UNIT IIIB

ENTROPY, EQUILIBRIUM DISTRIBUTIONS, AND THE SECOND LAW OF THERMODYNAMICS

The concept of equilibrium provides a basis for the definition of a new property, *entropy*. The second law of thermodynamics is formulated in terms of entropy. The distribution of the most probable (an equilibrium) macrostate is developed without recourse to trial and error. This development leads to a relationship among macroscopic properties, the Gibbs equation, which is a foundation of the analysis of property changes. It is found that three terms contribute to the entropy change of a system. One is a reversible heat effect. The other two are the thermal and mechanical sources of irreversible entropy generation. In the light of these contributions a general thermodynamic design principle is advanced. The optimum design to accomplish a given objective is the one that minimizes the increase of the entropy of the universe.

Objectives

The objectives of this unit are divided into two categories. The objectives of Sections I and IV pertain to entropy, its macroscopic application and the second law. These objectives are required of all students.

1. State and use the definition of entropy in terms of W.
2. State and draw conclusions from the second law principle as applied to the universe.
3. Write the Gibbs equation for a specified simple or complex media.
4. Describe conditions that cause mechanical and thermal irreversible entropy production.
5. Evaluate the magnitude of the reversible, and irreversible thermal or mechanical contributions to entropy change.
6. Write and draw conclusions from the Clausius inequality.
7. For given conditions, if possible, specify the direction of change of the entropy of a system.

The objectives of Sections II and III of the unit are required only of students who intend to continue in Units III. These objectives are:

8. Write, and discuss the meaning of, the equilibrium distribution function for Maxwell-Boltzmann, Bose-Einstein, and Fermi-Dirac statistics.
9. Find the appropriate expression for the equilibrium entropy of Boltzons, Bosons and Fermions.
10. Apply the equilibrium distribution for Boltzons to the calculation of entropy.
11. Distinguish between reversible work and heat or irreversible work on a microscopic basis.