EG3029 Chemical Thermodynamics

Tutorial 2

Problem 1:

A gas is confined in a vertical 0.47 m diameter cylinder by a piston. On the piston rests a weight and the combined mass of the piston and weight is 150 kg. The local acceleration of gravity is 9.813 m s^{-2} and the ambient pressure is 101.57 kPa.

(a) What is the total force exerted on the gas by the atmosphere, the piston and the weight assuming no friction between the piston and the cylinder? *(19,094 N)*

(b) What is the pressure of the gas? *(110.054 kPa)*

(c) The gas in the cylinder is heated and expands pushing the piston and weight upward. Calculate the work done by the gas if the piston and weight are raised 0.83 m. What is the change in potential energy of the piston and weight? *(15.848 kJ, 1.222 kJ)*

Problem 2:

In a closed system (kinetic and potential energy are constant) three consecutive processes are done by an ideal gas (10 moles, M = 24.945 g mol^{-1});

initial conditions: P_1 = 1 bar, T_1 = 300K

process 1→2; reversible isothermal compression, V_2 = 0.1 m^3 kg^{-1}

process 2→3; isochoric cooling, P_3 = 2 bar

process 3→4; isobaric heating, T_4 = 600 K

(a) Calculate the initial volume V^t_1 and specific volume V_1 of the gas. *(0.2494 m^3, 1 m^3 kg^{-1})*

(b) Calculate the pressure P_2 after the first process. *(10 bar)*

(c) Calculate the temperature T_3 after the second process. *(60 K)*

(d) Calculate the final specific volume V_4. *(1 m^3 kg^{-1})*

(e) What forms of energy are present in transit across the system's boundary during the first process? Calculate the values. *(57.4 kJ)*

(f) Which kind of process can we use to reach the initial state?

(g) Draw a PV diagram with all processes 1→2→3→4→1.

Problem 3:

One mole of an ideal gas with C_P = (7/2)R and C_V = (5/2)R expands form P_1 = 8 bar and T_1 = 600 K to P_2 = 1 bar by each of the following paths:

(a) Constant volume. *(0 kJ, -10.91 kJ, -15.28 kJ)*

(b) Constant temperature. *(-10.37 kJ, 0 kJ)*

(c) Adiabatically. *(-5.586 kJ, 0 kJ, -7.821 kJ)*

Assuming mechanical reversibility, calculate W, Q, ΔU, ΔH for each process. Sketch each path on a single PV diagram.