

Chapter 5 Examples (2nd Law)

- 1 A heat pump is used to heat a house at 20°C. When the outside temperature is at -2 °C, the house loses heat at a rate of 80000 kJ/hr. If $COP_{HP}=2.5$, find
 - a. Power required by the heat pump
 - b. Rate of heat transferred from the outside air
- 2 Several power cycles operate between T_H at 2000 K and T_L at 400 K. Determine whether they are reversible, real, or impossible;
 - a. $Q_H = 1000$ kJ, $W = 850$ kJ
 - b. $Q_H = 2000$ kJ, $Q_L = 400$ kJ
 - c. $W = 1600$ kJ, $Q_L = 500$ kJ
- 3 A cooling system is used to keep the temperature of a room at 20°C. For this, 25 kW of heat has to be extracted from the room. Outside temperature is 34 °C. Find the minimum power required.
- 4 A heat engine operates between 200 °C and the ambient (30°C) producing work which runs a cooling system that cools a space at -30°C. If both heat engine and cooling system are reversible, find the ratio of engine heat supply to the extracted heat from the cold space.
- 5 A device is a combination of a heat pump and a heat engine which are operating between the same 2 heat reservoirs. All work produced by the heat engine goes towards running the heat pump.
 - a. Sketch the system
 - b. If Q_H of the heat engine is 13 kJ, W 6 kJ while Q_H of the heat pump is 11 kJ, is this device violating the 2nd Law?
 - c. If Q_H of the heat engine is 10 kJ, W 6 kJ while Q_H of the heat pump is 11 kJ, is this device violating the 2nd Law?