

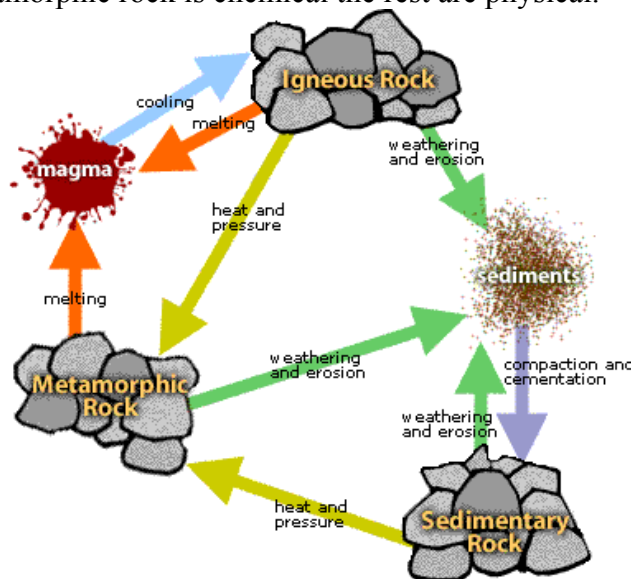
Objective 4 Physical & Chemical Change

Distinguish between physical and chemical changes in matter such as oxidation, digestion, changes in state and stages in the rock cycle

- A *physical change* is a change that affects only the physical properties (color, size, state etc.) of a substance.
- A *chemical change* is a change in a substance that involves the breaking and reforming of chemical bonds to make a new substance or substance.

Examples to know:

- Oxidation is an example of a chemical reaction in which an atom or molecule becomes more positively charge.
- Digestion is an example of a process in which both physical and chemical changes are present. If you take a bite of an apple and chew up the piece of apple in your mouth, you have experienced a physical change. You have broken down the apple into smaller pieces with no change coming to its chemical structure. The chemical changes of digestion begin in your mouth with enzymes in your saliva. The chemical changes continue in your stomach where enzymes and acids break down the food and begin break the chemical bonds and form new substances that the body can use.
- Changes in state are example of physical changes. The best example of the changes in state can be done with water. Water changing from ice, to liquid, to vapor are all examples of physical changes. Ice, liquid water, and water vapor are all water (the chemical formula is still H₂O), they have just changed their state.
- The rock cycle is another example of a process in which there are examples of both physical and chemical changes. A rock that is broken down by weathering and erosion has experienced a physical change. The rock has just been broken down into smaller pieces. A rock that is buried under immense pressure and heat over a long period of time will experience a chemical change. The rock's chemical structure will be broken down and reformed as another type of rock. Making Metamorphic rock is chemical the rest are physical.





Nuclear change: change in the composition of the nucleus

Nuclear reactions involve the atomic nucleus. Regular chemical reactions involve only the outer electrons of atoms. In a chemical reaction, elements do not change from one to another. When an atomic nucleus changes, it is very probable that the products will be different elements than the reactants.

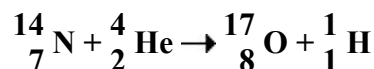
The energy needed to change an atomic nucleus is much greater than the energy needed to rearrange the valence electrons of atoms.

Fission is a nuclear reaction in which a very heavy nucleus is split into two approximately equal fragments. This process, known as a **chain reaction**, releases several neutrons which in turn split more nuclei. If it is not controlled, a nuclear explosion can occur.

Fusion is a nuclear reaction in which two or more small nuclei are forced together to form one larger nucleus. The energy released during a fusion reaction is much greater than in a fission reaction.

Transmutation - a change in the number of protons in the nucleus producing an atom with a different atomic number.

Transmutation can be represented with a nuclear equation. The earliest artificial transmutation was performed by Lord Rutherford in 1911. Nitrogen-14 was bombarded with alpha particles, producing Oxygen-17 and protons. The nuclear equation for this reaction looks like this:



This is a balanced equation. The total **mass number** (top) is 18 on both sides and the **total charge** (bottom) is +9 on both sides. Changing the nucleus of an atom often turns it into another element. For this reason, you rarely have the same elements on both sides of balanced nuclear equations.

Nuclear equations must be balanced just like regular chemical equations.

To balance nuclear equations, follow these two rules:

1. **Mass number is conserved in a nuclear change.**

The sum of the mass numbers before the change must equal the sum of the mass numbers after the change.

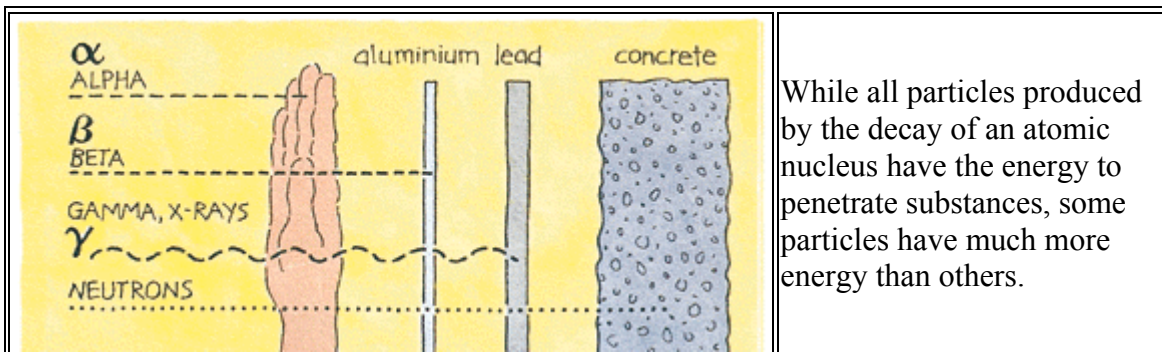
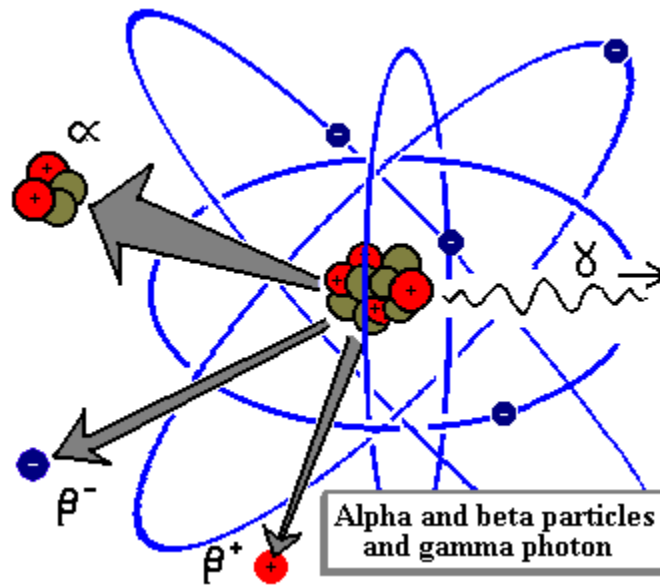
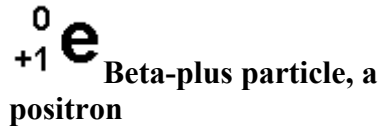
2. **Electric charge is conserved in a nuclear change.**

The total electric charge on subatomic particles and nuclei before and after the change must be equal.

This is a nuclear chemical symbol:

- ✓ The element is represented by its chemical symbol.
- ✓ The top number is the **mass number** - total protons and neutrons.
- ✓ The bottom number is the **atomic number** - number of protons, or positive charges.

Nuclear particles and nuclear equations:

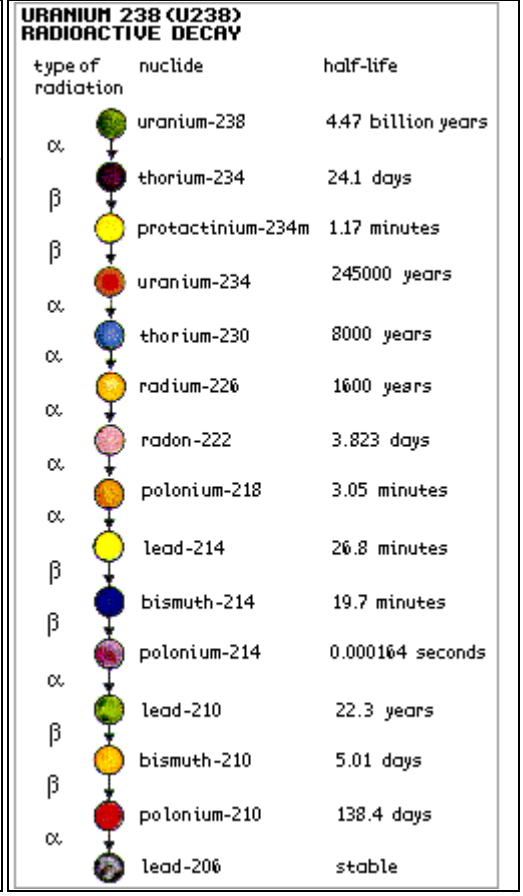


Half-life: The length of time it takes for one-half of the atoms of a radioactive nuclide to disintegrate.

Many radioactive particles decay into other radioactive particles, however, the final product of radioactive decay will always be a stable substance.
 Uranium-238 goes through a long sequence of decays before it finally becomes stable.
 The 14 individual decays that lead from U-238 to Pb-206 are shown here.

How many alpha particles are released?

How many beta particles are released?



Radiation and living things:

All radiation, whether particles or waves, has an effect on living things. If the radiation has enough energy, it can penetrate living cells and disrupt their processes. This is particularly dangerous if DNA or RNA molecules are affected. Very small changes in this genetic material can cause mutations and cancer. Large amounts of radiation released into the upper atmosphere can quickly travel around the world.. Because of the dangers involved, the measurement of radiation around living things is important. Radiation used to be measured in **rads** and **rems**.