Assignment #1

1-1. Most of the energy generated in the engine of a car is rejected to the air by the radiator through the circulating water. Should the radiator be analyzed as a closed system or as an open system? Explain.

1-2. A can of soft drink at room temperature is put into the refrigerator so that it will cool. Would you model the can of soft drink as a closed system or as an open system? Explain.

1-3. Portable electric heaters are commonly used to heat small rooms. Explain the energy transformation involved during this heating process.

1-4. What is the difference between the macroscopic and microscopic forms of energy?

1-5. How are heat, internal energy, and thermal energy related to each other? For a system to be in thermodynamic equilibrium, do the temperature and the pressure have to be the same everywhere?

1-6. For a system to be in thermodynamic equilibrium, do the temperature and the pressure have to be the same everywhere?

1-7. Is the state of the air in an isolated room completely specified by the temperature and the pressure? Explain.

1-8. A vacuum gage connected to a tank reads 30 kPa at a location where the barometric reading is 755 mmHg. Determine the absolute pressure in the tank. Take P_{Hg} = 13,590 kg/m^3. *Answer:* 70.6 kPa.

1-9. A pressure gage connected to a tank read 50 psi at a location where the barometric reading is 29.1 inHg. Determine the absolute pressure in the tank. Take P_{Hg} = 848.4 lbm/ft^3. *Answer:* 64.29 psia (lbm stands for pounds mass; a stands for absolute).

1-10. The barometer of a mountain hiker reads 930 mbars at the beginning of a hiking trip and 780 mbars at the end. Neglecting the effect of altitude on local gravitational acceleration, determine the vertical distance climbed. Assume an average air density of 1.20 kg/m^3 and take g = 9.7 m/s^2. *Answer:* 1289 m (mbar is millibar).

1-11. Determine the pressure exerted on the surface of a submarine cruising 300 ft below the free surface of the sea. Assume that the barometric pressure is 14.7 psia and the specific gravity of seawater is 1.03.

1-12. A gas is contained in a vertical, frictionless piston-cylinder device. The piston has a mass of 4 kg and cross-sectional area of 35 cm^2. A compressed spring above the piston exerts a force of 60 N on the piston. If the atmospheric pressure is 95 kPa, determine the pressure inside the 95 cylinder. *Answer:* 123.4 kPa.

1-13. Consider two closed systems A and B. System A contains 2000 kJ of thermal energy at 20°C whereas system B contains 200 kJ of thermal energy at 50°C. Now the systems are brought into contact with each other. Determine the direction of any heat transfer between the two systems.

1-14. A vertical, frictionless piston-cylinder device contains a gas at 500 kPa. The atmospheric pressure outside is 100 kPa, and the piston area is 30 cm^2. Determine the mass of the piston. Assume standard gravitational acceleration.

1-15. The average temperature of the atmosphere in the world is approximated as a function of altitude by the relation

$$T_{atm} = 288.15 - 6.5z$$

where T_{atm} is the temperature of the atmosphere in K and z is the altitude in km with z = 0 at sea level.

Determine the average temperature of the atmosphere outside an airplane that is cruising at an altitude of 12,000 m.

1-16. State whether the following statements are true or false and, if false, correct the statements.

(a) Thermodynamics is dependent on the microscopic properties of matter such as work, and energy.

(b) Thermodynamics provides a quantitative description of the overall change in a chemical or physical process.

(c) Thermodynamics provides a deep insight into chemical and physical processes.

(d) Because of its general applicability, thermodynamics provides information about not only the yields but also the velocity of any chemical process.

(e) Thermodynamics provides a convenient and powerful method of relating, systematizing and discussing the macroscopic properties.

(f) The subject of classical thermodynamics is based on the four laws of thermodynamics. (g) By applying the laws and principles of thermodynamics it is not possible to predict whether a particular chemical process can take place under any given conditions.

(h) Thermodynamics cannot tell us that a process will occur but can tell us how fast it will occur.

1.17. The reaction $Zn + 2HCI = ZnCl_2 + H_2$ is carried out in a closed vessel kept in a thermostat bath. A study of the chemical process is made by thermodynamics.

(a) What is the system in the study? (b) What is the surrounding? (c) Is the system thermally isolated? (d) Is the system mechanically isolated? (e) Is the system in question an open system? (f) Is our body an open system?

1.18 Consider a system which expands against the outside pressure. Will there be any work done in this process? If so, what type of work is done by whom? Will this work involve any exchange of kinetic energy between the system and its surroundings?

1.19 It is stated that the state of a system can be defined completely by the four observable macroscopic properties of matter known as the variables of state. What are these variables of state? Are these variables of state independent of each other?