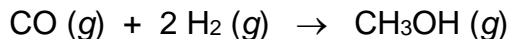


EXAM III – Oct. 31, 2019

Answers to Calculation-Based Problems

2. (36 pts) The U.S. produces approximately 2.6 billion gallons of methanol (CH₃OH) each year. It is used in fuels, as a solvent for perfumes and dyes, and in the preparation of a wide range of other chemicals – formaldehyde, plastics, paints, explosives, etc. A common preparation method involves reacting carbon monoxide and hydrogen gas as shown below:



The following questions are related to this reaction (or these substances). **Note that your answer to each part is independent of the others.**

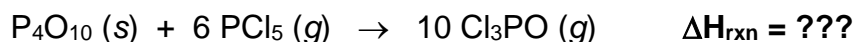
- d. (10 pts) Using the thermodynamic data provided (p. 5), please **calculate** ΔH° for this reaction in **kJ per mole of CH₃OH** formed. Is the reaction **endothermic or exothermic**?

Answer: $\Delta H^\circ = -90.5 \text{ kJ}$ (exothermic)

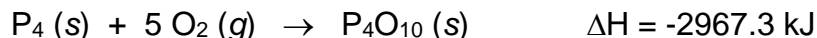
- e. (10 pts) Suppose that an engineer in a chemical plant performs this reaction in a 1500.0-liter stainless steel vat at 25.0 °C and determines the pressure of methanol to be 25.4 atm. **How many moles** of CH₃OH were formed?

Answer: $n = 1.56 \times 10^3$ moles

3. (24 pts) The questions below relate to the following reaction:



- a. Please use the thermodynamic data below to **determine** ΔH_{rxn} for this process.

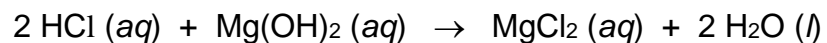


Answer: $\Delta H = -610.1 \text{ kJ}$

- b. How much heat is absorbed or released when 50.0 g of PCl₅ reacts completely?

Answer: -24.4 kJ released

4. (22 pts) The over-the-counter remedy called “milk of magnesia” contains magnesium hydroxide, which neutralizes hydrochloric acid in the stomach. Suppose that you carry out the following reaction in a coffee-cup calorimeter to determine the heat flow involved:



You add 250.0 mL of 4.00 M HCl to enough Mg(OH)₂ to make 500.0 total grams of solution. Initially, you measure a temperature of 23.6 °C; after reaction is complete, the temperature is 50.3 °C. Calculate ΔH_{rxn} in kJ per mole of MgCl₂ formed. The specific heat of solution 4.18 J/g °C. [Hint: Start by calculating the heat of reaction.]

Answer: $\Delta H = -112 \text{ kJ/mol}$