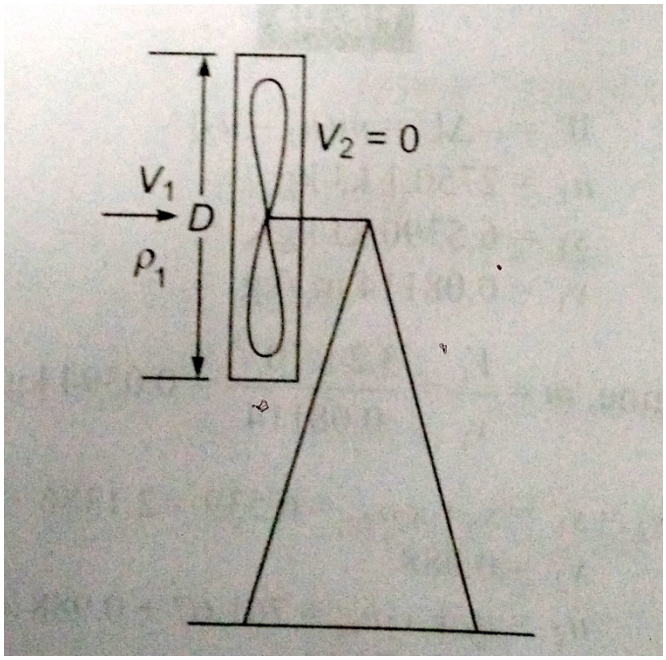
Q1. Two kg of a gas are squeezed in a device from a volume of 1.4 m^3 to a volume of 0.9 m^3. During this time the pressure remains constant at 100 kN/m^2, and it is found that the internal energy decreases by 12 kJ. How much energy is transferred as heat to or from the gas for this process?

Q2. Steam enters an insulated valve as a liquid-vapour mixure at 4 MPa and leaves at 10 kPa, 50^0C. What is the density of steam at inlet?

Q3. A gas mixture of 60% methane and 40% propane by volume is compressed isentropically from 40^0C, 0.4 x 10^6 N/m^2 to 1.2 x 10^6 N/m^2. Determine the final temperature of the mixture, the work required per unit mass, and the entropy change for each gas, assuming ideal gas behavior with constant specific heats.

Q4. Consider a compressor with air at 1 bar and 15^0C, compressing (a) isothermally to 27.59 bar, and (b) polytropically, the index being 1.3 to the same pressure. Compare the work done, the heat exchange with the surroundings, the final temperature, and the changes in internal energy and entropy due to the compression per unit mass of air.

Q5. The figure below illustrates a windmill with blade diameter D, air velocity V_1 and density ρ_1 entering the blades. Consider the windmill to be adiabatic and the exit air velocity from the blades is negligible. Find the power produced?



Q6. A steam engine receives steam at 3 MPa and 300^0C and expands isentropically and reversibly to 1 MPa. Determine the work done if the cylinder volume at the start of expansion $3.2\times10^{-3}\ m^3$.

Q7. A steam power plant operates on the Rankine cycle. The steam enters the turbine at 7.0 MPa and 550^0Cwith the velocity of 30 m/s. it discharges to the condenser at 20KPa with the

velocity of 90 m/s. Calculate the thermal efficiency and the power produced for a flow rate of 37.8 Kg/s.

Q8. Steam at 1.8 MPa, 400^0C steadily enters a nozzle whose inlet area is 0.02 m^3. The mass flow rate of steam is 5 Kg/s. Steam leaves the nozzle at 1.4 MPa with a velocity of 275 m/s. Heat loss to the surroundings is 2.8 KJ/Kg. Determine (a) the inlet velocity, and (b) the exit temperature of the steam.

Q9. A pump draws a solution with a specific gravity of 1.50 from a storage tank through a 8 cm pipe. The velocity of the suction pipe is 1.2 m/s. the open end of the 5 cm discharge pipe is 15 m above the top of the liquid in the storage tank. Friction head losses are found to be 25 Nm/Kg. What is the power required by the pump?

Q10. In the electric heating system in a house, air at 100 kPa, 17^0C flows over resistance wires with 1.5 kW energy input. If the heat loss to the surroundings is 200 W and the volume flow rate of air is 150 m^3/min, what is the exit temperature of air?

Q11. An iron block casting weighing 50 Kg and at 500 K is immersed in a large lake at a temperature of 285 K and eventually comes to thermal equilibrium with the lake water. Assuming an average specific heat of iron as 0.45 kJ/kgK, determine (a) the entropy change of the iron block, (b) the entropy change of the lake water, and (c) the entropy generated during the process.

Q12. A frictionless piston-cylinder assembly contains saturated water vapour at 100^0C. A quantity of 600 kJ of heat is rejected to the surroundings at 25^0C with some vapour condensing into liquid, where the pressure inside the cylinder is maintained constant at 1 atm. Determine the entropy change of (a) the water (b) the surroundings and (c) the universe.

Q13. A 500 Kg iron block (c_p=0.45 kJ/kgK) at 200^0C is allowed to cool to 27^0C by transferring heat to the surroundings at 27^0C. Determine the reversible work and energy destruction for this process.

Q14. Air with the temperature of 27^0C receives heat at constant volume until the temperature is 927^0C. Find the heat added per kilogram and use the ideal gas law and the air tables.

Q15. Atmospheric air at 1.06 bar and 15^0C is compressed isothermally to 14 bar and is thereafter expanded isentropically back to atmospheric pressure. What is the final temperature and specific volume of air? Calculate also the net work done and the heat exchange with the surroundings. Take R=0.287 and c_p=0.992kJ/kgK.

Q16. If 20 kJ are added to a Carnot cycle at temperature 100^0Cand 14.6 kJ are rejected at 0^0C, determine the location of absolute zero on the Celsius scale.

Q17. (a) A 100 ohm resistor carrying a current of 5 A for 1 second is kept at a constant temperature of 27^0C by a stream of cooling water. Find the entropy change of 1) the resistor

and 2) the universe, (b) if the same resistor initially at 27^0C is thermally insulated and the same current is passed for the same time, find the entropy change of 3) the resistor, and 4) the universe, given the mass of the resistor is 50 gm and c_p = 840 J/kgK.