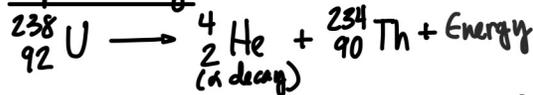# Nuclear Energy

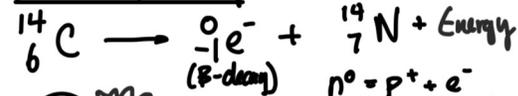**Nuclear Energy** is the *energy* (*heat or light*) produced through the decay (*breakup*) of **unstable isotopes** during the nuclear decay process.

Alpha Decay

$$^{238}_{92}U \longrightarrow \, ^{4}_{2}He + \, ^{234}_{90}Th + Energy$$
(α decay)

Bonds (p^+-n°; p^+-e^-) are broken. Each bond broken release energy.

Beta (β-) Decay

$$^{14}_{6}C \longrightarrow \, ^{0}_{-1}e^- + \, ^{14}_{7}N + Energy$$
(β-decay)

$n^\circ = p^+ + e^-$
The p^+-e^- bond is broken releasing energy (more than α)

Energy between Subatomic Particles is released with these particles decay (*break apart*). Alpha Decay break 4 subatomic particle bonds, while in Beta Decay, a neutron breaks apart into a proton and beta particle. More particle bonds broken = more energy produced.
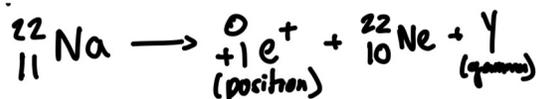
13

Gamma Radiation

Gamma Radiation is a byproduct of other nuclear decay processes (*such as alpha and beta decay*)

A **Gamma Ray** is a small high energy packet of light (*photon*) that is produced due to extra energy of an *excited atom*.

An *excited atom* when extra energy is added to an atom after a particle decays into a more stable isotope

$$^{22}_{11}Na \longrightarrow \, ^{0}_{+1}e^+ + \, ^{22}_{10}Ne + \gamma$$
(positron) (gamma)

Unstable Isotope → energy → Excited Extra Energy → energy → Stable Isotope

The positron (e^+) decay above *excites* the new atom Ne-22, which then quickly releases the energy as a gamma ray particle

14

1

Effects of Nuclear Radiation

The **energy of radiation** is based on the mass of the radiation particle and the energy of the particle itself.

Alpha Decay	**Beta Decay**	**Gamma Decay**
4 Subatomic Particles	Proton and Electron	Photon from Atom
High Energy, High Mass	Lower Energy, Low Mass	Low Energy, No Mass
Large Size	Small Size	Smallest Size
Lowest Penetration	Medium Penetration	High Penetration
Stopped by Paper	Stopped by Aluminum	Not Stopped

Penetration of nuclear decay is based on the relationship between the **particle energy** and the **size** of the particle itself.

15

Dangers of Nuclear Radiation

Nuclear Radiation procedures energy that can have dramatic effects on the body through simple exposure to radiation. The most common health effects of radiation include:
- Mutations or Changes in Cells of DNA
- Cancers and Changes in Cell Growth
- Radiation Sickness

People / Workers in the following areas are at greater risk: Radiologists, Nuclear Power Plant Workers, Cancer Doctors
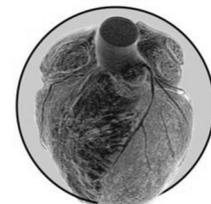

CT Scans
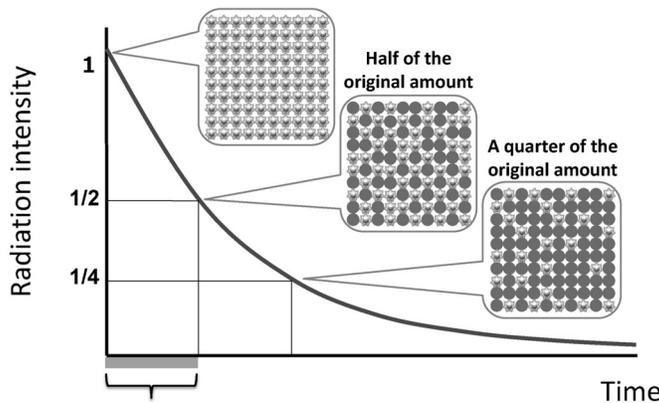
Nuclear Workers

Natural Background Radiation

Nuclear Medicine

16

Nuclear Decay Rate

Based on the stability each isotope of an atom has a chance to decay every moment of time.
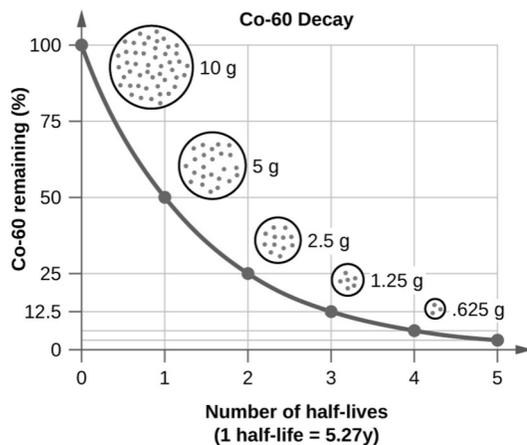

Each isotope will decay over time, the rate starting fast (*more particles can decay*) then slowing down (*less particles to decay*) over time as the sample decays. The decay rate is based on the **stability of the atoms** in the sample.

17

Nuclear Half Life

The time for particles to decay is based on the stability of particles

The **Half-Life** of a particle is the time it takes for half (50%) of the particles to decay from the original isotope state.

More Stable = Longer Half Life
Less Stable = Shorter Half Life

Nuclear Decay is an *inverse function* with a negative slope

18