(7.4) An acidic aqueous solution is irradiated by α-particles from dissolved ^{239}Pu at a concentration of 0.03 M. The plutonium is originally in the in its hexavalent state, but is reduced to the tertavalent state by the reaction Pu(VI)+2H·=Pu(IV)+2H$^+$. How much of the plutonium can be reduced in one week?

Constants and units:

$N_A := 6.0221367 \cdot 10^{23} \cdot mole^{-1}$ $eV := 1.60217733 \cdot 10^{-19} \cdot joule$ $keV := 10^3 \cdot eV$

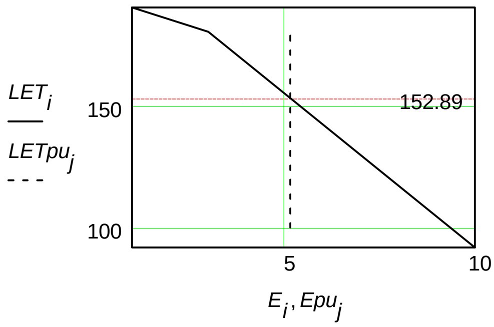
$\mu m := 10^{-6} \cdot m$ $Å := 10^{-8} \cdot cm$ $Bq := sec^{-1}$ $M := mole \cdot liter^{-1}$

Average LET value is interpolated from Table 6.2 for 5.157 MeV α from ^{239}Pu as follows:

$i := 1..3$ $j := 1..2$

$E_i :=$	$LET_i :=$
1	190
3	180
10	92

$Epu_j :=$	$LETpu_j :=$
5.157	100
5.158	180



$LET := 152.891 \cdot keV \cdot \mu m^{-1}$ $LET = 15.289 \cdot \frac{eV}{Å}$

This LET value gives a G-value for H· from Fig. 7.6 of: $G := 0.25 \cdot 10^{-7} \cdot mole \cdot joule^{-1}$

$t_{half} := 2.411 \cdot 10^4 \cdot yr$ $E_\alpha := 5.158 \cdot 10^6 \cdot eV$

$C_{Pu} := 0.03 \cdot M$ $N_{Pu} := C_{Pu} \cdot N_A$ $R_{Pu} := N_{Pu} \cdot \frac{ln(2)}{t_{half}}$

$dDdt := R_{Pu} \cdot E_\alpha$

$t := 7 \cdot day$ $dC := t \cdot \frac{dDdt}{2} \cdot G$ (2 H· for each Pu) $dC = 1.028 \cdot 10^{-4} \cdot M$

$dC_{rel} := \frac{dC}{C_{Pu}}$ $dC_{rel} = 3.428 \cdot 10^{-3}$ $dC_{rel} = 0.343 \cdot \%$