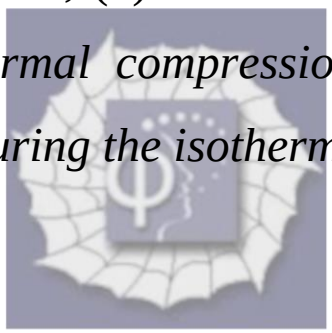
250.

Problem 26.11 (RHK)

In a Carnot cycle, the isothermal expansion of an ideal gas takes place at 412 k *and the isothermal compression at* 297 K. *During the expansion,* 2090 J *of heat energy are transferred to the gas. We have to determine* (a) *the work performed by the gas during the isothermal expansion,* (b) *the heat rejected from the gas during the isothermal compression; and* (c) *the work done on the gas during the isothermal compression.*



Solution:

In a Carnot engine cycle isothermal expansion of the gas takes place when the gas is in contact with the hot-reservoir. Therefore, the temperature of the hot-reservoir $T_H = 412$ K.

And the isothermal compression takes place when the gas is in contact with the cold-reservoir. Therefore, the temperature of the cold-reservoir is

$T_L = 297$ K.

In a Carnot engine the ratio of the heat absorbed from the hot-reservoir Q_1 and the heat rejected to the cold-reservoir Q_2 is determined by the temperatures T_H and T_L. It is given by the relation

$$\frac{Q_2}{Q_1} = \frac{T_L}{T_H}.$$

Therefore, the heat rejected to the cold-reservoir that is during the isothermal compression will be

$$Q_2 = 2090 \times \frac{297}{412} \text{ J} = 1506.6 \text{ J}.$$

In an isothermal process the internal energy of the gas remains unchanged. Therefore, the work performed by the gas during the isothermal expansion will be equal in magnitude to the heat absorbed Q_1, that is it will be 2090 J.

Similarly during the isothermal compression, as heat is rejected to the cold-reservoir and the internal energy of the gas remains constant, amount of work done on the gas will be equal in magnitude to Q_2, that is it will be 1506.6 J.