39.14 A Carnot heat pump operates between $20°F$ and $70°F$. What is the coefficient of performance?

A. 0.4

B. 1.4

C. 9.6

D. 10.6

Look up the Carnot Cycle in the reference handbook and find the Coefficient of Performance formulas. A Carnot heat pump operates at the upper limit of COP, which is a function of the temperatures of the hot and cold reservoirs which the heat pump is operating between.

$$COP_{HP,carnot} = \frac{T_H}{(T_H - T_L)}$$

The temperatures must be in absolute terms i.e. Rankine, so add 460 to $°F$ before substituting into the formula. (Technically, there is no need to change to absolute in the denominator since the difference will remain unchanged.)

$$COP_{HP,carnot} = \frac{T_H}{(T_H - T_L)} = \frac{(70 + 460)}{(70 - 20)} = \frac{530R}{50R} = 10.6$$

Answer D

39.15 In a Carnot heat pump, R-22 evaporates at $31psia$ and condenses at $211psia$. What is the coefficient of performance?

A. 0.9

B. 4.3

C. 5.1

D. 6.8

Lookup the Pressure Versus Enthalpy Curves for Refrigerant 22 and read from the chart the temperatures for the evaporator and condenser based on the pressures given. These correspond to the low and high temperature reservoirs, respectively, for the heat pump:

$$T_L = T_{evaporator@P=31psia} \approx -10°F + 460 = 450°R$$

$$T_H = T_{condenser@P=211psia} \approx 100°F + 460 = 560°R$$

Look up the Carnot Cycle in the reference handbook and find the coefficient of performance formula:

$$COP_{HP,carnot} = \frac{T_H}{(T_H - T_L)} = \frac{560°R}{560°R - 450°R} = 5.1$$

Answer C