

7-55E An office that is being cooled adequately by a 12,000 Btu/h window air-conditioner is converted to a computer room. The number of additional air-conditioners that need to be installed is to be determined.

Assumptions 1 The computers are operated by 4 adult men. **2** The computers consume 40 percent of their rated power at any given time.

Properties The average rate of heat generation from a person seated in a room/office is 100 W (given).

Analysis The amount of heat dissipated by the computers is equal to the amount of electrical energy they consume. Therefore,

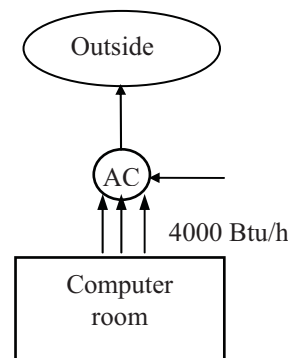
$$\dot{Q}_{\text{computers}} = (\text{Rated power}) \times (\text{Usage factor}) = (3.5 \text{ kW})(0.4) = 1.4 \text{ kW}$$

$$\dot{Q}_{\text{people}} = (\text{No. of people}) \times \dot{Q}_{\text{person}} = 4 \times (100 \text{ W}) = 400 \text{ W}$$

$$\dot{Q}_{\text{total}} = \dot{Q}_{\text{computers}} + \dot{Q}_{\text{people}} = 1400 + 400 = 1800 \text{ W} = 6142 \text{ Btu/h}$$

since 1 W = 3.412 Btu/h. Then noting that each available air conditioner provides 4,000 Btu/h cooling, the number of air-conditioners needed becomes

$$\begin{aligned} \text{No. of air conditioners} &= \frac{\text{Cooling load}}{\text{Cooling capacity of A/C}} = \frac{6142 \text{ Btu/h}}{4000 \text{ Btu/h}} \\ &= 1.5 \approx \mathbf{2 \text{ Air conditioners}} \end{aligned}$$



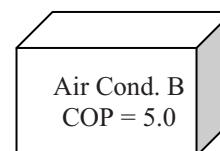
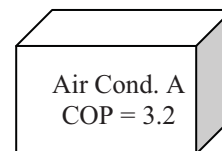
7-56 A decision is to be made between a cheaper but inefficient air-conditioner and an expensive but efficient air-conditioner for a building. The better buy is to be determined.

Assumptions The two air conditioners are comparable in all aspects other than the initial cost and the efficiency.

Analysis The unit that will cost less during its lifetime is a better buy. The total cost of a system during its lifetime (the initial, operation, maintenance, etc.) can be determined by performing a life cycle cost analysis. A simpler alternative is to determine the simple payback period. The energy and cost savings of the more efficient air conditioner in this case is

$$\begin{aligned} \text{Energy savings} &= (\text{Annual energy usage of A}) - (\text{Annual energy usage of B}) \\ &= (\text{Annual cooling load})(1/\text{COP}_A - 1/\text{COP}_B) \\ &= (120,000 \text{ kWh/year})(1/3.2 - 1/5.0) \\ &= 13,500 \text{ kWh/year} \end{aligned}$$

$$\begin{aligned} \text{Cost savings} &= (\text{Energy savings})(\text{Unit cost of energy}) \\ &= (13,500 \text{ kWh/year})(\$0.10/\text{kWh}) = \mathbf{\$1350/\text{year}} \end{aligned}$$



The installation cost difference between the two air-conditioners is

$$\text{Cost difference} = \text{Cost of B} - \text{cost of A} = 7000 - 5500 = \$1500$$

Therefore, the more efficient air-conditioner B will pay for the \$1500 cost differential in this case in about 1 year.

Discussion A cost conscious consumer will have no difficulty in deciding that the more expensive but more efficient air-conditioner B is clearly the better buy in this case since air conditioners last at least 15 years. But the decision would not be so easy if the unit cost of electricity at that location was much less than \$0.10/kWh, or if the annual air-conditioning load of the house was much less than 120,000 kWh.