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

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

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

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

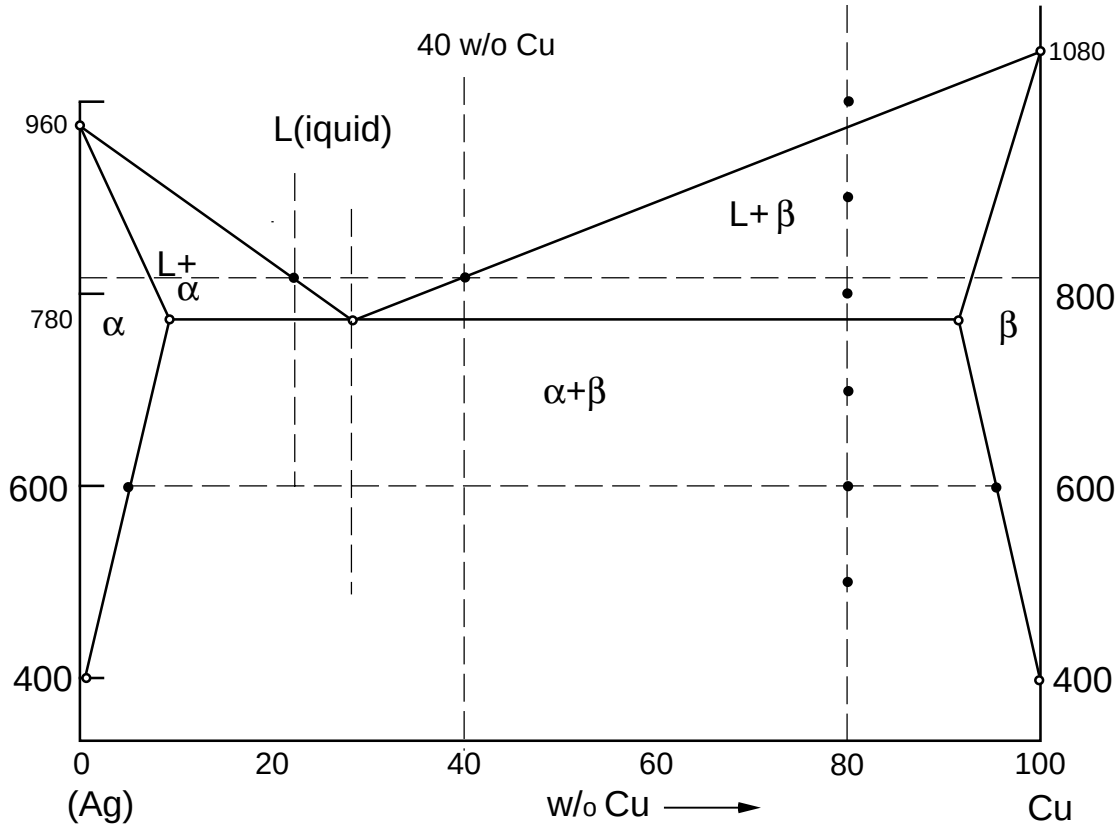
2. 100 g of this phase would have 38.2 g Sn and 61.8 g Cu.
   m = mass in g
   M = atomic weight

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

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

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

3.



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

5. From phase diagram in Prob. 3, other composition with same liquidus T is $\approx$ 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 $\approx 1060^{o}C$

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

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

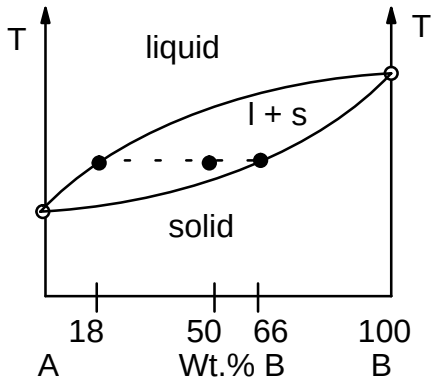
9. Eutectic liquid is 28 wt.% Cu. It freezes into a mixture of α (9 wt.% Cu) and β (92 wt.% Cu). Fraction α given by lever rule:

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

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

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

10.



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 = (2kg)(0.33) = **0.66 kg**

m_S = (2kg)(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)].