

Radioactivity Problems:

1. Iodine ($^{131}_{53}\text{I}$) is used to clinically diagnose the thyroid gland. Suppose the patient is given an injection of $550\mu\text{g}$ of $^{131}_{53}\text{I}$. The half-life of $^{131}_{53}\text{I}$ is 8 days.
 - a. What is the patient's activity immediately after injection?
 - b. What is the patient's activity after 1 hour? After 10 hours?
 - c. What is the patient's activity after 6 months?
 - d. Suppose that after initial injection of $550\mu\text{g}$, that 50% of it was excreted from the body after 48 hours. What is the remaining activity in the patient's body on the third day of treatment if the biologic half-life of $^{131}_{53}\text{I}$ is 2 days? Hint, what is the effective half-life of the $^{131}_{53}\text{I}$?

2. In PET, a radiopharmaceutical is introduced into an organism. The annihilation of an emitted positron and an electron from the surrounding tissue produces two photons that will be detected. We say that the positron gets ejected and quickly annihilates. What happens is we form a quasi-atom of the positron and electron called positronium.
 - a. Show that in the decay of such a quasi-atom, that if the speeds of the electron and positron are ignored, the two photons are emitted in opposite directions and determine the energy of a photon in eV .
 - b. What effects occur if the positronium quasi-atom has a kinetic energy, and what relevance does this mean for image production?