Assignment – 01
EN – 203, due date: 27-8-2004

Q.1. Explain Joules experiment which led to discovery of first law of thermodynamics. Also give the mathematical expression of first law applicable to a cycle and derive it for a process.

Q.2. State the historical development of temperature measuring scales. Also give the reason why that particular scale is developed.

Q.3. A new temperature scale "°N" is to be defined, the boiling and freezing pts. on this scale are 100°N and 400°N respectively. What will be the reading on the new scale corresponding to 60°C? At what temperature would the Celsius and the new temperature scale reading be the same?

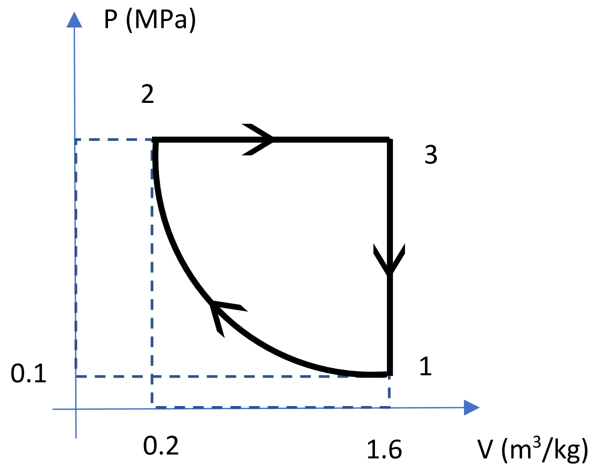
Q.4. A steel flask of 0.04 m^3 capacity is to be used to store air at 100 bar, 27°C. The flask is to be protected against excessive pressure by a fusible plug which will melt and allow the air to escape if the temperature rises too high. Find the temperature at which the fusible plug must melt to limit the pressure of a full flask to a maximum of 125 bar.

Q.5. A football was inflated to gauge pressure of 1 bar when the ambient temperature was 15°C. When the game started the next day, the air temperature at the stadium was 5°C. Assume that the volume of the football remains constant at 2500 cm^3. Find out the amount of heat lost by the air in the football and the gauge pressure of air in the football at the stadium. Also determine the gauge pressure of air to which the ball must have been originally inflated so that it would be equal to 1 bar gauge at the stadium.

Q.6. An ideal gas (air) undergoes a cyclic process consisting of the following three processes:

Process 1-2 : Compression process with Pv = constant
Process 2-3 : Constant pressure
Process 3-1: Constant volume;

Find out the work done and heat transfer (KJ/kg) during process 2-3 and net work output (KJ/kg) of the cycle.



Q.7. A spherical balloon of 1 metre diameter contains a gas at 150 kPa. The gas inside the balloon is heated until pressure reaches 450 kPa. During the process of heating the pressure of gas inside the balloon is proportional to the cube of the diameter of the balloon. Find the work done by the gas.

Q.8. A piston-cylinder device contains 0.05 m^3 of a gas initially at 200 kPa. At this state, a linear spring which has a spring constant of 150 kN/m is just touching the piston but exerting no force on it. Now heat is transferred to the gas causing the piston to rise and to compress the spring until the volume inside the cylinder doubles. If the cross-section area of the piston is 0.25 m^2. Find :

(i) The final pressure inside the cylinder
(ii) Work done by the gas

Q.9. An insulated rigid pressure vessel is divided into two portions by a movable partition one part of the vessel is occupied by an ideal gas at a Pressure P_1, Volume V_1 and Temperature T_1. The other part is occupied by the same ideal gas but at Pressure P_2 Volume V_2 and Temperature T_2. The partition is removed and both portions mix adiabatically and reach a new state given by variables P_3, V_3, T_3. Derive the expression for final pressure P_3 and temperature T_3 in terms of initial state variables.

Q.10. While leaving the room John left the fan on, the fan consumes 2W of electricity. Assume the room has perfectly insulated walls, roof and ground. Initially, the room was at 27°C, what should be the room temperature after 2 hours? Assume the room is a cube of dimension 5m X 5m X 4m, the density of air inside the room remains constant throughout the time as 1.27 kg/m^3. Assume air as an ideal gas.

Q.11. An insulated rigid tank of volume 4 m^3 contains air at 6 bar and 127°C. A valve is connected to the tank and is open to let the air escape from the tank. The process continues until the pressure inside the tank drops to 2 bar. The temperature of the air is kept constant throughout the process by an electric resistance heater. Determine the amount of electrical energy supplied in this process. (The enthalpy and internal energy at 127°C are 400.98 kJ/kg and 286.16 kJ/kg).