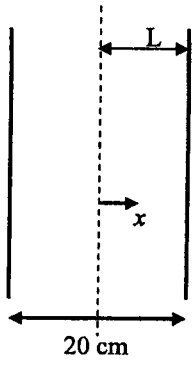
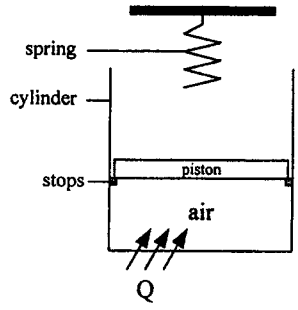
國立臺灣科技大學
九十四學年度碩士班招生考試試題
系所組別：機械工程系碩士班丙組
科　　目：熱力學

每題二十分，總分一百分。

1. A 20 cm thick slab of stainless steel is heated by electrical current such that a uniform volumetric heat generation of 60,000 W/m^3 is produced. The slab is cooled in both sides by convection of heat to a surrounding fluid maintained at 20°C. The convective heat transfer coefficient is 30 W/m^2·K, and the steel properties are k = 15 W/m·K, ρ = 8055 kg/m^3, and C_p = 480 J/kg·K.
(a) What is the steady-state temperature distribution in the slab?
(b) Show a rough graph of the temperature distribution with the surface and centerline temperatures quantified.



2. Consider the piston and cylinder arrangement shown in the figure. A frictionless piston with a cross section area of 0.5m^2 rests initially on stops on the cylinder walls such that the contained volume is 1m^3. The mass of the piston is such that 0.2 MPa pressure is required to move it against atmospheric pressure. When the piston has moved to a point where the container volume is 1.5m^3 the piston encounters a linear spring that requires 200 kN to deflect it 1 m. Initially the cylinder contains 1 kg of air at 0.1 MPa. The air is then heated until the final pressure is 0.5 MPa.
Determine:
(a) Final volume and temperature of the air. (十分)
(b) The work done during the process (五分)
(c) The heat transferred to the air. (五分)
(For air, R = 0.286 kJ/kg·K, C_v = 0.72 kJ/kg·K)



3. An insulated isolated system consists of a heat source at temperature T_H and a heat sink at temperature T_L. Show that the direction of heat transfer is from the source to the sink.

4. For diatomic gas, the specific heat at constant pressure usually can be approximated as $C_P = 7R/2$, where R is the gas constant. Calculate the change of entropy of 3 kg of nitrogen that changes state from 300 K and 100 kPa to 900 K and 500 kPa.

5. Consider steady heat transfer through a 6 m×6 m brick wall of a house of thickness 30 cm. The thermal conductivity of the brick wall is 0.72 W/m·°C. On a day when the temperature of the outdoors is 0°C, the house is maintained at 27°C. The temperatures of the inner and outer surfaces of the brick wall are measured to be 20°C, and 5°C, respectively. Determine the rate of entropy generation in the wall.

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