5. Plutonium decay ***(3 points)***

Let the number of Pu^{239}-atoms be reduced during time interval $t = 1\,\mathrm{s}$ by a factor of $1 - \lambda$ (with $\lambda \ll 1$). Then, during the time period of $\tau_{1/2}$, it is reduced by a factor of $(1-\lambda)^{\tau_{1/2}/t} \approx e^{-\lambda\tau_{1/2}/t} = \frac{1}{2} \Rightarrow \lambda = t\ln 2/\tau_{1/2}$. Therefore, the number of atom decay events is $N_d = Nt\ln 2/\tau_{1/2}$, where $N = \rho dS/m_0$ is the number of atoms, i.e. the α-particle flux is $\Phi = N_d/2St$ (where the factor 2 accounts for the fact that the particles are emitted towards the both sides of the plate). Upon bringing all the expressions together, we obtain

$$\Phi = \frac{\rho d \ln 2}{2\tau_{1/2} m_0} \approx 2.36 \times 10^{13}\,\mathrm{m}^{-2}\cdot\mathrm{s}^{-1}.$$