

3-50 A classroom is to be air-conditioned using window air-conditioning units. The cooling load is due to people, lights, and heat transfer through the walls and the windows. The number of 5-kW window air conditioning units required is to be determined.

Assumptions There are no heat dissipating equipment (such as computers, TVs, or ranges) in the room.

Analysis The total cooling load of the room is determined from

$$\dot{Q}_{\text{cooling}} = \dot{Q}_{\text{lights}} + \dot{Q}_{\text{people}} + \dot{Q}_{\text{heat gain}}$$

where

$$\dot{Q}_{\text{lights}} = 10 \times 100 \text{ W} = 1 \text{ kW}$$

$$\dot{Q}_{\text{people}} = 40 \times 360 \text{ kJ/h} = 4 \text{ kW}$$

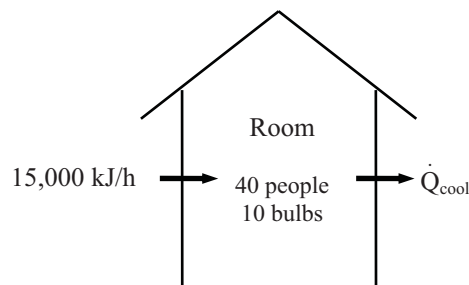
$$\dot{Q}_{\text{heat gain}} = 15,000 \text{ kJ/h} = 4.17 \text{ kW}$$

Substituting,

$$\dot{Q}_{\text{cooling}} = 1 + 4 + 4.17 = 9.17 \text{ kW}$$

Thus the number of air-conditioning units required is

$$\frac{9.17 \text{ kW}}{5 \text{ kW/unit}} = 1.83 \longrightarrow \mathbf{2 \text{ units}}$$



3-51 The lighting energy consumption of a storage room is to be reduced by installing motion sensors. The amount of energy and money that will be saved as well as the simple payback period are to be determined.

Assumptions The electrical energy consumed by the ballasts is negligible.

Analysis The plant operates 12 hours a day, and thus currently the lights are on for the entire 12 hour period. The motion sensors installed will keep the lights on for 3 hours, and off for the remaining 9 hours every day. This corresponds to a total of $9 \times 365 = 3285$ off hours per year. Disregarding the ballast factor, the annual energy and cost savings become

Energy Savings = (Number of lamps)(Lamp wattage)(Reduction of annual operating hours)

$$= (24 \text{ lamps})(60 \text{ W/lamp})(3285 \text{ hours/year})$$

$$= \mathbf{4730 \text{ kWh/year}}$$

Cost Savings = (Energy Savings)(Unit cost of energy)

$$= (4730 \text{ kWh/year})(\$0.08/\text{kWh})$$

$$= \mathbf{\$378/\text{year}}$$

The implementation cost of this measure is the sum of the purchase price of the sensor plus the labor,

$$\text{Implementation Cost} = \text{Material} + \text{Labor} = \$32 + \$40 = \$72$$

This gives a simple payback period of

$$\text{Simple payback period} = \frac{\text{Implementation cost}}{\text{Annual cost savings}} = \frac{\$72}{\$378/\text{year}} = \mathbf{0.19 \text{ year}} \quad (2.3 \text{ months})$$

Therefore, the motion sensor will pay for itself in about 2 months.

