

(5.14) In the ion source of a mass spectrograph,  $\text{UF}_6$  vapor is introduced which partly becomes ionized to  $\text{UF}_5^+$ . The ionic currents were measured at mass positions 333, 330, and 329. The ion current ratios were  $I_{333}/I_{330} = 139$ , and  $I_{330}/I_{329} = 141.5$ . What is the half-life of  $^{234}\text{U}$  if that of  $^{238}\text{U}$  is  $4.5 \cdot 10^9$  y? Radioactive equilibrium is assumed to exist in the  $\text{UF}_6$ .

First we define the atomic weights

$$M_F := 19 \cdot \text{gm} \cdot \text{mole}^{-1} \quad M_{U234} := 234 \cdot \text{gm} \cdot \text{mole}^{-1} \quad M_{U238} := 238 \cdot \text{gm} \cdot \text{mole}^{-1}$$

$$M_{U234F5} := M_{U234} + 5 \cdot M_F \quad M_{U234F5} = 0.329 \cdot \text{kg} \cdot \text{mole}^{-1}$$

$$M_{U238F5} := M_{U238} + 5 \cdot M_F \quad M_{U238F5} = 0.333 \cdot \text{kg} \cdot \text{mole}^{-1}$$

The measured ionic currents are:

$$I_{333} := 139 \quad I_{329} := 141.5$$

$$\text{Ratio} := \frac{1}{I_{333} \cdot I_{329}} \quad \text{Ratio} = 5.084 \cdot 10^{-5} \quad t_{238} := 4.5 \cdot 10^9 \cdot \text{yr} \quad \text{Known half-life}$$

$$t_{234} := t_{238} \cdot \text{Ratio} \quad t_{234} = 7.22 \cdot 10^{12} \cdot \text{sec} \quad \text{or} \quad t_{234} = 2.3 \cdot 10^5 \cdot \text{yr}$$