Name: _____ *Date:* _____

Nuclear Radiation - Risks, Benefits, and Uses

Homework Unit 13 - Topic 2

As we progress through this unit, it is our hope that you become an informed citizen on the issue of nuclear technology. The likelihood is that nuclear energy and other alternative sources of energy will have to be further developed in our country as fossil based fuels diminish. The use of radiation stretches beyond the issue of energy and into other areas that affect our lives as well.

Answer the following as True or False, based on your understanding at this time.

1. ____ Home smoke detectors contain radioactive materials.
2. ____ Radioactive materials and radiation are unnatural; they did not exist on Earth until created by scientists.
3. ____ All exposure to radiation causes cancer.
4. ____ You are exposed to radiation every day.
5. ____ Very small amounts of matter are converted to huge amounts of energy when generating nuclear power.
6. ____ Physicians can distinguish cancer caused by radiation from cancer resulting from other causes.
7. ____ Humans can detect radiation with their senses.
8. ____ Medical X-rays are dangerous.
9. ____ Nuclear power plants cause serious hazards to the environment and to public health.
10. ____ Improperly managed nuclear power plants can explode like a nuclear bomb.
11. ____ Some types of nuclear waste must be stored for centuries to prevent leakage of radiation.
12. ____ New and dangerous elements are being created by scientists every day.
13. ____ All nuclear power plants produce material that can be converted into nuclear weapons.
14. ____ All medical techniques that use radiation are highly dangerous and risky.

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Readings: Uses of Radiation

Nuclear Power Generation:

Almost anything we choose to do in life has a "risk/benefit" analysis that could be done. The same is true of using nuclear technologies. Is the potential risk associated with the use outweighed by the benefits?

Around the issue of generating power, this analysis is certainly an issue facing the next generation. As oil continues to increase in cost, other energy sources may well have to be considered. The U.S. does generate 20% of its power from its 104 nuclear reactors. NY state has 3 nuclear reactors, 2 of which are within an hour of Rochester (Sodus and Barker). The U.S. is the world's largest producer of nuclear power, but several European countries rely much more on nuclear power, led by France at nearly 75%.

One of the great things about nuclear power generation is that it is "clean" and produces zero greenhouse gas emissions (no CO_2). Also, it is estimated that to meet the electricity needs of one person for a year requires the burning of 4 railroad cars full of coal, whereas 2-3 aspirin sized pieces of uranium do the same. In other words, and amazing amount of energy comes out of a small amount of mass when nuclear changes are being done to the material instead of chemical ones.

In the U.S. there has only ever been one nuclear power generating accident. It occurred in 1979 at the "Three Mile Island" nuclear power plant outside of Harrisburg, PA. Because of this accident, the nuclear power industry was basically halted from building any new reactors. Even though this accident was relatively minor, it scared people about the potential of a worse event, a reality that actually happened at the Chernobyl reactor in the Ukraine in 1986. Many people were killed in this disaster, where the reactor core entered a state of complete "melt-down. The 100 mile area surrounding this reactor is still uninhabitable by humans today. Most recently, nuclear power plants were destroyed in Japan by a giant tsunami, and the long-term affects of that disaster are still unknown.

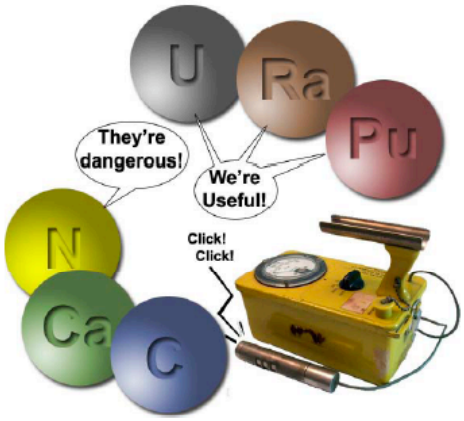
As of March 2008, 30 power companies around the U.S. have had plans approved by the Department of Energy to build nuclear power plants, all of which will come on line in the next 10 years. Has this changed in lieu of the Japan nuclear disaster? Hmmm...

Uses of Radioactive Materials:

Radioactive isotopes are put to use because of their radioactivity in a variety of ways:

1. To irradiate fresh fruits and vegetables to kill bacteria that cause decay. This gives the food longer shelf life and refrigerator life, and DOES NOT cause the food to become radioactive!! (The radiation just passes through, killing bacteria, but having no effect on the food item.)
2. In scientific research to:
   a) Radioactively determine the age of fossil remains, using U-238 to Pb-206 ratio in the surrounding rock layers.
   b) Radioactively dating archeological remains that are less than 50,000 years old, using C-14 decay.
   c) Figuring out complex bio-chemical processes, like photosynthesis.
3. In medicine to diagnose and treat diseases.
4. In devices like smoke detectors, which have small amounts of radioactive Am-241 in them.

Radiation is both useful and dangerous. The danger is caused by the fact that radioactive emissions are high energy and can ionize atoms they contact. Ionizing radiation damages cells causing burns, rashes, or cancer. Damage to reproductive cells can cause genetic defects. As a result it is important to be able to detect radiation. The tool used for detecting radiation is a Geiger counter. A Geiger counter is a hollow negatively charged cylinder filled with argon gas. It has a positive wire in the center and a thin window through which radiation passes. The radiation ionizes the argon gas. The ions are attracted to the electrodes where they create an electric pulse which is amplified to an audible click.

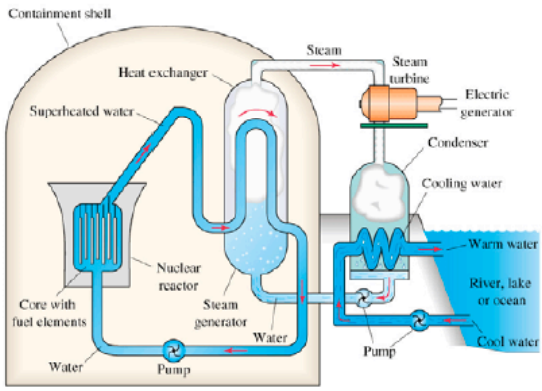


Xenophobia among atoms.

Radioactive isotopes, or radioisotopes, of different elements have a wide variety of uses depending on their chemical activity, their radioactive properties, and their half-lives. Radioisotopes can be used as tracers because radioactivity has no effect on chemical behavior. P-31 in fertilizer is used to trace uptake of phosphorus by plants. C-14 is used to map the path of carbon in metabolic processes. Radioisotopes with short half lives that concentrate in certain organs are administered as tracers. Tc-99 is used for location of tumors. I-131 is used for detection and treatment of thyroid disturbances because the thyroid gland uses iodine. Some cancer therapies depend on radiation because malignant cells are more sensitive to radioactivity than normal cells. Gamma radiation from cobalt 60 can be aimed at cancerous tumors. Gamma radiation can also destroy bacteria, yeasts, molds, and insect eggs, so it is used in food preservation. Radiation intensity decreases as radiation passes through matter, so it can be used to measure the thickness of industrial products.

Radioactive dating depends on the characteristic of radioactive substances known as half-life. Carbon dating is used to measure the age of fossils of living things fro the not too distant past. Carbon-14 is radioactive and has a half life of 5,730 years. Carbon dioxide in the air contains carbon-14. Plants take in carbon dioxide and make carbohydrates as long as they are alive. Animals eat plants as long as they are alive. Each gram of carbon in a living organism emits about 15 disintegrations per minute (dpm). As soon as an organism dies, it stops taking in carbon, so its amount of C-14 begins to decrease as does the number of dpm. A reading of 7 dpm/g of carbon indicates an age of about 5700 y. Uranium dating is useful for measuring the age of very old rocks. Uranium-238 is radioactive and has a half life of 10^9 years. Uranium-238 is found in igneous rock and decays into lead-206. After the rock cools, the amount of uranium-238 in the rock begins to decrease and the amount of lead begins to increase. The fraction of uranium left can be determined by comparing its mass to the mass of the lead. Then the number of half lives elapsed and the age can be determined.

One of the more important uses of radioactivity is nuclear energy. A **Nuclear reactor (fission reactor)** converts nuclear energy into heat energy which can then be used to generate electricity. The fuel for a nuclear reactor is usually U-235. It is found in the core. A nuclear reactor needs a moderator, a substance that slows neutrons down without absorbing them, in order to increase the chance of collision between the neutrons and the U-235 nuclei. Hydrogen, deuterium, water, heavy water, beryllium and graphite are used as moderators. The coolant keeps the system from overheating. Control rods made of boron or cadmium steel absorb neutrons controlling the rate of fission. Shielding provides protection from radiation damage.



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Risk/Benefit Analysis of Nuclear Radiation

Use any resources needed to complete the table below.

RISKS associated with nuclear radiation	BENEFITS associated with nuclear radiation

Do you personally believe the benefits of using nuclear radiation (power) outweigh the risks? Write a paragraph below stating your position and supporting it with facts.

_____

_____

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_____

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