

$$UA = \frac{\dot{Q}}{\Delta T} = \frac{300,000 \frac{Btu}{hr}}{80^\circ F} = 3750 \frac{Btu}{hr \cdot ^\circ F}$$

Since the rate at which heat must be added to the building is linearly related to the temperature (UA is similar to the slope of a line, where \dot{Q} and ΔT are the independent and dependent variables), a $2^\circ F$ reduction in the internal temperature setpoint will reduce the average ΔT from $29^\circ F$ to $27^\circ F$.

The associated energy savings can be calculated by applying to the entire heating season:

$$\text{Energy Savings} = \left(3750 \frac{Btu}{hr \cdot ^\circ F} \right) (250 \text{ days}) \left(24 \frac{hr}{day} \right) (2^\circ F) = 4.5 \times 10^7 Btu$$

Calculate the cost savings associated with this reduction in energy, accounting for efficiency, converting units to therms, and applying the cost per therm. Look up **Measurement Relationships** in the Reference Handbook if necessary.

$$\text{Cost Savings} = \frac{(4.5 \times 10^7 Btu) \left(\frac{\$0.75}{therm} \right)}{(.8) \left(100,000 \frac{Btu}{therm} \right)} = \$422$$

Answer B

43.22 A $10,000 \frac{Btu}{hr}$ air conditioner with a SEER-13 rating runs 100 days per year for 12 hours per day. The unit is replaced with a more efficient model with a SEER-23 rating. The average cost of electricity is \$0.15 per kWh. What is the annual savings?

- A. \$60
- B. \$80
- C. \$100
- D. \$120

Look up **SEER** or **Season Energy Efficiency Ratio** in the Reference Handbook.

$$SEER = \frac{\text{total seasonal cooling output (Btu)}}{\text{total seasonal input energy (W} \cdot \text{hr)}}$$

The numerator, total seasonal cooling output, is a function of the unit's rating and runtime for the season. This remains unchanged regardless of the SEER.

The denominator, input energy, will vary based on the SEER. For convenience, let the input energy be represented by E_1 and E_2 for the two cases.

$$\text{total seasonal cooling output} = \left(10,000 \frac{Btu}{hr} \right) (100 \text{ days}) \left(12 \frac{hr}{day} \right) = 12 \times 10^6 Btu$$

Rearrange the SEER formula and solve for E_1 and E_2 :

$$\text{total seasonal input energy (W} \cdot \text{hr)} = \frac{\text{total seasonal cooling output (Btu)}}{SEER}$$

$$E_1 = \frac{12 \times 10^6 \text{ Btu}}{13} = 923,077 \text{ W} \cdot \text{hrs}$$

$$E_2 = \frac{12 \times 10^6 \text{ Btu}}{23} = 521,739 \text{ W} \cdot \text{hrs}$$

Calculate the energy savings between the original and replacement unit:

$$\text{Energy savings} = E_1 - E_2$$

$$\text{Energy savings} = 923,077 \text{ W} \cdot \text{hrs} - 521,739 \text{ W} \cdot \text{hrs} = 401,338 \text{ W} \cdot \text{hrs}$$

Calculate the cost savings by applying the electricity rate:

$$\text{Cost savings} = (401,338 \text{ W} \cdot \text{hrs}) \left(\frac{1 \text{ kW}}{1000 \text{ W}} \right) \left(\frac{\$0.15}{\text{ kW} \cdot \text{ hr}} \right) = \$60.20$$

Answer A