MME 231: Lecture 09

The Laws of Thermodynamics

Problem solving

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Problems

3.11 **5 kg** of steam contained within a piston-cylinder assembly undergoes an expansion from state 1, where the specific internal energy (the internal energy per unit mass) is $\mathbf{u_1 = 2709.9\ kJ/kg}$, to state 2, where $\mathbf{u_2 = 2659.6\ kJ/kg}$. During the process, there is a heat transfer of energy to the steam with a magnitude of **80 kJ**. Also, a paddle wheel transfers energy to the steam by work in the amount of **18.5 kJ**. There is no significant change in the kinetic or potential energy of the steam. Determine the amount of energy transfer by work in kJ from steam to the piston during the process.

3.14 **20 litres** of hydrogen gas at **27 C** and **50 atm** expands reversibly and isothermally to **200 litres**. In doing so, it absorbs **400 kJ** of thermal energy from its surroundings. Determine the change in internal energy of hydrogen gas for the process.

3.15 One mole of an ideal gas is heated at a constant pressure of **1 atm** from **0 to 100 C**. (a) Calculate in calories the work involved. (b) If the gas were expanded isothermally at **0 C** from **1 atm** to some other pressure, what must be the final pressure if the system performs work which is equal to the work of part a? Use **R = 1.987 cal/mol-K**.

3.16 Calculate the work performed by the system for the reversible adiabatic expansion of **2 moles** of an ideal gas at **300 K** and **20 atm** to a final pressure of **2 atm**. Ignoring non-mechanical work, what would be the change in internal energy for this process? Use the relationship $\mathbf{PV^{\gamma} = constant}$, where γ **= 5/3**.

3.22 One mole of an ideal gas is compressed adiabatically in a piston-cylinder device from **2 bar** and **25 °C** to **7 bar**. The process is irreversible and requires **35%** more work than a reversible, adiabatic compression from the same initial state to the same final pressure. What is the entropy change of the gas?

Next Class

Lecture 10
Thermodynamic Variables and Relations

Rashid/ Ch#4 – Sec. 4.1 & 4.2