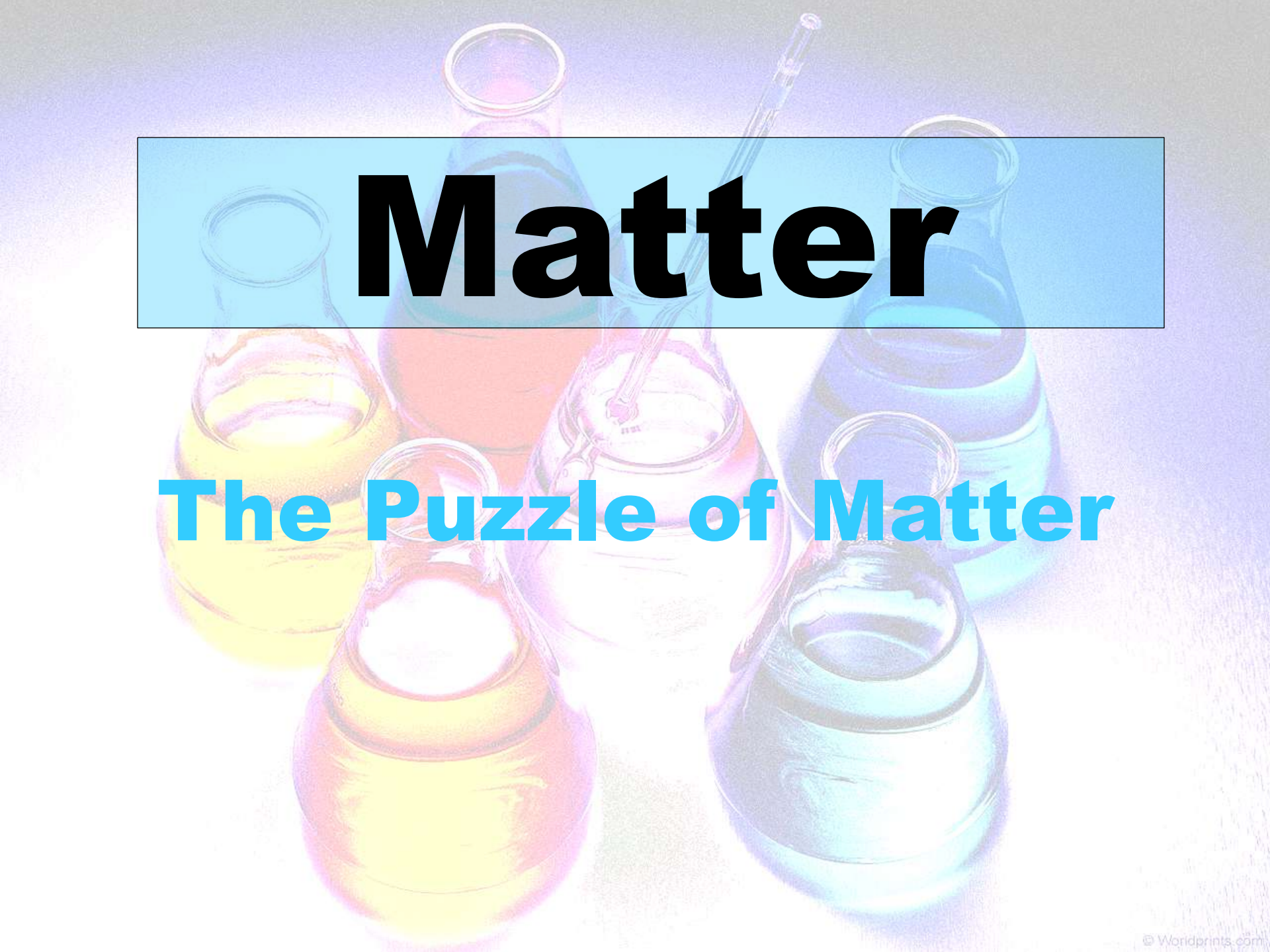
Matter

The Puzzle of Matter



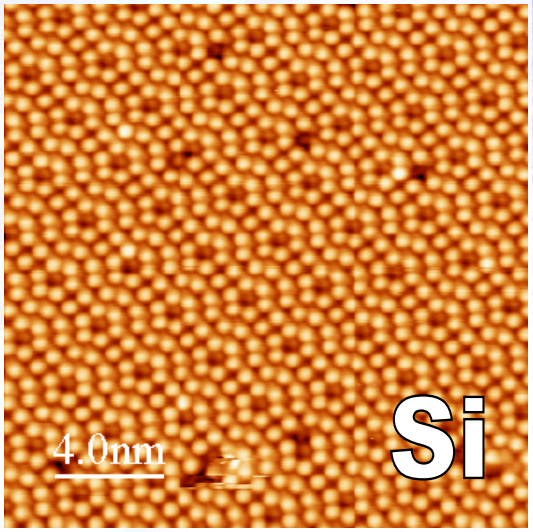
The Particulate Nature of Matter

- **What is Matter?**
  - **Matter** → the "stuff" that the universe is composed of.
  - Has mass and occupies space.
  - Examples include: stars, air, gasoline, chair, cells, etc…
  - Matter is very diverse.
  - All matter is composed of a small number of fundamental particles.

The Particulate Nature of Matter

The Atomic Nature of Matter

- Atoms are too small to be seen with the naked eye, so how do we know they exist?
  - In recent years, scientists developed a scanning tunneling microscope (STM) that can produce images of atoms.

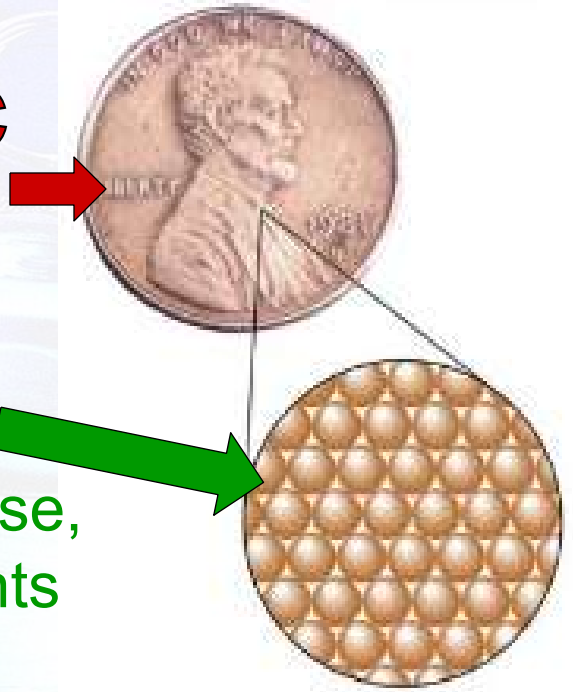


The Particulate Nature of Matter

- When chemists look at metals and other substances under really powerful microscopes, they are able to see the atoms.

Macroscopic

You can see with your naked eye!



Microscopic

You need a microscope to see. In this case, you need a STM! It shows the components that make up what you are able to see.

Like the bricks in a building, only much smaller!

The Particulate Nature of Matter

- With ultra-high magnification, objects appear more similar.
- This is because all objects are made up of small particles called atoms.
- Atoms are so tiny that you need a powerful magnifying instrument to see them.
- It is like how sand looks uniform from a distance.

The Particulate Nature of Matter

Beach at Cabasson (Baigne-cul)

Henri-Edmond Cross

- Although objects in the macroscopic world look continuous and uniform, they are really made of atoms (particulate)!

Elements and Compounds

- **What are Atoms?**
  - **Atoms** → fundamental unit of which elements are made.
  - Not all atoms are alike.
  - Copper atoms are different from oxygen atoms, which are different from hydrogen atoms.
- All the matter in the universe is constructed by putting about 100 types of atoms together in different ways!

Elements and Compounds

- We call the 100+ types of atoms the *elements* of the universe.

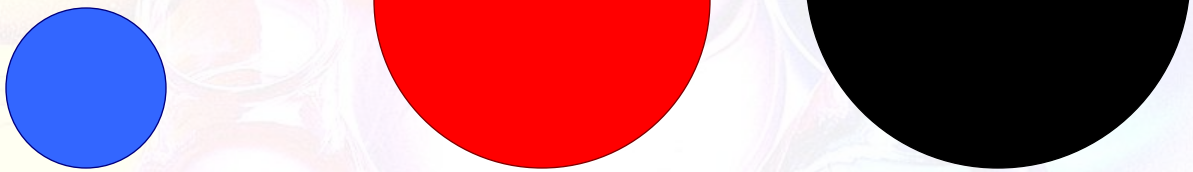
Top Ten Elements in the Universe

Element	Percent (by atoms)		Element	Percent (by atoms)
Hydrogen	73.9		Iron	0.11
Helium	24.0		Nitrogen	0.097
Oxygen	1.1		Silicon	0.065
Carbon	0.46		Magnesium	0.058
Neon	0.13		Sulfur	0.044

Elements and Compounds

Compounds

- Atoms are often drawn or represented as spheres.



1 Hydrogen Atom

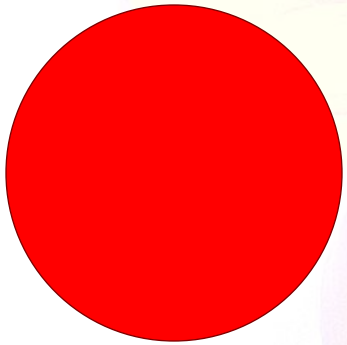
1 Oxygen Atom

1 Carbon Atom

- We can combine the atoms in a variety of ways to form compounds.

Elements and Compounds

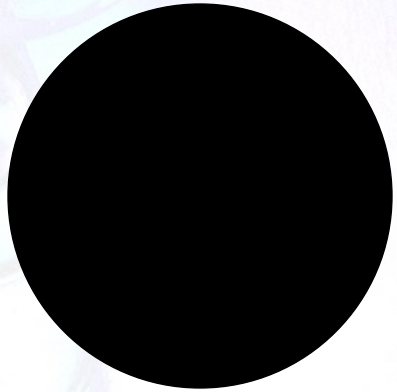
- **Compounds** → substances made by bonding atoms together in specific ways.
  - Contains 2 or more different types of atoms bound together in a particular way.
  - Specific compound consists of the same particle throughout.



1 Oxygen Atom

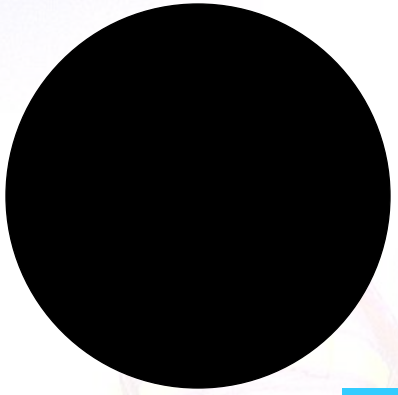
Carbon Monoxide

poisonous gas

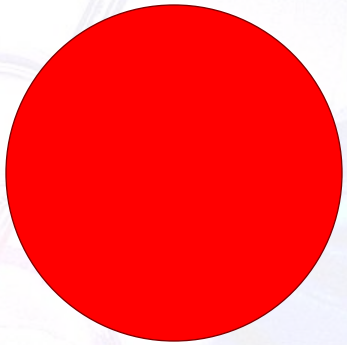


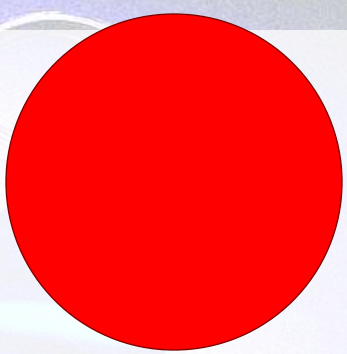
1 Carbon Atom

Elements and Compounds



1 Carbon Atom

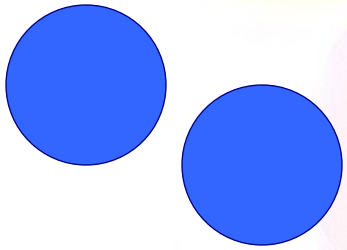




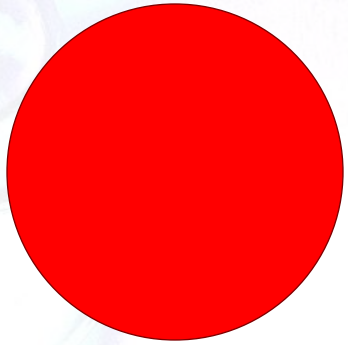
2 Oxygen Atoms

Carbon Dioxide

you breathe out, plants use



2 Hydrogen Atoms

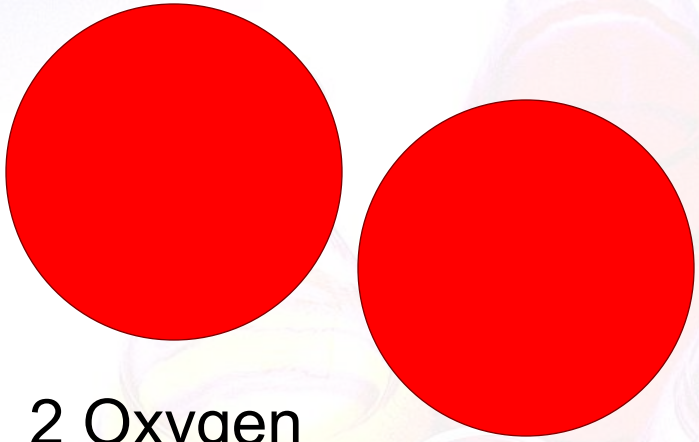


1 Oxygen Atom

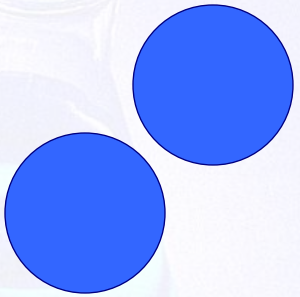
Water

most important liquid on Earth

Elements and Compounds



2 Oxygen Atoms

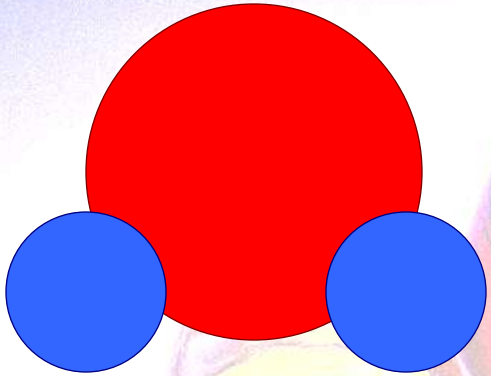


2 Hydrogen Atoms

Hydrogen Peroxide

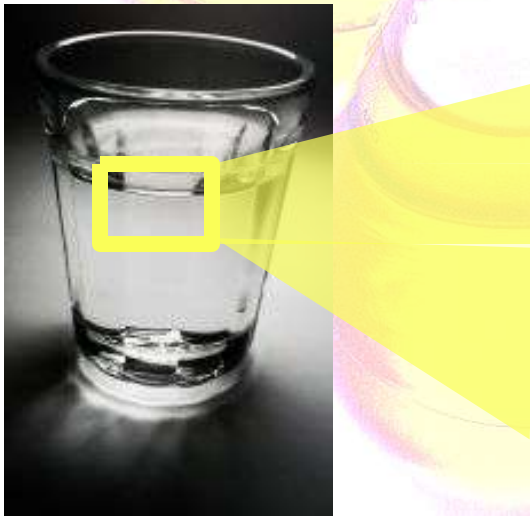
used to disinfect cuts and bleach teeth and hair.

Elements and Compounds

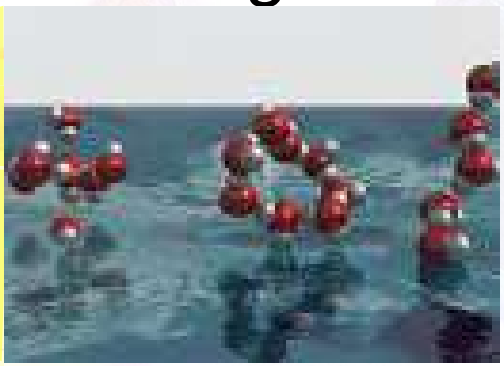


1 Water Molecule

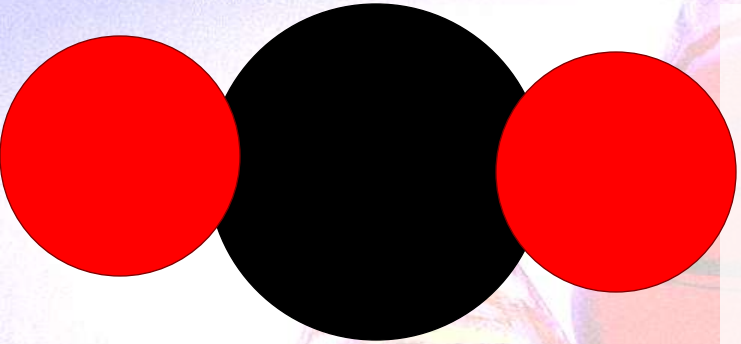
H_2O



- In a glass of water, the particles consist of 2 hydrogen atoms bonded to an oxygen atom.
- **Molecule** → made up of atoms that are "stuck" together (behave as a unit).
  - A glass of water contains a huge number of molecules packed closely together.



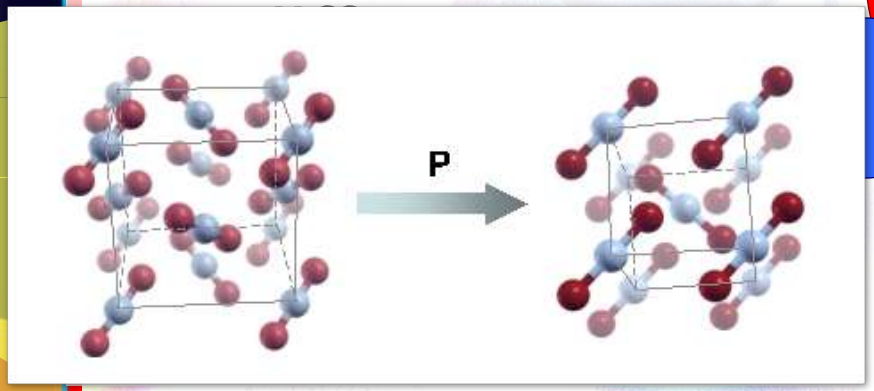
Elements and Compounds

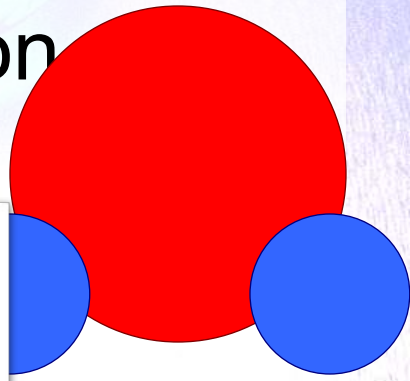


1 Carbon Dioxide Molecule

CO_2

- Dry ice is solid carbon dioxide and contains many CO_2 molecules packed together.
- Notice that all the molecules in dry ice are the same.
  - Water and carbon dioxide are





1 Water Molecule

H_2O

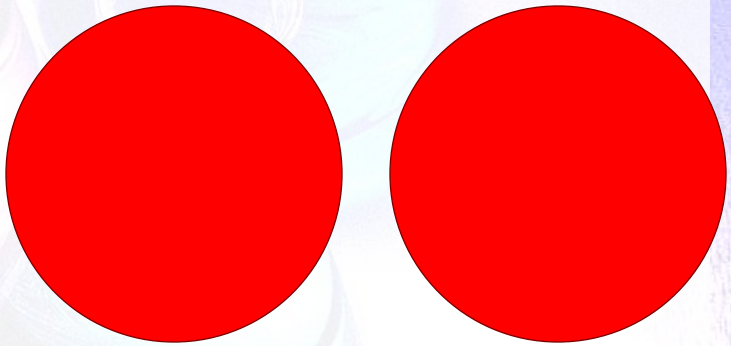
Elements and Compounds

Elements

- Atoms of the same type can also combine to form molecules.
- Since pure hydrogen and oxygen each contain only one type of atom, they are called elemental substances.

1 Hydrogen Molecule

H_2

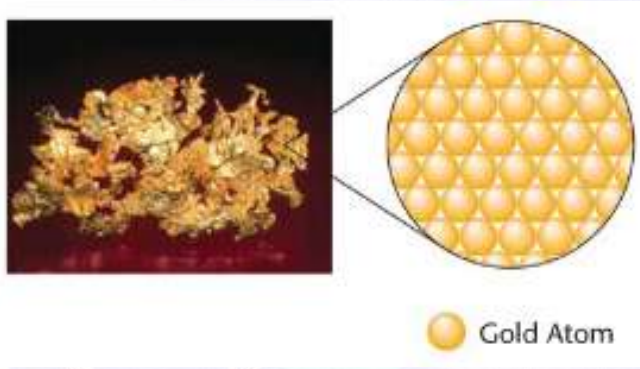


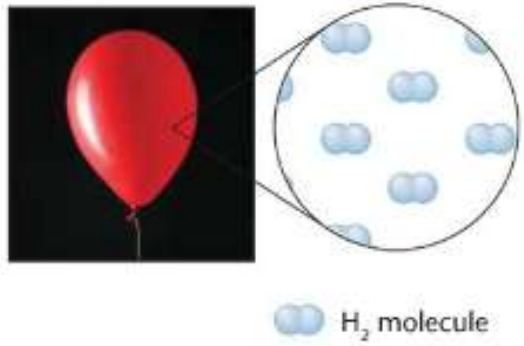
1 Oxygen Molecule

O_2

Elements and Compounds

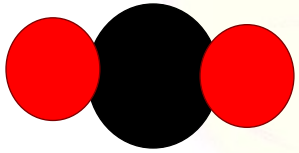
- **Elements** → substances containing only one type of atom.
  - Examples include:
    - Pure gold contains only gold atoms.
    - Elemental copper contains only copper atoms.
    - Hydrogen gas contain only hydrogen atoms.
    - Any pure sample of an element contains only atoms of that element, *never* any atoms of any other element.





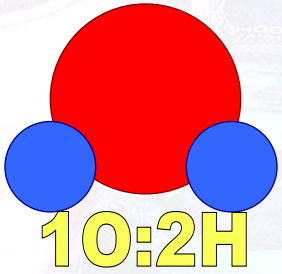
Elements and Compounds

- A **compound** always contains atoms of different elements.
- A compound also always has the same composition (combination of atoms).



Carbon Dioxide

CO_2 O-C-O



Water

H_2O H-O-H

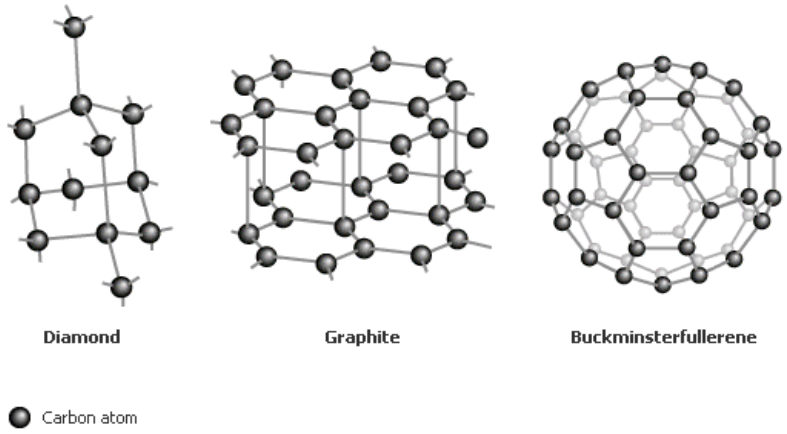
- The properties of a compound are very different from those of the elements it contains.

Elements and Compounds

Chemistry in Your World:

Carbon (C) – Element of Many Forms

- Three forms of elemental carbon:
  - **Graphite** makes up pencil lead.
  - **Diamond** is a brilliant, hard gemstone.
  - **Buckminsterfullerene** is a C_{60} molecule that resembles a soccer ball.




The
End!