

Nuclear processes:

Students will develop models to illustrate the changes in the composition of the nucleus of the atom and the energy released during the processes of fission, fusion, and radioactive decay. (HS-PS1-8)

1. (PS1-8.1) I can compare and contrast the process of fission and fusion
2. (PS1-8.2) I can predict the results of transmutation through alpha and beta decay
3. (PS1-8.3) I can model the changes in composition of the nucleus during fission, fusion, and radioactive decay.

Vocabulary:

Radioactive decay

Isotope

Alpha particle

Beta particle

Transmutation

Strong Nuclear Force

Fusion

Fission

<https://www.youtube.com/watch>

Vocabulary:

Nuclear Reaction: a process in which there is a change in the nucleus of the atom

Strong Nuclear Force: force that holds protons and neutrons together

Fission: The splitting of an atomic nucleus into smaller parts.

Fusion: process in which the nuclei of two atoms combine to form a larger nucleus

Isotope: atoms of the same element with different numbers of neutrons (therefore different mass numbers)

Radioactive decay: The release of nuclear particles and energy due to the decay of the unstable nuclei of atoms

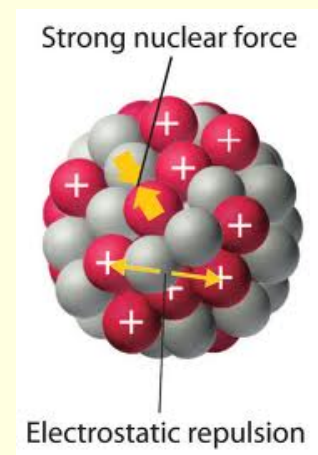
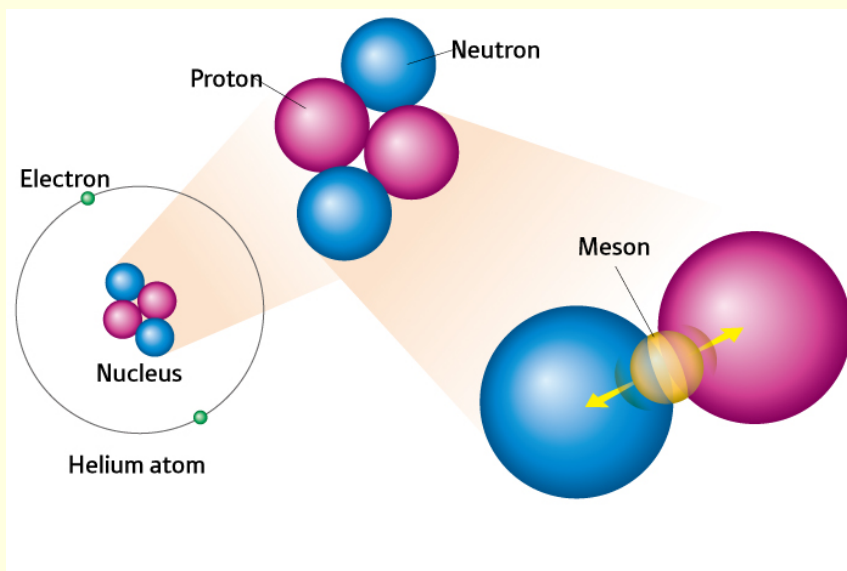
Alpha particle: 2 protons and 2 neutrons are given off
atomic mass decreases by 4
atomic # decreases by 2

Beta particle: neutron splits into a proton and electron
high energy electron given off
atomic mass -no change
atomic # increase by 1

Transmutation: the changing of one element to another through radioactive decay

Strong nuclear force

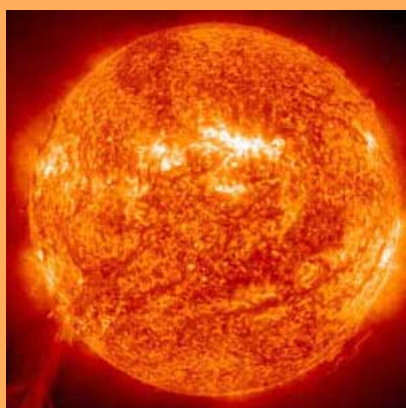
Holds protons and neutrons in the nucleus



It's difficult to break apart or combine nuclei.

Nuclear Reaction:

a process in which there is a change in the **nucleus** of the atom



sun -- fusion



atomic bomb-- fission

crash course - fusion and fission

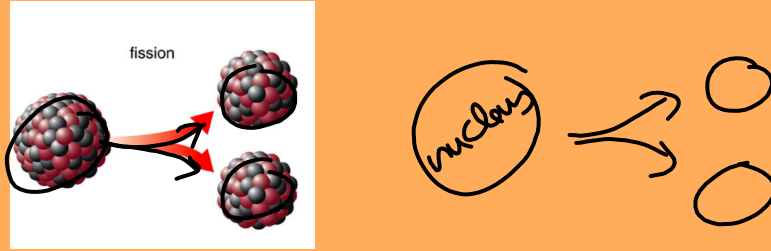


(a chemical reaction involves electrons only)

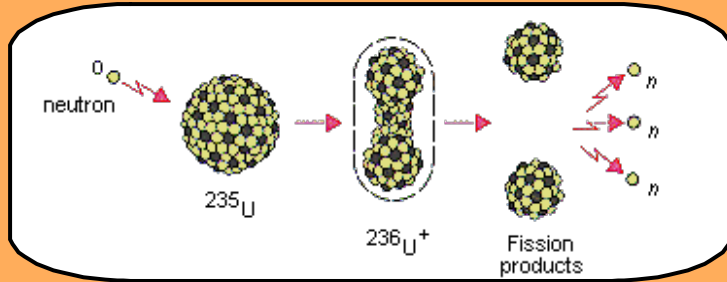
I can compare and contrast the process of fission and fusion

Fission

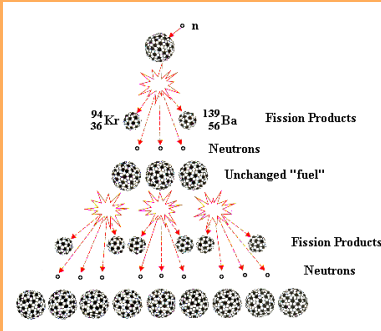
The splitting of an atomic nucleus into smaller parts.



Tremendous amounts of energy can be produced from a very small amounts of mass.

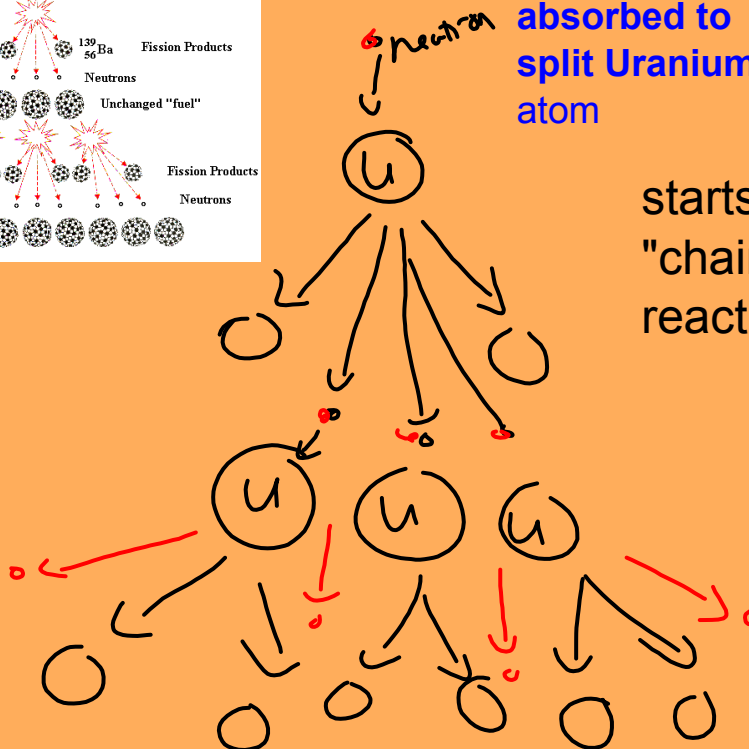


nuclear reactors for energy



neutron is absorbed to split Uranium atom

starts a "chain" reaction



fission and fusion



What is the difference between a chemical and nuclear reaction?

What is a chain reaction?

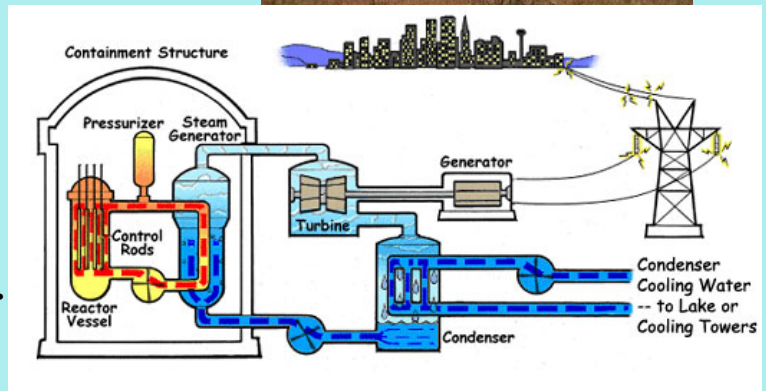
Fission Reactions

1. Nuclear power plants

Fuel rods enriched with ${}_{92}^{235}\text{U}$ are used to heat water or steam. The water or steam goes on to power a steam turbine.

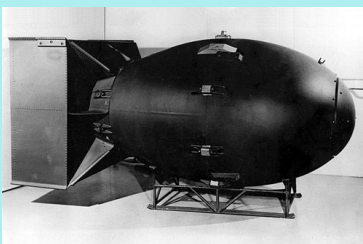


A containment vessel surrounds the reactor so no radiation escapes.



2. Nuclear bombs

A core of ${}_{92}^{235}\text{U}$ is forced to undergo fission when a uranium bullet fires into the core on detonation, forcing the core to critical mass.



Bombing in Japan, 1945



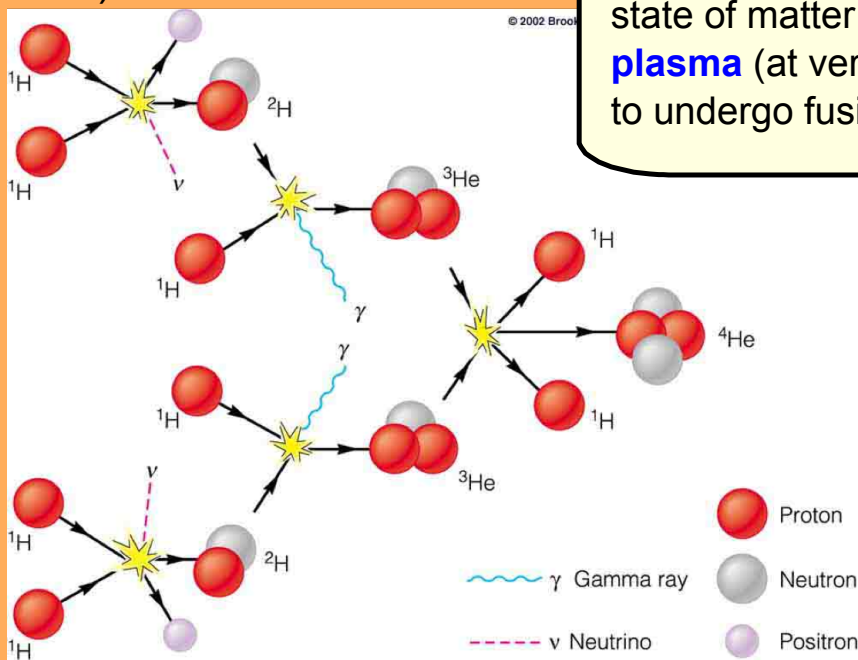
<http://www.youtube.com/watch?v=aMYYEskVHvk>

Fusion

A process in which the nuclei of two atoms combine to form a larger nucleus.

Sun goes through the process of fusion. (Hydrogen turns into Helium)

state of matter must be **plasma** (at very high temps) to undergo fusion

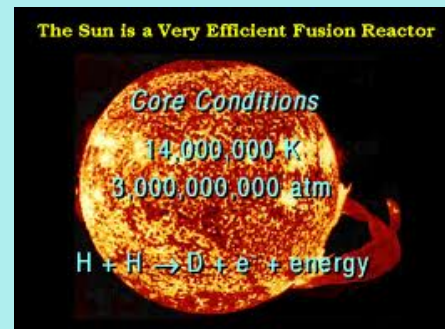
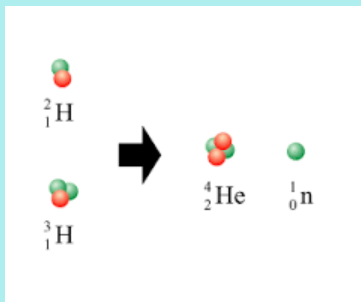


Fusion Reactions

1. Occur in the core of the sun and all stars,

hydrogen is turned into helium.

This is how the sun produces energy.



2. Hydrogen bombs work by fusion.

A standard nuclear fission bomb (uranium and plutonium) goes off, heating hydrogen isotopes under high pressure, which causes the hydrogen isotopes to begin fusing.

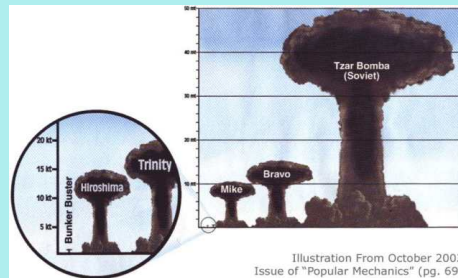


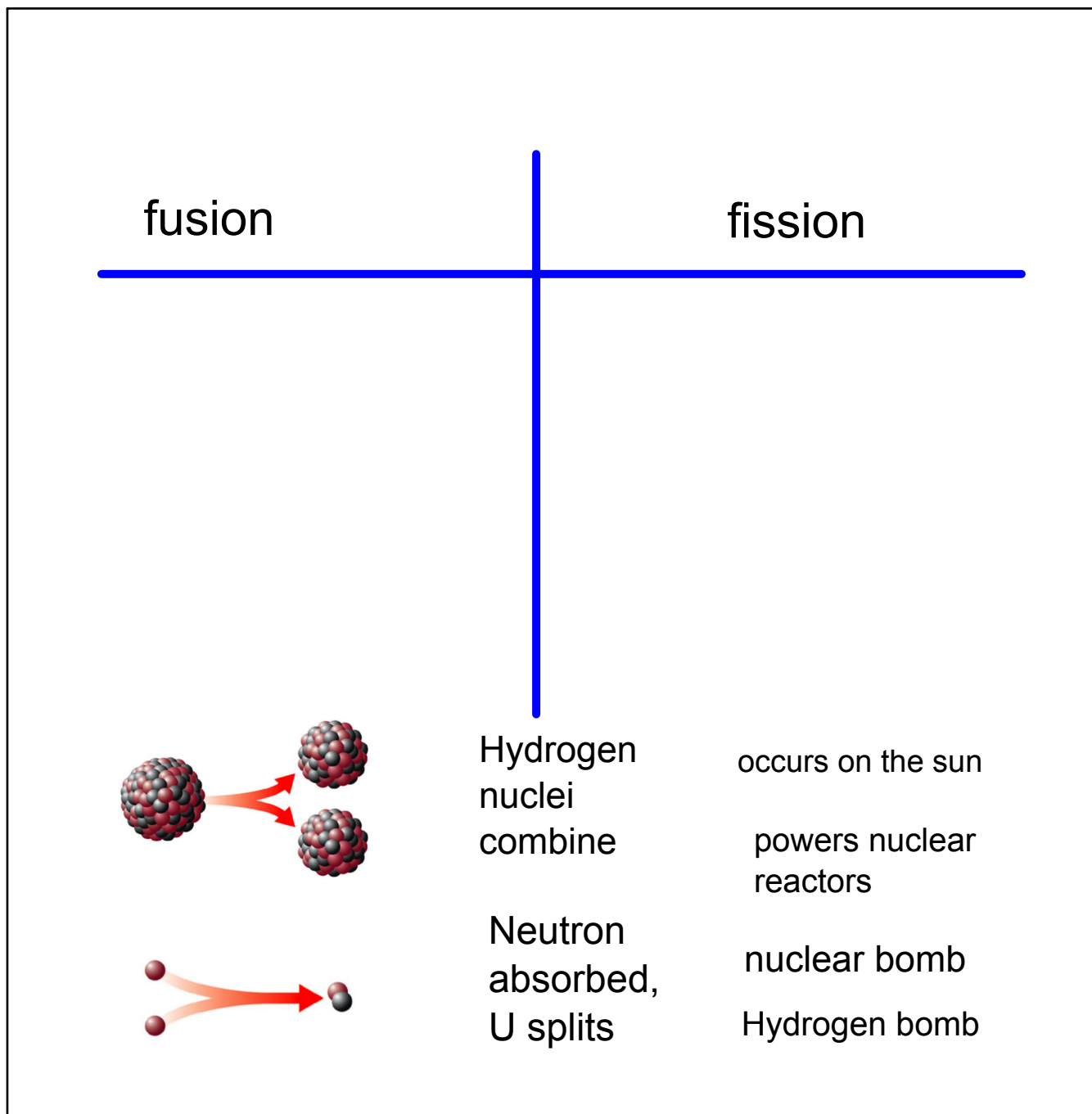
Illustration From October 2002 Issue of "Popular Mechanics" (pg. 69)

H-bomb

3. Energy of the future?

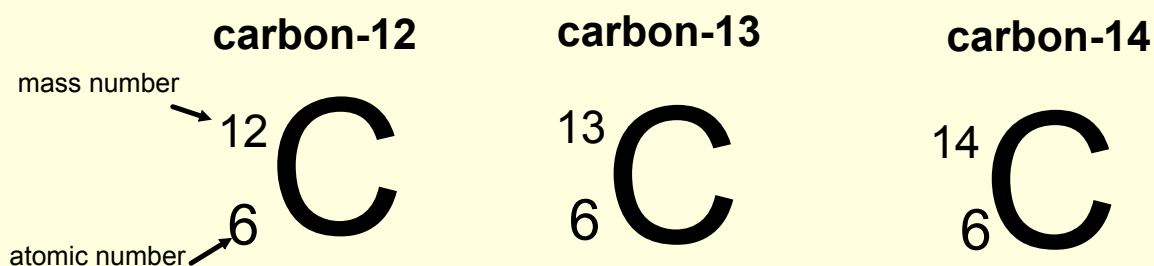
Wendelstein 7-X

fusion as energy source



isotopes:

atoms of the same element with different numbers of neutrons
(atomic masses are different as well)



What is in each nuclei?

$$p^+ = \underline{\quad}$$

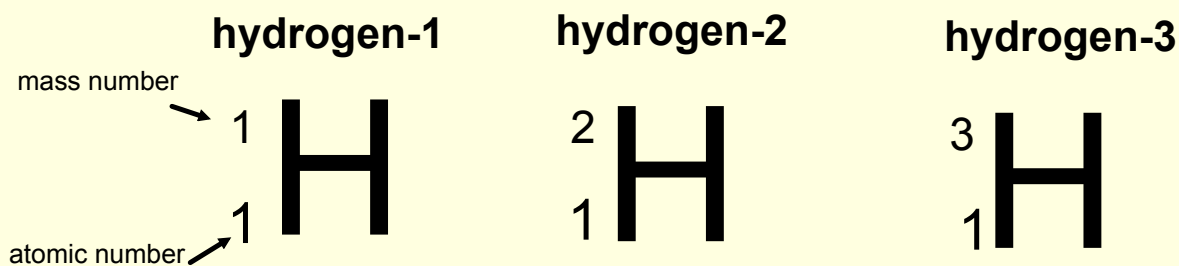
$$p^+ = \underline{\quad}$$

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$$n^0 = \underline{\quad}$$

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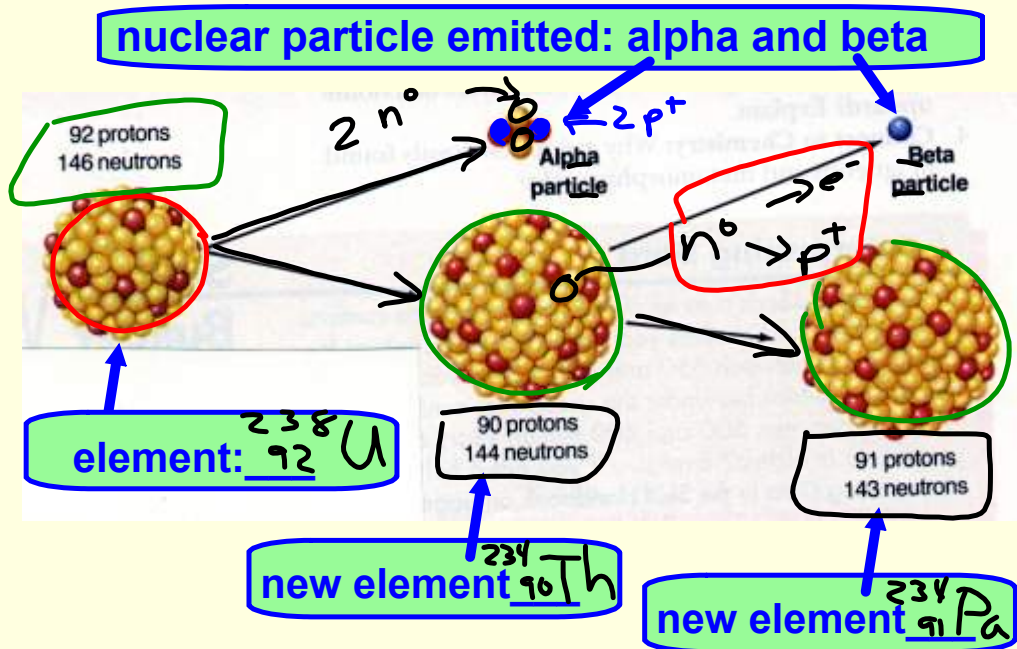
$$n^0 = \underline{\quad}$$



Draw the nuclei:

Radioactive decay

The release of nuclear particles and energy due to the decay of the unstable nuclei of atoms



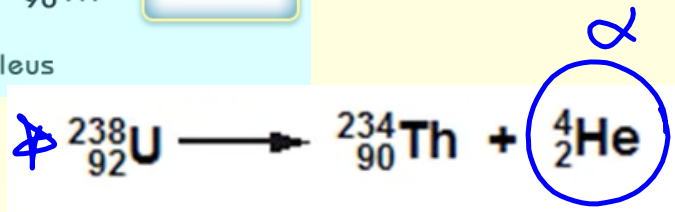
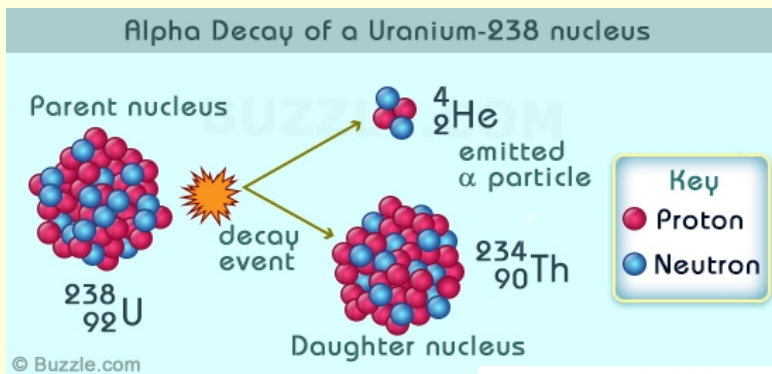
Transmutation

changing of one element to another through radioactive decay

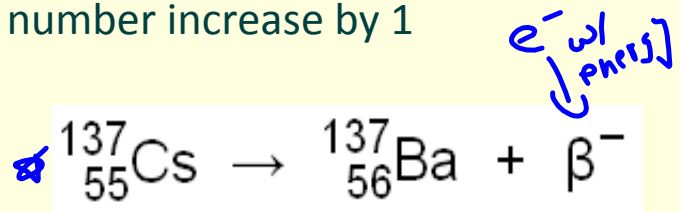
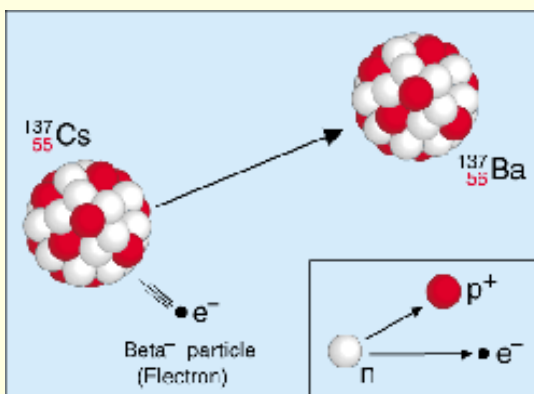
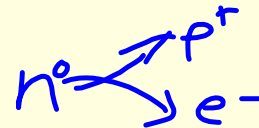
Elements can radioactively decay

-emit alpha, beta or gamma particle
and can transmutate (change) to new element

- **Alpha particle-** (stopped by paper) α
2 protons and 2 neutrons are given off
atomic mass decreases by 4, atomic # decreases by 2



- **Beta particle-** (stopped by foil) β
neutron splits into a proton and electron
high energy electron given off
atomic mass -no change, atomic number increase by 1



- **Gamma particle** (stopped by lead or concrete) γ
very high energy given off (no particles)
no transmutation

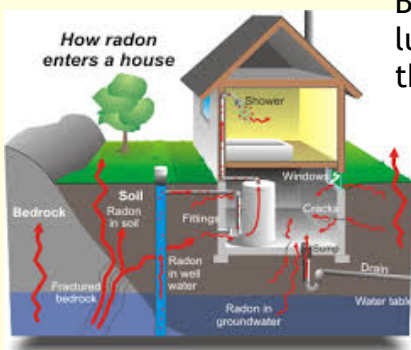
Alpha Decay

Smoke detectors



Americium-241 is inside smoke detectors, and when smoke particles enter the detector the alpha particles released by the americium atoms in alpha decay are caught by the smoke particles, which activates the smoke detector's alarm system.

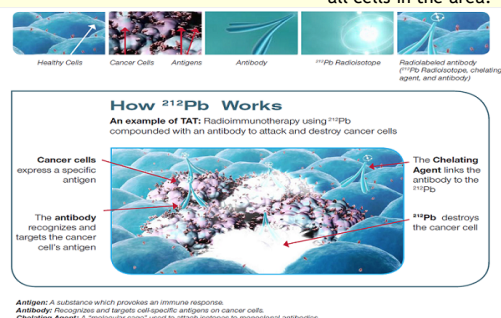
Gaseous radon in the soil (or your basement)



Breathing in radon gas can damage lung cells due to the alpha particles that the gas molecules emit.

A new cancer treatment, targeted alpha therapy (TAT), kills cancer cells

Lead-212 is attached to a carrier molecule, which when ingested travels to the site of the tumor and gives off alpha radiation, killing all cells in the area.



Determining the elemental composition of substances such as rocks and soil.

Alpha Particle X-Ray Spectroscopy (APXS) The alpha particles come from an alpha decay reaction, usually of curium-244. NASA used APXS in its rover missions to Mars, including the Pathfinder missions, to determine what elements are present in Martian rocks.



Beta Decay

Cancer treatment--Radionuclide therapy(RNT) or radiotherapy



Lutetium-177 or yttrium-90 is attached to a molecule and ingested, where it travels to the cancer cells. As the radioactive atoms decay, they release beta particles and kill the nearby cancer cells.

Carbon dating is used to date artifacts, wood, and animal remains

This is done by finding the ratio of carbon-14 to carbon-12 in the object. There is always a certain amount of carbon-14 in the atmosphere, and when a plant or animal dies the carbon-14 it had in its body starts to turn into nitrogen-14 via beta decay. By using the ratio of carbon-14 to carbon-12, the approximate date of the material can be determined.



Vocab practice

1. The splitting of an atomic nucleus into smaller parts.
2. The changing of one element to another through radioactive decay
3. Force that holds protons and neutrons together
4. Atoms of the same element with different numbers of neutrons (therefore different mass numbers)
5. 2 protons and 2 neutrons are given off, atomic mass decreases by 4, atomic # decreases by 2
6. Process in which there is a change in the nucleus of the atom
7. Process in which the nuclei of two atoms combine to form a larger nucleus
8. The release of nuclear particles and energy due to the decay of the unstable nuclei of atoms
9. Neutron splits into a proton and electron, high energy electron is given off, atomic mass has no change, atomic # increase by 1

Alpha particle

Beta particle

Fission

Fusion

Isotope

Nuclear Reaction

Radioactive decay

Strong Nuclear Force

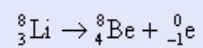
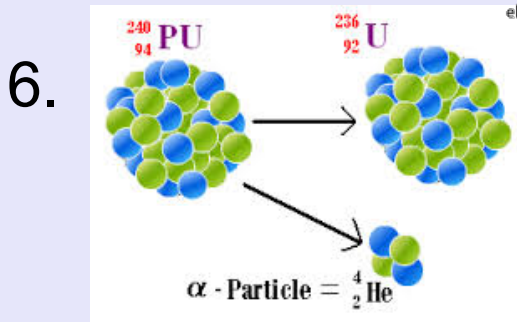
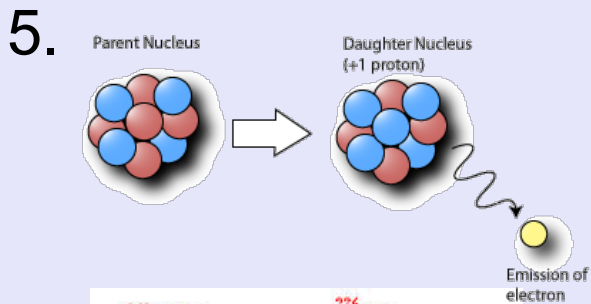
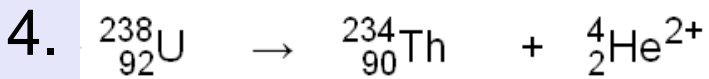
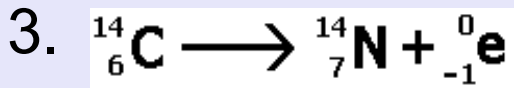
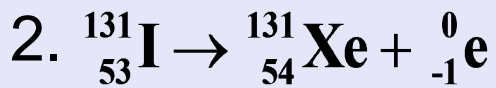
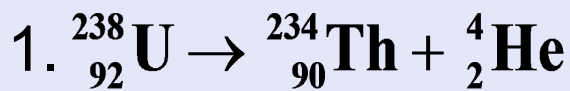
Transmutation

How is the atomic number change during:
 an apha decay? lose 2 proton, ↓ by 2
 a beta decay? No
 a gamma decay? No 2

Radiation type	Stopped by:	Particle emitted:	Change in atomic number:	Change in atomic mass:
alpha				
beta				
gamma				

Alpha or Beta Emission?

emission type



Predict the Products

Alpha Decay:



Beta Decay:



Woman in Science:

Marie Skłodowska Curie was once denied admission to a university because she was a woman.

She went on to become the first woman to be awarded a Nobel Prize, and today remains **the only person in history** to be awarded two Nobel Prizes in two different fields of science.



Attachments

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watch.webloc