1. Is it possible to have a copper–silver alloy of composition 20 wt% Ag–80 wt% Cu, which, at equilibrium, consists of α and liquid phases having mass fractions $W_\alpha = 0.80$ and $W_L = 0.20$? If so, what will be the approximate temperature of the alloy? If such an alloy is not possible, explain why.

Yes, it is possible to have a Cu-Ag alloy of composition 20 wt% Ag-80 wt% Cu which consists of mass fractions $W_\alpha = 0.80$ and $W_L = 0.20$. Using the appropriate phase diagram, by trial and error with a ruler, the tie-line segments within the $\alpha + L$ phase region are proportioned such that

$$W_\alpha = 0.8 = \frac{C_L - C_G}{C_L - C_\alpha}$$

for $C_G = 20$ wt% Ag. This occurs at about 800°C.

2. A 40 wt% Pb–60 wt% Mg alloy is heated to a temperature within the $\alpha +$ liquid phase region. If the mass fraction of each phase is 0.5, then estimate
(a) The temperature of the alloy.
(b) The compositions of the two phases.

3. For a lead–tin alloy of composition 80 wt% Sn–20 wt% Pb and at 180°C (355°F) do the following:
(a) Determine the mass fractions of the \( \alpha \) and \( \beta \) phases.
(b) Determine the mass fractions of primary \( \beta \) and eutectic microconstituents.
(c) Determine the mass fraction of eutectic \( \beta \).
(a) This portion of the problem asks that we determine the mass fractions of α and β phases for an 80 wt% Sn-20 wt% Pb alloy (at 180°C). In order to do this it is necessary to employ the lever rule using a tie line that extends entirely across the α + β phase field, as follows:

\[
W_\alpha = \frac{C_\beta - C_\alpha}{C_\beta - C_\alpha} = \frac{97.8 - 80}{97.8 - 18.3} = 0.224
\]

\[
W_\beta = \frac{C_\alpha - C_\alpha}{C_\beta - C_\alpha} = \frac{80 - 18.3}{97.8 - 18.3} = 0.776
\]

(b) Now it is necessary to determine the mass fractions of primary β and eutectic microconstituents for this same alloy. This requires us to utilize the lever rule and a tie line that extends from the maximum solubility of Pb in the β phase at 180°C (i.e., 97.8 wt% Sn) to the eutectic composition (61.9 wt% Sn). Thus
(c) And, finally, we are asked to compute the mass fraction of eutectic $\beta$, $W_{e\beta}$. This quantity is simply the difference between the mass fractions of total $\beta$ and primary $\beta$ as

$$W_{e\beta} = W_\beta - W_\beta' = 0.776 - 0.504 = 0.272$$