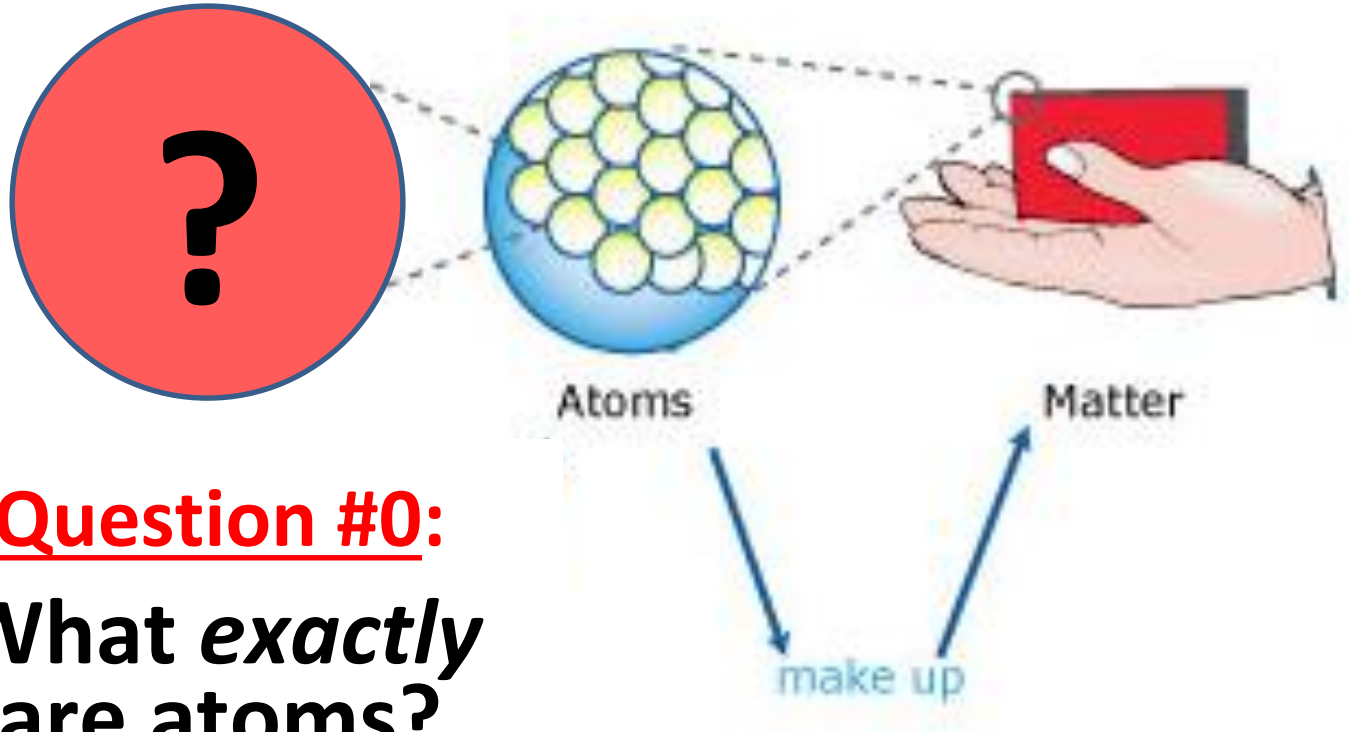
Structure of Matter



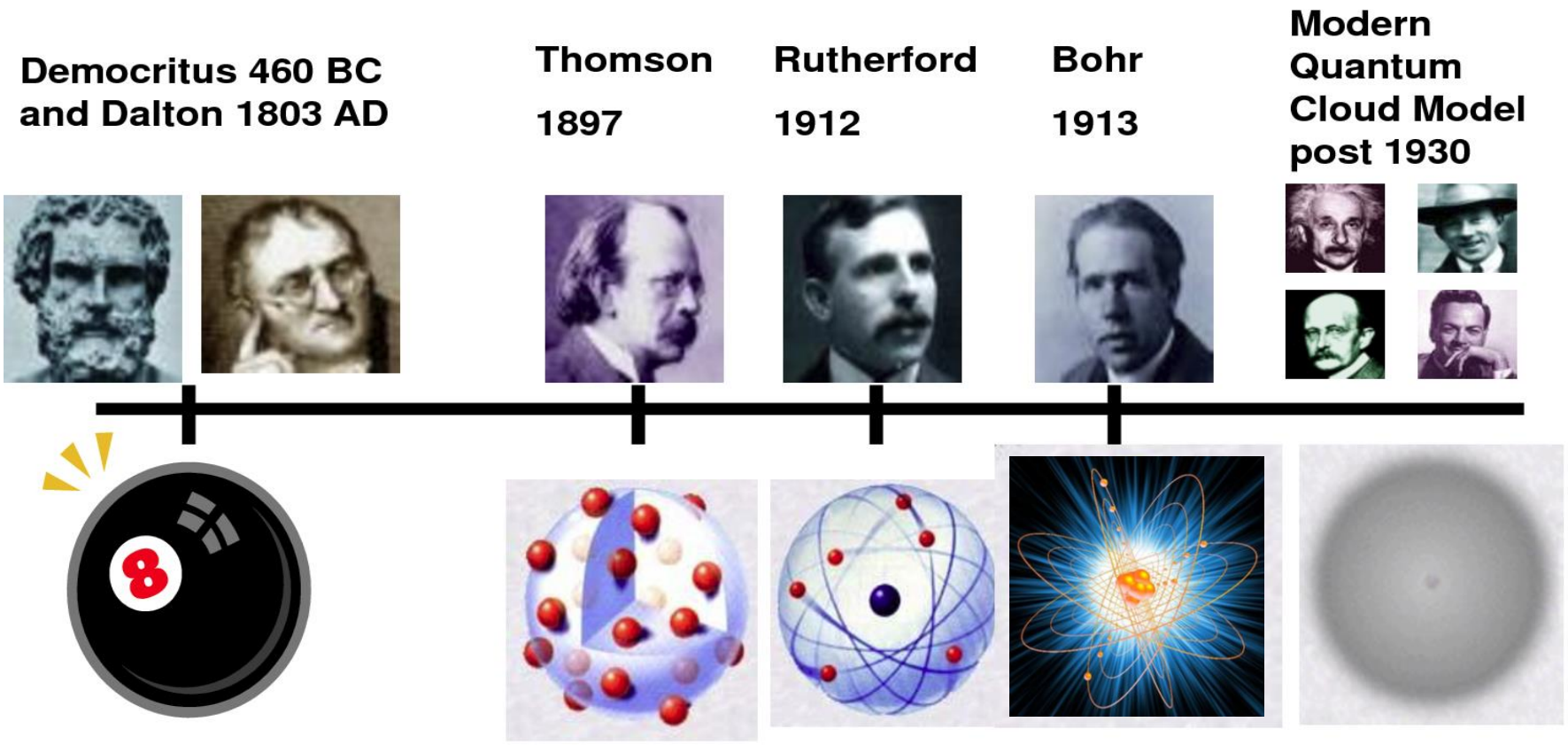
Question #0:

What *exactly* are atoms?

Are they all the same?

If not, what makes them different?

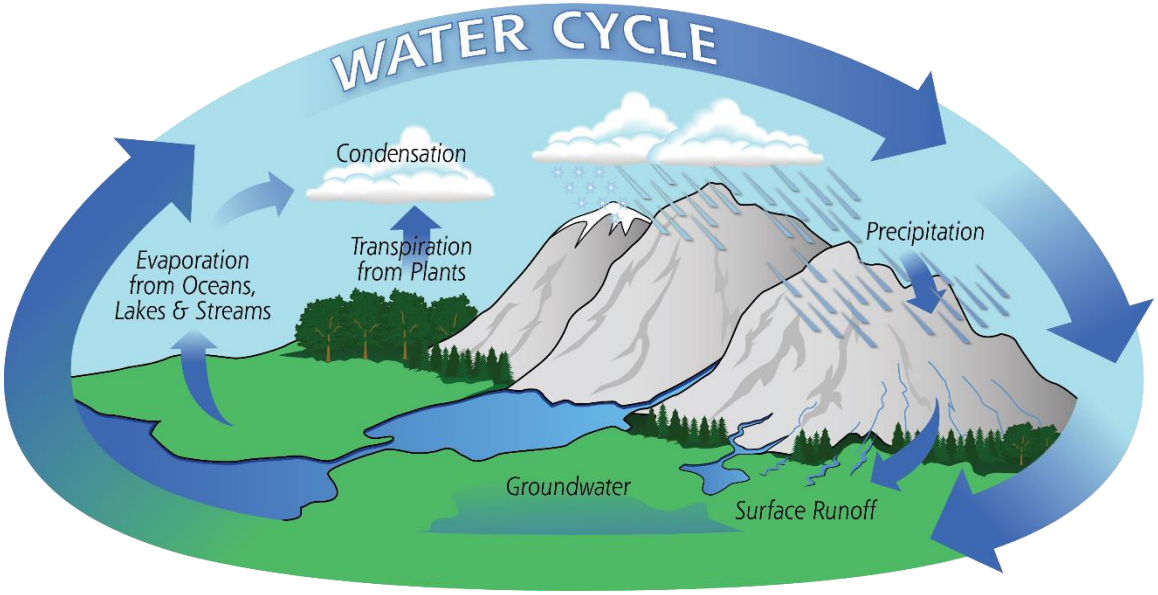
Atomic Theory Development



Born as early as 400 BC, it took more than 2000 years before Science was ready to accept the idea of atomic structure of matter…*and another 150 years to develop a good model!*

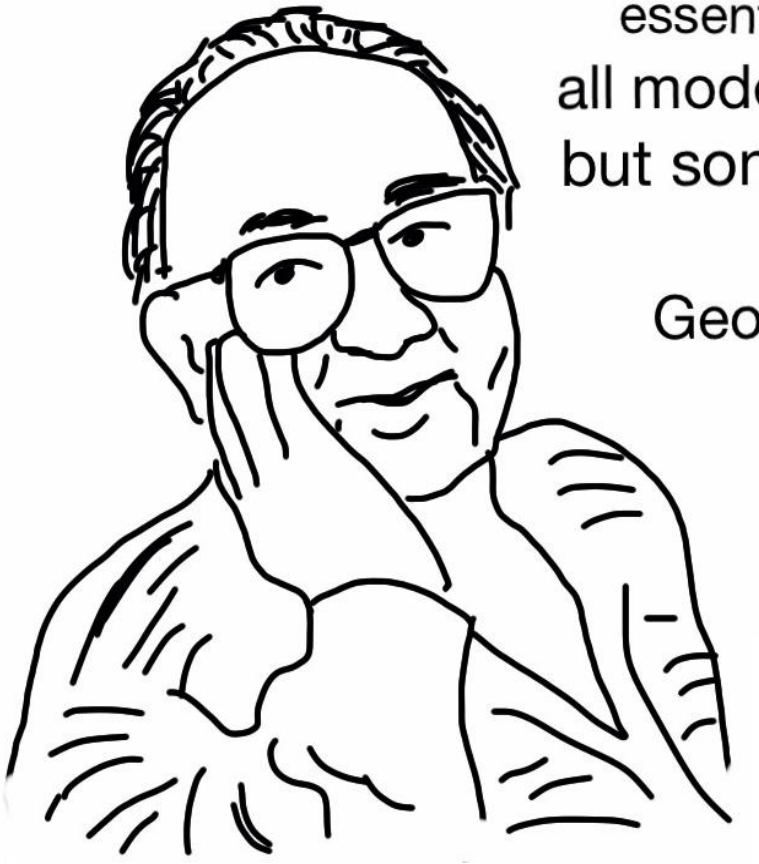
What is a Model?

In Science, a model is a physical, mathematical, or conceptual (abstract) representation of a real phenomenon that is difficult to observe directly – that is, a *convenient substitute*.



Scientific models are used in a variety of scientific disciplines to explain and predict the behavior of real objects or systems.

A Model is Never Perfect



essentially,
all models are wrong,
but some are useful

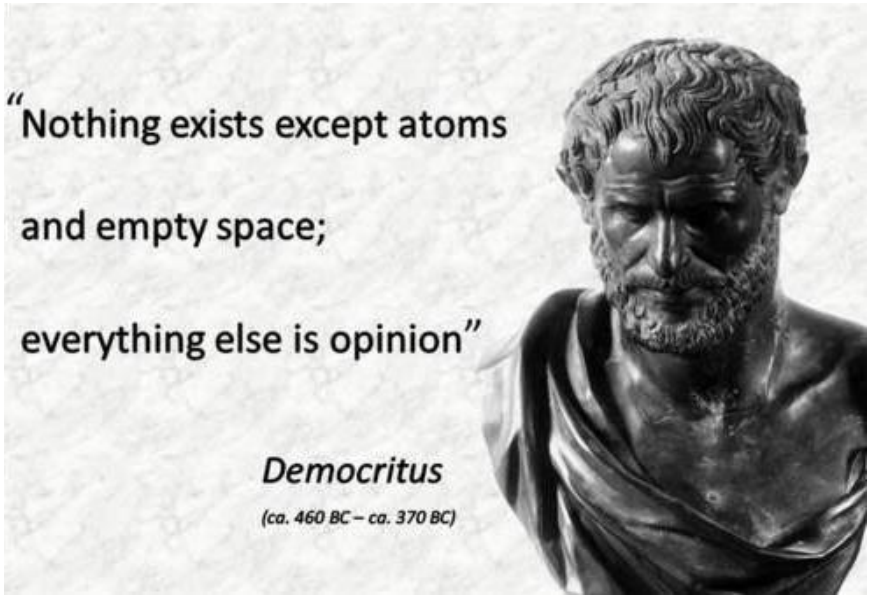
George E. P. Box

(one of the most influential statisticians of the 20th century)

Scientific models are approximations of the objects and systems that they represent!

Scientists are constantly working to improve and refine models.

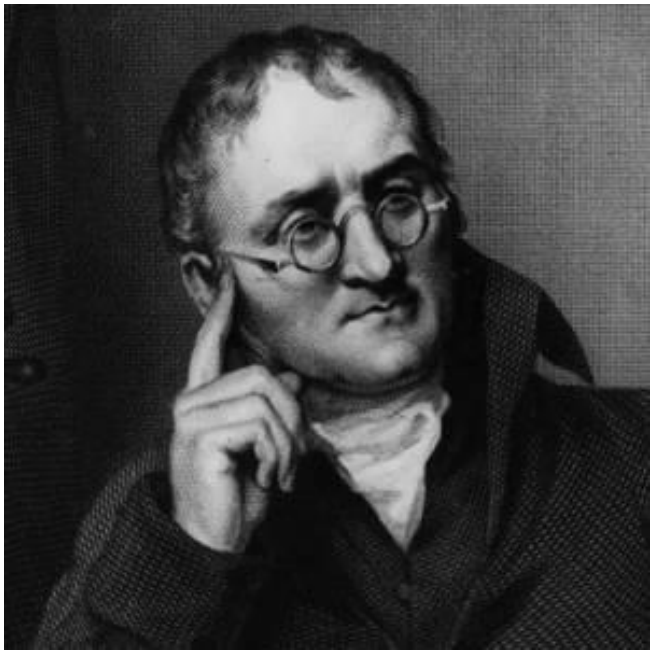
Democritus
~400 BC



"atomos"="not to be cut"

- **Matter could not be divided into smaller and smaller pieces forever, eventually the smallest possible piece would be obtained.**
- **This piece, *atomos* (atom), would be indivisible.**
- **Between atoms, there would be empty space.**
- **To Democritus, atoms were small, hard particles of different shapes and sizes that were all made of the same material.**
- **Atoms were infinite in number, always moving and capable of joining together.**

John Dalton
early 1800s



The first truly scientific theory of the atom: conclusions were reached by experimentation and examination of the results in an empirical fashion.

- **All elements are composed of atoms.**
- **Atoms are indivisible and indestructible particles.**
- **Atom model: a billiard ball or a *marble*.**

HOW?

- **Atoms of the same element are exactly alike.**
- **Atoms of different elements are different.**
- **Compounds are formed by the joining of atoms of two or more elements.**

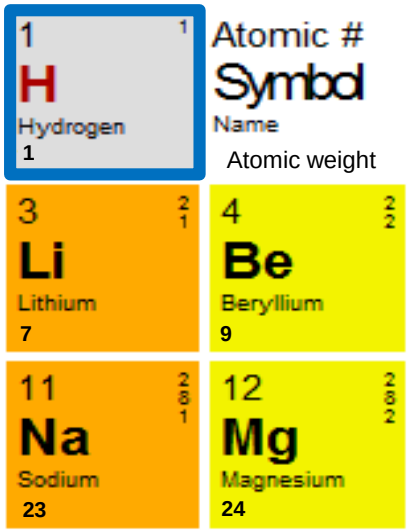
Atomic Weight

- **Atoms of a given element are identical in size, mass, and all other properties.**
- **Chemical compounds are formed when atoms of different elements combine in simple whole-number ratios (example: two hydrogen atoms per one oxygen atom makes one molecule of water).**
- **Atomic weights of elements can be determined by careful studies of chemical reactions!**
- **1803-1805: John Dalton published his first table of relative atomic weights containing six elements:**

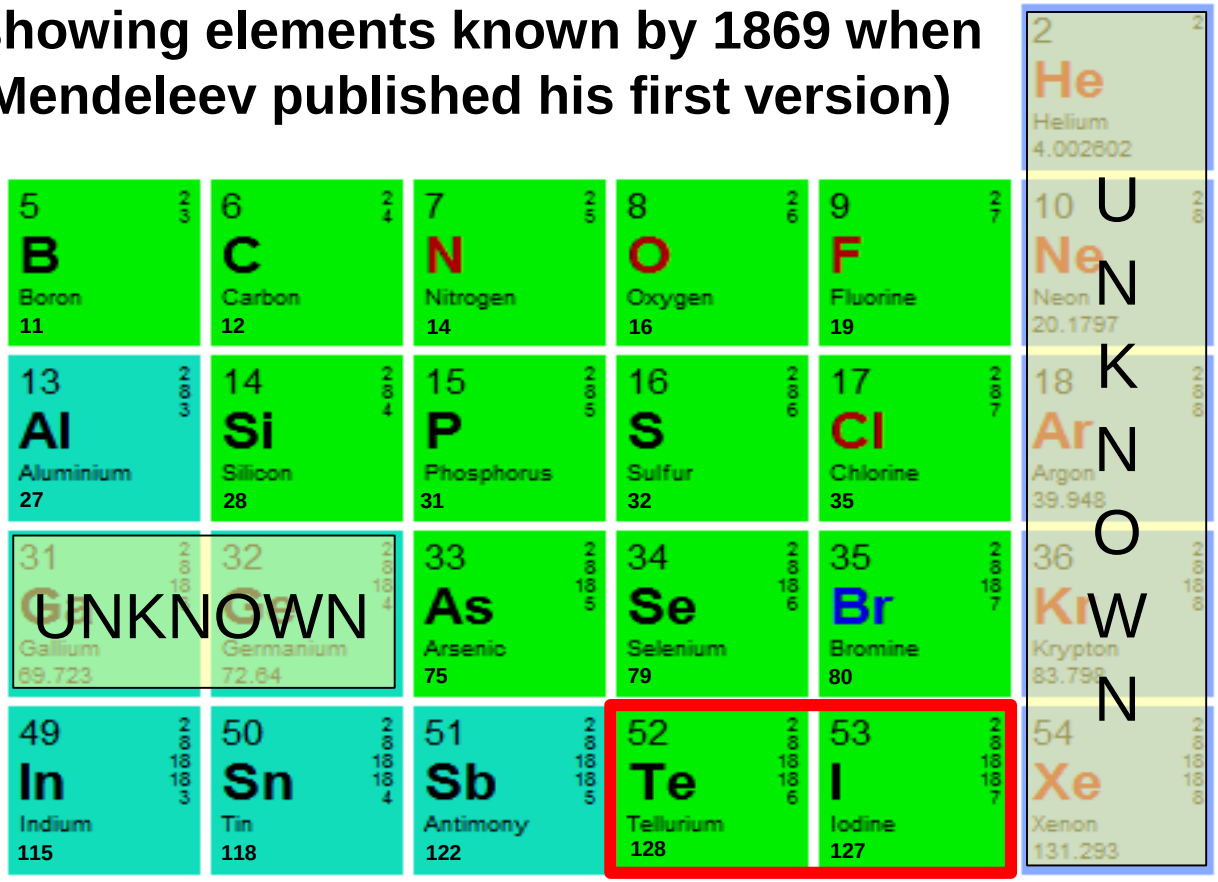
  hydrogen **(conventionally assumed to weigh 1),** ***oxygen, nitrogen, carbon, sulfur,*** **and** ***phosphorus*****.**
- **Dmitri Mendeleev, 1869: periodic table of 66 elements ordered and grouped according to their atomic weight.**

Scientific Mysteries of 1870s

LIGHTEST



Fragment of the Periodic Table (showing elements known by 1869 when Mendeleev published his first version)



Elements are grouped and *ordered* according to their atomic weight…

…but not always!

Puzzling question: what carries electricity?