Section 2.5 (Chemistry-First) and 3.5 (Atoms-First) Common Elements

An Introduction to Chemistry

By Mark Bishop

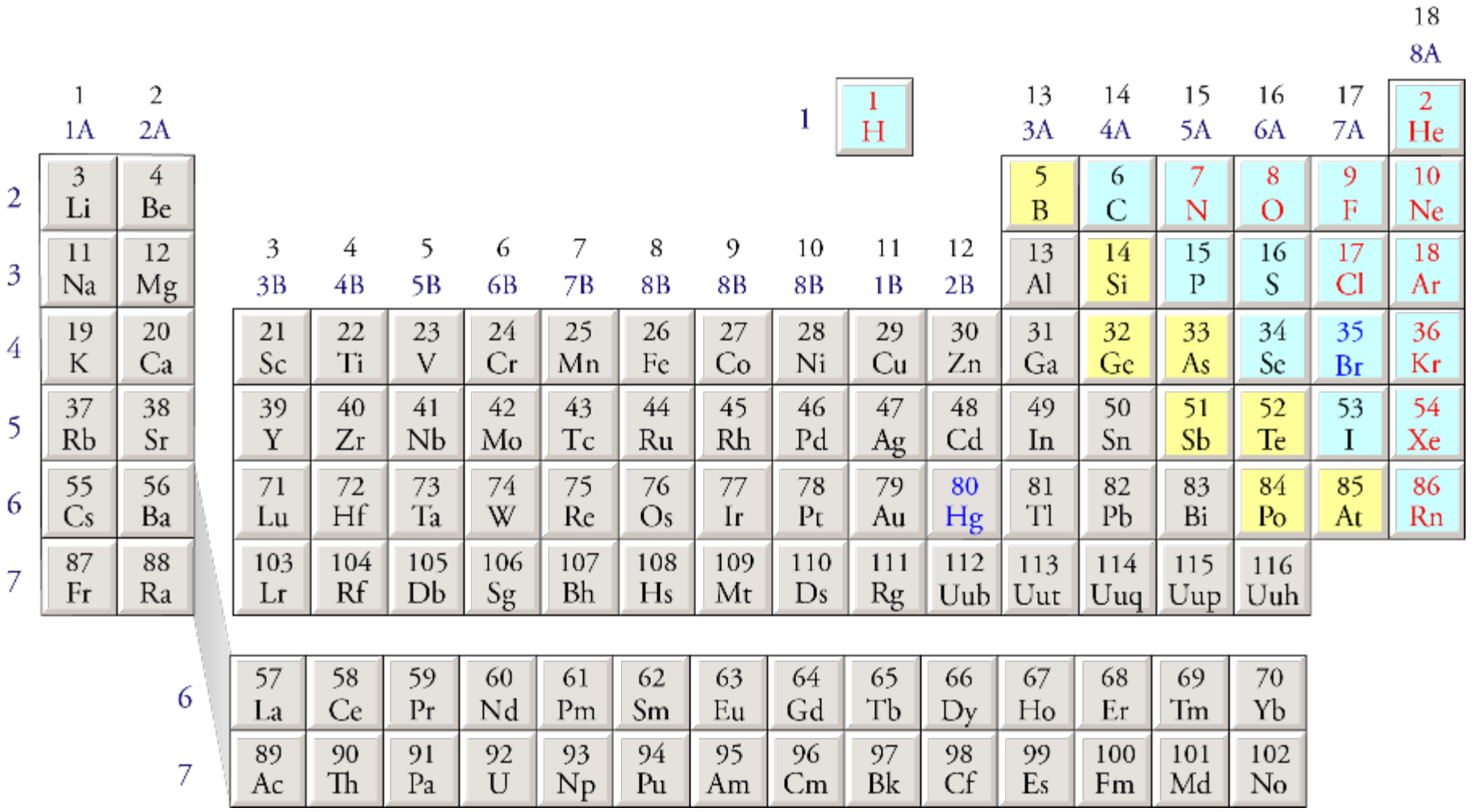
To Describe Structure of Elements

- What particles?
  - Noble gases – atoms
  - Other nonmetals - molecules
    - Diatomic elements – H_2, N_2, O_2, F_2, Cl_2, Br_2, I_2
    - S_8, Se_8, P_4
  - Metallic elements – cations in a sea of electrons

To Describe Structure of Elements (2)

- Solid, liquid, or gas?
  - Gases - H_2, N_2, O_2, F_2, Cl_2, He, Ne, Ar, Kr, and Xe
  - Liquids – Br_2 and Hg
  - Solids – the rest
- Standard description of (1) solid, (2) liquid, (3) gas, or (4) metal.

Helium Gas, He



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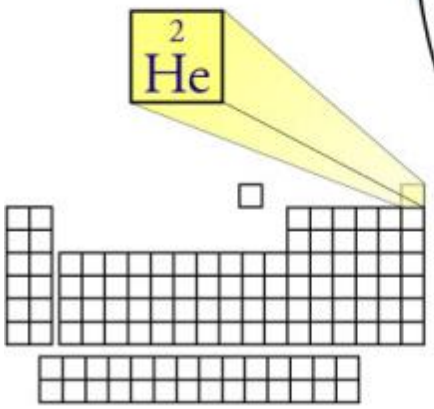
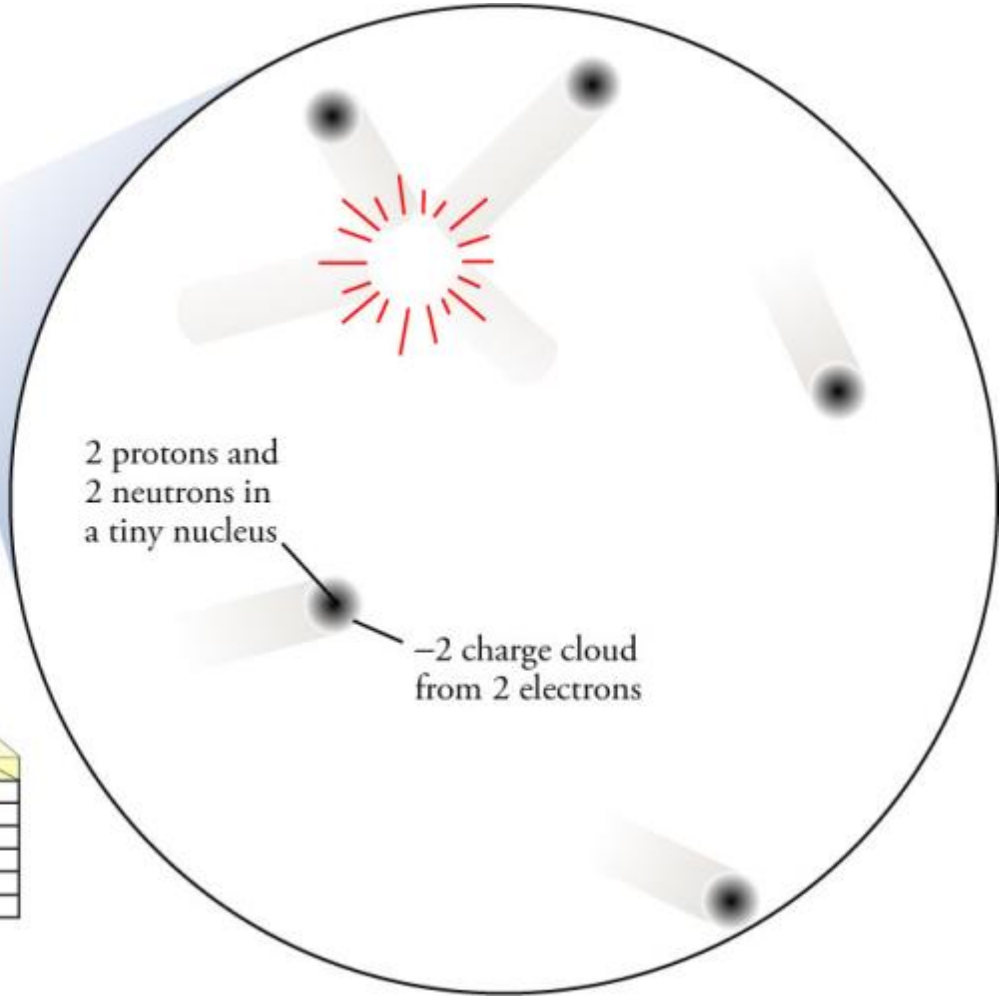
Description of Gas

- Particles constantly moving in straight-line paths
- About 0.1% of volume occupied by particles…99.9% empty.
- Average distance between particles is about 10 times their diameter.
- No significant attractions or repulsions.
- Constant collisions that lead to changes in direction and velocity.
- Variable volume and shape, due to lack of attractions and a great freedom of motion.

Helium Gas, He





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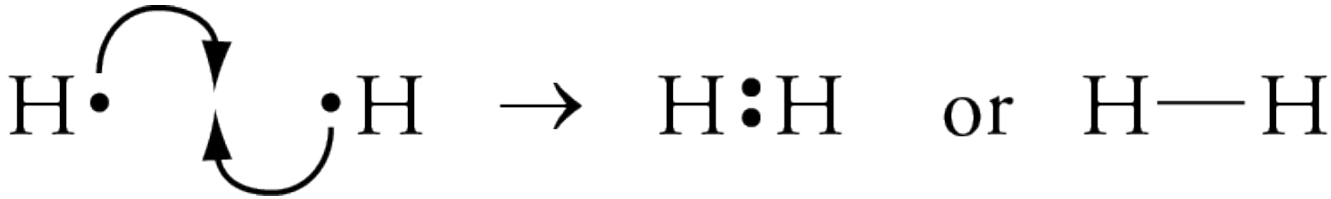
Hydrogen Molecules

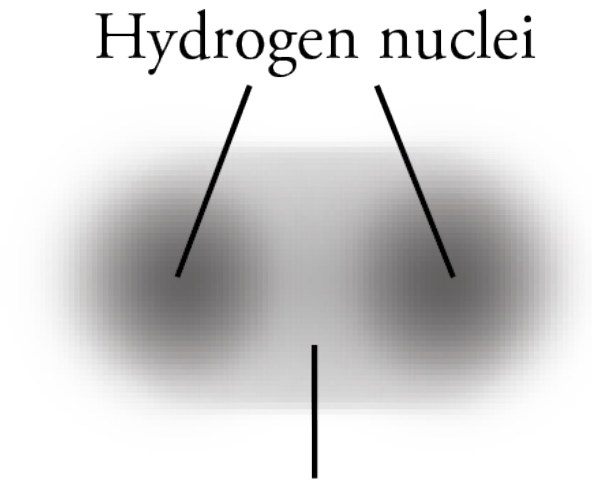
- Each hydrogen atom has one electron.
- Electrons are more stable when they are paired.
- To form a pair of electrons, two hydrogen atoms combine to form one a hydrogen molecule, H_2.



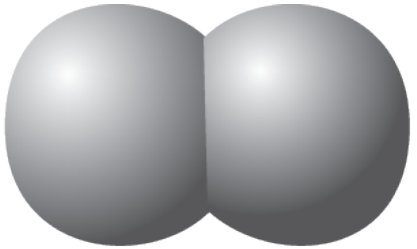
Covalent Bonds and Molecules

- **Covalent bond** = a link between atoms due to the sharing of two electrons
- **Molecule** = an uncharged collection of atoms held together by covalent bonds
- The link that holds two hydrogen atoms together is a covalent bond. We call the pair of hydrogen atoms a hydrogen molecule.
- Its chemical formula is H_2.

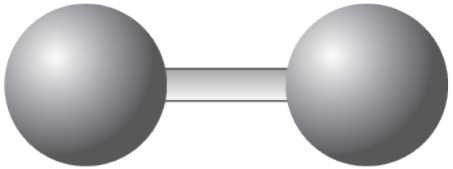
Hydrogen, H_2, Molecule



The two electrons generate a charge cloud surrounding both nuclei.

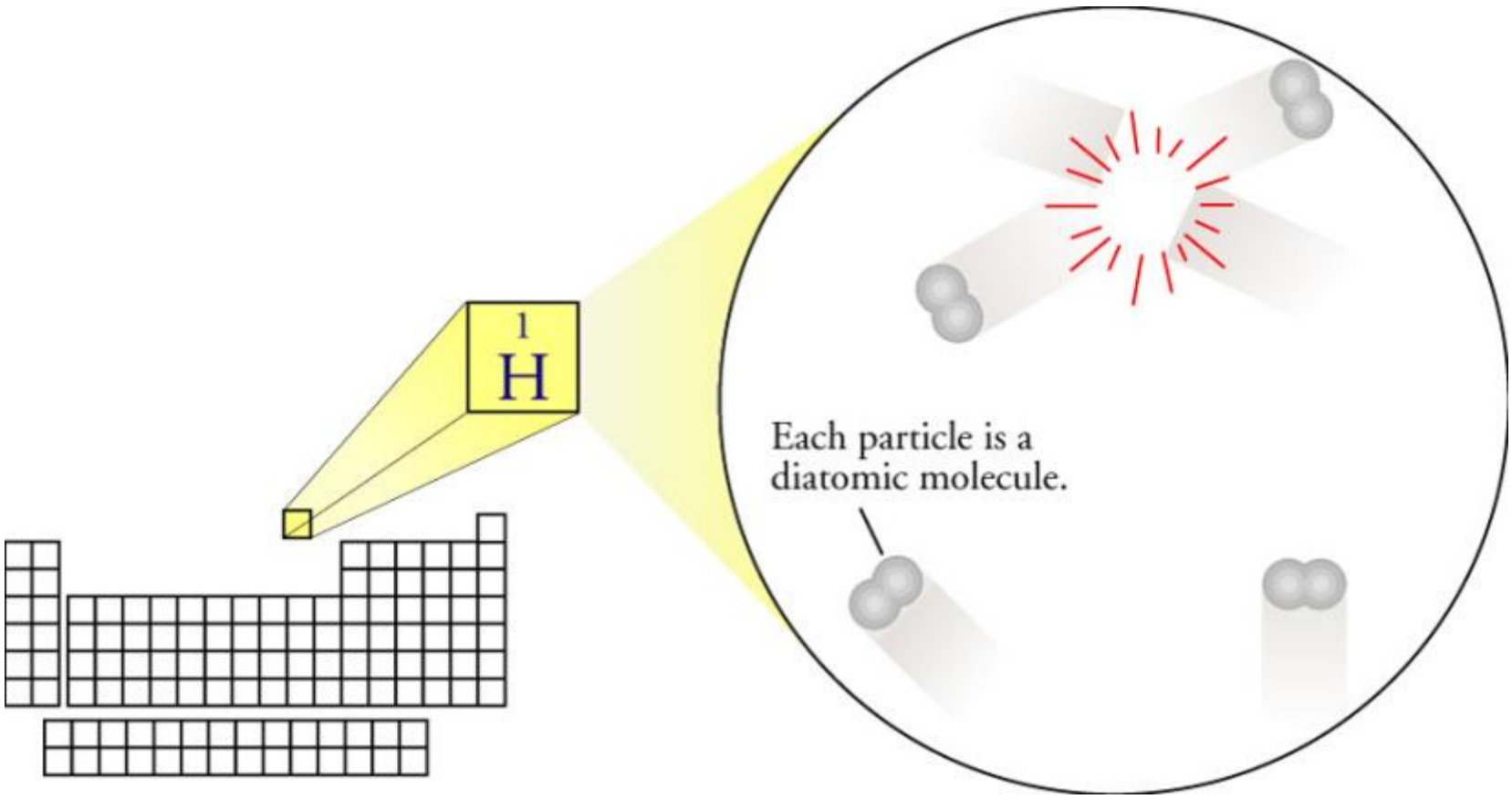


Space-filling model
Emphasizes individual atoms



Ball-and-stick model
Emphasizes bond

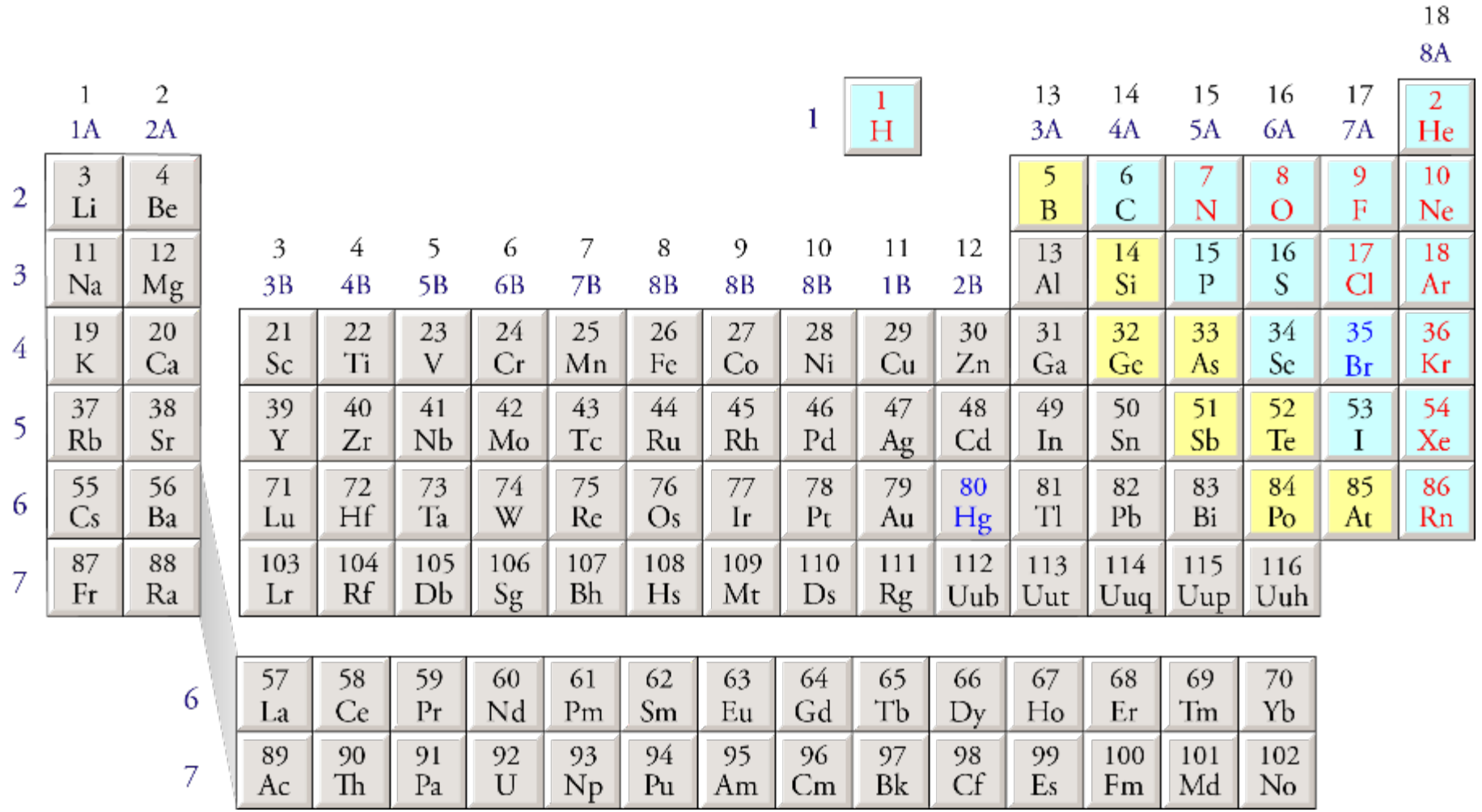
Hydrogen Gas, H_2



Diatomic Molecules

- Molecules that have two atoms are called **diatomic**.
- Hydrogen (H_2), nitrogen (N_2), oxygen (O_2), fluorine (F_2), chlorine (Cl_2), bromine (Br_2), and iodine (I_2) are diatomic.

Diatomic Molecules



Bromine

- The element bromine, Br_2, is composed of diatomic molecules.
- Bromine is one of the two elements that are liquids.

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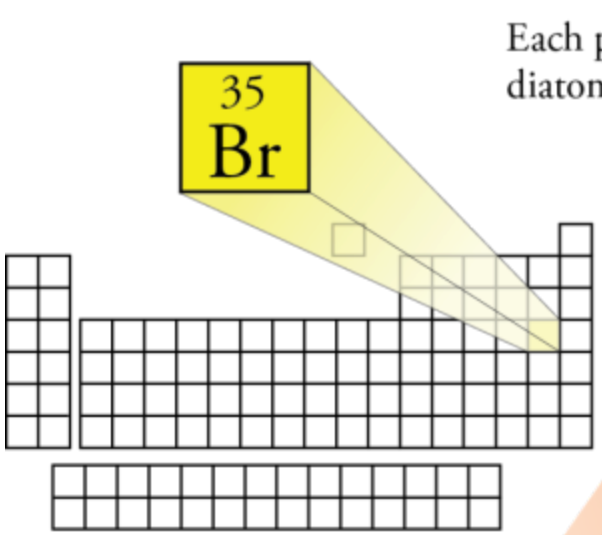
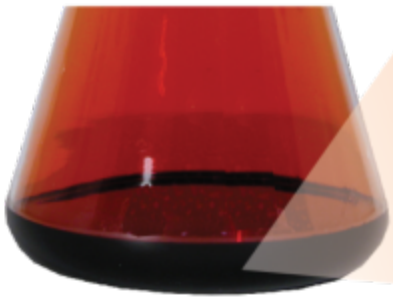
- Standard description of (1) solid, (2) liquid, (3) gas, or (4) metal.

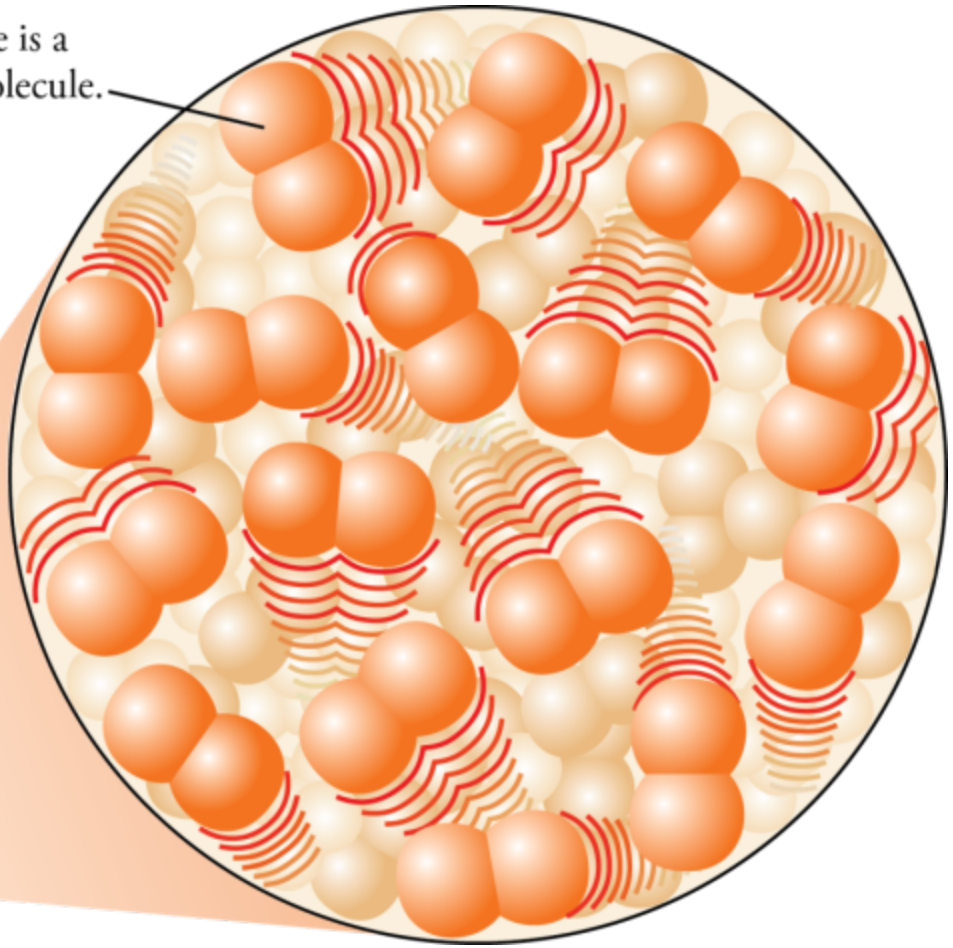
Description of Liquid

- Particles constantly moving.
- Up to 70% of volume occupied by particles…30% empty
- Attractions are strong but not strong enough to keep particles from moving throughout the liquid.
- Constant collisions that lead to changes in direction and velocity.
- Constant volume, due to significant attractions between the particles that keeps the particles at a constant average distance, but not constant shape, due to the freedom of motion.

Bromine Liquid, Br_2







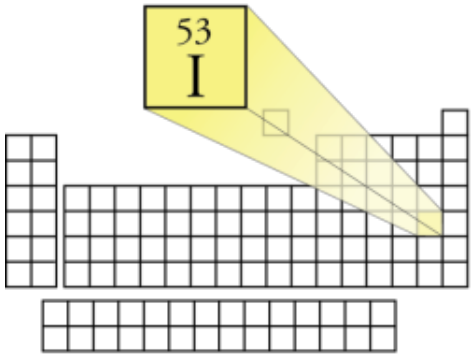
Iodine

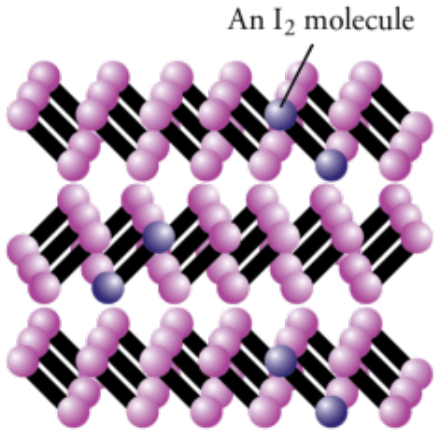
- Like all of the halogen (group 17), the element iodine, I_2, is composed of diatomic molecules.
- Because iodine is not on our list of gases or liquids, it must be a solid at room temperature and pressure.
  - Gases - H_2, N_2, O_2, F_2, Cl_2, He, Ne, Ar, Kr, and Xe
  - Liquids – Br_2 and Hg
  - Solids – the rest

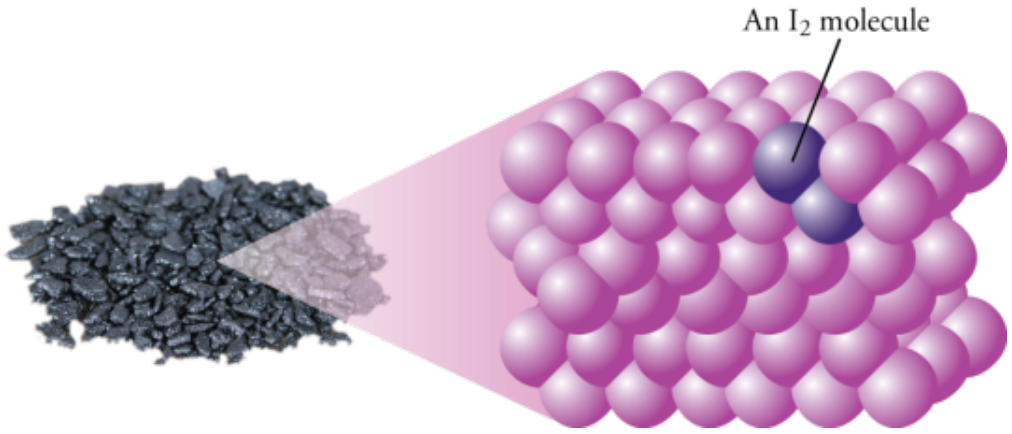
Description of Solid

- Particles constantly moving.
- Up to 70% of volume occupied by particles…30% empty.
- Strong attractions keep particles trapped in cage.
- Constant collisions that lead to changes in direction and velocity.
- Constant volume and shape due to strong attractions and little freedom of motion.

Iodine Solid







https://preparatorychemistry.com/element_properties_Canvas.html

Typical Metallic Solid and Its "Sea of Electrons"