



AP[®] Environmental Science 2004 Sample Student Responses

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3. Radioactive isotopes are widely used in the field of medicine, in the generation of electricity, and in the military. The use of radioactive isotopes has increased significantly over the past fifty years, leading to a corresponding increase in the amount of radioactive waste produced. The question of how to deal with radioactive waste is a topic of ongoing environmental concern.
- Explain how the properties of low-level radioactive waste differ from those of high-level radioactive waste and how these properties lead to different storage requirements. For one of the two types of radioactive waste, give an example of a specific isotope that may be present in the waste, and explain how human activity generates the waste.
 - The United States Department of Energy recently chose Yucca Mountain in Nevada as the site for the deep underground burial of high-level radioactive waste. Describe THREE characteristics of an ideal deep underground storage site for high-level radioactive waste.
 - Identify TWO other options that have been suggested for the long-term management of radioactive waste. Discuss the feasibility of each method.
 - Exposure to high levels of ionizing radiation has adverse effects on human health and can result in immediate death. Identify one sublethal adverse effect on human health that can result from exposure to ionizing radiation, and explain how this effect is caused by the radiation.

(a) Low-level radioactive waste becomes "safe" in a shorter amount of time than high-level wastes. Low level wastes need to be safely stored for 100-500 years - currently, most low-level radioactive wastes are stored in specially designated radioactive waste landfills. High-level waste must be stored for thousands of years before it decays enough to not be harmful to living tissue. Uranium-235 may be present in radioactive waste - it is used in nuclear power plants to generate energy through fission.

(b) An ideal deep underground storage site for high-level radioactive waste is geologically stable. The site should not be prone to earthquakes or volcanic activity so that the waste is not disturbed. The site also needs to be far away from groundwater supplies, so that any leakage does not contaminate water. Contaminated water would not only harm people drinking it, but the water could travel hundreds of miles and contaminate other areas. The disposal site should also be secluded from human development. If an accident were to occur, it would be catastrophic to have

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a largely populated city nearby.

(c) One method for dealing with radioactive waste is to dump it in the ocean or bury it in deep ocean vents. Dumping waste in the ocean is a bad idea because it would damage aquatic life and circulate around the globe. Deep ocean vents is risky because underwater volcanoes or uprisings of magma could release the waste right back into the ocean.

It has also been suggested that radioactive waste be shipped off into outer space. This is not really feasible because an explosion might occur during launch or as the shuttle leaves the atmosphere, spreading the waste throughout the atmosphere.

(d) Ionizing radiation damages living tissue. Radiation can cause mutations in DNA which spread throughout the body or cause cells to be unable to reproduce. Then the body as a whole cannot function. Cancer is an example of an effect of ionizing radiation. Cancer may originate in one spot but eventually travels to other places in the body.

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- (a) Explain how the properties of low-level radioactive waste differ from those of high-level radioactive waste and how these properties lead to different storage requirements. For one of the two types of radioactive waste, give an example of a specific isotope that may be present in the waste, and explain how human activity generates the waste.
- (b) The United States Department of Energy recently chose Yucca Mountain in Nevada as the site for the deep underground burial of high-level radioactive waste. Describe THREE characteristics of an ideal deep underground storage site for high-level radioactive waste.
- (c) Identify TWO other options that have been suggested for the long-term management of radioactive waste. Discuss the feasibility of each method.
- (d) Exposure to high levels of ionizing radiation has adverse effects on human health and can result in immediate death. Identify one sublethal adverse effect on human health that can result from exposure to ionizing radiation, and explain how this effect is caused by the radiation.

(a) The properties of low-level and high-level radioactive waste differ. Low-level waste is less harmful, but harder to get rid of than high-level radioactive waste. Because of this, the two levels require different storage procedures. In high-level radioactive waste, Uranium-238 may be present. Nuclear power plants help generate Uranium waste.

(b) One characteristic of a good deep underground storage site is that the area is very stable, meaning it is not prone to earthquakes or volcanic eruptions that may disturb the storage site and release the radioactive waste. Another advantageous characteristic of a storage site is a very low water table so that the radioactive waste is a good deal away from groundwater, lessening the chances of

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contamination. Another beneficial part of a really good storage site would be to have it in an isolated area with very little human disturbance so that the waste would be left alone.

(c) Another option that has been suggested for the management of radioactive waste is to launch the waste into space. While this might be possible, it would be nearly impossible to check on the canister containing the waste to make sure it was still sealed and there is always the possibility that ~~the~~^{the} canister of radioactive waste may hit something else floating around in space, thus releasing some very harmful radioactive material. A second option is to convert the radioactive waste into harmless isotopes. While this option sounds like the perfect solution, scientists have not created a feasible way of doing so.

(d) One adverse effect on human health that is caused by ionizing radiation is cancer. The radiation can mutate or alter human genetics resulting in many types of cancer.

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Low level radioactive waste differs from high-level waste because it has a shorter half life. It becomes safe much quicker than high-level radioactive waste. Low level waste does not have to be stored nearby as long as high-level waste before it can be disposed of. An example of high-level waste is P-235, it comes from powerplants and it has to be guarded because some of it can be weapons grade.

A high-level waste site should not be near a fault line, near any ground water deposits, or near any volcanic activity.

Exposure to ionizing radiation can cause cancer because it causes the bodies cells to mutate. When this happens the cells begin doing nothing but multiplying themselves.

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