Name: ____________________

Period: ____________________

Nuclear Power

Atoms can be changed

Democritus believed there to be a smallest, indivisible particle: atomos. In the early 20th century scientists learned that the atom is indeed divisible and even fusible.

All Atoms are not Stable

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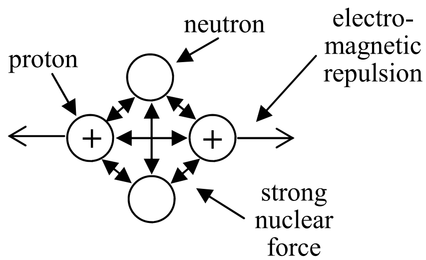
Protons and neutrons are known as **nucleons** because they are in the nucleus.



Neutrons add **strong nuclear force** without repelling the protons. Since the strong nuclear force only works over short distances eventually there are too many protons and the repulsion wins. Over 83 protons and the nucleus will undergo **radioactive decay**.

Isotope Notation

Mass #: protons + neutrons

$^{14}_{6}C$

Atomic #: protons

Kinds of Radiation

There are three kinds of radiation: **alpha decay; beta decay; gamma rays.**

Type	Description	Atomic Changes	Example
Alpha Decay	Low energy particle. Helium nucleus: 2 protons; 2 neutrons; stopped by paper or skin	Atomic number: - 2 (protons) Mass number: - 4 (2p + 2n)	U-238 → Th-234 + α (Alpha particle)
Beta Decay	A Neutron splits into a proton and an electron. Stopped by clothes or wood.	Atomic number: +1 Mass number: no change	C-14 → N-14 + β (Beta particle)
Gamma Radiation	High energy radiation. Stopped by lead or many feet of concrete. Dangerous to living things.	No changes	No changes γ (Gamma ray)

If Fluorine 20 undergoes beta decay, what will it become?

If Sulfur 34 undergoes alpha decay, what will it become?

This is the decay series for Uranium-238. (Atomic numbers are on the bottom.) On each arrow put either a "α" for alpha" decay or "β" for beta decay.

$^{238}_{92}U \rightarrow$ $^{234}_{90}Th \rightarrow$ $^{234}_{91}Pa \rightarrow$ $^{234}_{92}U \rightarrow$ $^{230}_{90}Th \rightarrow$

$^{226}_{88}Ra \rightarrow$ $^{222}_{86}Rn \rightarrow$ $^{218}_{84}Po \rightarrow$ $^{214}_{82}Pb \rightarrow$ $^{214}_{83}Bi \rightarrow$

$^{214}_{84}Po \rightarrow$ $^{210}_{82}Pb \rightarrow$ $^{210}_{83}Bi \rightarrow$ $^{210}_{84}Po \rightarrow$ $^{206}_{82}Pb$

Name: ____________________

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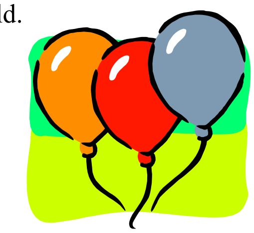
Fission versus Fusion

Nuclear power plants use fission.

There are two types of nuclear reactions.

The sun uses fusion and is the source of all power on earth.

Fission		Fusion
Large atoms are split apart. Uranium is split into smaller atoms.	Nuclear Process	Small atoms are fused together. Two hydrogen atoms are fused into a helium atom.
1 lb completely fissioned Uranium = 6,000 barrels of oil = 1,000 tons high-quality coal	Energy Produced	1 km^3 of sea water = more energy than all known fossil fuels in the world.
Toxic radioactive waste that takes billions of years to decay until safe.	Waste Products	Perfectly safe Helium. We could make balloons.



The real winner: nuclear fusion. So why don't we use it? Fusion occurs in the sun. It takes millions of degrees to even start fusion. So far we can't control it. But scientists are working on it.

As a future voter — demand money for fusion research!

Half-life

Half-life: the time it takes half of a radioactive substance to decay. Carbon-14 has a half-life of 5,730 years. In 5,730 years 100 kg of carbon-14 would reduce to 50 kg. Unfortunately, a radioactive substance never decays to zero; there's always a half more.

Carbon Dating

Scientist use the known half-life of carbon-14 to date plants, animals, and artifacts. By finding how much carbon-14 is in a sample, scientists know how old something is.

Chain Reactions

In fission a neutron must split an atom. This will produce another neutron to split another atom and another neutron, etc. A chain reaction is like toppling dominos.

1. Alpha Particle	A. The largest natural element. Fuel for fission reactors.	1. Chain Reaction	A. Combining smaller atoms into larger atoms. Harmless products; stars use this.
2. Gamma Ray	B. Can be stopped by wood; occurs when a neutron breaks into a proton and electron.	2. Fission	B. Splitting large atoms into smaller ones. Toxic by-products.
3. Beta Particle	C. An atom that emits energy or a particle.	3. Fusion	C. When one fission causes another and another, etc.
4. Radioactive	D. A helium nucleus (2 protons and 2 neutrons); low in energy.	4. Half-life	D. Using the known decay of an isotope to determine the age of objects.
5. Uranium	E. Powerful radiation that can cause biological damage; takes many feet of concrete to stop.	5. Carbon Dating	E. The time necessary for 50% of a radioactive sample to decay.