

(18.3) In order to determine the lead content of a color pigment, 8.9871 g was dissolved in conc.  $\text{HNO}_3$ , and 5.00 ml  $^{210}\text{Pb}$  solution added. After excess acid had been removed through evaporation, excess 1 M NaCl was added, the solution heated and filtered. After cooling and crystallization, the  $\text{PbCl}_2$  was washed and recrystallized. 0.3276 g of the crystals was measured in a scintillation counter, giving 185160 counts in 5 min. 1.000 ml of the original  $^{210}\text{Pb}$  solution gave 57000 cpm. The background was 362 cpm. Calculate the lead content (%) of the pigment.

First the usual definitions:

$$Bq := \text{sec}^{-1} \quad \text{cpm} := \text{min}^{-1}$$

and the molecular weights needed:

$$M_{w\text{Pb}} := 207.19 \cdot \frac{\text{gm}}{\text{mole}} \quad M_{w\text{Cl}} := 35.45 \cdot \frac{\text{gm}}{\text{mole}} \quad m_{\text{PbCl}_2} := 0.3276 \cdot \text{gm}$$

$$M_{w\text{PbCl}_2} := M_{w\text{Pb}} + 2 \cdot M_{w\text{Cl}}$$

Then the data given in the text:

$$m_{\text{sample}} := 8.9871 \cdot \text{gm} \quad R_{\text{sample}} := \frac{185160}{5 \cdot \text{min}} \quad R_{\text{bg}} := \frac{362}{1 \cdot \text{min}} \quad R_0 := \frac{57000}{1 \cdot \text{min}}$$

$$v_0 := 1 \cdot \text{mL}$$

Now we can calculate the amount of lead the isolated lead chloride sample:

$$m_{\text{Pb}} := m_{\text{PbCl}_2} \cdot \frac{M_{w\text{Pb}}}{M_{w\text{PbCl}_2}}$$

and the specific activity of the  $^{210}\text{Pb}$  solution and the activity of the isolated sample:

$$R_{0\text{net}} := R_0 - R_{\text{bg}} \quad S_0 := \frac{R_{0\text{net}}}{v_0} \quad v := 5 \cdot \text{mL}$$

$$R_{\text{samplenet}} := R_{\text{sample}} - R_{\text{bg}}$$

Assume the amount of added lead can be neglected in comparison to the amount of lead in the sample.

Then calculate the precipitation yield and correct the lead mass.

$$\text{yield} := \frac{R_{\text{samplenet}}}{v \cdot S_0} \quad \text{yield} = 0.129$$

$$m_{\text{Pbinsample}} := \frac{m_{\text{Pb}}}{\text{yield}} \quad \text{Pbcontent} := \frac{m_{\text{Pbinsample}}}{m_{\text{sample}}} \cdot 100 \quad \%$$

$$\text{Pbcontent} = 20.974 \quad \%$$