THERMODYNAMICS

FULL MARKS: 70

1. **2x10**

i)Explain what is meant by intensive and extensive properties and give two example of each.

ii)Specify which of the following can be analyzed by the control mass(closed system) method and which by the control volume(open system) method:

(a)Two Kg of air,

(b)A steam turbine,

(c)A boiler,

(d)Heating of a fluid in a closed rigid vessel,

(e)Melting of a block of ice,

(f)Filling an empty cooking gas bottle,

(g)A water pump,

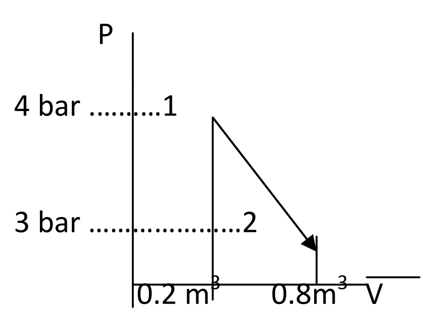
(h)A steam nozzle.

iii)Calculate the density of air at 1 bar and at 27^{o}C.

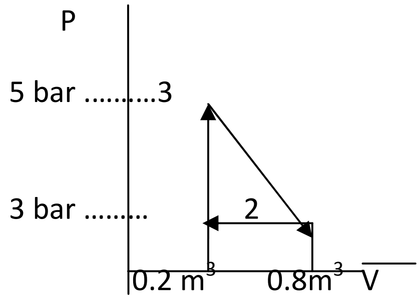
iv)A manometer using mercury(density = 13600 kg/m^3) as the manometric fluid gives a reading of 2 cm when attached to a vessel containing a gas. If the local atmospheric pressure is 1 bar, what are the gauge and absolute pressures of the gas in the vessel?

v)A sample of steam is at 5 bar, 0.7 quality and occupies a volume of 4m^3. Calculate the mass of this sample of steam.

vi)Calculate the work done for the process shown in the figure given below.



vii)Calculate the heat transferred during the cycle shown in the figure given below.



viii)A comot engine has an efficiency of 60%. If it receives 500 Kj/s of energy from source, Calculate the power it develops and the rate of heat rejection to the sink.

ix)A system at 27^{o}C is compressed reversibly and isothermally such that it receives 30kJ of work. Calculate its entropy change.

x)Calculate the entropy change when 5 Kg of saturated water is heated at 5 bar to get saturated vapour.

2.

A 1m^3 rigid tank contains air at 1 Mpa, 400K. What is the mass of air in the tank? Additional air is now pumped into the tank such that the pressure and temperature become 5Mpa and 450K. What mass of air is pumped into the tank? If the air finally in the tank is cooled to 300K. What pressure is attained?

[3+3+4]

3.

Dry and saturated steam at 10 bar is cooled at constant volume untile the pressure becomes 1 bar. What is the quality of steam after cooling ? What are the initial and final temperatures of the steam? [6+2+2]

4.

5Kg of air is compressed frictionlessly and polytropically with n=1.3 from 1 bar, 27^{o}C to 6 bar. Determine; (a) Work done (b) Change in the internal energy (c) Heat transferred.

[4+4+2]

5.

Air enters a frictionless adiabatic nozzle with a velocity of 30m/s and at a state of 5 bars, $18^{o}C$ and leaves at a pressure of 1 bar. Determine the velocity of air at the nozzle exit.

[10]

6.

A reversible engine receives heat Q_H from a reservoir at a temperature T_H< and rejects head Q_C to a reservoir at a temperature T_C. The work developed by the heat engine is used to drive a reversible heat pump that removes Q_C from a reservoir at a temperature T_C and rejects Q_H amount of heat to a reservoir at a temperature T_H. Show that

$$\frac{Q_H}{Q'_H} = \frac{T_H(T'_H - T'_C)}{T'_H(T_H - T_C)} \qquad [10]$$

7.

Air expands isothermally from 6 bar, 300K to 1 bar. For 10kg of this air, determine the change in entropy. Derive any formula you use. [5+5]

8.

Answer any two of the following

(i)State and explain the zeroth law of thermodynamics and define temperature based on this law.

(ii)State and explain the Clausus Inequality.

(iii)Show that during the change of phase at constant pressure, specific entropy change is given by

$S_g - S_f = \frac{hfg}{T_s}$ where T_s is the saturation temperature.