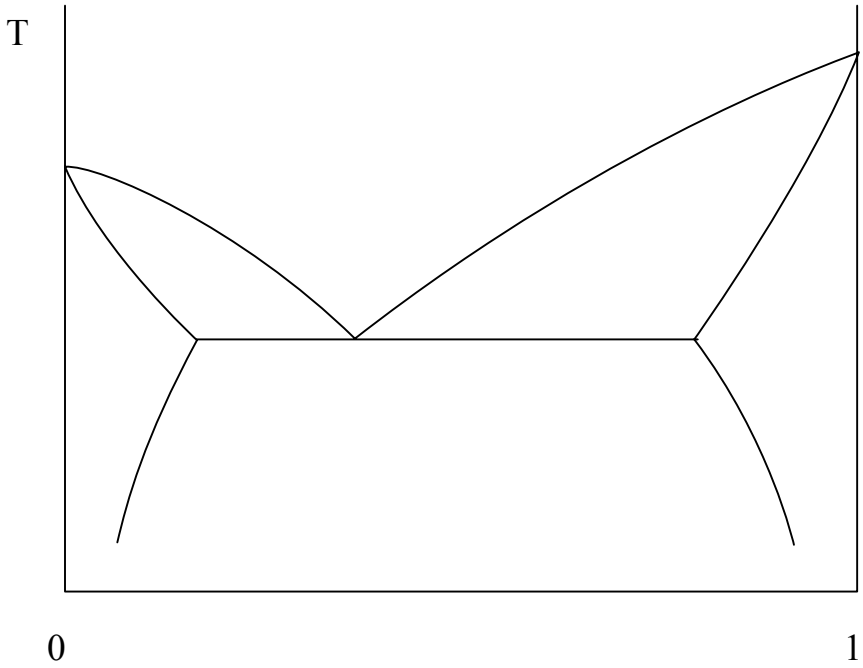
1)
Below is the skeleton of a Txy diagram (at constant P of 1 atm) for a binary system VLLE.

a) Fill in the diagram as much as you can, given the following information:

i) Two partially-miscible liquid phases can be formed: γ (rich in component 1) and δ (rich in component 2).
ii) The normal boiling point of component 1 is 100°C, which differs by 20°C from component 2's boiling point.
iii) γ, δ, and vapor co-exist at 50°C and 1 atm with the following composition: $x_1^{\gamma} = 0.75$, $x_2^{\delta} = 0.80$, $y_1 = 0.40$.



the axes are scaled linearly

b) Draw the process of cooling a gaseous mixture of 1 and 2, initially $y_1 = 0.30$, from 100°C to 20°C. Label the initial point as **A** and final point as **D**.

As the gaseous mixture is cooled, the first liquid phase formed is the _____ phase. Let's call this point **B**. The composition of the dew is _____ mole% component 1. This occurs at approximately _____°C. When this mixture is cooled further, three phases co-exist at _____°C. (Point **C**). The compositions in the phases are _____. When the mixture is cooled further, the _____ disappears and _____ is formed.

c) For the same process as in b):

At 50.1°C, there are more _____ phase than the _____ phase. In fact, we can calculate the ratio of the amounts of the two phases: _____ / _____ = _____

At 49.9°C, there are more _____ phase than the _____ phase. In fact, we can calculate the ratio of the amounts of the two phases: _____ / _____ = _____

2) (adapted from Final Exam Fall 1999)

Consider the reaction of CO_2 gas with liquid water containing small amount of $Ca(OH)_2$ to form $CaCO_3$ as pure solid precipitate:

$$Ca(OH)_{2\,(aq)} + CO_{2\,(g)} \rightarrow CaCO_{3\,(s)} + H_2O_{\,(l)}$$

This process that takes place in the oceans is believed to be a major contributor to the removal of CO_2 from the Earth's atmosphere.

a) What is the equilibrium constant for the reaction at 25°C? You can use the information in steam tables and appendix C. If heat capacities are required, assume that they are constant at their values at 25°C.
b) Find another expression for the equilibrium constant at 25°C that is a function of the partial pressure of CO_2 in the gas phase and the molal concentration of $Ca(OH)_2$ in the aqueous phase. We are considering the process described above: atmospheric pressure, dilute $Ca(OH)_{2(aq)}$. Assume that the species only exist in the phase specified in the reaction.
c) For a CO_2 fraction of 0.01 mole% in the Earth's atmosphere, what must the concentration of $Ca(OH)_{2(aq)}$ be when the reaction above is at equilibrium? Assume that the sea temperature is 25°C.