Marks 5

- The radioactive isotopes ^{131}I and ^{137}Cs have been detected in drinking water near the Japanese Fukushima nuclear reactor. They have half lives of 8 days and 30 years, respectively. What is the definition of half-life?

Half-life is the amount of time required for the amount (or activity) of a sample to decrease to half its initial value.

What percentage of both isotopes will still be detectable after 25 years?

The number of nuclei, N, decays with time, t, according to $\ln(N_0/N_t) = \lambda t$ where λ is the activity coefficient. This is related to the half life, $t_{1/2}$ by $\lambda = \ln 2/t_{1/2}$.

For ^{131}I, $t_{1/2}$ = 8 days = 8/365 years:

$\lambda = \ln 2 / (8/365)$ **years^{-1} = 32 years^{-1}**

When t = 25 years,

$\ln(N_0/N_t) = \lambda t$ **= (32 years^{-1})(25 years)**

$N_0/N_t = e^{790}$ **or** $N_t / N_o \approx 0$

N_t is very close to zero and effectively all of the ^{131}I has decayed.

For ^{137}Cs, $t_{1/2}$ = 30 years:

$\lambda = \ln 2 / (30)$ **years^{-1} = 0.023 years^{-1}**

When t = 25 years,

$\ln(N_0/N_t) = \lambda t$ **= (0.023 years^{-1})(25 years)**

$N_0/N_t = 1.8$ **or** N_t / N_o **= 0.56 = 56%**

^{131}I: **0%**	^{137}Cs: **56%**

If you were exposed to equal concentrations of both isotopes for 1 hour, which isotope would do more damage? Explain.

^{131}I would do more damage.

It has the shorter half-life so undergoes more disintegrations and produces more radiation in a given time period.