(15.2) Using the information above, how many grams of the body's molecules (assume average mole weight of 10^5) will be damaged in a year if the *G*(damage) value is $3.1*10^{-7}$ mol/J? Assume $E_{abs}(\beta) = E_{max}/3$.

$Bq := sec^{-1}$ $\quad eV := 1.6021773\cdot 10^{-19}\cdot joule$ $\quad MeV := 10^6\cdot eV$

$N_A := 6.022137\cdot 10^{23}\cdot mole^{-1}$ $\quad M_w := 10^5\cdot gm\cdot mole^{-1}$ $\quad G_{value} := 3.1\cdot 10^{-7}\cdot mole\cdot joule^{-1}$

$t_{irr} := 1\cdot yr$ $\quad t_{irr} = 3.156\cdot 10^{7}\ \cdot sec$ $\quad m_{body} := 70\cdot kg$

$R_{3H} := 163.548\cdot Bq$ $\quad E_{abs3H} := \frac{0.0186}{3}\cdot MeV$ $\quad E_{abs3H} = 9.933\cdot 10^{-16}\ \cdot joule$

$R_{14C} := 2.848\cdot 10^{3}\cdot Bq$ $\quad E_{abs14C} := \frac{0.1565}{3}\cdot MeV$ $\quad E_{abs14C} = 8.358\cdot 10^{-15}\ \cdot joule$

$R_{40K} := 4.388\cdot 10^{3}\cdot Bq$ $\quad E_{abs40K} := \frac{1.31\cdot 0.8933}{3}\cdot MeV$ $\quad E_{abs40K} = 6.25\cdot 10^{-14}\ \cdot joule$

$R_{Ra} := 0.37\cdot Bq$ $\quad$ Data for the decay chain are found in Fig. 13.4. and/or a nuclide chart, etc.

The main decay chain: $^{226}Ra(\alpha)^{222}Rn(\alpha)^{218}Po(\alpha)^{214}Pb(\beta^-)^{214}Bi(\beta^-)^{214}Po(\alpha)^{210}Pb(\beta^-)^{210}Bi(\beta^-)^{210}Po(\alpha)$

$E_{\alpha 226Ra} := 4.784\cdot MeV$ $\quad Q_{226Ra} := E_{\alpha 226Ra}\cdot\frac{226}{222}$ $\quad Q_{226Ra} = 4.87\cdot MeV$

$E_{\alpha 222Rn} := 5.490\cdot MeV$ $\quad Q_{222Rn} := E_{\alpha 222Rn}\cdot\frac{222}{218}$ $\quad Q_{222Rn} = 5.591\cdot MeV$

$E_{\alpha 218Po} := 6.003\cdot MeV$ $\quad Q_{218Po} := E_{\alpha 218Po}\cdot\frac{218}{214}$ $\quad Q_{218Po} = 6.115\cdot MeV$

Neglect the recoil energy of the daughter for the beta emitting daughters, but include γ:s

$E_{\beta 214Pb} := 0.7\cdot MeV$ $\quad E_{\gamma 214Pb} := 0.352\cdot MeV$

$Q_{214Pb} := E_{\beta 214Pb}\cdot\frac{1}{3} + 37\cdot\%\cdot E_{\gamma 214Pb}$ $\quad Q_{214Pb} = 0.364\cdot MeV$

$E_{\beta 214Bi} := 3.3\cdot MeV$ $\quad E_{\gamma 214Bi} := 1.508\cdot MeV$ $\quad$ Average for main γ:s from Table of Isotopes

$Q_{214Bi} := E_{\beta 214Bi}\cdot\frac{1}{3} + E_{\gamma 214Bi}$ $\quad Q_{214Bi} = 2.608\cdot MeV$

$E_{\alpha 214Po} := 7.687\cdot MeV$ $\quad Q_{214Po} := E_{\alpha 214Po}\cdot\frac{214}{210}$ $\quad Q_{214Po} = 7.833\cdot MeV$

Include the assumption that the 5 daughters have 0.3 decays for each decay of ^{226}Ra in the energy sum

$$E_{absRa} := Q_{226Ra} + 0.3\cdot\left(Q_{222Rn} + Q_{218Po} + Q_{214Pb} + Q_{214Bi} + Q_{214Po}\right)$$

$$Q_{tot} := t_{irr}\cdot\left(R_{3H}\cdot E_{abs3H} + R_{14C}\cdot E_{abs14C} + R_{40K}\cdot E_{abs40K} + R_{Ra}\cdot E_{absRa}\right)$$

$N_{damaged} := Q_{tot}\cdot G_{value}$ $\quad N_{damaged} = 2.924\cdot 10^{-9}\ \cdot mole$

$m_{damaged} := N_{damaged} \cdot M_w \qquad m_{damaged} = 2.924 \cdot 10^{-7} \cdot kg$

$\frac{m_{damaged}}{m_{body}} = 4.177 \cdot 10^{-7} \cdot \%$