Bronze is an alloy made of copper (Cu) and tin (Sn). Calculate the mass of a bronze cylinder of radius 9.85 cm and length 41.00 cm. The composition of the bronze is 79.42 percent Cu and 20.58 percent Sn and the densities of Cu and Sn are 8.94 g/cm3 and 7.31 g/cm3, respectively. What assumption should you make in this calculation? Enter your answer in scientific notation.

Solution. We assume that the alloy is at a certain temperature, say, for example, at room temperature, so that the densities remain constant. That is, the calculation is made for a temperature of +20 degrees Celsius.

In this case, given: $\rho_{Cu}=8.94\frac{g}{cm^3}$, $\rho_{Sn}=7.31\frac{g}{cm^3}$, $w_{Cu}=79.42\%$, $w_{Sn}=20.58\%$.

The density of the alloy is calculated as follows: $\rho=\frac{m_{Cu}+m_{Sn}}{\frac{m_{Cu}}{\rho_{Cu}}+\frac{m_{Sn}}{\rho_{Sn}}}$. Take the ratio: $\alpha=\frac{m_{Cu}}{m_{Sn}}=\frac{w_{Cu}}{w_{Sn}}=\frac{79.42}{20.58}=3.86$, then $\rho=\frac{3.86+1}{\frac{3.86}{\rho_{Cu}}+\frac{1}{\rho_{Sn}}}=\frac{4.86}{\frac{3.86}{8.94}+\frac{1}{7.31}}=8.68\frac{g}{cm^3}$.

Find the volume of the cylinder according to the formula: $V=\pi r^2h=3.14\times(9.85)^2\times41=12491cm^3$.

Find the mass of the bronze cylinder: $m=\rho V=8.68\times12491=108421.88$ g, or 108.422 kg.

Answer: the mass of the bronze cylinder is 108.422 kg at 20^0C.