1. Problem 3 from HW#5

Refer to A-B-C phase diagram attached
(a) Draw Alkemade lines to define compositional triangles and put arrows on all boundary lines to indicate the direction of falling temperature. Label any peritectics and eutectics.

(b) For a melt composition containing 50%C, 35%A and 15%B, trace the cooling path for the liquid. Describe the events that occur during cooling of this melt. Trace the cooling path for the solid.

(c) For a melt composition containing 80%C, 10%A and 10%B, trace the cooling path for the liquid. Describe the events that occur during cooling of this melt. Trace the cooling path for the solid.
(b) For a melt composition containing 50% C, 35% A and 15% B, trace the cooling path for the liquid. Describe the events that occur during cooling of this melt. Trace the cooling path for the solid.
(c) For a melt composition containing 80% C, 10% A and 10% B, trace the cooling path for the liquid. Describe the events that occur during cooling of this melt. Trace the cooling path for the solid.
2. For the K – G – R phase diagram attached, make an isoplethal of the composition that is 70\% G, 10\% R, and 20\% K. Pick logical temperatures to analyze the number of phases, relative amounts of phases and compositions of phases from 100\% liquid to 100\% solid during cooling.

<table>
<thead>
<tr>
<th>Temp (C)</th>
<th>Phases</th>
<th>Phase Compositions</th>
<th>Relative Amounts</th>
</tr>
</thead>
<tbody>
<tr>
<td>2060</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1900</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1700</td>
<td>3</td>
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<td>1491</td>
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</tr>
<tr>
<td>1489</td>
<td>3</td>
<td></td>
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</table>
Use the CaO-SiO2-Al2O3 ternary to answer problems 3 and 4.

(a) A powder mixture of 40wt% SiO2, 20% Al2O3 and 40% CaO is heated. What will be the first temperature that a liquid phase will form? → Anorthite

(b) What temperature is necessary to melt the mixture entirely? ~1285°C

(c) List the phases present at: (i) 1500°C, (ii) 1400°C, (iii) 1300°C, (iv) 1200°C.

(d) At 1300°C, give the composition of each phase present and the relative amounts of the phases.

(e) What phases do you expect to find after cooling the ceramic to room temperature? What are relative amounts?

(f) For compositions X and Y, locate the composition and show the cooling paths for the solid and the liquid phases. Label clearly and use color to differentiate.

X: 5wt% SiO2, 20% Al2O3 and 75% CaO
Y: 20wt% SiO2, 30% Al2O3 and 50% CaO
4. Wollastonite (labeled pseudowollastonite on the diagram) forms needle shaped grains when it is crystallized from the melt; these are known to enhance the fracture toughness of ceramics (more on that later). Design a composition (in terms of the three main components) and thermal treatment (melting and solidification) to make a ceramic that contains 50wt\% wollastonite, 40\% anorthite and 10\% gehlenite.

\[ \text{CaO} \cdot \text{Al}_2\text{O}_3 \cdot \text{SiO}_2 \]
5. The ternary diagram for the SiO2 rich region of the Na2O – CaO - SiO2 is attached.

(a) Is the diagram in weight % or mole %? **Weight % - 50 isn't exactly where Na2O-SiO2 is located.**

(b) Why is there no phase region for glass on the diagram? **Glass is a non-EQ structure**

(c) A typical window glass has 75 wt% SiO2, 10 wt% CaO and 15 wt% Na2O. For this composition, find the following:
- temperature required for formation of a single phase liquid
- cooling path for that single phase liquid
- final composition of solid after very slow (equilibrium) cooling. Include relative amounts of phases

(d) If there were a formulation change in which the amount of CaO and Na2O were each decreased by 50%, how would the thermal requirements for forming a melt and eventually a glass change?