37.59 A water-cooled chiller produces $500gpm$ of $45°F$ supply chilled water from $56°F$ return chilled water. The chiller has a coefficient of performance of 4.8. What is the load on the condenser?

A. $181tons$

B. $229tons$

C. $277tons$

D. $325tons$

Use the sensible cooling rule of thumb for water to determine the refrigeration effect, $\dot{Q}_{in}$.

$$\dot{Q}_{in} = 500gpm\Delta T_{CHW}$$

$$\dot{Q}_{in} = 500\,(500)\,(56-45) = 2,750,000\frac{Btu}{hr}$$

Use the Coefficient of Performance for a refrigeration cycle to determine the work done by the compressor.

$$COP_R = \frac{\dot{Q}_{in}}{\dot{W}_{in}}$$

$$\dot{W}_{in} = \frac{\dot{Q}_{in}}{COP} = \frac{2,750,000\frac{Btu}{hr}}{4.8} = 572,917\frac{Btu}{hr}$$

The condenser load is the total heat rejected by the condenser which is the sum of the heat absorbed by the evaporator and the compressor input energy. Calculate $\dot{Q}_{out}$. Convert units from $\frac{Btu}{hr}$ to $tons$.

$$\dot{Q}_{out} = \dot{Q}_{in} + \dot{W}_{in}$$

$$\dot{Q}_{out} = 2,750,000\frac{Btu}{hr} + 572,917\frac{Btu}{hr} = 3,322,917\frac{Btu}{hr}$$

$$\dot{Q}_{out} = 3,322,917\frac{Btu}{hr}\left(\frac{1ton}{12,000\frac{Btu}{hr}}\right) = 277tons$$

Answer C