MATE 201
Fall 2019

Homework # 5

Due date: December 2nd, 2019
(lecture time)
No late submissions!

Group submission (up to 4 students per group) is allowed.

Your homework submission should have a cover page which contains the following information;
your name, student number, course name, homework number and date of submission.

Question 1:

Given here are the solidus and liquidus temperatures for the copper–gold system. Construct the phase diagram for this system and label each region.

Composition (wt% Au)	*Solidus Temperature (°C)*	*Liquidus Temperature (°C)*
0	1085	1085
20	1019	1042
40	972	996
60	934	946
80	911	911
90	928	942
95	974	984
100	1064	1064

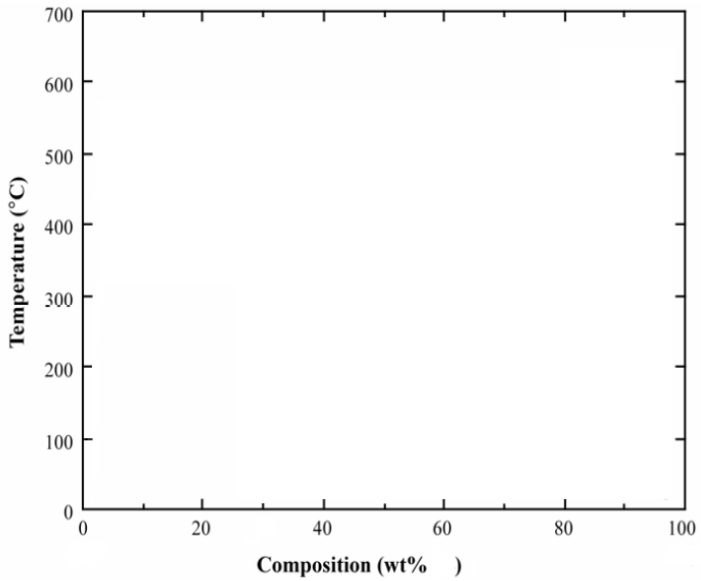
Question 2:

A hypothetical A–B alloy of composition 65 wt% A–35 wt% B consists of α and β phases at some temperature. If the mass fraction of the α phase is 0.67 and its composition is 13.5 wt% B–87 wt% A, what is the composition of the β phase?

Question 3:

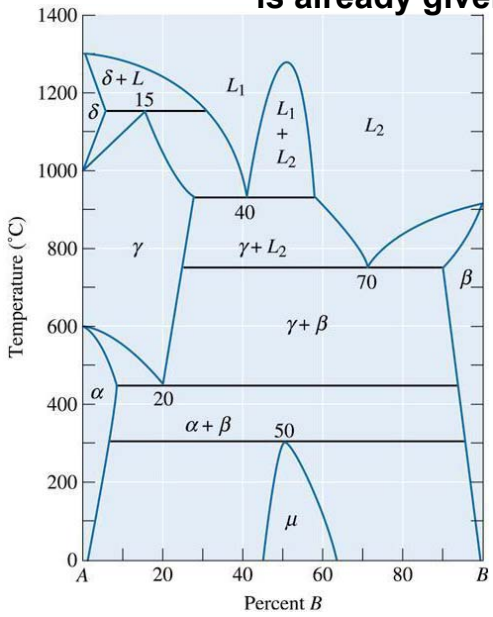
Construct and label the hypothetical phase diagram for a system with metals A and B based on the following information:

- The melting temperature of metal A is 480°C.
- The maximum solubility of B in A is 4 wt% B, which occurs at 420°C.
- The solubility of B in A at room temperature is 0 wt% B.
- One eutectic occurs at 420°C and 18 wt% B–82 wt% A.
- A second eutectic occurs at 475°C and 42 wt% B–58 wt% A.
- The intermetallic compound AB exists at a composition of 30 wt% B–70 wt% A, and melts congruently at 525°C.
- The melting temperature of metal B is 600°C
- The maximum solubility of A in B is 13 wt% A, which occurs at 475°C.
- The solubility of A in B at room temperature is 3 wt% A.



Question 4:

Write down the phase reactions present in the A-B alloy system. One of the reactions is already given below.



1150°C

920°C $L_1 \rightarrow \gamma + L_2$ *(monotectic)*

750°C

450°C

300°C

Question 5:

A copper-silver alloy of composition 70 wt% Cu is slowly cooled from a temperature of 1200°C.

a) At what temperature does the first solid phase form?

b) What is the composition of this solid phase?

c) At what temperature does the alloy solidify completely ?

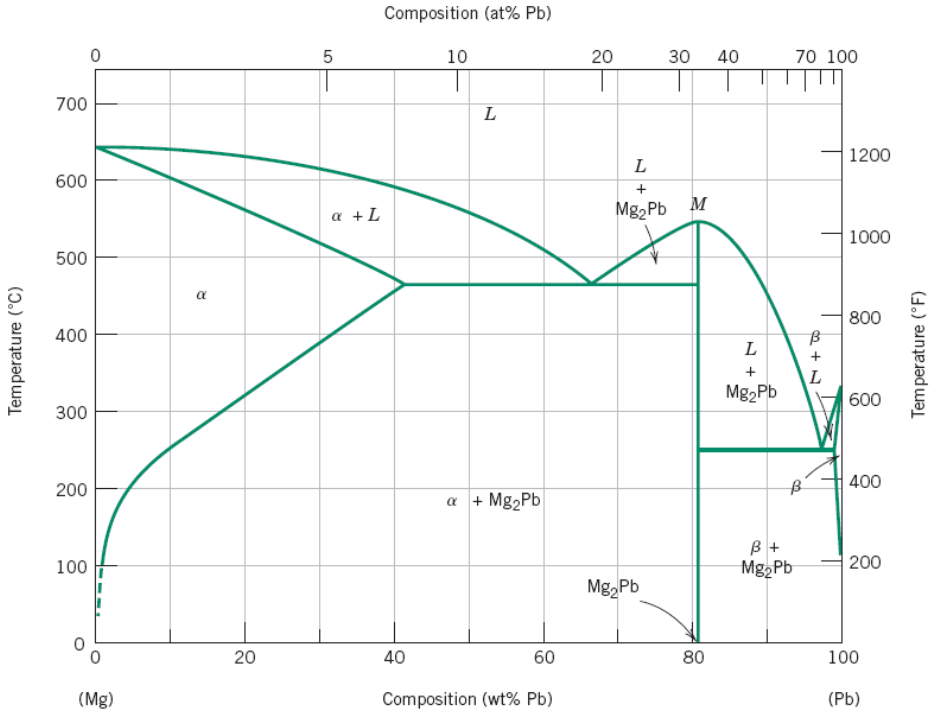
d) What is the composition of the last liquid remaining prior to complete solidification?

Question 6:

Calculate the amount (in kg) of each phase present in a 2 kg 10 at.% Pb – 90 at.%Sn solder alloy at a) 300°C, b) 200°C, and c) 150°C.

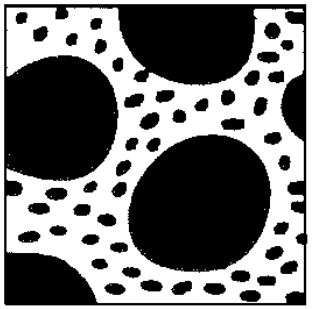
Question 7:

For a 76 wt% Pb–24 wt% Mg alloy, make schematic sketches of the microstructure that would be observed for conditions of very slow cooling at the following temperatures: 575°C (1070°F), 500°C (930°F), 450°C (840°F), and 300°C (570°F). Label all phases and indicate their approximate compositions.

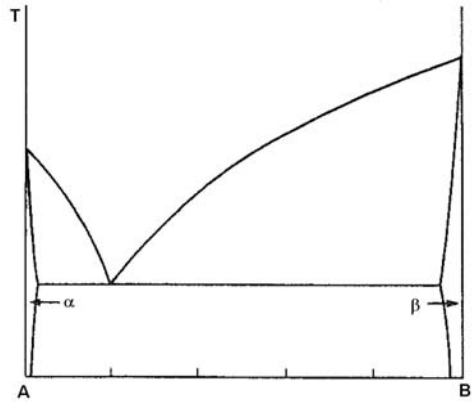


Question 8:

In a materials laboratory experiment, a student sketches a microstructure observed under an optical microscope as shown on the right.



The phase diagram for this alloy system is below:



<u>Determine</u>
(a) whether the black regions in the sketch represent α or β phase and
(b) the approximate alloy composition.

Question 9:

6 kg of plain carbon steel with 0.50 wt% C is cooled from 1000°C to just below 727°C under equilibrium conditions.

(a) What is the proeutectoid phase?

(b) How many kilograms each of total ferrite and cementite form?

(c) How many kilograms each of pearlite and the proeutectoid phase form?

(d) Schematically sketch and label the resulting microstructure.

Question 10

What is the AISI number of a steel with a microstructure of 30% pearlite and 70% proeutectoid ferrite?

Question 11

A steel alloy contains 94.55 wt.% Fe, 5.00 wt.% Si and 0.45 wt.% C.

1) What is the eutectoid temperature of this alloy?

2) What is the eutectoid composition?

3) What is the proeutectoid phase?

Assume that there are no changes in the positions of other phase boundaries wih the addition of Si.