(17.2) Oxygen can be determined through the reaction $^{16}O(n,p)^{16}N$ (β,γ 7 s); σ_{no} at 14 MeV n is 49 mb. 3.982 g of a fatty acid were irradiated for 20 s in $4*10^{12}$ n m^{-2} s^{-1}. After the irradiation the sample was rapidly transferred with a rabbit system to a scintillation detector which had an efficiency of 1.1% for the ^{16}N γ-rays (~6 MeV). Exactly 8 s after the end of the irradiation, the sample was counted for 1 min, yielding 13418 counts above background. What was the oxygen fraction of the sample?

First some definitions and data from the text:

$N_A := 6.022137\cdot 10^{23}\cdot mole^{-1}$ $M_O := 16.00\cdot gm\cdot mole^{-1}$ $t_{half} := 7\cdot sec$ $\lambda := \frac{ln(2)}{t_{half}}$

$\sigma := 49\cdot 10^{-3}\cdot 10^{-28}\cdot m^2$ $N_{count} := 13418$ $m_{tot} := 3.982\cdot gm$

$\phi := 4\cdot 10^{12}\cdot m^{-2}\cdot sec^{-1}$ $t_{irr} := 20\cdot sec$ $t_{cool} := 8\cdot sec$ $t_{count} := 1\cdot min$ $\psi := 1.1\cdot \%$

Then the calculations (1 min counting means that practically all ^{15}N atoms have decayed, *i.e.* the number of counts can be converted to total number of atoms at start of counting. However, to make it general we will calculate as if a significant number of atoms still remained.):

$N_N := \frac{N_{count}}{\left(1 - exp\left(-\lambda\cdot t_{count}\right)\right)}\cdot\frac{1}{\psi}$ $N_N = 1.223\cdot 10^6$ atoms at beginning of counting

$N_{0N} := N_N\, exp\left(\lambda\cdot t_{cool}\right)$ $N_{0N} = 2.701\cdot 10^6$ atoms at end of bombardment

$N_O := \frac{\lambda\cdot N_{0N}}{\phi\cdot\sigma\cdot\left(1 - exp\left(-\lambda\cdot t_{irr}\right)\right)}$ $N_O = 1.583\cdot 10^{22}$ oxygen-16 atoms in sample

$C_{oxygen} := \frac{N_O}{N_A}\cdot M_O\cdot\frac{1}{m_{tot}}$ $C_{oxygen} = 0.106$ or $C_{oxygen} = 10.561\cdot\%$

$exp\left(-\lambda\cdot t_{count}\right) = 0.003$ (fraction not decayed during counting, i.e. our correction)