

LN-10 IDLE MIND SOLUTIONS

1. Brass is 70 wt.% Cu, 30 wt.% Zn.
100 g brass would have 70 g Cu and 30 g Zn.

m = mass in g

M = atomic weight

$$n_{\text{Cu}} = \frac{m_{\text{Cu}}}{M_{\text{Cu}}} = \frac{70 \text{ g Cu}}{63.456 \text{ g Cu/mol Cu}} = 1.103 \text{ mol Cu}$$

$$n_{\text{Zn}} = \frac{m_{\text{Zn}}}{M_{\text{Zn}}} = \frac{30 \text{ g Zn}}{65.39 \text{ g Zn/mol Zn}} = 0.459 \text{ mol Zn}$$

$$\text{at.\% Zn} = \frac{100 n_{\text{Zn}}}{n_{\text{Cu}} + n_{\text{Zn}}} = \boxed{29.4}$$

2. 100 g of this phase would have 38.2 g Sn and 61.8 g Cu.

m = mass in g

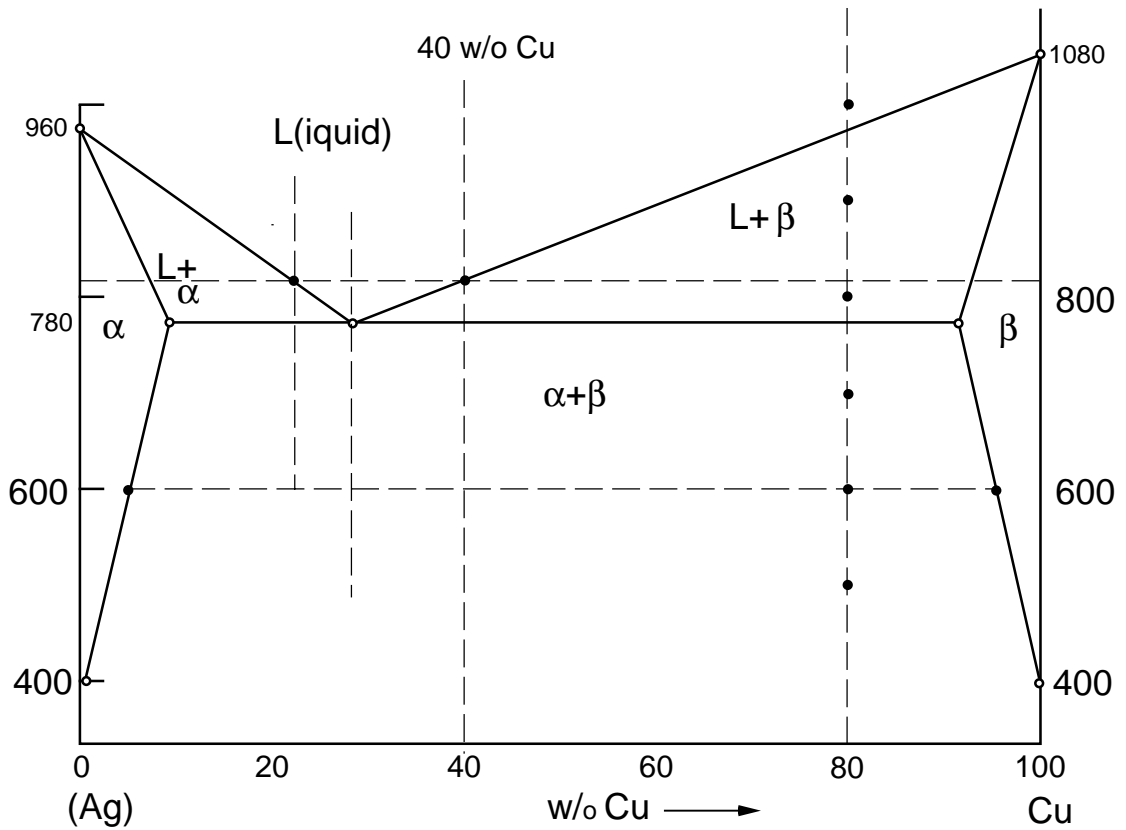
M = atomic weight

$$n_{\text{Cu}} = \frac{m_{\text{Cu}}}{M_{\text{Cu}}} = \frac{61.8 \text{ g Cu}}{63.456 \text{ g Cu/mol Cu}} = 0.974 \text{ mol Cu}$$

$$n_{\text{Sn}} = \frac{m_{\text{Sn}}}{M_{\text{Sn}}} = \frac{38.2 \text{ g Sn}}{118.71 \text{ g Sn/mol Sn}} = 0.322 \text{ mol Sn}$$

$$\text{copper - tin ratio} = \frac{n_{\text{Cu}}}{n_{\text{Sn}}} = \frac{0.974}{0.322} = \boxed{3.03}$$

3.



4. From phase diagram in Prob. 3, liquidus T for 40 wt.% Cu alloy is $\approx 840^\circ\text{C}$

5. From phase diagram in Prob. 3, other composition with same liquidus T is ≈ 20 wt.% Cu

6. (c) 26 g of Sterling Silver has $(26)(0.925) = 24.05$ g Ag and $(26)(0.075) = 1.95$ g Cu. Total Cu = $1.95 + 376 = 378$ g.

$$\text{wt.\% Cu} = \frac{378 \text{ g Cu}}{24 \text{ g Ag} + 378 \text{ g Cu}} = 94$$

(a) From phase diagram in Prob. 3, liquidus T $\approx 1060^\circ\text{C}$

(b) From phase diagram in Prob. 3, solidus T $\approx 870^\circ\text{C}$

7. An alloy of eutectic composition (28 wt.% Cu) is a mixture of α and β phases at 600°C. From the phase diagram, their compositions are:

α is 5 wt.% Cu (Ag-rich phase)

β is 96 wt.% Cu

The fraction α is given by the lever rule:

$$f_{\alpha} = \frac{x_{\beta} - x}{x_{\beta} - x_{\alpha}} = \frac{0.96 - 0.28}{0.96 - 0.05} = 75\%$$

If 100 g total are present, there are 75 g of α phase. Since α is 5 wt.% Cu, 75 g of α contains $(75)(0.05) =$ 3.7 g Cu

8. An alloy of 80 wt.% Cu has the following phases present at the following temperatures:

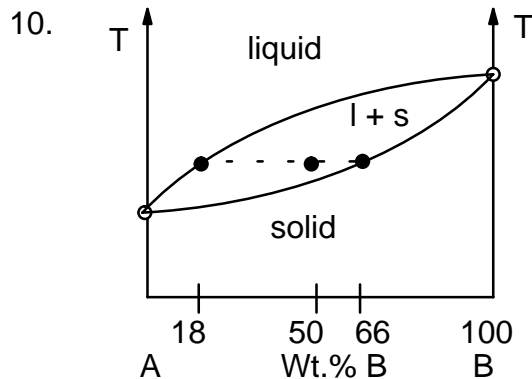
900°C	L + β
800°C	L + β
700°C	α + β
600°C and below	α + β

9. Eutectic liquid is 28 wt.% Cu. It freezes into a mixture of α (9 wt.% Cu) and β (92 wt.% Cu). Fraction α given by lever rule:

$$f_{\alpha} = \frac{x_{\beta} - x_e}{x_{\beta} - x_{\alpha}} = \frac{0.92 - 0.28}{0.92 - 0.09} = 77\%$$

$$f_{\beta} = 100 - f_{\alpha} = 23\%$$

If 80 g total is present, $(80)(0.77) =$ 61.7 g α and 18.3 g β



From lever rule:

$$f_L = \frac{x_S - x}{x_S - x_L} = \frac{0.66 - 0.50}{0.66 - 0.18} = 33\%$$

$$f_S = 1 - f_L = 67\%$$

If 2 kg total are present,

$$m_L = (2\text{kg})(0.33) =$$
 0.66 kg

$$m_S = (2\text{kg})(0.67) =$$
 1.34 kg

11. C = Components = 2 (Pb and Sn)
P = Phases = 2 (Pb-rich solid and Sn-rich liquid)
F = C – P + 2 in general
F = C – P + 1 with P fixed
= 2 – 2 + 1 = 1

At constant pressure, the experimental variables are T and C! That means that in the two-phase field any change of T will bring about a change in composition and thus will change the ratio of liquid to solid phase. Lowering T will generate more solid phase – make the system more “mushy”; it will not run off and can “bond”, say, two pieces of wire! [You normally will not use solder of eutectic composition since it is either liquid or solid (0 degree of freedom)].