- METALLOIDS
- HALOGENS
- NOBLE GASES
- LANTHANIDE + ACTINIDE SERIES

Periodic Table of the Elements

The period number refers to the number of the outermost shell containing electrons.

HW colour + label these groups in Data Book