The devastating earthquake that struck northern Japan on March 10, 2011 also caused several of the nuclear reactors at the Fukushima Nuclear Plant to explosively vent radioactive gas and dust clouds into the environment.

Although the initial radiation levels were extremely high, the natural decay of the radioactive compounds will cause the radiation levels at any given distance to steadily reduce in intensity.

The most common radioisotopes that are likely to be involved in the vented gases are Cesium-137 and Iodine-131. These will become incorporated into atmospheric dust grains and fall to the ground, contaminating the soil. Cesium-137 has a half-life of 30 years, while Iodine-131 has a half-life of 8 days. This means that, for example, if you measured the dosage you get from a sample of Iodine-131, after 8 days, the dosage will have dropped to 1/2 its original level on Day-1. After 16 days it will be 1/4 of its original level on Day-1, and so on.

The formula for half life and radiation dose rate is:

$$D(t) = D(0)e^{\left(-\frac{t}{T}\right)}$$

where D(0) is the dose rate on Day-0, D(t) is the dose rate on Day-t, and T is the half-life in days.

Problem 1 - The natural background radiation dose rate is about 3.5 milliSeiverts/year. What is this natural radiation dose rate in microSeiverts/hour?

Problem 2 - On Friday, March 18, *NHK News*, the online news service for Japan ,reported that Japan's Science Ministry had posted new radiation measurements. The Ministry indicated that at a location 30 km northwest of the Fukushima Daiichi nuclear plant, the radiation dose rates were 170 microSeiverts/hour on March 17, and 150 microSeiverts/hour on March 18. Assuming that the decrease is entirely caused by the decay of a radioisotope, A) what is the half-life of this isotope in days? B) What is the likely candidate for the radioisotope that is causing most of the radiation at this location?

Problem 1 - The natural background radiation dose rate is about 3.5 milliSeiverts/year. What is this natural radiation dose rate in microSeiverts/hour?

Answer; 3.5 milliSeiverts/year x (1000 micros/1 milli) x (1 year/365 days) x (1 day/24 hours) = **0.4 microSeiverts/hour**.

Problem 2 - On Friday, March 18, *NHK News*, the online news service for Japan ,reported that Japan's Science Ministry had posted new radiation measurements. The Ministry indicated that at a location 30 km northwest of the Fukushima Daiichi nuclear plant, the radiation dose rates were 170 microSeiverts/hour on March 17, and 150 microSeiverts/hour on March 18. Assuming that the decrease is entirely caused by the decay of a radioisotope, A) what is the half-life of this isotope in days? B) What is the likely candidate for the radioisotope that is causing most of the radiation at this location?

Answer: A) From the information given, and the formula for D(t) we have D(0) = 170, t = 1 day, D(1) = 150, the we solve

$$150 = 170e^{\left(-\frac{1day}{T}\right)}$$

$$\frac{150}{170} = e^{\left(-\frac{1day}{T}\right)}$$

$$0.882 = e^{\left(-\frac{1day}{T}\right)}$$ now take the natural-log of both sides

$$\ln(0.882) = -\frac{1day}{T} \quad \text{so} \quad -0.126 = -\frac{1day}{T}$$

then $T = \frac{1}{0.125}$

so **T = 8 days is the half-life for the dosage decay.**

B) **The most likely candidate contributing to the radiation exposure at this location is Iodine-131.**