**ME6301- ENGINEERING THERMODYNAMICS**
**QUESTION BANK**
**UNIT-I**
**BASIC CONCEPT & FIRST LAW**

PART –A (2 marks)

**1. Define the term thermal engineering.**

Ans: Thermal engineering is the science that deals with the energy transfer to practical applications such as energy transfer power generation, refrigeration, gas compression and its effect on the properties of working substance.

**2. What is meant by thermodynamic system? How do you classify it? (MU – Oct'99, Apr'2000: BRU – Apr'96; MSU – Apr'96)**

Ans: Thermodynamic system is defined as the any space or matter or group of matter where the energy transfer or energy conversions are studied.

It may be classified into three types.

(a) Open system
(b) Closed system
(c) Isolated system

**3. What is meant by closed system? Give an example.(BNU – Nov'95)**

Ans: When a system has only heat and work transfer, but there is no mass transfer, it is called as closed system.

Example: Piston and cylinder arrangement.

**4. Define a open system, Give an example.**

Ans: When a system has both mass and energy transfer it is called as open system.
Example: Air Compressor.

**6. Define an isolated system**

Ans: Isolated system is not affected by surroundings. There is no heat, work and mass transfer take place. In this system total energy remains constant.
Example: Entire Universe

**7. Define: Specific heat capacity at constant pressure. (MU – Oct'99)**

Ans: It isdefined as the amount of heat energy required to raise or lower the temperature of unit mass of the substance through one degree when the pressure kept constant. It is denoted by $C_p$.

**8. Define: Specific heat capacity at constant volume.**

Ans: it is defined as the amount of heat energy required to raise or lower the temperature of unit mass of the substance through one degree when volume kept constant.

**9. What is meant by surroundings?**
Ans: Any other matter out side the system boundary is called as surroundings.

**10. What is boundary?**
Ans: System and surroundings are separated by an imaginary line is called boundary.

**11. What is meant by thermodynamic property? (MU – Apr'2001; BRU – Nov'96; BNU – Nov'94)**

Ans: Thermodynamic property is any characteristic of a substance which is used to identify the state of the system and can be measured, when the system remains in an equilibrium state.

**12. How do you classify the property?**
Ans: Thermodynamic property can be classified into two types.

1. Intensive or Intrinsic and
2. Extensive and Extrinsic property.

**13. Define Intensive and Extensive properties. (MU – Oct'96,98; MKU – Apr'96)**

Ans: The properties which are independent on the mass of the system is called intensive properties.
e.g., Pressure, Temperature, Specific Volume etc.,

The properties which are dependent on the mass of the system is called extensive properties. e.g., Total energy, Total volume, weight etc.

**15. What do you understand by equilibrium of a system?**

Ans: When a system remains in equilibrium state, it should not undergo any charges to its own accord.

**16. What is meant by thermodynamic equilibrium? (MU – Apr'98; MSU – Apr'96)**

Ans: When a system is in thermodynamic equilibrium, it should satisfy the following three conditions.

(a) Mechanical Equilibrium :- Pressure remains constant
(b) Thermal equilibrium :- Temperature remains constant
(c) Chemical equilibrium : There is no chemical reaction.

**17. State the First law of thermodynamics (MU – Apr'95)**

Ans:First of thermodynamics states that when system undergoes a cyclic process the net heat transfer is equal to work transfer.

**18. Define: PMM of first kind**

Ans: PMM of first kind delivers work continuously without any input. It violates first law of thermodynamics, It is impossible to construct an engine working with this principle.

**19. Define the term process (MKU – Nov'96)**

Ans: It is defined as the change of state undergone by a gas due to energy flow.

**20. Define the term Cycle: (MKU – Nov'96)**

Ans: When a system undergoes a series of processes and return to its initial condition, it is known as cycle.

**21. What is meant by open and closed cycle.**
Ans: In a closed cycle, the same working substance will recirculate again and again.

In a open cycle, the same working substance will be exhausted to the surroundings after expansion.

**22. What is meant by reversible and irreversible process. (MU – Apr'2001; BNU – Nov'94)**

Ans: A process is said to be reversible, it should trace the same path in the reverse direction when the process is reversed. It is possible only when the system passes through a continuous series of equilibrium state.

If a system does not pass through continuous equilibrium state, then the process is said to be irreversible.

**23. What is meant by Point and Path function? (Mu – Oct'2000; MKU – Nov'94)**

Ans: The quantities which is independent on the process or path followed by the system is known as point functions.Example: Pressure, volume, temperature, etc.,

The quantities which are dependent on the process or path followed by the system is known as path functions.

Example: Heat transfer, work transfer.

**24. What is Quasi – Static process? (MU – Oct'98, Apr'2000 & 2001; BNU – Nov'95)**

Ans: The process is said to be quasi – static, it should proceed infinitesimally slow and follows continuous series of equilibrium states. Therefore, the quasi static, it should proceed infinitesimally slow and follows continuous series of equilibrium states. Therefore, the quasi static process may be an reversible process.

**25. Explain Zeroth Law of thermodynamics? (MU – Nov'94, Apr'2001; BRU – Apr'96)**

Ans: Zeroth law of thermodynamics states that when two systems are separately in thermal equilibrium with a third system, then they themselves are in thermal equilibrium with each other.

**26. Define the term enthalpy? (MU – Oct'99)**

Ans: The Combination of internal energy and flow energy is known as enthalpy of the system. It may also be defined as the total heat of the substance.

Mathematically, enthalpy (H) = U + pv KJ)

Where, U – internal energy
p – pressure
v – volume
In terms of $C_p$& T → H = $mC_p$ ($T_2$-$T_1$)K

**27. Define the term internal energy (MKU – Apr'96)**

Ans: Internal energy of a gas is the energy stored in a gas due to its molecular interactions.

It is also defined as the energy possessed by a gas at a given temperature.

**28. What is meant by thermodynamic work?**

Ans: It is the work done by the system when the energy transferred across the boundary of the system. It is mainly due to intensive property difference between the system and surroundings.

**29. Define Heat.**

Ans: Heat is the energy crossing the boundary due to the temperature difference between the system and surroundings.

Ans: Energy can neither be created nor destroyed, but it can be transferred from one form to another.

**32. Define entropy of a pure substance. (MU – Oct'2000; MKU – Nov'96; BRU – Nov'95)**

Ans: Entropy is an important thermodynamic property, which increases with addition of heat and decreases with its removal. Entropy is a function of temperature only. It is an unavailability of energy during energy transfer.

**30. Give the general gas energy equations. (MU – Apr'95 & 98)**

Ans: dH = dE + dW.

**33. Define an isentropic process. (MU – Oct'99)**

Ans: Isentropic process is also called as reversible adiabatic process. It is a process which follows the law of $pV^y = C$ is known as isentropic process. During this process entropy remains constant and no heat enters or leaves the gas.

**34. Explain the throttling process.**

Ans: When a gas or vapour expands and flows through an aperture of small size, the process is called as throttling process.

**35. Work done in a free expansion process is _____ (MU – Apr'97)**

Ans: Zero

**36. Define free expansion process.**

Ans: When a gas expands suddenly into a vacuum through a large orifice is known as free expansion process.

**37. Which property is constant during throttling? (MU – Oct'98, Oct'2000)**

Ans: Enthalpy

**38. If in the equation $PV^n = C$, the value of n = then the process is called _____**

Ans: Constant Volume process

**39. The polytropic index (n) is given by _____ (MU – Apr'95 & 96)**

Ans: n = log (P2/P1)/ log (V1/V2)

**40. Work transfer is equal to heat transfer in case of _____ process.MU – Nov'94)**

Ans: Isothermal process.

**41. Write down the characteristic gas equation.**

Ans: Characteristic gas equation is pV = mRTWhere,

p =
pressure V
= Volume

R = Characteristic gas
constant T = Temperature.

**42. What is meant by steady flow process? (BNU – Nov'96)**

Ans: During the process the rate of flow of mass and energy across the boundary remains constant, is known as steady flow process.

**43. What is the difference between steady flow and non – flow process?**

Ans: During the steady flow process the rate of flow of mass and energy across the boundary remains constant.

In case of non – flow across the system and boundary.

**PART –B**

**1**. one kg of gas expands at CO&11stant pressure from 0.085 m3 to 0.13 Ill).if the initial temperature of the gas is 22.5 °c. find the final. Temperatures, net heat transfer, change in
internal energy, pressure of gas. (16)
**2**. A certain quantity of gas is head at constant pressure from 35 °0 to 185°c. Estimate the
amount of hem transferred, ideal work done, change in internal energy, when the initial volume of
the gas is 0.6 m3. (16)
**3**. Explain and derive Isothermal process (16)
**4**. Explain and derive Isobaric process. (16)
**5**. 2kg of gas at a pressure of 1.5 bar. Occupies a volume of 2.5 m3. If this gas compresses
isothermally to 1/3 times the initial volume. Find initial. Final temperature, work done, heat transfer. (16)

**6**. one kg of air is compressed polytropically (n=1.3) from 1 bar and 27 deg Celsius to 3 bar. Find I. work transfer , 2.Heat transfer,3. Change in internal energy (16)

**7**. A paddle wheel fixed to a shaft of an engine revolves in a closed hollow vessel Containing water. This closed vessel is connected freely on the shaft and restraint to its turning moment is proved by mass attached to its side. Find the temperature rise for the following observations.

**8**. A cylinder contains 0.45 m3 of gas at 1 x 105 N/m2 and 80oC. The gas is compressed to a volume of 0.13 m3, the final pressure being 5 X 105 N/m2. Determine i) The mass of gas ii) The value of index 'n' for compression The increase in internal energy of the gas and iv) The heat received or rejected by the gas during compression. Take $\gamma = 1.4$ R = 294.2 J/kg K

**9.** A turbine operates under steady flow condition receives steam at the following statepressure = 1.2Mpa, Temperature =1880C, Enthalpy = 2785 kJ/kg, velocity = 33.3m/sec and elevation = 3m. The steam leaves the turbine at the following state: pressure = 20Kpa, Enthalpy = 2512 kJ/kg, velocity = 100m/sec and elevation = 0m. Heat is lost tothe surrounding at the rate of 0.29kJ/sec. If the rate steam flow to the turbine is 0.42kg/sec what is the power output of the turbine in KW

**10.**Three grams of nitrogen gas at 6atm and 160°c is expanded adiabatically to double its initial volume, then compressed at constant pressure to its initial volume and then com-pressed again at constant volume to its initial state. Calculate the net work done on the gas. Draw P-V diagram for the process. Specific heat ratio of nitrogen is 1.4.

**11.**One litre of hydrogen at 273 K is adiabatically compressed to one-half of its initial volume. Find the change in temperature of the gas, if the ratio of two specific heats for
hydrogen is 1.4

## UNIT-2
## SECOND LAW

**PART –A (2 marks)**

**44. State the Kelvin – Plank statement of second law of thermodynamics**

Ans: Kelvin – Plank states that it is impossible to construct a heat engine working on cyclic process, whose only purpose is to convert all the heat energy given to it into an equal amount of work.

**45. State Clausius statement of second law of thermodynamics.**

Ans: It states that heat can flow from hot body to cold without any external aid but heat cannot flow from cold body to hot body without any external aid.

**46. State Carnot's theorem.**

Ans: No heat engine operating in a cyclic process between two fixed temperature, can be more efficient than a reversible engine operating between the same temperature limits.

**47. What are the Corollaries of Carnot theorem.**

Ans: (i) In all the reversible engine operating between the two given thermal reservoirs with fixed temperature, have the same efficiency.

(ii) The efficiency of any reversible heat engine operating between two reservoirs is independent of the nature of the working fluid and depends only on the temperature of the reservoirs.

**48. Define – PMM of second kind.**

Ans: Perpetual motion machine of second kind draws heat continuously from single reservoir and converts it into equivalent amount of work. Thus it gives 100% efficiency.

**49. What is the difference between a heat pump and a refrigerator?**

Ans: Heat pump is a device which operating in cyclic process, maintains the temperature of a hot body at a temperature higher than the temperature of surroundings.

A refrigerator is a device which operating in a cyclic process, maintains the temperature of a cold body at a temperature lower than the temperature of the surroundings.

**50. What is meant by heat engine?**

Ans: A heat engine is a device which is used to convert the thermal energy into mechanical energy.

**51. Define the term COP?**

Ans: Co-efficient of performance is defined as the ratio of heat extracted or rejected to work input.

$$COP = \frac{\text{Heat extracted or rejected}}{\text{Work input}}$$

**52. Write the expression for COP of a heat pump and a refrigerator?**

Ans: COP of heat pump

$$COP_{HP} = \frac{\text{Heat Supplied}}{\text{Work input}} = \frac{T_2}{T_2 - T_1}$$

COP of Refrigerator

$$COP_{HP} = \frac{\text{Heat extrated}}{\text{Work input}} = \frac{T_1}{T_2 - T_1}$$

**53. What is the relation between $COP_{HP}$ and $COP_{ref}$?**

Ans: $COP_{HP} = COP_{ref} + 1$

**54. Why Carnot cycle cannot be realized in practical?**

Ans: (i) In a Carnot cycle all the four process are reversible but in actual practice there is no process is reversible.

(ii) There are two processes to be carried out during compression and expansion. For isothermal process the piston moves very slowly and for adiabatic process the piston moves as fast as possible. This speed variation during the same stroke of the piston is not possible.

(iii) It is not possible to avoid friction moving parts completely.

**55. Name two alternative methods by which the efficiency of a Carnot cycle can be** increased.

Ans: (i) Efficiency can be increased as the higher temperature $T_2$ increases. (ii) Efficiency can be increased as the lower temperature $T_1$ decreases.

**56. Why a heat engine cannot have 100% efficiency?**

Ans: For all the heat engines there will be a heat loss between system and surroundings.

Therefore we can't convert all the heat input into useful work.

**57. When will be the Carnot cycle efficiency is maximum?**

Ans: Carnot cycle efficiency is maximum when the initial temperature is 0°K.

**58. What are the processes involved in Carnot cycle.**

Ans: Carnot cycle consist of

i) Reversible isothermal compression ii) isentropic compression

iii) reversible isothermal expansion iv) isentropic expansion

**59. Write the expression for efficiency of the carnot cycle.**

$$\text{Ans: } n = \frac{T2 - T1}{T2}$$

**60. Define: Thermodynamic cycles.**

Ans: Thermodynamic cycle is defined as the series of processes performed on the system, so that the system attains to its original state.

**61. Define the term compression ratio.**

Ans: Compression ratio is the ratio between total cylinder volume to clearance volume.

It is denoted by the letter 'r'

**62. What is the range of compression ratio for SI and diesel engine?**

Ans: For petrol of SI engine 6 to 8 For diesel engine 12 to 18.

**63. Which cycle is more efficient for the same compression ratio and heat input, Otto cycle or Diesel cycle?**

Ans: Otto cycle is more efficient than diesel cycle

**65. The efficiency of the diesel cycle approaches the otto cycle efficiency when the cut off ratio is _____**

Ans: reduced

**66. Which device is used to control the Air – fuel ratio in the petrol engine?**

Ans: Carburettor

**67. Which device is used to control the Air fuel ratio in the diesel engine?**
Ans: Injection nozzle

**68. The speed of a four stroke I.C. engine is 1500rpm. What will be the speed of the cam shaft?**

Ans: 750 rpm.

**69. All the four operations in two stroke engine are performed in _____ number of revolution of crank shaft.**

Ans: one

**PART –B**

**1**. Air flows through an adiabatic compressor at 3 kg/s the inlet conditions are 2 bar and 310k and exit conditions are 20 bar and 560 k. compute the net rate of availability transfer and irreversibility. (16)
**2**. Air in a closed vessel of fixed volume of 0.15 m 3, exerts pressure of 12 bar at 250 °c ,if the vessel is cooled so that the pressure falls to 3.5 bar, determine the final temperature, heat transfer and change of entropy. (16)
**3**. Explain Carnot engine cycle and its efficiency. (16)
**4**. Explain the term availability and unavailability. (16)
**5**. A heat engine operates between a source a 600 °c and a sink at 60 c Determine the least rate of heat rejection per KW net output of the engine. (16)
**6.** 0.2 kg of air at 1.5 bar and 27 "c is compressed to a pressure of 15 bar according to the law

pv (l.25) =c. determine work done heat flow to or from the air, increase or decrease in entropy(16)

**7.** An Engine-working on Otto cycle has a volume of 0.45 m3 , pressure 1 bar andtemperature 30o,C at the beginning of compression stroke. At the end of compression stroke, the pressure is 11 bar and 210 KJ of heat is added at constant volume. Determine

(i) Pressure, temperature and volumes

at salient points in the cycle.' (ii) Efficiency

**8**. Derive the expression for thermal efficiency of a Carnot cycle with its p-V and Ts Diagram?

**9**. A Carnot engine takes heat from an infinite reservoir at 5500C and rejects it to a sink 2750C. Half of the work delivered by the engine is used to run generator and the other

half is used to run heat pump which takes heat at 2750C and rejects it at 4400C. Express the heat rejected at 4400C by the heat pump as % of heat supplied to the engine at 5500C. If the operation of the generator is 500W, Find the heat rejected/hour by the heat pump at 4400C?

**10**. Establish the inequality of Clausius and express Entropy change in irreversible process

## UNIT- 3

## PROPERTIES OF PURE SUBSTANCE & STEAM POWER CYCLE

**PART –A (2 marks)**

**1. Define latent heat of ice?**

Total amount of heat added during conversion of ice 0° C into water of 0°C.

**2. What is pure substance?**

Pure substance is a substance which has a fixed chemical composition throughout its mass

.Example: Water, Nitrogen, Carbon dioxide, and helium. A pure substance does not have to be of a single chemical element or compound .A mixture of various chemical element or components is also called as pure substance as long as the mixture is homogeneous.

**3. What is saturation temperature and saturation pressure?**

At a given pressure, the temperature at which a liquid boils is called saturation temperature. At the given temperature, the pressure at which the liquid boils is called saturation pressure it is also called as vapour pressure.

**4. Define latent heat of vaporizations.**

The amount of heat added during heating of water from boiling point to dry saturated stage is called as latent heat of vaporization or enthalpy of vaporization of latent heat of steam.

**5. Define the terms 'Boiling point 'and 'Melting point' .**

Boiling point:

It is the temperature at which the liquid starts to change its state from liquid to vapour. Melting point:

It is the temperature at which the solid starts to change its state from solid to liquid.

**7. Define the sensible heat of water.**

The amount of heat required to raise the temperature of unit mass of water from 0°C to the saturation temperature under a constant pressure. it is denoted by hf .

**8. Define the term super heat enthalpy.**

The heat supplied to the dry steam at saturation temperature, to convert it into superheated

steam at the temperature Tsup is called super heat enthalpy.

**9. What is wet and dry steam?**

The heat which partially evaporated and having water particles suspension is Called wet stream.

The steam which fully evaporated state and is not having any water particles is Called dry steam.

**10. State phase rule of pure substances.**

The number of independent variable associated with a multicomponents, multiphase system is given by the phase rule. It is also called as Gibbs phase rule .It is expressed by the equation as

$n = C - \Psi + 2$

Where,

n = the number of independent variable.
C = the number of components,

$\Psi$ = the number of phase present in equilibrium.

**11. Define dryness fraction of steam OR What is quality of steam?**

It is defined as the ratio of the mass of the total steam actually present to the mass of the totalsteam.

$$\text{Dryness fraction} = \frac{\text{Mass of dry steam}}{\text{Mass of total mixture}}$$

**12. Explain the term: Degree of super heat, Degree of sub cooling.**

**Degree of super heat:**

It is the difference between superheated temperature and saturated temperature at the same pressure.

**Degree of sub cooling.**

It is the amount by which the water is cooled beyond the saturated temperature at the same pressure**.**

**13. Define triple point and critical point for pure substance. Triple point:**

Triple point is the state at where all the three phases ie solid, liquid and vapour to exist in equilibrium.

**Critical point:**

It represents the highest pressure and temperature at which the liquid and vapour phases coexist in equilibrium. At the critical point the liquid and the vapour phases are distinguishable ie Liquid directly converted into vapour.

**14.When saturation pressure increases, what happens to saturation temperature** and freezing point? When saturation pressure increases, then the saturation temperature is increasing and the freezing point decreasing.

**15 Explain the process of steam generation and show the various stages on T-S diagram.**

In the T-S diagram, the region left of the water line, the water exists as liquid. In the right of the dry steam line, the water exists as a superheated steam. In between water and dry steam line, the water exists as a wet steam. Therefore, the dryness fraction lines are represented in these regions. The value of various quantities can be read from the diagram .It can be noted from the figure that thewater line and steam line are converging with the increase in temperature. At a particular point , the water directly converted into dry steam without formation of wet steam. The point is called 'Critical Point'

**16. Write the formula for calculating entropy change from saturated water to super heated steam conditions.**

Entropy of super heated steam S sup = Sg + Cps log{Tsup / Ts}

**PART –B**

1. Find the specific volume and enthalpy of steam at 9 bar when the condition of steam is
a) Wet with dryness fraction 0.95 b) dry saturated c) superheated temperature of 240° (16)
2. Steam initially at 400 Kpa and 0.6 dry is heated in a rigid vessel of 0.1m3 volume. The final condition is 600 Kpa. Find the amount of heat added and mass of steam. (16)
3. Explain P-V diagram and P-V-T surface. (16)
4. 2 kg of steam initially at 5 bar and 0.6 dry is heated at constant pressure until the temperature becomes 350 c.find the change in entropy and internal energy. (16)

5.A steam plant working on a simple rankine cycle operated between the temperature of 260°c and 95°c .the steam is dry and saturated when it enters the turbine and expanded isentropic ally. Find rankine efficiency. (16)

6) 2.5 kg of steam is heated at constant pressure of 250 kpa and 100°c, until temperature is 250°c. Find the amount of heat added and change in entropy. (16)

(Use mollier chart)

## UNIT – 4
## IDEAL AND REAL GASES AND THERMODYNAMIC RELATION

**PART –A (2 marks)**

**1. State Charle's law.**

Charle's law states "The volume of a given mass of a gas varies directly as its absolute temperature, when the pressure remains constant.

$$V \alpha T$$

**2. State Joules's law.**

Joules's law states "The internal energy of a given quantity of a gas depends only on the temperature".

**3. State Regnault's law.**

Regnault's law states that Cp and Cv of a gas always remains constant.

**4. State Avogadro's law.**

Avogadro's law states."Equal volumes of different perfect gases at the same temperature and pressure, contain equal number of molecules".

**5. State Dolton's law of partial pressure.**

Dolton's law of partial pressure states "The total pressure of a mixture of gases is equal to the sum of the partial pressure exerted by individual gases if each one of them occupied separately in the total volume of the mixture at mixture temperature ".

$$P = p1 + p2 + p3 + ... Pk$$

**6. How does the Vander waals equation differ from the ideal gas equation of states?**

1. Intermolecular attractive study is made.

2. Shape factor is considered.

These assumptions are not made in ideal gas equation of state.

**8. Distinguish between ideal and real gas.**

An ideal gas is one which strictly follows the gas laws under air conditions of temperature and pressure.
In actual practice, there is no real gas which strictly follows the gas laws over the entire range of temperature and pressure .However hydrogen, oxygen, nitrogen and air

Behave as a gas under certain temperature and pressure limits.

**9. What are Maxwell relations?**

$(\delta T/\delta v)s = - (\delta p/\delta s)v$
$(\delta T/\delta p)s = (\delta v/\delta s)p$
$(\delta p/\delta T)v = (\delta s/\delta v)t$
$(\delta v/\delta T)p = - (\delta s/\delta p)t$

**10 .Define Joule – Thomson Co-efficient.**

Joule – Thomson Co-efficient is defined as the change in temperature with change in Pressure, keeping the enthalpy remains constant .It is denoted by the

$$\mu = (\delta T/\delta p)\ n$$

**11. Define Co – efficiency of volume expansion and isothermal compressibility. Co – efficiency of volume expansion:**

Co – efficiency of volume expansion is defined as the change in volume with change i n temperature per unit volume keeping the pressure constant It is denoted by ß

$$ß = 1/v\ (\delta v/\delta T)p$$

Isothermal compressibility:

It is defined as the change in volume with change in pressure per unit volume by keeping the

temperature constant .It is denoted by K

$$K = 1/v\ (\delta v/\delta p)T.$$

**12. What is compressibility factor?**

We know that , the perfect gas equation is pv = RT .But for real gas , a correction factor has to be introduced in the perfect gas equation to take into account the deviation of real gas from the perfect gas equation .This factor is known as compressibility factor (Z) and is denoted by

**13. Z = pv/RT What is compressibility factor value for an ideal gas at critical point?**

1. Intermolecular attractive study is made.

2. Shape factor is considered.

**14. What is Joule's Thomson coefficient? Why is it zero for an ideal gas?**

Joule's Thomson coefficient is defined as the change in temperature with change in pressure, keeping the enthalpy remains constant. It is denoted by

$$\mu = (\delta T/\delta p)h = 1/Cp[\ T(\delta v/\delta T)p - v]$$

We know that the equation of state as

Differentiate the above equation of state with respect to T by keeping pressure, p constant

**15. What is ClasiusClapeyron Equation?**

ClasiusClapeyron Equation which involves relationship between the saturation pressure, saturation temperature, the enthalpy of evaporation and the specific volume of the two phases involved

$dp/dT = hfg/Tvfg$

**17. State the assumption made in kinetic theory of gases?**

1. There is no intermolecular force between particles.

2. The volume of the molecules is negligible in comparison with the gases.

**18. State Helmholtz function**

Helmholtz function is property of a system and is given by subtracting the product of absolute temperature (T) and entropy (s) from the internal energy u.

ie Helmholtz function = u-Ts

**.19. State Gibbs function.**

Gibbs function is property of a system and is given by
$G = u – Ts + Pv = h – Ts$

Where

h – Enthalpy

T – Temperature

s - Entropy

**PART –B**

.1. Derive Dalton's law of partial pressure. Define amagats law of partial volume. (16)
2. Derive vandar Waals equation. (16)
3. Derive Maxwell's equation (16)
4. Derive clausius-clapeyron equation. (16)
5. Derive Joule-Thomson coefficient equation. (16)
6. A mixture of gases contains 50%nitrogen,40% oxygen and 10% carbon di oxide by mass. 2kg of mixture is compressed from 200 kpa and 293k to 400 kpapolytropically which follows the PV(I.25)=C. Determine the work done, heat transferred and change in entropy.
(Take (cp)n2=1.04 (cp)o2= 0.918 kj / kg k, (cp)co2=O.846 k/k (16)

**UNIT – 5**
**PSYCHROMETRY**

**PART –A (2 marks)**

**1. What is the difference between air conditioning and refrigeration?**

Refrigeration is the process of providing and maintaining the temperature in space below atmospheric temperature.

Air conditioning is the process of supplying sufficient volume of clean air containing a specific amount of water vapour and maintaining the predetermined atmosphere condition with in a selected enclosure.

**2. Define psychrometry.**

The science which deals with the study of behaviour of moist air (mixture of dry air and water vapour is known as phychrometry.

**3. Name some psychrometry.**

1. Sensible heating.

2. Sensible cooling.

3. Humidifying

4. Dehumidifying.

5. Heating and humidifying

6. Heating and dehumidifying.

7. Cooling humidifying

8. Cooling dehumidifying.

**4. Define dry bulb temperature.**

The temperature which is measured by an ordinary thermometer is known as dry bulb temperature .It is generally denoted by td

5. **Define wet bulb temperature.**

It is the temperature of air measured by a thermometer When its bulb is covered with wet cloth and exposed to a current rapidly moving air.It is denoted by tw.

6. **Define dew point temperature**.

The temperature at which the water vapour presents in air begins to condense when
The air is cooled is known as dew point temperature .It is denoted by tdp.

7. **Define relative Humidity (RH) and specific humidity.**

RH is the ratio of the mass of water vapour (mv) in a certain volume of moist air at Given temperature to the mass of water vapour in the same volume of saturated air at the Same temperature.

RH = mv /mvs

Specific humidity (ω) is the ratio of mass of water vapour (mv) to the mass of dry air in the given volume of mixture.

ω = mv / ma.

**8. Differentiate between absolute and relative humidity.**

Absolute humidity is defined as the ratio of the mass of water vapour (mv) in Certain volume of moist at given temperature to the mass of water vapours at Atmospheric conditions

RH is the ratio of the mass of water vapour in a certain volume of moist air at a given Temperature to the mass of water vapour in tha same volume of saturated air at the same Temperature.

RH = mv /mvs



9. **Define DTP and degree of saturation.**

DTP is the temperature to which moist air to be cooled before it starts condensing.
Degree of saturation is the ratio of specific humidity of moist air to the specific

Humidity of saturated air at temperature.

Specific humidity of moist air

$\mu$ = ----------

Specific humidity of saturated air

**10. What is dew point temperature? How is it related to dry bulb and wet bulb? Temperature at the saturation condition?**

It is the temperature at which the water vapour present in air begins to condense The air is cooled.For saturated air, the dry bulb, wet bulb and dew point temperature are All same.

**11. State Dalton's law of partial pressure.**

The total pressure exerted by air and water mixture is equal to the barometric Pressure. $P_b = p_a + p_v$

Where

Pb = barometric pressure.

pa = Partial pressure of dry air.

pv = Partial pressure of water vapour.

**12. Define Apparatus Dew point of cooling coil.**

For dehumidification, the cooling coil is to be kept at a mean temperature which is below the dew point temperature of the entering .This temperature of the coil is called ADP temperature.

**13. List down psychometric process.**

1. Sensible heating process

2. Sensible cooling process.

3 .Humidification process.

4. Dehumidification process.

5. Heating and humidification process.

6. Cooling and Dehumidification process.

7. Adiabatic mixing airstreams process.

8. Evaporative cooling process.

**14. Define bypass factor of coil.**

The ratio of the amount of air which does not contact the cooling coil to the Amount of supply air is called BPF

$$BPF = \frac{\text{Amount of air bypassing the coil}}{\text{Total amount of air passed.}}$$

**15.Define the humidification process.**

Humidification is defined as the process of adding moisture at constant dry bulb Temperature.

**16. State the effects of very high and a very low bypass factor. Very high by pass factor:**

1. It requires lower ADP .Refrigeration plant should be of larger capacity.

2. It requires more air .Larger fan and motor required.

3. It requires less heat transfer area.

4. It requires more chilling water Larger piping required

**Very low by pass factor.**

1. Higher ADP is to be employed.

2. It requires less air. Fan and motor size reduced.

**17. What factors affect by pass factor?**

1. Pitch of fins.

2. Number of coil tubes.

3. Air velocity over the coil.

4. Direction of air flow.

**18 .What are the assumption made while mixing two air streams?**

1. Surrounding is small.

2. Process is fully adiabatic.

3. There is no work interaction

4. Change in kinetic and potential energies are negligible.

**PART –B**

**I**. Dry bulb and wet temperatures of 1 atmospheric air stream are 40°0 and 30°c respectively. Determine (a)Humidity (b) Relative humidity (c) Specific humidity. (16)

**2**. Atmospheric air with barometric pressure of 1.013 bar has 38°c dry bulb temperature and 28°c wet bulb temperature. Determine (a) Humidity ratio (b) Relative humidity (c) dew point temperature. (16)

**3.** Atmospheric air at 760 mm of Hg has 45°c DBT and 30°c WBT, using psychometric chart calculate R.H, Humidity ratio, DPT, enthalpy, specific volume of air. (16)

**4**.Atmospheric air at 1 bar pressure has 2.5°0 DBT and 75% RH using psychometric chart, calculate DBT, enthalpy, vapour pressure. (16)

**5**. Explain sensible heating process, sensible cooling, and humidification process. (16)

**6**. An air water vapour mixture at 0.1 Mpa, 30°0, 80% RH. Has a volume of 50 m3

Calculate the specific humidity, dew point, wet bulb temperature, mass of dry air and mass of water vapour. (16)

**7**.Calculate the specific humidity, dew point, wet bulb temperature, mass of dry air and mass of water vapour. (16)

**8**. Give short notes on following (a) Specific humidity (b) Relative humidity (c) Dew point temperature (d) Wet bulb depression

**9.** Air has a dry bulb temperature of 250C and wet bulb temperature of 150C. If the barometer reads 1bar, Calculate

(a) Vapour pressure

(b) Specific humidity

(c) Saturation ratio

(d) Relative humidity

(e) Dew point temperature

(f) Vapour density

(g) Enthalpy of mixture