Physic 231 Lecture 29

Main points of last lecture:
- Radiation and global warming
- Work in thermodynamic processes:
  \[ W_{system} = P \Delta V \]
- First Law of Thermodynamics:
  \[ \Delta U = \Delta Q - P \Delta V \]

Main points of today’s lecture:
- Work in thermodynamic processes:
  \[ W_{system} = P \Delta V \]
- First Law of Thermodynamics:
  \[ \Delta U = \Delta Q - P \Delta V \]
- Processes
  - cyclic: \[ \Delta P = \Delta V = \Delta T = 0 \]
  - isobaric: \[ \Delta P = 0 \]
  - isovolumetric: \[ \Delta V = 0 \]
  - isothermal: \[ \Delta T = 0 \]
  - adiabatic: \[ \Delta Q = 0 \]
Computation of work:

- What is the work done on the gas going from \((P_i, V_i)\) to \((P_f, V_f)\)?
  - a) \(P_i(V_i-V_f)\)
  - b) \(P_f(V_i-V_f)\)
  - c) 0
  - d) \((P_i+P_f)(V_i-V_f)/2\)
  - e) \(-(P_i+P_f)(V_i-V_f)/2\)

- A thermal path which returns to its initial condition is called a *cycle*.
- The work done by the gas on a *clockwise* cycle is the area contained in the path.
- The work done by the gas on a *counterclockwise* cycle is the *negative* of the area in the path.
- The work done on the gas is the negative of the work done by the gas.
Example

- The work done to compress one mole of a monatomic ideal gas is 6200 J. The temperature of the gas changes from 350 K to 550 K. How much heat flows between the gas and its surroundings? Determine whether the heat flows into or out of the gas.
Example

- The drawing refers to one mole of monatomic ideal gas and shows a process that has four steps, two isobaric (A to B and C to D) and two isovolumetric (B to C and D to A). Complete the following table by calculating $\Delta U$, $\Delta W$ and $\Delta Q$ (including the algebraic signs) for each of the four steps. Note that the gas has returned to its initial state at the end of the process, so that the value for the total $\Delta U$ can be predicted in advance without any calculation.
**Example**

- A person takes in a breath of 0°C air and holds it until it warms to 37.0°C. The air has an initial volume of 0.600 L and a mass of 7.70 x 10\(^{-4}\) kg. Determine (a) the work done by the air on the lungs if the pressure remains constant at atm, (b) the change in internal energy of the air, and (c) the energy added to the air by heat. Model the air as if it were a monatomic gas.
Conceptual question

- Which gives the largest average radiation intensity at the distance specified, i.e. the most incident power on a 1 m² area at that distance?
  - 1. a 50-W source at a distance $R$.
  - 2. a 100-W source at a distance $2R$.
  - 3. a 200-W source at a distance $4R$. 
The parameters that describe a gas are \( n \): the number of moles, \( P \): the pressure, \( T \): the temperature, and \( V \): the volume. An ideal gas is contained within a cylinder sealed at the top with an immovable plug. When heat flows into the gas, what are *all* the parameters that change?

- a) \( n, V \)
- b) \( n, T \)
- c) \( P, T \)
- d) \( T \)
- e) \( P, T, V \)