31.20 **A $2000 ft^2$ house has an average cooling demand of $3.5 tons$ during a typical summer day. The inside temperature is maintained at $72°F$ and the average outside temperature is $93°F$. Electricity costs $\$0.15/kWh$. Assuming the air conditioning system has the maximum possible theoretical efficiency, what is the daily cost of cooling?**

A. \$2

B. \$5

C. \$9

D. \$12

The maximum possible theoretical efficiency for a cooling cycle is based on the reversed Carnot Cycle. For refrigeration, the Coefficient of Performance is determined entirely from the temperatures of the cold and hot reservoirs i.e. the indoor and outdoor conditions. Absolute tempratures must be used.

$$COP_c = \frac{T_L}{T_H - T_L} = \frac{72 + 460}{(93 + 460) - (72 + 460)} = 25.3$$

By definition, the COP is the ratio of the refrigeration effect to the input compressor energy required to produce the cooling. Calculate W_{in} and convert units to KW.

$$COP = \frac{Q_L}{W_{in}}$$

$$W_{in} = \frac{Q_L}{COP} = \frac{(3.5 tons)\left(12,000 \frac{Btu}{hr \cdot ton}\right)}{\left(3412 \frac{Btu}{hr \cdot KW}\right)(25.3)} = 0.48 KW$$

Use the electricity rate to calculate the cost for run the cooling system continuously for 1 day.

$$Cost = (0.48 KW)(24 hr)\left(0.15 \frac{\$}{KW \cdot hr}\right) = \$1.75$$

Answer A