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國立臺灣大學 108 學年度碩士班招生考試試題

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(1) An elastic balloon (assumed spherical) filled with 0.5 mole of hydrogen gas has a diameter of 0.3 m and an internal pressure of 150 kPa initially (state 1), as shown in the figure below. The gas is then heated to a diameter of 0.4 m and a pressure of 200 kPa (state 2). During the process, the pressure is proportional to the balloon's diameter. Calculate

(a) the work done by the gas during the process, (6%)

(b) the work done by the balloon on the atmosphere, assuming that atmospheric pressure to be 100 kPa, (6%)

(c) estimate the amount of heat added, assuming the hydrogen to be an ideal gas with the universal gas constant 8.314 J mol^{-1} K^{-1}, and specific heat 14.3 kJ kg^{-1} K^{-1}, (6%)

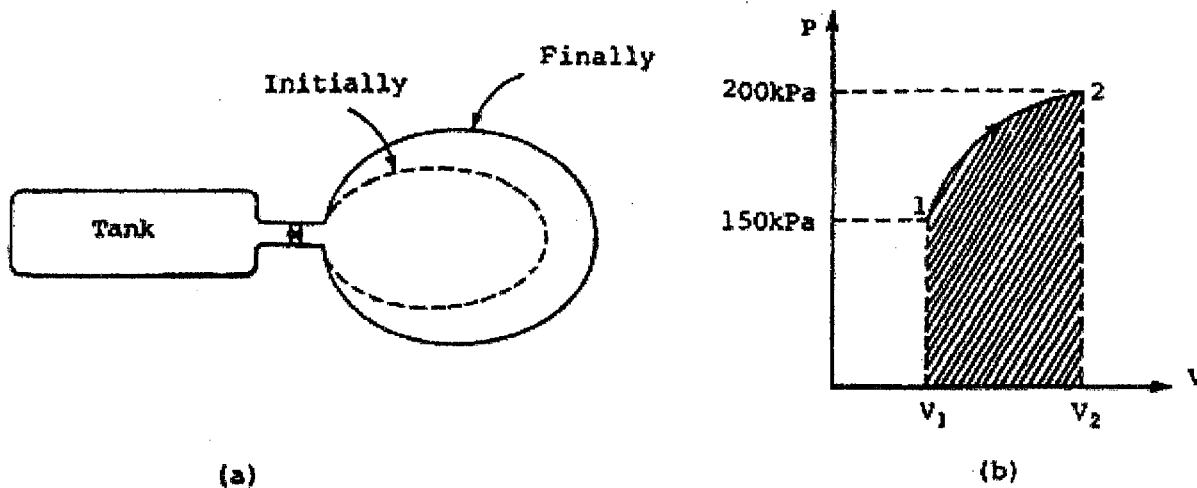(d) discuss the difference in values of the results in (a) and (b). (6%)

Figure. Inflation of an elastic balloon: (a)schematic, (b)P-V diagram

(2) (a) 50 grams of ice at −20°C is placed in a cup containing 100 grams of liquid water at 10°C. Assume that there is no heat transfer from the water to the cup or to the environment. What is the state when the ice/water mixture has come to thermal equilibrium? Here the latent heat of fusion of ice is 333 J g^{-1}, the specific heats of ice and water are 2.22 and 4.19 J g^{-1} K^{-1}, respectively. (13%)

(b) A 34 kg steel casting at a temperature of 427°C is quenched in 136 kg of oil initially at 21°C. Assuming no heat losses and the steel casting and oil to have constant specific heats of 0.5 and 2.5 J g^{-1} K^{-1}, respectively, determine the change in entropy for a system consisting of the oil and casting. (13%)

(3) Please describe each stage of the cycles in P-V diagrams: (a) Carnot cycle (7%) (b) Otto cycle (7%) (c) Diesel cycle (7%) (d) Stirling cycle. (7%)

(4) A 5-m x 4-m x 3-m room contains air at 25°C and 100 kPa at a relative humidity of 80 percent. Determine (*a*) the partial pressure of dry air (7%) (*b*) the specific humidity (7%) (*c*) the masses of the dry air and water vapor in the room. (8%)   For water at 25°C, saturation vapor pressure is 3.1698 kPa.

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