Chapter 1 SUMMARY

- Basic concepts of thermodynamics are introduced and discussed. *Thermodynamics* is the science that primarily deals with energy.

- The first *law of thermodynamics* is simply an expression of the conservation of energy principle, and it asserts that *energy* is a thermodynamic property.

- The *second law of thermodynamics* asserts that energy has *quality* as well as *quantity,* and actual processes occur in the direction of decreasing quality of energy.

- A system of fixed mass is called a *closed system,* or *control mass,* and a system that involves mass transfer across its boundaries is called an *open system,* or *control volume.*

- The mass-dependent properties of a system are called *extensive properties* and the others, *intensive properties. Density* is mass per unit volume, and *specific volume* is volume per unit mass.

- The sum of all forms of energy of a system is called *total energy,* which is considered to consist of internal, kinetic, and potential energies. *Internal energy* represents the molecular energy of a system and may exist in sensible, latent, chemical, and nuclear forms.

- A system is said to be in *thermodynamic equilibrium* if it maintains thermal, mechanical, phase, and chemical equilibrium.

- Any change from one state to another is called a *process.*

- A process with identical end states is called a *cycle.*

- During a *quasi-static* or *quasi-equilibrium process,* the system remains practically in equilibrium at all times.

- The state of a simple, compressible system is completely specified by two independent, intensive properties.
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- The zeroth law of thermodynamics states that two bodies are in thermal equilibrium if both have the same temperature reading even if they are not in contact.

- The temperature scales used in the SI and the English system today are the Celsius scale and the Fahrenheit scale, respectively.

- The absolute temperature scale in the SI is the Kelvin scale, which is related to the Celsius scale by

$$T(K) = T(^\circ C) + 273.15$$

- In the English system, the absolute temperature scale is the Rankine scale, which is related to the Fahrenheit scale by

$$T(R) = T(°F) + 459.67$$

- The magnitudes of each division of 1 K and 1 ^{0}C are identical, and so are the magnitude of each division of 1 R and 1^{0}F. Therefore,

$$\Delta T(K) = \Delta T(°C)$$

and

$$\Delta T(R) = \Delta T(°F)$$

- An important application area of thermodynamics is the biological system. Most diets are based on the simple energy balance: the net energy gained by a person in the form of fat is equal to the difference between the energy intake from food and the energy expended by exercise.

- Force per unit area is called *pressure*, and its unit is the *pascal*, 1 Pa = 1 N/m^2. The absolute, gage, and vacuum pressures are related by

$$P_{gage} = P_{abs} - P_{atm} \qquad (kPa)$$

$$P_{vac} = P_{atm} - P_{abs} \qquad (kPa)$$

- The pressure at a point in a fluid has the same magnitude in all directions. The variation of pressure with elevation is given by

$$\frac{dP}{dz} = -\rho\, g$$

where the positive *z* direction is taken to be upward.

- When the density of the fluid is constant, the pressure difference across a fluid layer of thickness Δz is

$$\Delta P = P_2 - P_1 = \rho\, g\, \Delta z \qquad (kPa)$$

- The absolute and gage pressures in a liquid open to the atmosphere at a depth *h* from the free surface are

$$P = P_{\text{atm}} + \rho\, g\, h \quad \text{or} \quad P_{\text{gage}} = \rho\, g\, h$$

- Small to moderate pressure differences are measured by a manometer, and a differential fluid column of height *h* corresponds to a pressure difference of

$$\Delta P = \rho g h \qquad (kPa)$$

where ρ is the fluid density and g is the local gravitational acceleration.

- The atmospheric pressure is measured by a barometer and is determined from

$$P_{atm} = \rho g h \qquad (kPa)$$

where h is the height of the liquid column above the free surface.