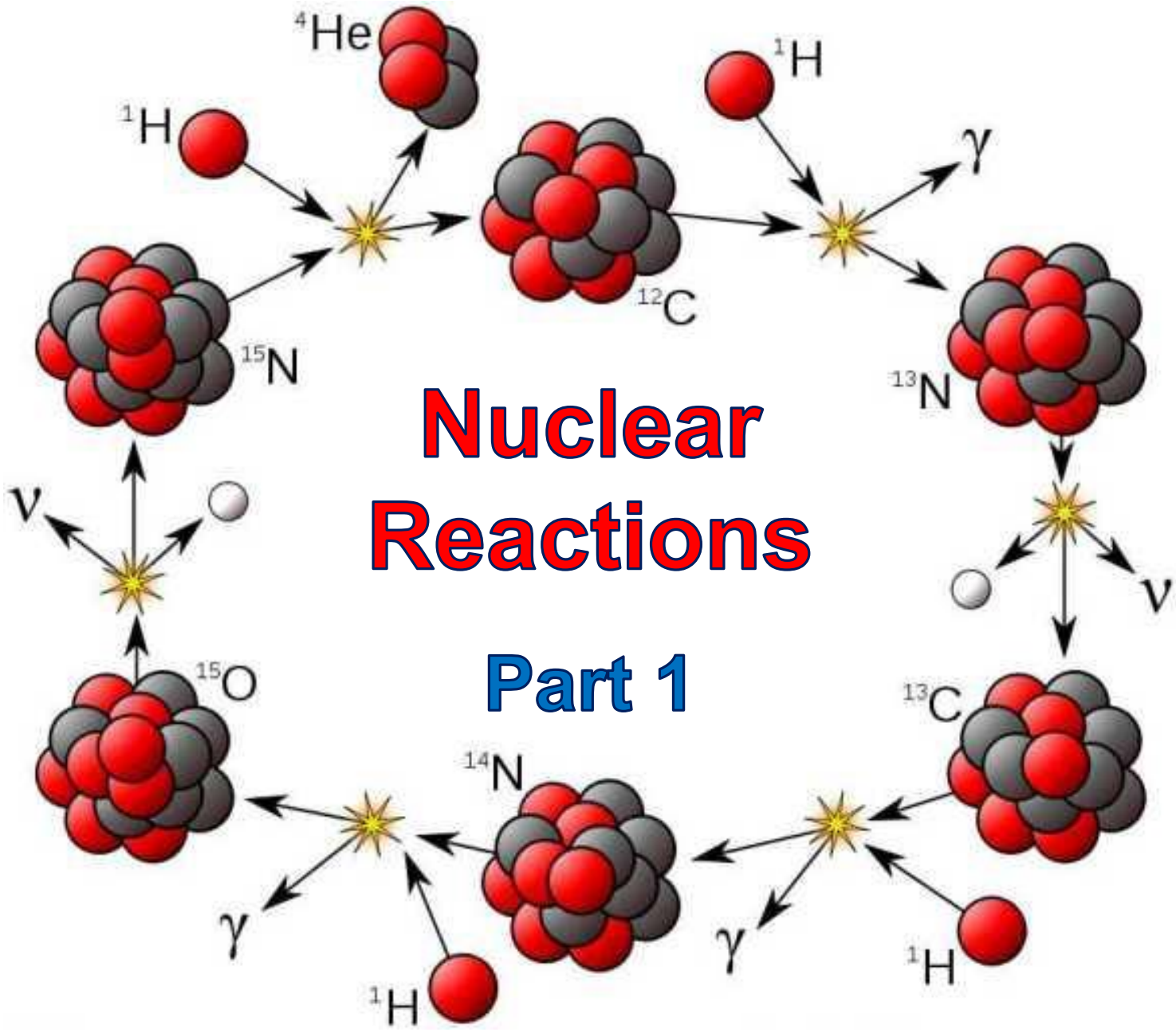


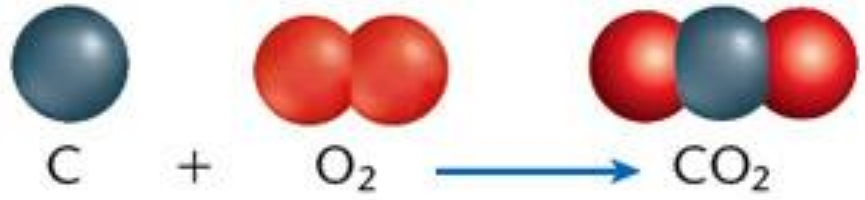
Nuclear Reactions

Part 1

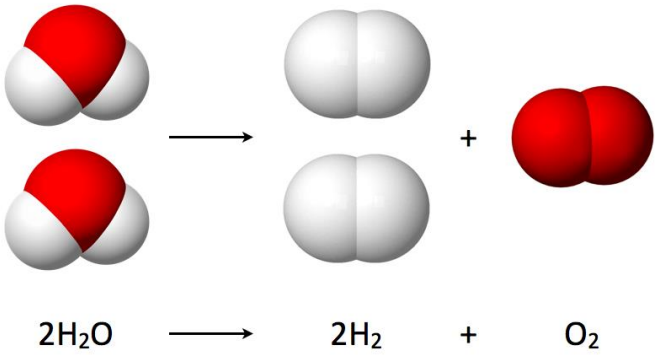
Review: Chemical Reactions

Change of matter that involves *bonding*, *separating* or *rearranging* of two or more atoms.

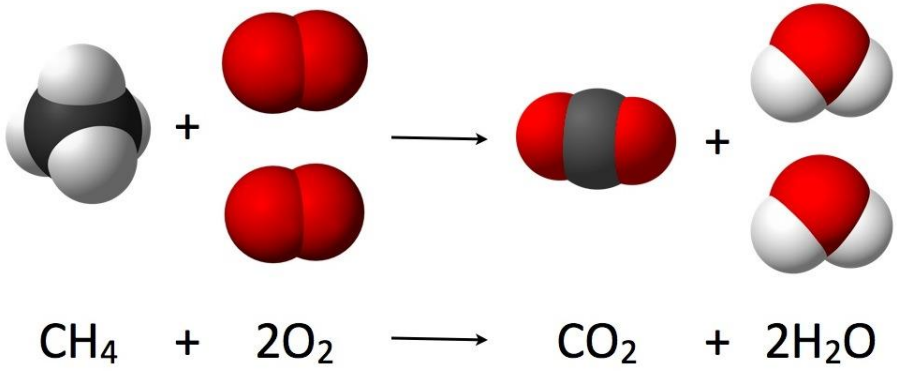
Formation of Carbon Dioxide



Electrolysis of Water



Combustion (burning) of Methane



Nuclear Reactions

involve change of the atomic nucleus

1. **Radioactive decay** – an unstable nucleus spontaneously emits a small particle of **ionizing radiation** to become a **different isotope** of the same element or a **different element** (the latter process is called ***transmutation***).

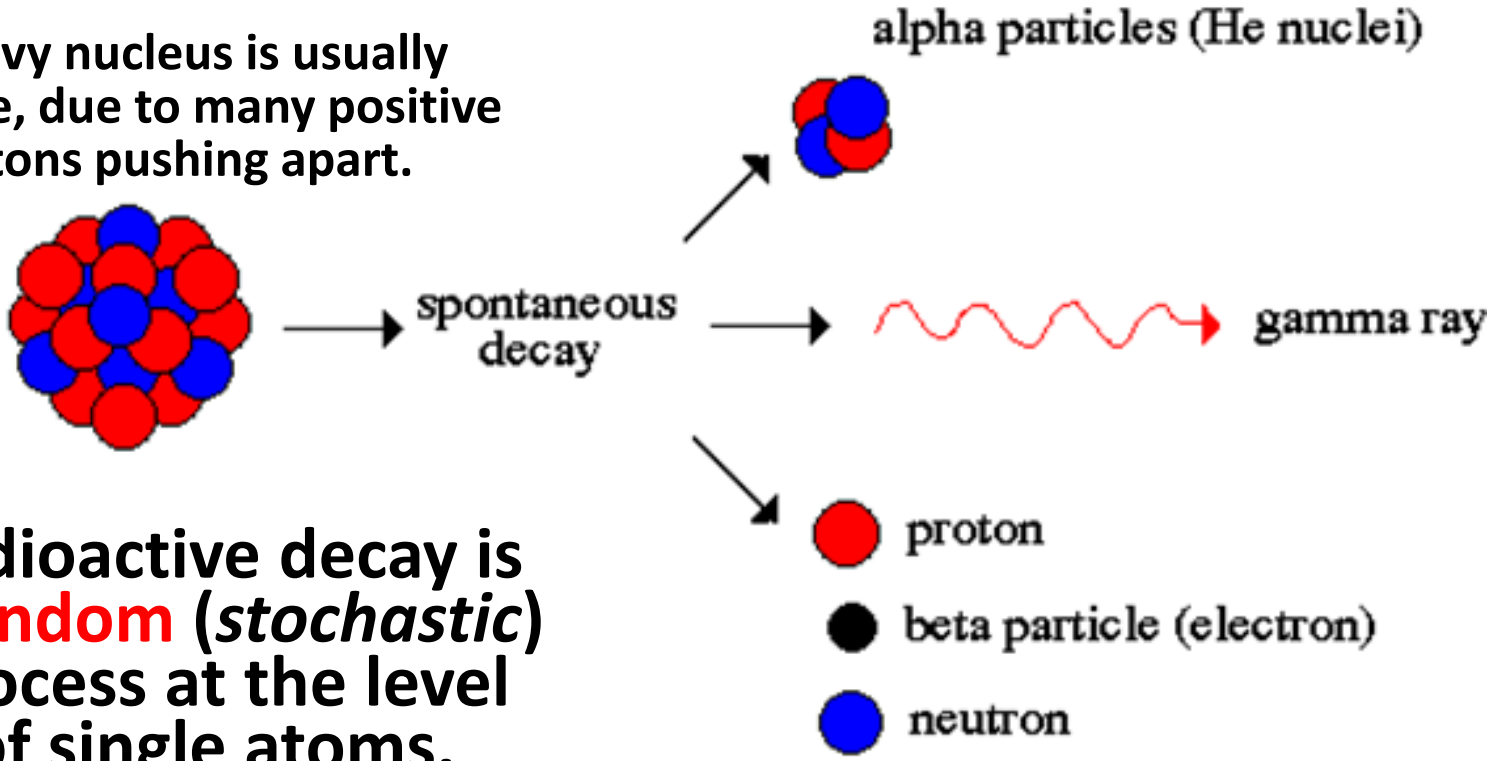
2. **Nuclear Fusion** – the **joining** of two atomic nuclei to form a larger one.

3. **Nuclear Fission** – the **splitting** of an atomic nucleus into two smaller ones.

Radioactive Decay

Radioactive decay, also known as radioactivity or nuclear decay, is the process by which a nucleus of an unstable atom loses energy by emitting ionizing radiation: ^4He (alpha particles), β particles (electrons), γ rays (energetic photons), neutrons.

A heavy nucleus is usually unstable, due to many positive protons pushing apart.



Radioactive decay is a random (*stochastic*) process at the level of single atoms.

Ionizing Radiation can pose a serious health threat to humans: it is capable of changing the basic makeup of atoms and molecules in cells, and more specifically the DNA molecules inside of cells.

Alpha Particle

LARGE PARTICLE, TRAVELS A FEW INCHES

STOPPED BY A SHEET OF PAPER

- interacts strongly with matter
- unable to penetrate the outer layer of dead skin cells
- capable of causing serious cell damage if an alpha emitting substance is ingested in food or air

Beta Particle

VERY SMALL PARTICLE, TRAVELS A FEW FEET

STOPPED BY WOOD, PLASTIC OR ALUMINUM

- can penetrate skin a few centimeters
- main threat is still primarily from internal emission from ingested material

Neutron

SMALL PARTICLE, TRAVELS A FEW FEET

ENERGY ABSORBED BY WATER AND CONCRETE

- the only type of radiation that is able to turn other materials radioactive

Gamma Ray

HIGH ENERGY, TRAVELS LONG DISTANCES

ENERGY ABSORBED BY HEAVY METALS AND CONCRETE

- very high energy electromagnetic radiation
- cause diffuse damage throughout the body (“radiation sickness”)

Half-Life of Radioactive Isotope

The decay rate of a radioactive isotope is characterized by its half-life: the *time it takes for one-half of the atoms* of a radioactive material *to disintegrate*.

Radioisotope	Half-life
Polonium-215	0.0018 seconds
Bismuth-212	60.5 seconds
Sodium-24	15 hours
Iodine-131	8.07 days
Cobalt-60	5.26 years
Radium-226	1600 years
Uranium-238	4.5 billion years