Atomic Nature of Matter

Objectives:
1. Define the atom and parts of the atom
2. Define the properties of an atom; molecules, compounds; states of matter
Atoms

• Atoms are the building blocks of matter.
• Matter – any thing that has mass and takes up space.
• There are approximately 112 types of atom
Atoms (cont)

• The smallness of an atom
  – 1 drop of water contains about $10^{23}$ atoms.

• Atoms are ageless
  – All atoms on Earth originated in the deep interiors of ancient stars

• Atoms are recyclable
  – Atoms cycle from one object to another
  – We do not own the atoms, we borrow them
Elements

• class of identical atoms

• Living things are composed of about 5 elements
  1. oxygen (O)
  2. carbon (C)
  3. hydrogen (H)
  4. nitrogen (N)
  5. calcium (Ca)

• Everyday materials are composed of about 14 elements
Molecules

- Atoms combine to form molecules.
- Can be simple or complex combinations
  - Simple: 2 hydrogen atoms and 1 oxygen atom combine to form water
  - Complex: DNA (the blueprint of life!)
- Most molecules are too small to be seen
- Macromolecule can be seen
  - A diamond is a macromolecule
Compounds

• Chemical reaction – process in which atoms rearrange to form different molecules/compounds

• Compound - Substance that is made from atoms of different elements combined in fixed proportions.

• Chemical formula - tells us the proportion of each kind of atom.
  – Examples: CO$_2$, NaCl
Compounds (continued)

• Have different properties from the elements they are made from.
  – NaCl (table salt): Sodium is explosive in water and chlorine is a poisonous gas.
  – H₂O (water): at room temperature, hydrogen and oxygen are gases but water is a liquid
The Atomic Nucleus

- central region of the atom where most of the mass is.
- Discovered by Ernest Rutherford – gold foil experiment (1910)
Rutherford’s Experiment

• Shot Alpha particles at gold foil
  – Alpha particles - positively charged pieces given off by uranium

• When the alpha particles hit a fluorescent screen, the screen glows.
Lead block

Uranium

Gold Foil

Fluorescent Screen
He expected the particles to pass through.

He thought all of the mass of an atom was evenly distributed.
What happened?

Particles deflected in all directions
How he explained it

Atom is mostly empty
Small dense, positive piece at center

Alpha particles are deflected by it if they get close enough because they are positive
Atomic Nucleus

- Atoms are classified by their atomic number. (the number of protons in the nucleus)
- Nucleus contains protons and neutrons.
- The number of protons define the element.
Electrons in the Atom

• Atoms are neutral
  – The number of electrons = the number of protons
  – When not equal, you have an ion not an atom.
  – Arrangement of electrons dictates how atoms combine to form molecules
• Chart that lists atoms by their atomic number and by their electron arrangements.

• Elements arranged so chemical and physical properties have trends following a pattern of repetition.
States of Matter

- 4 states of matter
  - Solid
  - Liquid
  - Gas
  - Plasma

- All substances can be transformed from one state to another

- Changes of state are caused by changing energy which affects the temperature
Atoms in Constant Motion

• Solids – atoms and molecules vibrate around fixed positions.
• Liquids - molecular vibration increases and material takes the shape of their container.
• Gases – molecules gain more energy, they break away from each other.
• Plasma – electrons shake loose of atoms results in free electrons and positive ions.