Thermodynamics I
Chapter 1 First Law of Thermodynamics for Closed Systems
Selected Problems

Source: *Cengel, Y.A., and Boles, M.A.,THERMODYNAMICS :An Engineering Approach, 5th Edition in SI unit,McGraw-Hill, 2006.*
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3-70 A closed system undergoes a cycle consisting of two process During the first process, 40 kJ of heat is transferred to the system while the system does 60 kJ of work. During the second process, 45 kJ of work is done on the system.

(a) Determine the heat transfer during the second process.

(b) Calculate the net work and net heat transfer for the cycle.

Answers: (a) -25kJ; (b) 15kJ, 15kJ

3-35 Amass of 5 kg of saturated water vapor at 200 kPa is heated at constant pressure until the temperature reaches 300 ^{o}C. Calculate the work done by the steam during this process. (430.5 kJ)

3-39 Nitrogen at an initial state of 300 K, 150 kPa, and 0.2 m^3 is compressed slowly in an isothermal process to a final pressure of 800 kPa. Determine the work done during this process.

3-41 During an expansion process, the pressure of a gas changes from 100 to 900 kPa according to the relation P = aV + b, where a = 1 MPa/m^3 and b is a constant. If the initial volume of the gas is 0.2 m^3, calculate the work during the process. (400 kJ)

3-42 During some actual expansion and compression process in piston-cylinder devices, the gases have been observed to satisfy the relationship $PV^n = C$, where n and C are constant. Calculate the work done when a gas expans from a atate of 150 and 0.03 m^3 to a final volume of 0.2 m^3 , for the case of n = 1.3.

3-72 A classroom that normally contains 40 people is to be air conditioned with window air-conditioning units of 5-kW rating. 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 window is estimated to be 15,000 kJ/h. If the room air is to be maintained at constant temperature of 21^{o}C, determine the number of window air conditioning units required. Answer: 2 units

3-78 A piston-cylinder device contains 5 kg of refrigerant-12 at 800 kPa and 60°C. The refrigerant is now cooled at constant pressure until it exists as a liquid at 20^{o}C. Determine the amount of heat transfer, and show the process on a T -v diagram with respect to saturation lines. Answer: -829.25 kJ

3·79 A piston-cylinder device contains 0.2 kg of water initially at 800 kPa and 0.08 m^3. Now 180 kJ of heat is transferred to the water while its pressure is kept constant. Determine the final temperature of the water. Also show the process on a T-v diagram with respect to saturation lines.

3-80 An insulated piston-cylinder device contains 5 L of saturated liquid water at a constant pressure of 150 kPa. Water is stirred by a paddle wheel while a current of 8 A flows for 45 min through a resistor places in the water. If one-half -of the liquid is evaporated during this constant-pressure process and the paddle-wheel work amounts to 300 kJ. determine the voltage of the source. Also, show the process on a P-v diagram with respect to saturation lines. Answer: 230.9 V

3-81 A piston-cylinder device contains steam initially at 1 MPa, 350oC, 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.

3-82 A piston-cylinder device initially contains steam at 200 kPa, 200°C, and 0.5 m3. At this state, a linear spring (F α x) is touching the piston but exerts no force on it. Heat is now slowly transferred to the steam, causing the pressure and the volume to rise to 500 kPa and 0.6 m3, respectively . Show the process on a P-v diagram with respect to saturation lines, and determine (a) the final temperature, (b) the work done by the steam, and (c) the total heat transferred.

Answers: (a) 1131°C, (b) 35 kJ, (c) 807 kJ

3-83 A piston-cylinder device initially contains 0.5 m3 of saturated water vapor at 200 kPa. At this state, the piston is resting on a set of stops, and the mass of the piston is such that a pressure of 300 kPa is required to move it. Heat is now slowly transferred to the steam until the volume doubles. Show the process on a P-v diagram with respect to saturation lies and determine (a) the final temperature, (b) the work done during this process, and (c) the total heat transfer. Answers: (a) 878.90°C, (b) 150 kJ, (c) 875 kJ

3-84 A piston-cylinder device with a set of stops on the top contains 3 kg of saturated liquid water at 200 kPa. Heat is now transferred to the water, causing some of the liquid to evaporate and move the piston up. when the piston reaches the stops, the enclosed volume is 60 L. More heat is added until the pressure is doubled. Show the process on a *P-v* diagram with respect to saturation lines, and determine

(a) the amount of liquid at the final state, if any,

(b) the final temperature, and

(c) the total work and heat transfer.