

This is ACA # 7. It is OK to use your textbook, but if you can answers the questions without it that is OK too.

I recommend you print out this page and bring it to class. [Click here](#) to show a set of five ACA7 student responses, randomly selected from all of the student responses thus far, in a new window.

John , here are [your responses](#) to the ACA and the [Expert's response](#).

1. The equilibrium vapor pressure for water at 45 °C is 71.9 mmHg.

a) If the pressure due to water in the vapor phase in a container is 45.7 mmHg, what phase or phases are present in the container?

gas only 70%

Since the pressure due to the water vapor in the container is LESS that the equilibrium vapor pressure the only phase present is the vapor/gas phase. No liquid can be present, becuase if liquid were present the pressure due to the water vapor would have to be 71.9 mmHg.

b) Can the pressure due to water in the vapor phase ever exceed 71.9 mmHg at 45 °C in a container?

No Yes/No 85%

NO.

Explain

71.9 mmHg is the maximum pressure exerted by the vapor at 45 degrees Celsius. At the pressure the rate of evaporation is equal to the rate of condensation

Since the equilibrium vapor pressure for water at 45 °C is 71.9 mmHg that is the maximum pressure that can be exerted by water vapor, above liquid water at that temperature. Any effort to increase the pressure due to the vapor would simply increase the rate of condensation until the pressure due to the vapor was 71.9 mmHg again.

2. Look at the [table of vapor pressures](#) at different temperatures and enter the equilibrium vapor pressure for water at 85 °C.

433.6 mmHg 100%

The equilibrium vapor pressure for water at 85 °C is 433.6 mmHg.

633.9 mmHg 100%

The equilibrium vapor pressure for water at 95 °C is 633.9 mmHg.

b) A sample of water in a container at 95 °C exerts a pressure of 580 mmHg. Explain why we can assume that the sample is only vapor/gas under these conditions of temperature and pressure.

580 mmHg is lower than 633.9 mmHg so the pressure due to the vapor is lower than the equilibrium vapor pressure at 95 degree C, so no condensation can occur.

The equilibrium vapor pressure for water is 633.9 mmHg at 95 °C, which is the maximum pressure exerted by the vapor above the LIQUID at that temperature. Since the pressure exerted by the vapor is less than the equilibrium vapor pressure, no liquid can be present. If liquid were present more evaporation would have to occur to raise the pressure due to the vapor to the equilibrium vapor pressure.

c) If the container is cooled to 85 °C calculate the pressure exerted by the sample (use the ideal gas law $P_1/T_1 = P_2/T_2$) assuming the sample remains in the gas phase. Also assume the volume is held constant and no water is lost. (Watch out for the units on T, they must be Kelvin.)

564 mmHg 90%

The pressure due to the vapor at 85 °C is 564 mmHg.

We can use the ideal gas law. In this problem V, n and R are constant, so P/T is a constant, and we can solve for the pressure of the vapor at the lower temperature by substituting into the mathematical expression for the change of condition problem. $P_1 = 580 \text{ mmHg} : T_1 = 368 \text{ K} : P_2 = ?$ and $T_2 = 358 \text{ K}$. $P_2 = P_1 * T_2 / T_1 = 580 \text{ mmHg} * 358 \text{ K} / 368 \text{ K} = 564 \text{ mmHg}$

d) Based on you answer in Q1c and the equilibrium vapor pressure at 85 °C, indicate

the phase(s) present in the container at 85 °C.

gas and liquid

70%

Liquid and vapor are present in the container.

The calculated pressure due to the vapor at 85 °C is 564 mmHg. The equilibrium vapor pressure at 85 °C is 433 mmHg. Since the calculated pressure due to the vapor exceeds the equilibrium vapor pressure at that temperature condensation **MUST** occur. Remember, at 85 °C the **MAXIMUM** pressure due to the vapor above its liquid (water in this case) is 433 mmHg, since we calculated 564 mmHg (assuming all the sample remained in the vapor phase) condensation has to occur.

5) Solve the following : (Note: if the number is less than 1, like 3.356×10^{-3} , enter the number as 3.356e-3.)

a) $1/298 = 3.36e-3$

95%

$1/298 = 0.00336$ (1/298 is the same as 298^{-1})

b) $\ln(345/670) = -.664$

80%

$\ln(345/670) = -0.664$

One could do the quotient of 345/670, which is 0.515, then take the ln of 0.515

$\ln 0.515 = -0.664$

c) $\ln 345 - \ln 670 = -.664$

85%

$\ln 345 - \ln 670 = 5.844 - 6.507 = -0.664$

d) $\ln(525/340) = -\Delta H/8.314 \cdot (1/345 - 1/304)$

$\Delta H = 1.1e3 \text{ joules mol}^{-1}$

60%

$\ln(525/340) = \ln(1.544) = 0.434$

$(1/345 - 1/304) = (0.002898 - 0.003289) = -0.000391$

So we have $0.434 = -\Delta H/8.314 * -0.000391$ (Notice - * - = +)

$$\Delta H = 0.434 * 8.314 / 0.000391 = +9240 \text{ joules mol}^{-1}$$

4. Given the following values in the Clausius-Clapyron equation solve for P_2 (where P_2 is the vapor pressure at T_2) .

$$\ln (P_2/330) = -(28,000 \text{ J mol}^{-1}/8.314 \text{ J mol}^{-1}\text{K}^{-1}) * (1/313 \text{ K} - 1/293 \text{ K})$$

687 mmHg

65%

688 mmHg

$$\ln (P_2/330) = -(28,000 \text{ J mol}^{-1}/8.314 \text{ J mol}^{-1}\text{K}^{-1}) * (0.003194 \text{ K}^{-1} - 0.003413 \text{ K}^{-1})$$

$$\ln (P_2/330) = -(28,000 \text{ J mol}^{-1}/8.314 \text{ J mol}^{-1}\text{K}^{-1}) * (-0.000219 \text{ K}^{-1})$$

$$\ln (P_2/330) = 0.738$$

$$e^{\ln (P_2/330)} = e^{0.738}$$

$$P_2/330 = 2.09$$

$$P_2 = 688 \text{ mmHg}$$

5. Is there anything about the questions that you feel you do not understand? List your concerns/questions.

nothing

6. If there is one question you would like to have answered in lecture, what would that question be?

nothin

are vapor pressure & equilibrium v.p. the same.

Yes.

I try to use the term pressure due to the vapor to help clarify pressures that are not vapor pressures.