Concept of the Atom
Leucippus and Democritus, circa 400 B.C.E., Greece

Un-testable hypothesis (at the time):
Matter is composed of indivisible particles
("Atomos" is Greek for "indivisible")

Quantitative measurements
Antoine Lavoisier (1743-1794), French
• Falsified phlogiston theory
• Gave oxygen its name
• Emphasized importance of mass measurements in experiments.

Law of Conservation of Matter:
Matter (mass) is neither gained nor lost in a chemical reaction.

In other words:
The sum of the masses of reactants = The sum of the masses of products*

*There are exceptions in nuclear reactions, due to energy-mass equivalency.

Experimental Evidence for the Existence of Atoms
Joseph Louis Proust (1754-1826), French

Law of Definite Proportions
(or, the Law of Constant Composition)
Elements combine in fixed proportions (by mass).

Example:
Pure water is always 8 parts oxygen and 1 part hydrogen (by mass).

NOTE: There is also a law of multiple proportions, which means that elements can combine in a different fixed proportion to form different compounds.
Example: CO, CO₂ (carbon monoxide and carbon dioxide) from different ratios of C and O.
The Development of Atomic Theory

Experimental Evidence for the Existence of Atoms

Lorenzo Romano Amedeo Carlo Avogadro (1776-1856)

Avogadro’s law: Equal volumes of gases (at the same temperature and pressure) contain the same number of particles.

Example:
1 liter of hydrogen gas and 1 liter of oxygen gas will contain the same number of molecules (if both are at the same temperature and pressure).

John Dalton (1766-1844), British

Put the pieces together to form the first atomic theory!

If elements combined in whole-number ratios, then matter must be made up of discrete particles (called atoms).
Dalton’s Atomic Theory

1. Elements are composed of atoms
   - Solid, tiny, hard, unbreakable, spheres

2. All atoms of a given element are identical
   - Example: All carbon atoms are identical to each other.

3. Atoms of a given element are different from those of any other element
   - Example: Carbon atoms have different chemical and physical properties than sulfur atoms

4. Atoms of one element combine with atoms of other elements to form compounds (in simple ratios).
   - Law of Definite Proportions

5. Atoms are indivisible in a chemical process. Reactions only cause a rearrangement of atoms.
   - Law of Conservation of Mass:
     - Atoms present at beginning are present at the end
     - Atoms are not created or destroyed, just rearranged
     - Atoms of one element cannot change into atoms of another element
     - Cannot turn Lead into Gold by a chemical reaction

Discovery of the Electron

Joseph John Thomson (1856-1940), British

Used the cathode ray tube (modified by Crookes, 1850s) to do experiments that led to the idea of electrons.

Electrons are negatively charged particles that exist in an atom

Thomson won the Nobel Prize in Physics, 1906 for evidence of electrons as particles.

“Could anything at first sight seem more impractical than a body which is so small that its mass is an insignificant fraction of the mass of an atom of hydrogen?”

— J.J. Thomson.

Plum Pudding Model of the Atom

Atoms (matter) is electrically neutral.

If electrons are negatively charged, there must be positive charges to balance the electrons (later, protons were discovered by Goldstein).
Discovery of the nucleus

Ernest Rutherford (1871-1937), British

His famous gold foil experiment proved the existence of the nucleus in atoms and that:
1) The nucleus was composed of dense positive charge (protons).
2) Atoms are mostly empty space

Born and raised on a farm in New Zealand

"All science is either physics or stamp collecting" - Ernest Rutherford

Gold Foil Experiment

Rutherford and JJ Thomson (horsing around?)

http://www.wwnorton.com/chemistry/tutorials/ch3.htm

Rutherford’s Atom

Atoms are not hard spheres!

Due to the gold foil experiment:
1. Atoms are mostly empty space
   (the alpha particles went straight through the gold foil most of the time)
2. Atoms contain a dense nucleus composed of positive charge
   (later, neutrons were discovered and believed to stabilize the protons in the nucleus)