**Chemistry 342**
Problem Set 10
On phase diagrams

## *A. Constructing phase diagrams from cooling curves*

**1.** The break and halt temperatures for the cooling curves of melts of metals A and B are given in the table below. The second column gives the temperature at which a break or change in rate of cooling occurs, and the last columns, the temperature of a halt.

| Composition mole % A | Temperature of First break (°C) | Temperature of First halt (°C) | Temperature of Second halt (°C) |
|---|---|---|---|
| 100 | | 1100 | |
| 90 | 1060 | 700 | |
| 80 | 1000 | 700 | |
| 70 | 940 | 700 | 400 |
| 60 | 850 | 700 | 400 |
| 50 | 750 | 700 | 400 |
| 40 | 670 | 400 | |
| 30 | 550 | 400 | |
| 20 | | 400 | |
| 10 | 450 | 400 | |
| 0 | | 500 | |

Construct a phase diagram consistent with these cooling curves and label the phase regions. Give the probable formula of any compounds.

**2.** Thermal analysis of the system A-B gives the following information:
- 10 mole % B: break at 900 °C, second break at 650°C
- 30 mole % B: break at 650 °C, halt at 450°C
- 50 mole % B: break at 550 °C, halt at 450°C
- 60 mole % B: break at 650 °C, halt at 600°C, second halt at 450°C
- 80 mole % B: break at 750 °C, halt at 600°C
- 90 mole % B: break at 780 °C, halt at 600°C

A and B melt at 1000°C and 850°C respectively. Sketch the simplest phase diagram consistent with these data. Label all phase regions and give the formulas of any compounds.

**3.** The cooling curve data in the table below are for the system silver-platinum.

| Composition Pt mole % | Temperature of break (°C) | Temperature of halt (°C) |
|---|---|---|
| 0 | | 960 |
| 10 | 1025 | |
| 20 | 1075 | 1050 |

| | | |
|---|---|---|
| 30 | 1100 | 1050 |
| 40 | 1200 | 1050 |
| 50 | 1250 | 1050 |
| 60 | 1300 | 1050 |
| 70 | 1350 | 1050 |
| 80 | 1400 | 1050 |
| 90 | 1600 | |
| 100 | | 1770 |

Construct the simplest phase diagram consistent with the above data, label each phase region, and give the phase reaction occurring during the 1050°C halt.

**4.** The following information is obtained from cooling curve data on the system Sn-Mg:

| Composition of melt mole % Mg | Temperature of break, if any (°C) | Temperature of halt, if any (°C) |
|---|---|---|
| 0 | | 250 |
| 10 | | 200 |
| 40 | 600 | 200 |
| 67 | | 800 |
| 80 | 610 | 580 |
| 90 | 610 | 580 |
| 100 | | 650 |

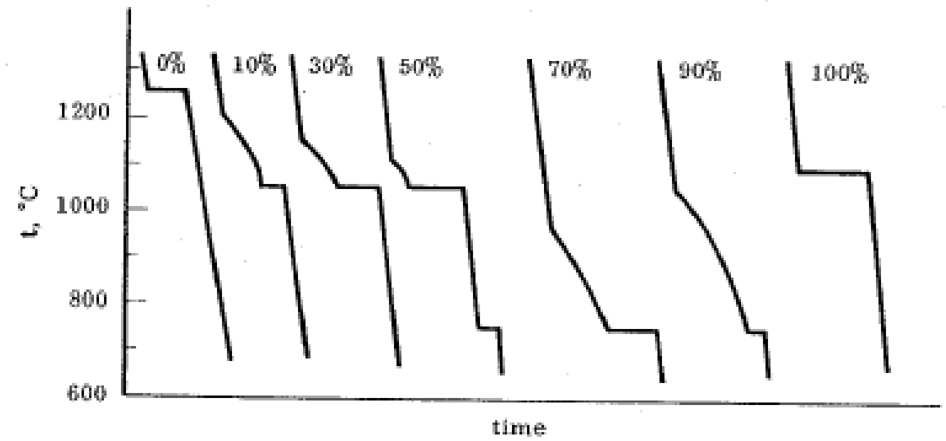
Sketch the simplest melting point diagram consistent with these data. Label the phase regions and give the compositions of any compounds formed.

**5.** The break and halt temperatures for the cooling curves of melts of metals A and B are given in the table below.

| Composition mole % A | Temperature of break (°C) | Temperature of First halt (°C) | Temperature of Second halt (°C) |
|---|---|---|---|
| 100 | | 1000 | |
| 90 | 950 | 800 | |
| 80 | 900 | 800 | |
| 70 | 900 | 800 | |
| 60 | 1000 | 800 | |
| 50 | | 1100 | |
| 40 | 1000 | 700 | |
| 30 | 750 | 700 | 500 |
| 20 | 550 | 500 | |
| 10 | 575 | 500 | |
| 0 | | 600 | |

Construct a phase diagram consistent with these curves and label each phase region. Give the probable formulas of any compounds

**6.** The cooling curves obtained for the system $CaF_2$-$CaCl_2$ (compositions are in mole % of $CaCl_2$ in the melt) are shown below:




Construct the most reasonable semi-quantitative freezing-point diagram, label all phase regions, and give the probable formulas of any compounds that are formed.

### *B. Compound formation*

**7.** Na and K melt at 98°C and 65°C, respectively. They form one solid compound, NaK, which decomposes at 10°C to give a solid and a melt containing 60 mole% K. There is a eutectic at -5°C. Sketch the simplest phase diagram consistent with the above data, label the phase regions, and draw cooling curves for melts containing 40 % K, 55% K, and 90% K. Indicate the phases appearing or disappearing at each break or halt.

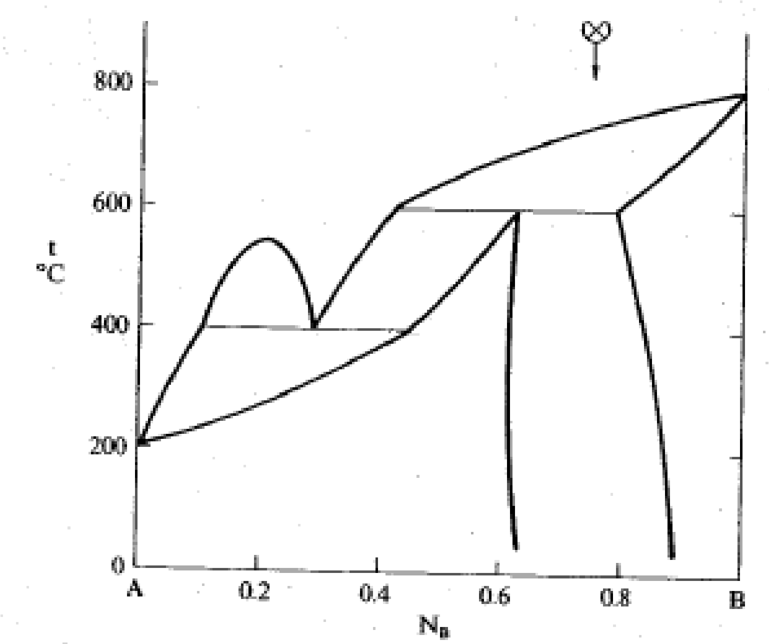
**8.** Au and Sb melt at 1060°C and 630°C, respectively, and form one compound, $AuSb_3$, which melts incongruently at 800°C. Sketch the simplest phase diagram consistent with this information and label all phase regions. Give the cooling curve for a melt containing 50% Au, and label each break and halt.

**9.** Metals A and B form the compounds $AB_3$ and $A_2B_3$. Solids A, B, $AB_3$ and $A_2B_3$ essentially are immiscible in each other, but are completely miscible as liquids. A and B melt at 600°C and 1100°C, respectively. Compound $A_2B_3$ melts congruently at 900°C and gives a simple eutectic with A at 450°C. Compound $AB_3$ decomposes at 800°C to give the other compound and a melt. There is a eutectic at 650°C. Draw the simplest phase diagram consistent with this information and label all phase regions. Sketch cooling curves for melts of composition 90% A and 30% A, and label as to phases appearing or disappearing at each break and halt.

*C. Peritectic systems*

**10.** Thermal analysis of the two-component system A-B, metals melting at 1200°C and 600°C, respectively, shows that two solid phases of composition 40% B and 60% B, respectively are in equilibrium at 800°C with liquid of composition 80% B. Construct the simplest melting point diagram consistent with this information, and label all phase regions. Sketch the cooling curves for compositions 20% B, 50% B, and 70% B and fully label what happens at each break and halt.

**11.** The melting point diagram for A and B has the appearance shown below:




Label all regions as to the phases present, using “A” or “B” to denote pure solid A or B, and $C_1$, $C_2$, etc., for pure solid compounds, and use $\alpha$, $\beta$, etc. to denote solid solutions rich in A, B, and so on. Use L to denote a liquid solution (or $L_1$, $L_2$, etc.).
Sketch the cooling curve for a system of the composition indicated by ⊗ in the figure above, and state what phases appear or disappear at each halt or break.