Is there a **Scientific Method** after all?

Scientists rarely follow *one straightforward path* to understanding the natural world…

In the modern times, we speak of "**practices of science**" —
or the many ways in which scientists look for answers.

OBSERVATION **EXPERIMENTATION**

ANALYSIS **MODELLING**

CLASSIFICATION **SYNTHESIS**

Change of Matter

REVIEW

A ***physical change*** **does NOT alter** the composition or identity of a substance.

- **Change of size**
- **Change of form**
- **Change of state**
- **Mixing**
- **Motion**
- **Etc.**

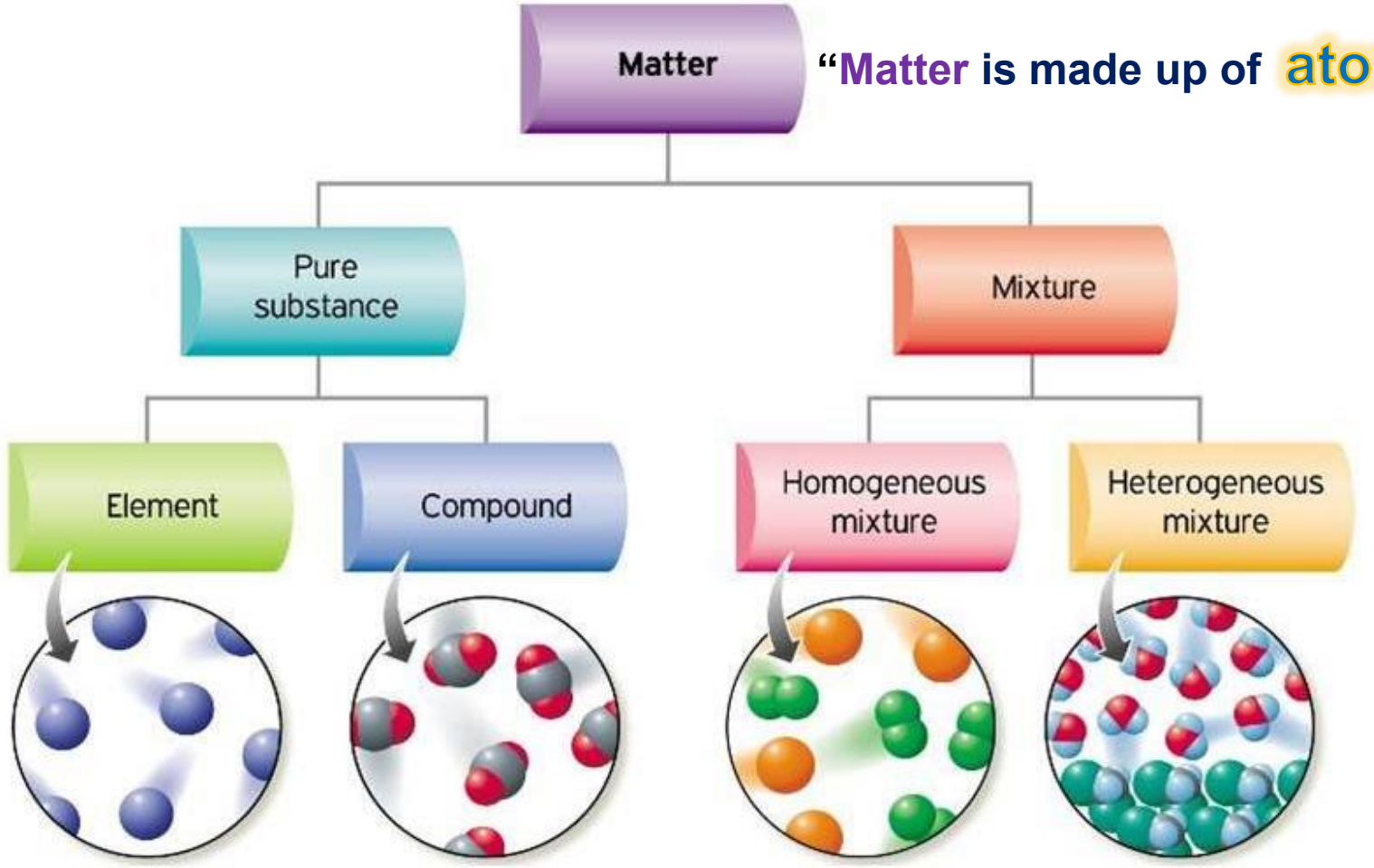
VS

A ***chemical change*** **does alter** the composition or identity of the substance(s) involved.

- **AKA Chemical reaction**
- **Hard to reverse**
- **Basis for life!**

Classification of Substances

REVIEW



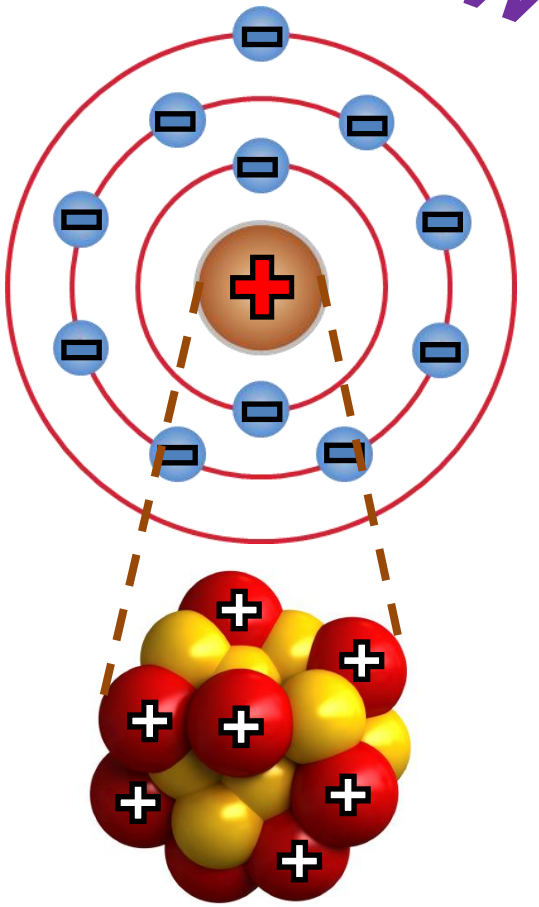
"Matter is made up of atoms"

"Single kind"

Atomic Structure

REVIEW

- **All atoms have:**
  - a positively charged nucleus
  - and negatively charged electrons moving around within atomic orbitals
- **Atomic nucleus consists of:**
  - positively charged protons
  - and neutrons that have no electric charge
- **Atoms are neutral:**
  # of protons = # of electrons



Atom ~10^{-10}m
Nucleus ~10^{-14}m
Proton/Neutron ~10^{-15}m
Electron <10^{-18}m

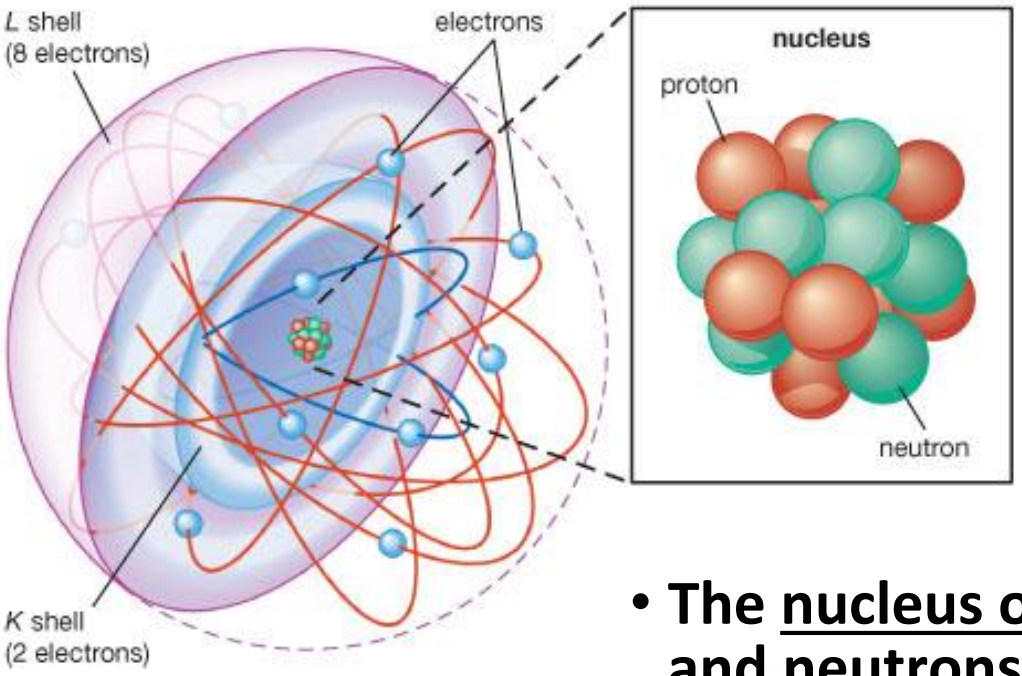
Elements and Isotopes

REVIEW

- **The <u>number of protons</u> in the atomic nucleus (aka *atomic number*) defines the "kind of atom", or the <u>identity of a chemical element</u>.**

- **<u>Isotopes</u> are different <u>forms of a given element</u> that have the same number of *protons* in each atom but differ in number of *neutrons*.**

What Holds an Atom Together?



- **The <u>electrons</u> are kept in orbit around the nucleus due to an <u>electromagnetic field</u> of attraction between the positive (+) charge of the protons and the negative (-) charge of the electrons.**

- **The <u>nucleus of protons and neutrons</u> is kept together by the <u>nuclear (strong) force</u>, which *opposes and overcomes the electromagnetic repulsion when particles are very close to each other (~1 fm!)*.**