

放射化学 RADIOCHEMISTRY

In these questions, use the given half lives and approximate values, *i.e.*, $\log_e 2 = 0.70$, $1.0 \text{ eV} = 1.6 \times 10^{-19} \text{ J}$, and Avogadro's number $N_A = 6.0 \times 10^{23} \text{ mol}^{-1}$. The significant figure is 2 digits.

1. ^{90}Sr is a radioactive nuclide with a half-life of 30 years (decay constant: $7.4 \times 10^{-10} \text{ s}^{-1}$). It undergoes β^- decay into a daughter nuclide. The daughter nuclide of ^{90}Sr also undergoes β^- decay into a stable nuclide with a half-life of 60 hours.

1.0 mg of ^{90}Sr in a hydrochloric acid solution is isolated from the daughter nuclide at $t = 0$.

Answer the following questions.

【Radioactive decay】 【Radioactive equilibrium】 【Separation in radiochemistry】

- (1) Calculate activity [Bq] of ^{90}Sr in the hydrochloric acid solution at $t = 0$.
- (2) Show the daughter nuclide of ^{90}Sr . And show a coprecipitation reaction to collect the daughter nuclide in precipitation by a reaction formula.
- (3) Calculate total activity [Bq] in the hydrochloric acid solution after 60 years (at $t = 60 \text{ y}$).

2. A solution containing $5 \times 10^3 \text{ Bq/mL}$ of a radioactive nuclide with a half-life of 2 minutes was prepared. 0.1 mL of this solution was injected into a rabbit by intravenous injection. 6 minutes later, 1.0 mL of blood was sampled from the rabbit. Then, the activity of the blood sample was determined to be 0.25 Bq. Calculate the total blood volume [mL] of this rabbit.

The radioactive nuclide was uniformly spread over the blood right after the injection, and did not migrate to other tissues.

【Detection and measurement of radioactivity】

【Isotope dilution analysis, Age determination from radioactive decay】

3. Calculate the mass (in g) of 5.0 MBq of ^{183}Re . The half-life of ^{183}Re is 70 days.
【Radioactive decay】
4. The decay mode of ^{183}Re (atomic number = 75) is electron capture (EC) decay. Answer the atomic and mass numbers of the decay product of ^{183}Re . **【Radioactive decay】**
5. ^{14}C decays with a half-life of 5700 years. A piece of clay pot excavated at a historical spot contains $9.6 \times 10^{-2} \text{ g}$ of ^{12}C and $1.4 \times 10^{-14} \text{ g}$ of ^{14}C , respectively. What is the age of this clay pot? The ratio of $^{14}\text{C} : ^{12}\text{C}$ in the air is $10^{-12} : 1$, which is constant over age.

【Age determination from radioactive decay】

6. 0.3 g of ${}^3\text{H}$ is stored in a glass tube. Calculate the released heat per second [J/s] from the tube. The decay constant of ${}^3\text{H}$ is $1.8 \times 10^{-9} \text{ s}^{-1}$, and the average beta-ray energy from ${}^3\text{H}$ is 6.0 keV. In the tube, no exothermic nor endothermic phenomenon occurs other than the radioactive decay of ${}^3\text{H}$. **【Radioactive decay】**

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