Take Home Quiz 5 KEY

Take home quizzes are due at the beginning of the following lecture. They are worth 2 points of EXAM credit. Please attach this sheet to your answers if additional sheets are used.

1. Figure 7.19 in the text shows the dry ($P_{H_2O} = 0$) and the wet ($P_{H_2O} = P_{fluid}$) cases. Use the Clapeyron equation to explain the following:

   A. For the dry case, why the slope of $dP/dT$ is positive.

   B. For the wet case, why the slope of $dP/dT$ is negative.

   C. For the wet case, below $P = 0.15$ GPa, why the curve shows a large initial depression of the melting point.

   D. For the wet case, above $P = 0.15$ Gpa, why the slope of the line is much less negative.

1A. The Clapeyron equation is

   $$\frac{dP}{dT} = \frac{\Delta S}{\Delta V}$$

   For the transition from solid to liquid, entropy increases, so $\Delta S$ is positive. The volume also increases on going from solid to liquid> Since both $\Delta S$ and $\Delta V$ are positive, $dP/dT$ must be positive.

1B. For the equation,

   $$H_2O_{(vapor)} + Albite = Liquid_{(aq)}$$

   volume decreases on going from vapor to liquid, so $\Delta V$ is negative. This means the $dP/dT$ is negative.
1C. Below 0.15 GPa, the gas volume decreases rapidly with increasing pressure, so $\Delta V$ is negative and large. Thus, there is a substantial depression of the melting point. It is the rate of change of $\Delta V$ with $P$ that is important. Mathematically,

$$\left( \frac{\delta \Delta V}{\delta P} \right)_T$$

1D. Above 0.15 GPa, the gas volume continues to shrink with increasing pressure, but at a much smaller rate. Thus, the melting point depression with increasing pressure is more gradual. $\Delta V$ is still negative, but the rate of change is smaller.