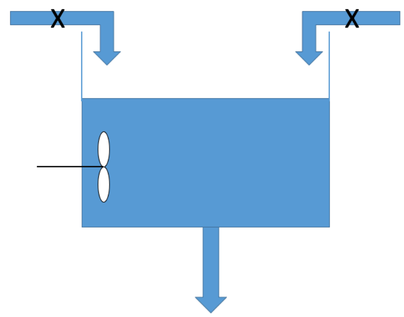
ABE 202 Homework 4. 2017

Due: Feb. 9, 2017 before class

1: The mixing tank shown here initially contains 50 kg of water at 25°C. Suddenly the two inlet valves and the single outlet valve are opened, so that two water streams, each with a flow rates of 5 kg/min, flow into the tank, and a single exit stream with a flow rate of 10 kg/min leaves the tank. The temperature of one inlet stream is 80°C, and that of the other is 50 °C. The tank is well mixed, so that the temperature of the outlet stream is always the same as the temperature of the water in the tank.

a. Compute the steady-state temperature that will finally be obtained in the tank.
b. Develop an expression for the temperature of the fluid in the tank at any time.



2: In Joule's experiments, the slow lowering of a weight (through a pulley and cable arrangement) turned a stirrer in an insulated container of water. As a result of viscosity, the kinetic energy transferred from the stirrer to the water eventually dissipated. In this process the potential energy of the weight was first converted to kinetic energy of the stirrer and the water, and then as a result of viscous forces, the kinetic energy of the water was converted to thermal energy apparent as a rise in temperature. Assuming no friction in the pulleys and no heat losses. how large a temperature rise would be found in 1 kg of water as a result of a 1-kg weight being lowered 1 m?

3: It is thought that people develop respiratory infections during air travel because much of the airplane cabin air is recirculated. Airlines claim that using only fresh air in the cabins is too costly since at an altitude of 30000 feet the outside conditions are -50°C and 0.1 bar, so that the air would have to be compressed and heated before being introduced into the cabin. The airplane cabin has a volume of 100 m^3 with air at the inflight conditions of 25°C and 0.8 bar. What would be the cost of completely refreshing the air every minute if air has a heat capacity of $C_p^* = 30$ J/(mol K) and energy costs $0.2 per kW hr?