

CHEM105 Test 2, Chapters 5, 6, 7, 8, 9

Name on back only please

Please show all equations, all work, and full explanations to receive any credit

1. Calorimeters are often calibrated using benzoic acid (C_6H_5COOH).
 - a. Write a balanced equation for the combustion of benzoic acid.
 - b. Use your balanced equation to calculate the enthalpy of combustion for benzoic acid.
 - c. 1.5 g of benzoic acid was combusted in a calorimeter; the measured temperature increased from $21.97^{\circ}C$ to $25.15^{\circ}C$. Calculate the heat capacity of the calorimeter.
 - d. Determine the change in entropy for the combustion of benzoic acid.
 - e. Predict the range of temperatures over which the combustion of benzoic acid is spontaneous.

- f. Identify the intermolecular forces of attraction between different benzoic acid (C_6H_5COOH) molecules; draw a diagram clearly showing the strongest interaction.
- g. Predict whether you would expect benzoic acid to be soluble in water. Use thermodynamics to fully support your prediction.
- h. At $T = 298.15\text{ K}$, the apparent molar enthalpy of solution, ΔH_{sol} , for benzoic acid is $+25.5\text{ kJ/mol}$. Use this to predict how benzoic acid's solubility in water would be expected to change with ***an increase in temperature***. Use thermodynamic and equilibria fundamental principles to fully support and to explain your rationale for this prediction
- i. 1.5 grams of benzoic acid (C_6H_5COOH) was dissolved into 100.0 mL of water at 298.15 K. Use the molar enthalpy of solution, ΔH_{sol} , for benzoic acid ($+25.5\text{ kJ/mol}$) to determine the final temperature of the water. Assume that all the heat gained or lost is used to heat or cool the water.

2. A recent patent was issued on a process that uses elemental magnesium sublimation to coat silicon carbide fibers for ceramic composite materials.
- Calculate the enthalpy of sublimation for elemental magnesium Mg (s).
 - Determine the entropy of sublimation for elemental magnesium Mg (s).
 - Determine the temperature at which elemental magnesium sublimates (its vapor pressure is one atmosphere).
 - Calculate the Gibbs Free Energy of magnesium sublimation under standard conditions. Explain why your answer does or does not make sense.

3. For the chemical reaction:



- Predict how the equilibrium would shift if pressure were increased by adding He gas.
- Predict how the equilibrium would shift if temperature were increased. Fully support your prediction with calculations.
- The K_c for this reaction is 0.040 at a temperature of 270°C. A 5.0 L reaction vessel contains 0.75 moles of $\text{PCl}_5 (\text{g})$, 0.15 moles of $\text{PCl}_3 (\text{g})$, and 0.20 moles of $\text{Cl}_2 (\text{g})$. Is this mixture at equilibrium? If not predict which way it would spontaneously shift to attain equilibrium.