

4-5 Water is being heated in a closed pan on top of a range while being stirred by a paddle wheel. During the process, 30 kJ of heat is transferred to the water, and 5 kJ of heat is lost to the surrounding air. The paddle-wheel work amounts to 500 N · m. Determine the final energy of the system if its initial energy is 10 kJ. *Answer: 35.5 kJ*

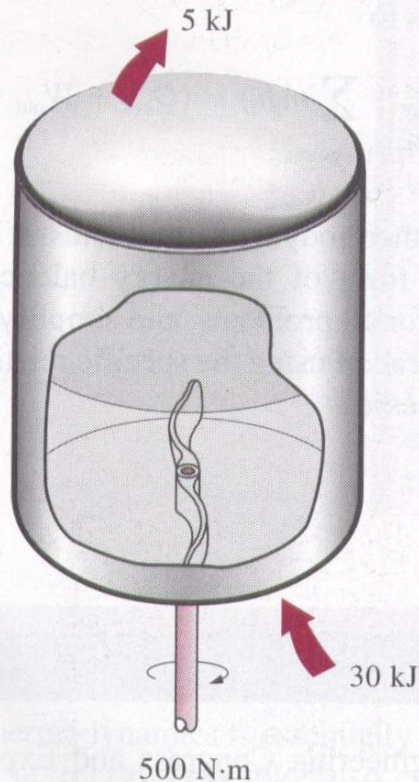


FIGURE P4-5

4-6E A vertical piston-cylinder device contains water and is being heated on top of a range. During the process, 65 Btu of heat is transferred to the water, and heat losses from the side walls amount to 8 Btu. The piston rises as a result of evaporation, and 5 Btu of boundary work is done. Determine the change in the energy of the water for this process.

Answer: 52 Btu

4-7 A classroom that normally contains 40 people is to be air-conditioned with window air-conditioning units of 5-kW cooling capacity. A person at rest may be assumed to dissipate heat at a rate of about 360 kJ/h. There are 10 light bulbs in the room, each with a rating of 100 W. The rate of heat transfer to the classroom through the walls and the windows is estimated to be 15,000 kJ/h. If the room air is to be maintained at a constant temperature of 21°C, determine the number of window air-conditioning units required. *Answer: 2 units*

4-11 The radiator of a steam heating system has a volume of 20 L and is filled with superheated vapor at 300 kPa and 250°C. At this moment both the inlet and exit valves to the radiator are closed. Determine the amount of heat that will be transferred to the room when the steam pressure drops to

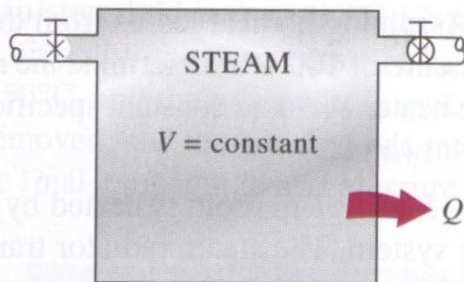


FIGURE P4-11

100 kPa. Also, show the process on a P - v diagram with respect to saturation lines. *Answer: 33.4 kJ*

4-12 A 0.5-m³ rigid tank contains refrigerant-134a initially at 200 kPa and 40 percent quality. Heat is now transferred to the refrigerant until the pressure reaches 800 kPa. Determine (a) the mass of the refrigerant in the tank and (b) the amount of heat transferred. Also, show the process on a P - v diagram with respect to saturation lines.

4-18 A piston-cylinder device contains 5 kg of refrigerant-134a at 800 kPa and 60°C. The refrigerant is now cooled at constant pressure until it exists as a liquid at 20°C. Determine the amount of heat loss and show the process on a T - v diagram with respect to saturation lines. *Answer: 1089 kJ*

4-21 A piston-cylinder device contains steam initially at 1 MPa, 350°C, and 1.5 m³. Steam is allowed to cool at constant pressure until it first starts condensing. Show the process on a T - v diagram with respect to saturation lines and determine (a) the mass of the steam, (b) the final temperature, and (c) the amount of heat transfer.

4-28 A 4-m \times 5-m \times 6-m room is to be heated by a baseboard resistance heater. It is desired that the resistance heater be able to raise the air temperature in the room from 7 to 23°C within 15 min. Assuming no heat losses from the room and an atmospheric pressure of 100 kPa, determine the required power of the resistance heater. Assume constant specific heats at room temperature. *Answer: 1.91 kW*

4-29 A 4-m \times 5-m \times 7-m room is heated by the radiator of a steam-heating system. The steam radiator transfers heat at a rate of 10,000 kJ/h, and a 100-W fan is used to distribute the warm air in the room. The rate of heat loss from the room is estimated to be about 5000 kJ/h. If the initial temperature of the room air is 10°C, determine how long it will take for the air temperature to rise to 20°C. Assume constant specific heats at room temperature.

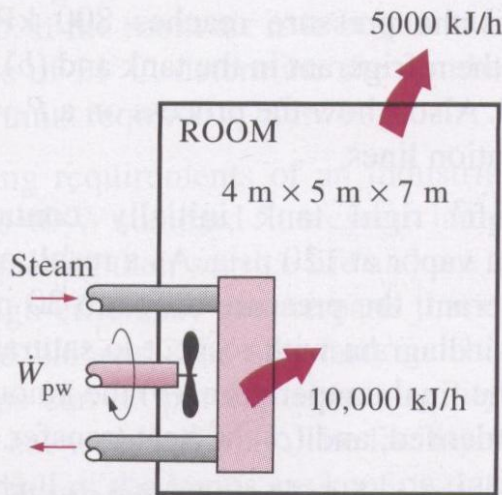


FIGURE P4-29

4-33 A piston-cylinder device whose piston is resting on top of a set of stops initially contains 0.5 kg of helium gas at 100 kPa and 25°C. The mass of the piston is such that 500 kPa of pressure is required to raise it. How much heat must be transferred to the helium before the piston starts rising?

Answer: 1857 kJ

4-34 An insulated piston-cylinder device contains 100 L of air at 400 kPa and 25°C. A paddle wheel within the cylinder is rotated until 15 kJ of work is done on the air while the pressure is held constant. Determine the final temperature of the air. Neglect the energy stored in the paddle wheel.

4-37 An insulated piston-cylinder device initially contains 0.3 m^3 of carbon dioxide at 200 kPa and 27°C . An electric switch is turned on, and a 110-V source supplies current to a resistance heater inside the cylinder for a period of 10 min . The pressure is held constant during the process, while the volume is doubled. Determine the current that passes through the resistance heater.

4-45 In a manufacturing facility, 5-cm -diameter brass balls ($\rho = 8522 \text{ kg/m}^3$ and $C_p = 0.385 \text{ kJ/kg} \cdot ^\circ\text{C}$) initially at 120°C are quenched in a water bath at 50°C for a period of 2 min , at a rate of 100 balls per minute. If the temperature of the balls after quenching is 74°C , determine the rate at which heat needs to be removed from the water in order to keep its temperature constant at 50°C .

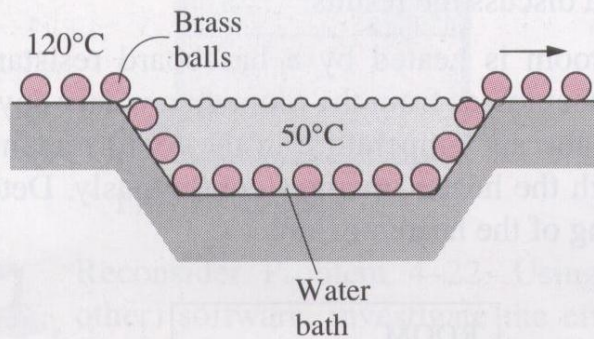


FIGURE P4-45

4-50 Carbon steel balls ($\rho = 7833 \text{ kg/m}^3$ and $C_p = 0.465 \text{ kJ/kg} \cdot ^\circ\text{C}$) 8 mm in diameter are annealed by heating them first to 900°C in a furnace, and then allowing them to cool slowly to 100°C in ambient air at 35°C . If 2500 balls are to be annealed per hour, determine the total rate of heat transfer from the balls to the ambient air. *Answer: 542 W*

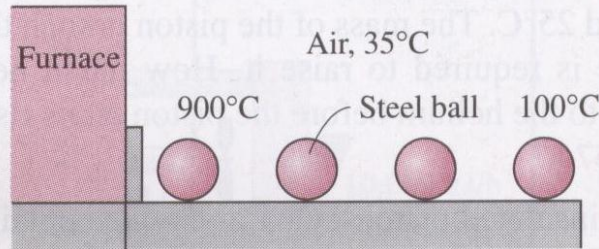


FIGURE P4-50