

4.1 Reversible and Irreversible Processes

18. A tank contains 111.0 g chlorine gas (Cl_2), which is at temperature $82.0\text{ }^\circ\text{C}$ and absolute pressure $5.70 \times 10^5\text{ Pa}$. The temperature of the air outside the tank is $20.0\text{ }^\circ\text{C}$. The molar mass of Cl_2 is 70.9 g/mol. (a) What is the volume of the tank? (b) What is the internal energy of the gas? (c) What is the work done by the gas if the temperature and pressure inside the tank drop to $31.0\text{ }^\circ\text{C}$ and $3.80 \times 10^5\text{ Pa}$, respectively, due to a leak?

19. A mole of ideal monatomic gas at $0\text{ }^\circ\text{C}$ and 1.00 atm is warmed up to expand isobarically to triple its volume. How much heat is transferred during the process?

4.2 Heat Engines

- 22.** An engine is found to have an efficiency of 0.40. If it does 200 J of work per cycle, what are the corresponding quantities of heat absorbed and discharged?
- 23.** In performing 100.0 J of work, an engine discharges 50.0 J of heat. What is the efficiency of the engine?

4.3 Refrigerators and Heat Pumps

29. A refrigerator has a coefficient of performance of 3.0. (a) If it requires 200 J of work per cycle, how much heat per cycle does it remove the cold reservoir? (b) How much heat per cycle is discarded to the hot reservoir?

4.5 The Carnot Cycle

33. The temperature of the cold and hot reservoirs between which a Carnot refrigerator operates are $-73\text{ }^{\circ}\text{C}$ and $270\text{ }^{\circ}\text{C}$, respectively. Which is its coefficient of performance?

4.6 Entropy.

43. Two hundred joules of heat are removed from a heat reservoir at a temperature of 200 K. What is the entropy change of the reservoir?

4.7 Entropy on a Microscopic Scale

53. A copper rod of cross-sectional area 5.0 cm^2 and length 5.0 m conducts heat from a heat reservoir at 373 K to one at 273 K . What is the time rate of change of the universe's entropy for this process?