

According to the database you (John Gelder) have already completed this BCE. The responses you have just entered have overwritten the responses submitted earlier. If you have any concerns contact Dr. Gelder. You may want to print a copy of this page for your records.

This is BCE #7.

I recommend you print out this page and bring it to class. [Click here](#) to show a set of five BCE7 student responses, randomly selected from all of the student responses thus far, in a new window.

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

1a. Look at the [table of vapor pressures](#) at different temperatures and enter the equilibrium vapor pressure for water at 80 °C and at 90 °C.

355.1 mmHg (80 °C)

The equilibrium vapor pressure for water at 80 °C is 355.1 mmHg.

525.8 mmHg (90 °C)

The equilibrium vapor pressure for water at 90 °C is 525.8 mmHg.

b) A sample of water in a container at 90 °C exerts a pressure of 500 mmHg. Explain why we can assume that the sample is only vapor/gas under these conditions of temperature and pressure.

The pressure exerted by the vapor is 500 mmHg and the equilibrium vapor pressure at 90 degrees Celsius is 525.8 mmHg. Since the pressure of the vapor at 90 degrees Celsius is lower than the equilibrium vapor pressure, no liquid water can be present.

The equilibrium vapor pressure for water is 525.8 mmHg at 90 °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 80 °C calculate the pressure exerted by the sample assuming the sample remains in the gas phase (use the ideal gas law  $P_1/T_1 = P_2/T_2$ ). Also assume the volume is held constant and no water is lost. Be sure the temperature is in Kelvin not Celsius.

486 mmHg 72%

The pressure due to the vapor at 80 °C is 486 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.  $P_1 = 500 \text{ mmHg} : T_1 = 363 \text{ K} : P_2 = ?$  and  $T_2 = 353 \text{ K}$ .  $P_2 = P_1 * T_2 / T_1 = 500 \text{ mmHg} * 353 \text{ K} / 363 \text{ K} = 486 \text{ mmHg}$

d) Based on you answer in Q1c and the equilibrium vapor pressure at 80 °C, indicate the phase(s) present in the container at 80 °C.

liquid and vapor 67%

Liquid and vapor are present in the container.

The calculated pressure due to the vapor at 80 °C is 486 mmHg. The equilibrium vapor pressure at 80 °C is 355 mmHg. Since the calculated pressure due to the vapor exceeds the equilibrium vapor pressure at that temperature condensation MUST occur. Remember, at 80 °C the MAXIMUM pressure due to the vapor above its liquid (water in this case) is 355 mmHg, since we calculated 486 mmHg (assuming all the sample remained in the vapor phase) condensation has to occur.

2. Solve each of the following; (NOTE: If you use scientific notation, enter  $4.99 \times 10^{-4}$  as 4.99e-4)

a)  $1/298 \text{ K} - 1/350 \text{ K} = 4.99\text{e-}4 \text{ K}^{-1}$  89%

The answer is  $0.000499 \text{ K}^{-1}$ .

1/298 K is equal to 0.003356 and 1/350 K is equal to 0.002857,

then

$$1/298 \text{ K} - 1/350 \text{ K} = 0.003356 \text{ K}^{-1} - 0.002857 \text{ K}^{-1} = 0.000499 \text{ K}^{-1}$$

$$\text{b) } (-24000 \text{ J mol}^{-1} / 8.314 \text{ J mol}^{-1} \text{ K}^{-1}) * (1/298 \text{ K} - 1/350 \text{ K}) = -1.43 \quad 89\%$$

The answer is -1.44.

$$(-24000 \text{ J mol}^{-1} / 8.314 \text{ J mol}^{-1} \text{ K}^{-1}) * (1/298 \text{ K} - 1/350 \text{ K}) = (-24000 \text{ J mol}^{-1} / 8.314 \text{ J mol}^{-1} \text{ K}^{-1}) * 0.000499 \text{ K}^{-1} = -1.44$$

3. Isopropyl alcohol has an equilibrium vapor pressure of 91 mmHg at 40 °C and an equilibrium vapor pressure of 32 mmHg at 25 °C. Using the Clausius-Clapeyron equation, calculate the  $\Delta H^\circ_{\text{vap}}$  for isopropyl alcohol.

$$\ln\left(\frac{vp_2}{vp_1}\right) = -\frac{\Delta H^\circ_{\text{vap}}}{R} \left(\frac{1}{T_2} - \frac{1}{T_1}\right)$$

54.0 kJ mol<sup>-1</sup>

44%

17% 54,000

watch out for units

The answer is 53.9 kJ mol<sup>-1</sup>

Substituting into the Clausius-Clapeyron equation  $\ln(VP_2/VP_1) = -\Delta H/8.314 * (1/T_2 - 1/T_1)$  the values from the question,

$$\ln(91 \text{ mmHg} / 32 \text{ mmHg}) = -\Delta H/8.314 * (1/313 - 1/298);$$

$$\ln(2.844) = -\Delta H/8.314 * (0.003195 - 0.003356);$$

$$1.045 = -\Delta H/8.314 * (-0.000161);$$

$$\Delta H = -1.045 / (8.314 * (-0.000161));$$

$$\Delta H = (1.045 * 8.314) / -0.000161 = 53.9 \text{ kJ mol}^{-1} .$$

4. What does the term normal boiling point mean.

the temperature when the equilibrium vapor pressure above the liquid is 760 mmHg.

The normal boiling point is the temperature the liquid boils when atmospheric pressure is 760 mmHg. So the equilibrium vapor pressure of a liquid at its normal boiling point is 760 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?

nothing

do units on temperature matter? Celsius vs Kelvin  
Yes units are important.