INDIAN INSTITUTE OF TECHNOLOGY, BOMBAY

**Department of Metallurgical Engineering and Materials Science**

**MM 209: THERMODYNAMICS : 2019-20: Fall**

**Tutorial No. 4 \_\_\_\_\_\_\_\_\_\_\_\_ Date: Aug 30, 2019**



1. A system consists of a chamber and a 1 kg weight which can be at any elevation. The heat capacity of the system as a whole is 104 J/K. The surrounding consists of several thermal reservoirs, several weights, with weightless pulleys and strings which operate with negligible friction. The initial state is the weight kept at the top, and the system is at 300K. The final state is when system is the weight come down through a height of 1 m, and the internal energy of the system increased by the amount equal to loss in potential energy (temperature would have risen marginally = 9.81/104 K). Now study the following different processes:

Thermal reservoir

* 1. System goes (i) from state 1 to state 2 reversibly, and then (ii) back to state 1 reversibly (system is a closed system).
  2. System goes (i) from state 1 to state 2 irreversibly by free fall through 1m and then (ii) back to state 1.
  3. System goes (i) from state 1 to state 2 irreversibly but by connecting the weight to a 0.75kg weight in the surrounding, and then (ii) back to state 1 reversibly
  4. System goes (i) from state 1 to state 2 reversibly, and then (ii) back to state 1 irreversibly by the weight connected to 2 kg weight in the surrounding.

Compare this with Claussius inequality in two forms: and dS

In each case calculate, for both processes (i) and (ii), and for the entire cycle, ∫ δq/T, ΔSsys, and ΔSsur. (see table on the reverse)

( For simplification assume all processes in the surrounding are reversible)

1. 1 mole super-cooled liquid silver initially at 900 C spontaneous freezes, at a constant pressure of 1 atm. in an adiabatic container. The final temperature cannot exceed the melting point, but it can be lower. Calculate :
2. Amount of silver that solidifies
3. Entropy change for this process.

The melting point of silver is 961C and enthalpy of fusion is 11240 J/mol at m.pt..

Assume: Cp (Ag,l ) = 30.5 J/mol/K, Cp (Ag, s ) = 31.5 J/mol/K.

[**HINT:** At 1 atm. pressure the reversible melting takes place only at the melting point]

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| process | | ~ ∫ δq/T | ~ ΔSsys | ~ ΔSsur |
| a | i r |  |  |  |
| ii r |  |  |  |
| cycle |  |  |  |
| b | i irr |  |  |  |
| ii r |  |  |  |
| cycle |  |  |  |
| c | i irr |  |  |  |
| ii r |  |  |  |
| cycle |  |  |  |
| d | i r |  |  |  |
| ii irr |  |  |  |
| cycle |  |  |  |