EG3029 Chemical Thermodynamics

Tutorial 1

Problem 1:
A closed system contains nitrogen (M = 28 g mol^{-1}). Using the ideal gas law, calculate the missing PVT parameter for the following data given. Give your results in SI units.
(a) P = 1 atm; T = 0°C.
(b) V^t = 12.85 ft^3; T = 59°F.
(c) P = 179 Torr; V = 0.122 L mol^{-1}.
(d) T = 32°R; P = 19 psi.
(e) P = 740 mmHg; V^t = 7 bbl.

The universal gas constant is R = 8.314 J mol^{-1} K^{-1}

Problem 2:
The Angle Falls in Venezuela are the world's highest waterfalls (~1,000 m). Take the amount of 1 kg of water as the system flowing over the waterfall. Assume that is does not exchange energy with its surroundings.
(a) Calculate the potential energy of the water at the top of the falls with respect to the base of the falls. Gravity g = 9.81 m s^{-2}. *(9,810 J)*
(b) What is the energy balance that applies during the water falling down? What is the kinetic energy of the water just before it strikes down?
(c) When striking down the energy is converted to internal energy. Calculate the temperature change with the heat capacity 4,184 J kg^{-1} K^{-1}. *(2.34 K)*

Problem 3:
A hydroturbine operates with a head of 50 m of water. Inlet and outlet conduits are 2 m in diameter. Calculate the maximum mechanical power that can be developed by the turbine for an inlet velocity of 5 m s^{-1}. *(7,706 kW)*

Problem 4:
An electric motor under steady load draws 7 A at 230 V. It delivers 1,370 W of mechanical power.
(a) What is the rate of heat transfer from the motor? *(240 W)*
(b) The motor is cooled by water at a flow rate of 1 kg min^{-1}. Calculate the temperature change of the water (heat capacity 4,184 J kg^{-1} K^{-1}). *(3.44 K)*

Problem 5:
One mole of an ideal gas in a horizontal piston/cylinder arrangement expands from a pressure of 10 atm to 1 atm. The temperature before the isothermal process is 0 °C.
(a) Calculate the work done by the gas assuming that the piston is moved gradually. *(-5224.84 J)*
(b) Calculate the work done by the gas assuming a sudden process. *(-2042.21 J)*