ME 216
ENGINEERING MATERIALS II
TUTORIAL

T.1. Figure 1 shows a part of the silver-tin thermal equilibrium diagram. Consider an alloy which contains 18% by mass of tin, cooling under equilibrium conditions:

a) At what temperature of the solidification begin?
b) What is the composition of the initial solid which forms?
c) At what temperature of the solidification completed?
d) What is the composition of the last trace of liquid?
e) What are the natures and composition of the phases present at 730°C?
f) In what proportions by mass are these phases present at 730°C?
g) For the alloy draw the microstructural changes step by step, cooling from 900°C.

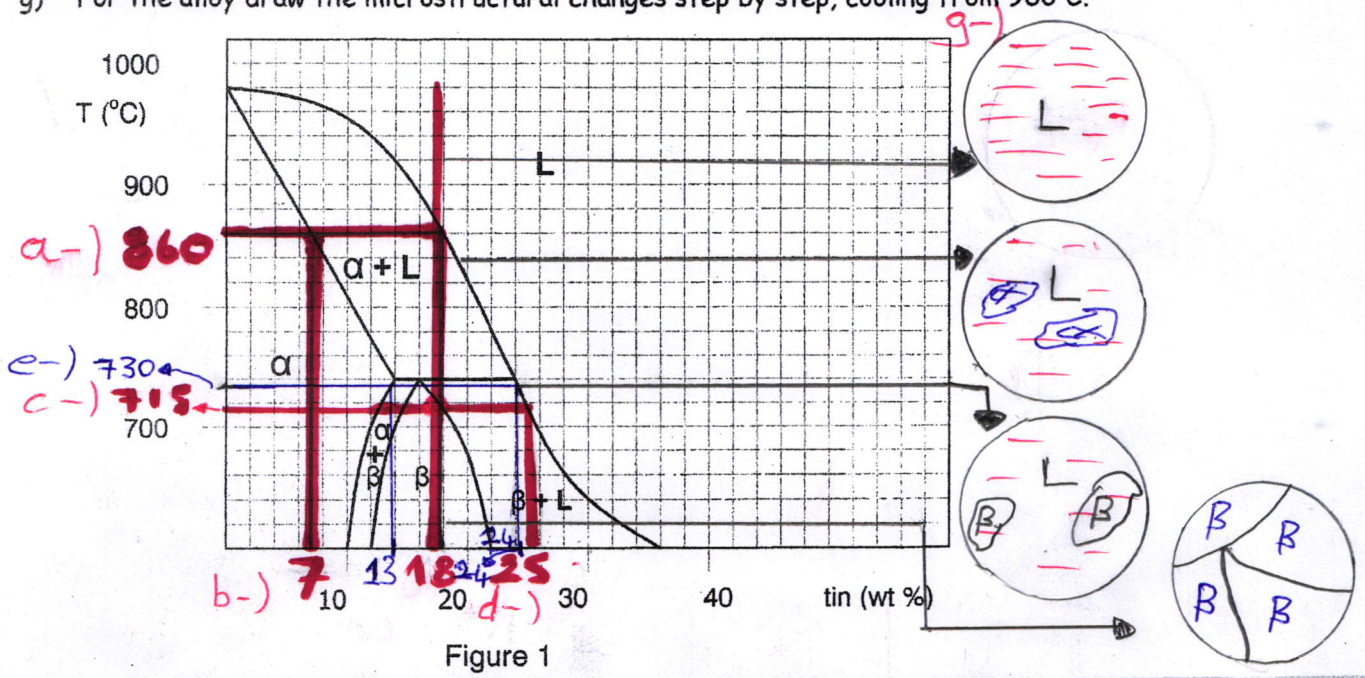


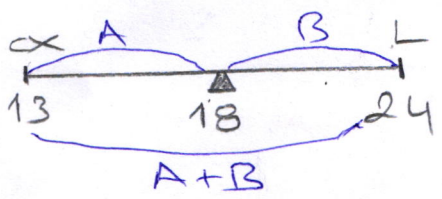
Figure 1

a-) 860°C b-) α + L composition; α: %7 Tin, L: %18 Tin

c-) 715°C d-) %25 Tin in Liquid.

e-) natures: α + L ; And composition of phases %13 α ; %24 L

f-)



$\Rightarrow W_\alpha = \frac{B}{A+B}$; $W_L = \frac{A}{A+B}$

$\Rightarrow W_\alpha = \frac{24-18}{24-13} \Rightarrow W_\alpha \cong 0,54 \Rightarrow$ %54 of mass is solid.

$\Rightarrow 54 * \frac{13}{100} \cong 7 \Rightarrow$ %7 (%amount of Tin in α)

$\Rightarrow W_L = \frac{18-13}{24-13} \Rightarrow W_L \cong 0,46 \Rightarrow$ %46 of mass is liquid.
(Or 100 − 54 = %46)

$\Rightarrow 46 . \frac{24}{100} \cong$ %11 (%amount of Tin in L)

$\Rightarrow$ Check → 11 + 7 = 18 %Tin.

T.2. Figure 2 shows a part of the Al-Mg thermal equilibrium diagram.

a) What the solid solubility of Mg in Al?
b) Over what temperature ranges will an alloy containing 3 % Mg exist as a single solid phase?
c) At what temperature does an alloy containing 5 % Mg begin to melt on heating?
d) What are the compositions of the phases for an alloy containing 16 % Mg is at 560°C?
e) What is the amount of Mg in solid and in Liquid for (d)?

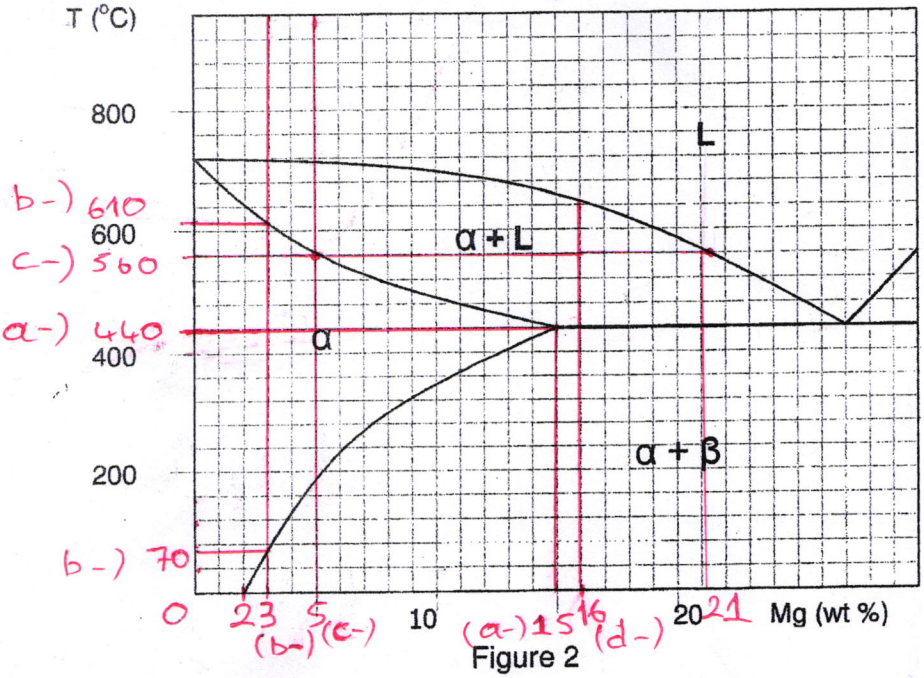


Figure 2

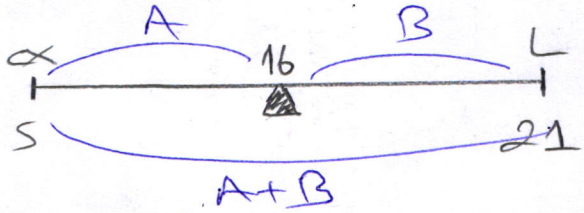
a-) 0°C → %.2 Mg
440°C → %.15 Mg

b-) 70°C, 610°C

c-) 560°C

d-) %.5 α
%.21 L

e-)



$$\Rightarrow w_\alpha = \frac{B}{A+B}$$

$$\Rightarrow w_L = \frac{A}{A+B}$$

$$\Rightarrow w_\alpha = \frac{21-16}{21-5} \Rightarrow w_\alpha = 0,3125 \Rightarrow \%31,25 \text{ (of mass is solid.)}$$

$$\Rightarrow 31,25 * 0,05 = \%1,5625 \text{ (amount of Mg in } \alpha.)$$

$$\Rightarrow w_L = \frac{16-5}{21-5} \Rightarrow w_L = 0,6875 \Rightarrow \%68,75 \text{ (of mass is liquid)}$$

(or 100 − 31,25 = %68,75)

$$\Rightarrow 68,75 * 0,21 = \%14,4375 \text{ (amount of Mg in L.)}$$

$$\Rightarrow (\text{check } 1,5625 + 14,4375 = 16\ \%\text{Mg.})$$

T. 3. Figure 3 shows an A-B thermal equilibrium diagram. For an alloy containing 70 % A, determine:

a) The solidification beginning temperature?
b) The temperature of the solidification completed?
c) The existing phases at 450°C.
d) The amount of B in solid at 450°C.
e) Draw microstructures from 600°C to room temperature.

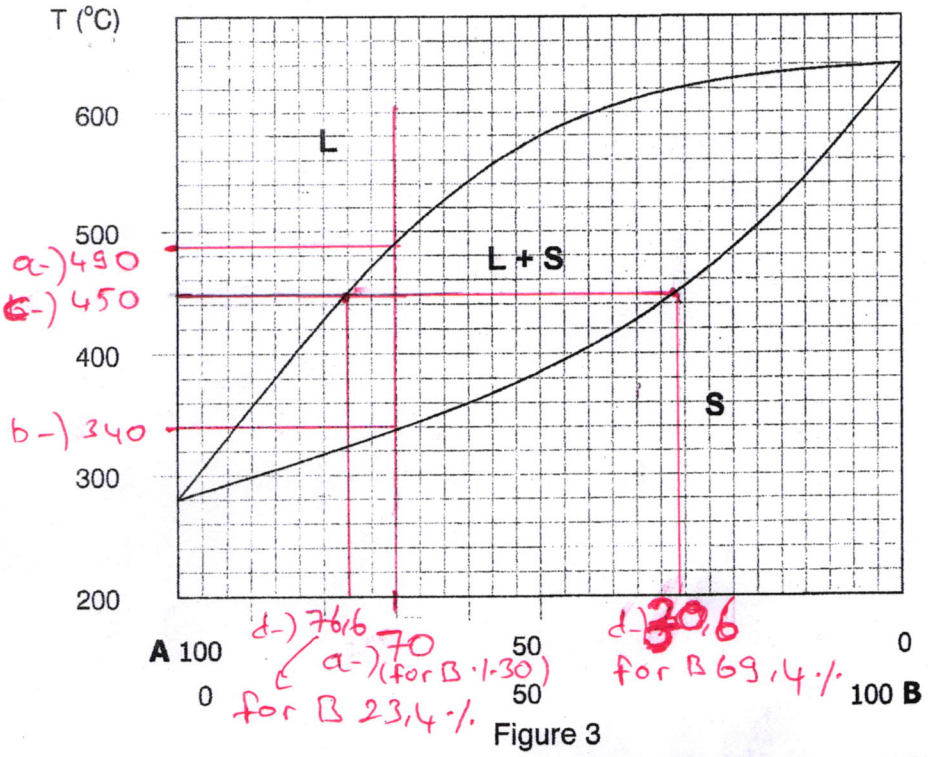
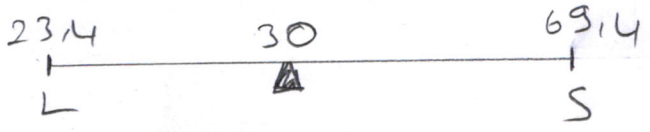


Figure 3

a-) 490°C // b-) 340°C // c-) L+S //

d-) For B;



$\Rightarrow w_L = \frac{69,4-30}{69,4-23,4}$

$\Rightarrow w_L \cong 0,8565$

$\Rightarrow$ %85,65 of mass is liquid.

$\Rightarrow 85,65 * 0,234 \Rightarrow$ ~% 20 B, in Liquid.

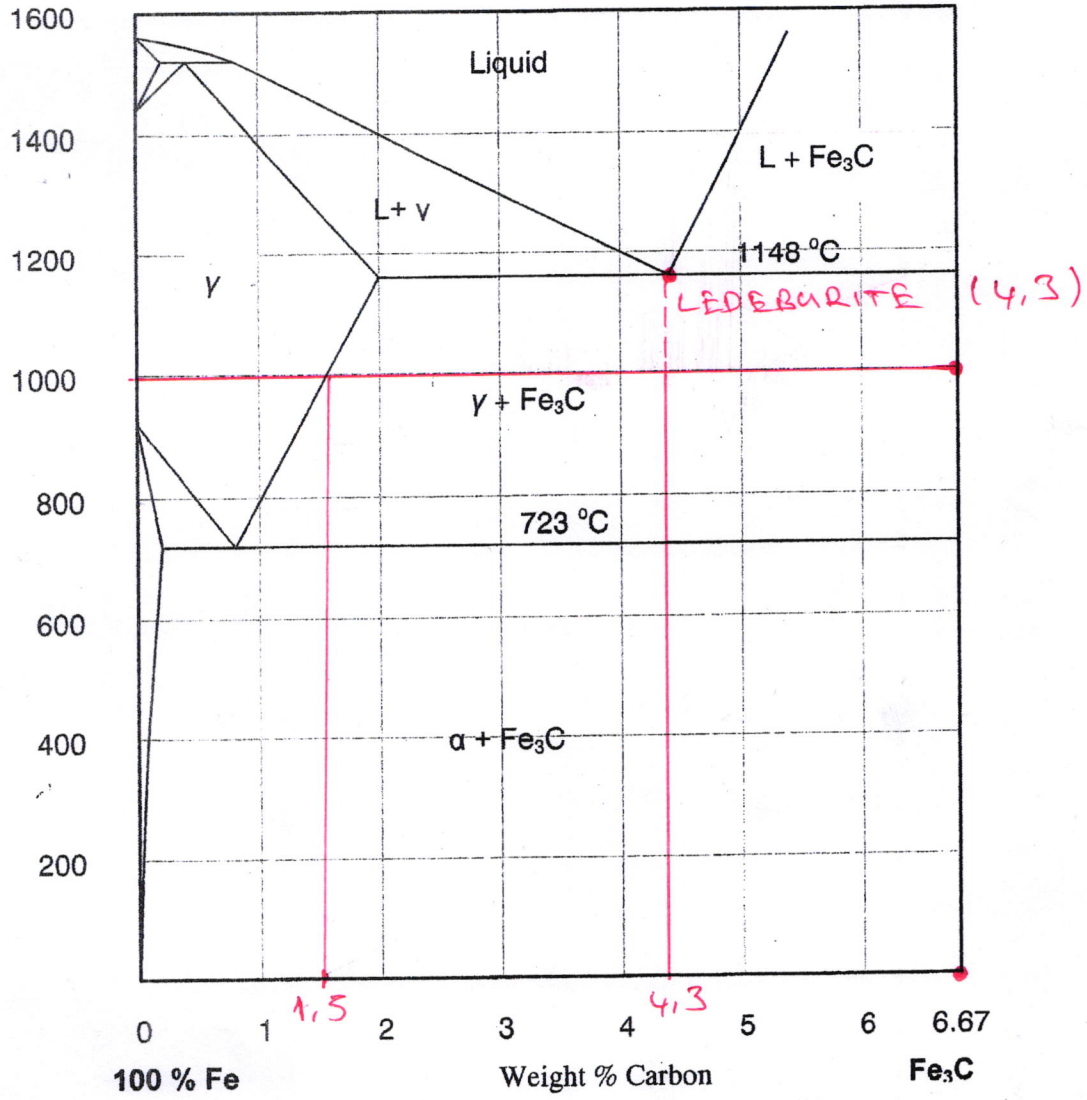
$\Rightarrow w_S = \frac{30-23,4}{69,4-23,4} \Rightarrow w_S \cong 0,1435 \Rightarrow$ %14,15 of mass is solid.

$\Rightarrow 14,35 * 0,694 \Rightarrow$ ~% 9,96 B, in Solid.

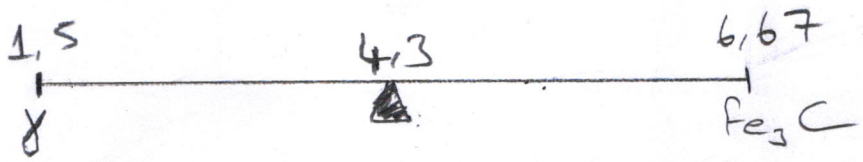
$\Rightarrow$ (Check $20 + 9,96 \cong 30$)

e-)

T. 4. Determine the percentages of austenite and cementite in ledeburite at 1000°C.



γ: Austenite ; Fe_3C: Cementite ;



$$\Rightarrow w_\gamma = \frac{6,67 - 4,3}{6,67 - 1,5} = 0,458 \Rightarrow \%\,45,8 \text{ of mass is } \gamma.$$

$$\Rightarrow 45,8 * 0,015 = 0,687$$

$$\Rightarrow w_{Fe_3C} = \frac{4,3 - 1,5}{6,67 - 1,5} = 0,542 \Rightarrow \%\,54,2 \text{ of mass is } Fe_3C.$$

(or $100 - 45,8 = \%\,54,2$)

$$\Rightarrow 54,2 * 0,067 = 3,631$$

$$\Rightarrow (\text{check } 3,631 + 0,687 = 4,318 \simeq 4,3\ \%)$$