Name: ____________________

Period: ____________________

Nuclear Power

3.3

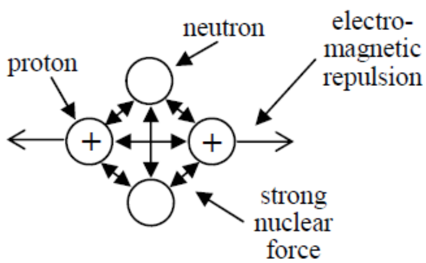
Atoms can be changed

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.

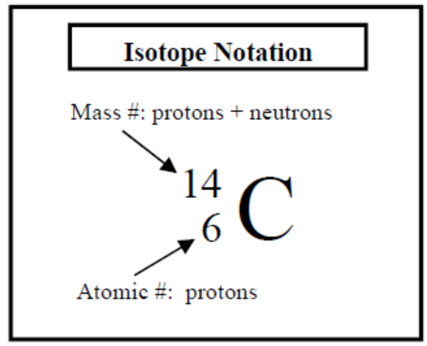
All Atoms are not Stable

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

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 **<u>radioactive decay</u>**.



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)

Nuclear Weapons

There are two main types of nuclear weapons: atomic bombs, which are powered by **fission reactions** similar to those in nuclear reactors [power plants], and hydrogen bombs, which derive their explosive power from **fusion reactions**.

An **atomic bomb** slams together two pieces of fissionable material, usually uranium-235 or plutonium-239, creating **critical mass**. This releases its energy instantaneously as atoms inside it split in an uncontrolled **chain reaction**. On August 6, 1945, an atomic bomb called Little Boy was dropped on the Japanese city of Hiroshima, followed three days later by another, called Fat Man, on Nagasaki.

Hydrogen bombs fuse together hydrogen atoms to form heavier helium atoms, releasing far more energy than a fission bomb. Two **<u>isotopes</u>** of hydrogen are used – deuterium (2 neutrons) and tritium (3 neutrons). Hydrogen bombs have never been used in war and are thousands of times more powerful than atomic bombs.

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.
J 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.
K 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!

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.

Directions: Identify each as a **fusion** , **fission** , or **both** kinds of reactions:

1. Used in nuclear power plants: _______________

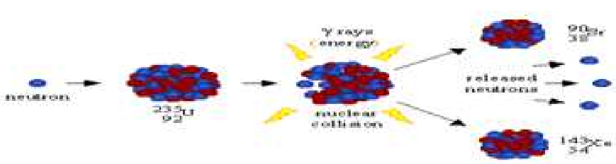
2. Occurs on the sun: ________________________

3. More power per gram: _____________________

4. A larger nucleus divides to make a smaller nucleus: _________________________________

5. Two hydrogen atoms fuse to make a helium atom: ______________________________

6. A critical mass is necessary to explode: _________________________________

7. 

: _________________

8. An atomic bomb: ____________________________