Nuclear Fusion

Fusion

- ~The joining of nuclei to make larger atoms
- The Sun produces energy in this manner.
- Hydrogen bombs use this process.
- Much more energy per gram is released by fusion than is by fission.
- Fusion reactions create no radioactive waste
- Unfortunately it is much harder to start and control a self sustaining reaction.
- It can not be used in a power plant yet.

Where elements are made?

- Elements are formed in nuclear fusion reactions in stars.
- Normally a star gets its energy by fusing 4 hydrogen atoms into a helium atom
- $4\ H \rightarrow He$
- As stars get older, they begin to fuse elements into heavier elements

Death of a star

- Near the end of a star's "life" it begins to collapse on itself, and making heavier elements
- Nova, supernova- explosion of a star
- When a star explodes, it sends all the elements it made scattering throughout the universe.

How they get here

- Clouds of these elements are what planets were formed from.
- Asteroids, and comets also could form and come to this planet.

Fusion reaction

$$^{3}_{1}H + {}^{2}_{1}H \xrightarrow{\text{fusion}} {}^{4}_{2}He + {}^{1}_{0}n + \text{energy}$$

- Hydrogen atoms are fused together to form helium.
- Using 4 hydrogen atoms takes more energy, but can be done.
- It is easier if you use isotopes of hydrogen Deuterium (D 1 n^o) and Tritium (T 2 n^o)

Fusion Reaction

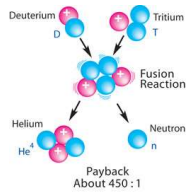


Diagram of deuterium-tritium reaction.

Radioactive waste

- Unusable materials that give off radiation
- This is produced by enriching uranium, and from the remnants of the spent fuel.
- It is also produced by the medical industry and oil and gas drilling and refining.
- This is highly dangerous if people were to come in contact with it, so it must be stored in a safe place.

Running out of fuel

- Like all other sources nuclear fuels are limited to the amount of fuel we can mine.
- We are in no danger of running out of uranium but some day that will be a problem.
- Breeder Reactors, used currently in Europe, take unusable U-238 and convert it into usable Pu-239 greatly increasing our supply of fuel.
- They are not used in the US yet for concerns over their safety.

Fusion Reactor

- If fusion reactors could run, then it would run off of isotopes of hydrogen.
- Deuterium is plentiful enough that there would not be a problem for a long time.
- If the reaction could use regular hydrogen instead it would be even better.

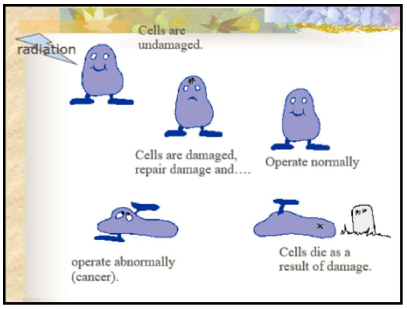
Transmutation of elements

- transmutation- changing one element into another.
- Done by bombarding an atom with alpha particles or some type of radiation.
- All elements outlined on the periodic table are created this way.

The more famous ones…

- The only synthesized element you probably heard of before this class is Plutonium.
- It is used for nuclear reactions (power plants, submarines, A-bombs)
- Americium is the most commonly used in smoke detectors.
- Research was done at the University of Berkeley, California
- refer to elements 95, 97 and 98

Dangers of Nuclear Power and Radiation



Effects of radiation

- Radiation breaks apart cell's structures and DNA.
- Cells can repair some of the damage of low level exposure over time.
- Higher levels of radiation can cause an increased rate of cancer, sterility, birth defects, death.

Radiation does not

- Cause an instant mutation in a person
- (You won't grow a third eye)
- You won't glow in the dark either
- Radiation is measured in mrem (millirems)

Doses

- The average person receives 360 mrem a year with no adverse effects.
- 56% of the survivors of 1945 bombing of Hiroshima and Nagasaki were still alive in 1990, and they received ~500,000 mrem.
- These effects are still being studied.

Biological effects depend on…

- 1. Energy of Radiation
- 2. Penetrating ability of radiation
- 3. Ionization ability of the radiation
- 4. length of exposure

Ionization ability

- Radiation can "knock" electrons off of atoms creating ions.
- Some radiation is better at this than others.
- **Ionizing radiation-** EM radiation higher than visible light (UV, X-rays, and gamma rays)
- Meaning they are good at this.
- All radiation lower than this (visible, IR, microwaves, radio waves) are **nonionizing**.
- Meaning they don't create ions very well.

Cell Phones

- Cell phones send and receive information using radio waves.
- This is nonionizing.
- Nonionizing is still dangerous if the energy is high enough (look at a microwave oven).
- Cell phones should release radiation in low enough energy levels that they are not harmful.
- The problem is you can't do effective long term studies on any cell phone because they keep changing so dramatically.

Immediate effects of large doses of radiation

Dose of radiation	Effects
above 5,000 mrem	can cause observable effects (more susceptible to illnesses)
100,000 mrem - 200,000 mrem	Nausea, loss of hair
200,000 mrem- 500,000 mrem	ulcers, internal bleeding
above 500,000 mrem	Death

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