Physical Properties of Matter

Mass

- Mass is a measure of how much material an object has
- Weight is a measure of the forces acting on an object (gravitational, centrifugal, etc.)

Physical Properties of Matter

Mass

Example

A 100 g chunk of iron has the same mass whether it is on earth or on the moon (the amount of iron has not changed).

We would say it weighs 100 g or 0.23 lbs.

On the moon, it would only weigh 0.039 lbs because the gravitational force is less on the moon

Physical Properties of Matter

Mass

- In science, we often say an objects “weighs” some amount, but what we really mean is that it has a mass of that amount.
- The common units for mass are gram (g), kilogram (kg), and milligram (mg)
  - 1 kg = 1000 g
  - 1 mg = .001 g

Physical Properties of Matter

Volume

- Volume is a measure of how much space an object occupies.
- Volume may depend on temperature and/or pressure
- The common units for volume are liter (L) and milliliter (mL)
  - 1 L = 1000 mL
  - 1 mL = 1 cm^3

Physical Properties of Matter

Density

- Density is defined as an objects mass divided by its volume

$$\text{density} = \frac{\text{mass}}{\text{volume}}$$

- Density is usually what we refer to when we say an object is “heavy”—it has a high mass in a given volume

Physical Properties of Matter

Density

- The common units for density are g/mL
- If we know two of the three quantities, we can then determine the other

Physical Properties of Matter

Density

Example

A 1 ct. diamond weighs 205.3 mg. Diamond has a density of 3.51 g/mL. How big is the diamond?

$$d = \frac{m}{V} \quad \text{rearranging gives} \quad V = \frac{m}{d}$$

$$V = \frac{(205.3\,\text{mg})\left(\frac{1\,\text{g}}{1000\,\text{mg}}\right)}{3.51\,\text{g/mL}} = .0585\,\text{mL}$$

Physical Properties of Matter

Temperature

- Temperature is actually a measure of the internal energy of an object. The higher the temperature, the more internal energy an object possesses.
- In science, temperature must be measured on an absolute scale with a defined value of zero below which temperature may not fall.

Physical Properties of Matter

Temperature

- Both Celsius and Fahrenheit temperature scales do not satisfy this requirement—each may have negative values of temperature.
- Absolute zero is the lowest temperature attainable by an object—this corresponds to the minimum possible internal energy of an object. In practice, we may never reach absolute zero.

Physical Properties of Matter

Temperature

The absolute temperature scale uses units of degrees Kelvin (abbreviated K).

0.00 K = -273.15 ^{o}C

The size of one degree Kelvin is the same as one degree Celsius.

When performing calculations involving temperature, if you use degrees Kelvin, you will always be safe.

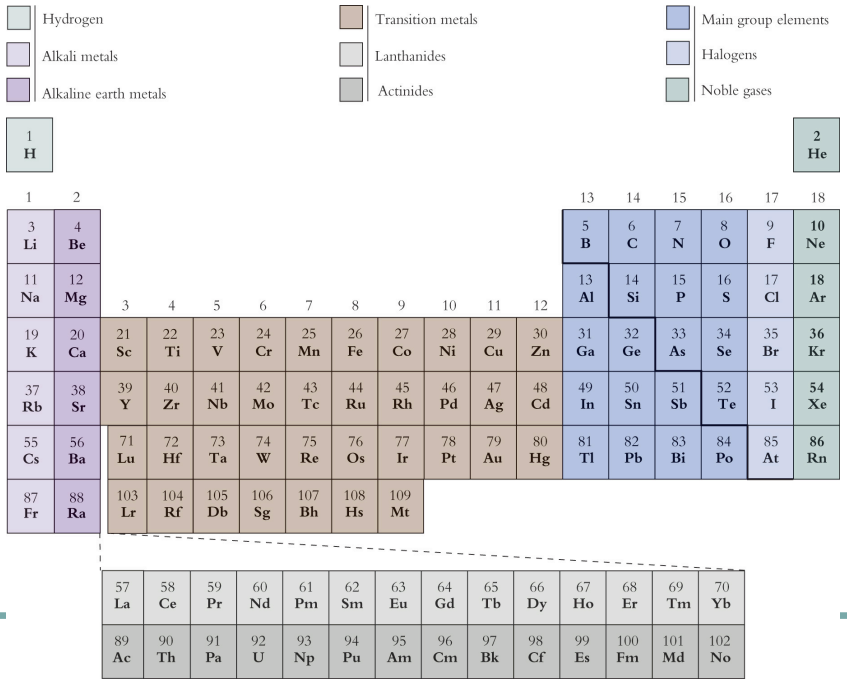
Atoms and Molecules

- An atom is a particle of matter that cannot be further divided without changing the chemical identity of the atom. The word *atom* derives from the Greek word meaning “uncuttable”.
- Atoms are comprised of protons, neutrons, and electrons.
- There are ~ 109 different kinds of atoms. The different kinds of atoms are called elements.

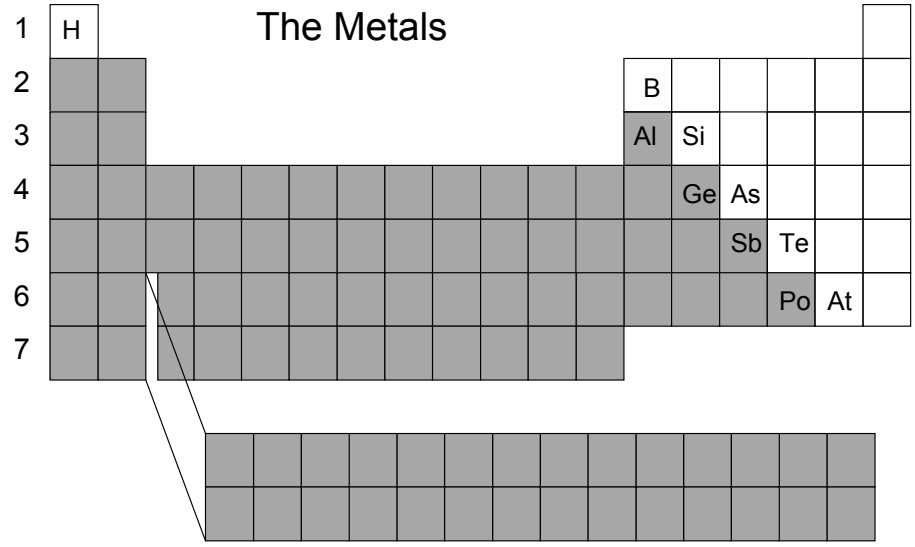
Examples of Atoms

H	Hydrogen	He	Helium
C	Carbon	Cu	Copper
O	Oxygen	Au	Gold
N	Nitrogen	Ag	Silver
Na	Sodium	Mg	Magnesium
Fe	Iron	Cl	Chlorine
U	Uranium	Ne	Neon

The Periodic Table



The Periodic Table



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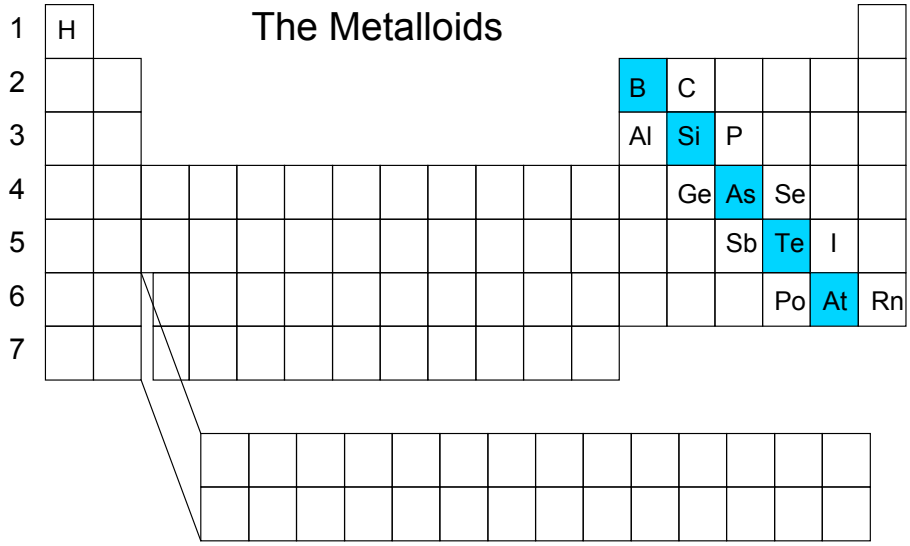
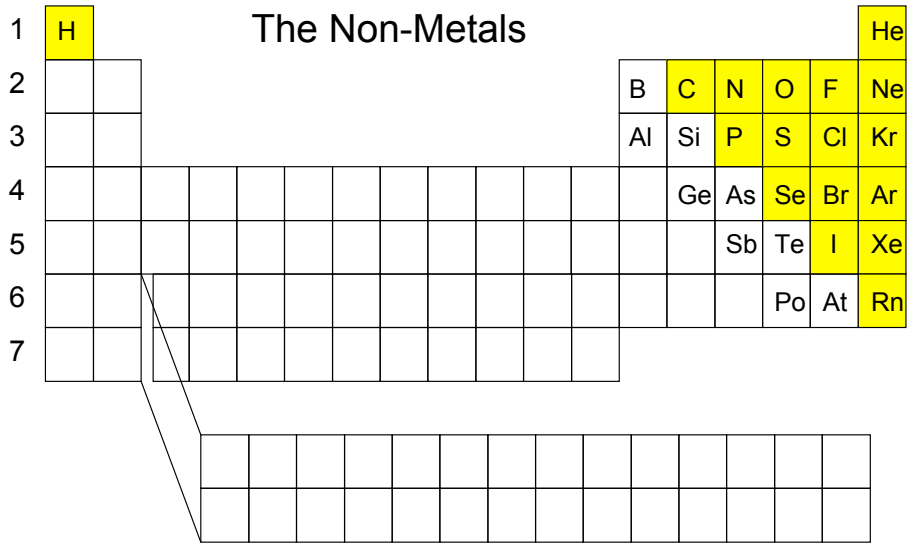


The Periodic Table



Atoms and Molecules

- A molecule is a compound composed of two or more atoms. The atoms may be of the same element or of a combination of different elements.
- Most of the matter we see in the universe is comprised of molecules.

Examples of Molecules

H_2O	Water
CO_2	Carbon Dioxide
NaCl	Sodium chloride (table salt)
$C_{12}H_{22}O_{11}$	Sucrose
N_2	Nitrogen
O_3	Ozone

Changes in Matter

- **Physical Change:** When a substance undergoes a physical change, its molecular identity remains the same.
- Examples include:
  - Boiling
  - Melting
  - Freezing

Changes in Matter

- **Chemical Change:** When a substance undergoes a chemical change, the atoms in the substance are rearranged or exchanged with another substance to form new atoms or molecules.
- Examples include
  - Burning propane in your grill
  - Baking a cake
  - Making a new drug
  - Burning fat cells in your body