CHEM 2011: Introduction to Thermodynamics **Tutorial 2: First Law of Thermodynamics**
February 2, 2023 Joe Tran

Question 1. *A thermos bottle containing milk is shaken vigorously. Consider the milk as the system.*

(a) *Will the temperature rise as a result of the shaking?*

(b) *Has heat been added to the system?*

(c) *Has work been done on the system?*

(d) *Has the system's internal energy changed?*

Question 2. *One mole of an ideal monatomic gas initially at 300 K and pressure of 15.0 atm expands to a final pressure of 1.00 atm. The expansion can occur via any of the five different paths. For each case, calculate the value of q, W, ΔU and ΔH for*

(a) *Isothermal and reversible.*

(b) *Isothermal and irreversible.*

(c) *Isothermal expansion performed irreversibly in a two-step process. In the first step, the pressure was 7.00 atm, and in the second step, the expansion was at the final pressure.*

(d) *Adiabatic and reversible.*

(e) *Adiabatic and irreversible.*

Question 3. *Initially, 0.1 mol of methane is at 1.00 bar pressure and $80^\circ C$. The gas behaves ideally and the value of $\frac{C_P}{C_V}$ is 1.31. The gas is allowed to expand reversibly and adiabatically to a pressure of 0.10 bar.*

(a) *What are the initial and final volumes of the gas?*

(b) *What is the final temperature?*

(c) *Calculate ΔH for this process?*

Question 4. *The constant-pressure heat capacity of an ideal gas, A was found to vary with temperature according to the expression*

$$\bar{C}_P = (22.17 + 0.32T) \text{ in units of } J/mol\ K$$

(a) *Calculate q, W, ΔU and ΔH when the temperature of 2.00 moles of gas A is raised from $0^\circ C$ to $50^\circ C$ at constant pressure.*

(b) *Calculate q, W, ΔU and ΔH when the temperature of 2.00 moles of gas A is raised from $0^\circ C$ to $50^\circ C$ at constant volume.*