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Department of Mechanical Engineering,

Engineering Thermodynamics

2 Marks Question and Answers

Unit I - Basic Concept and First Law.

1. What is meant by thermodynamics system? How do you classify it?

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

2. What is meant by closed system? Give an example.

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.

3. Define open system. Give an example

When a system has heat, work and mass transfer, it is called as open system

Example: Air compressor

4. Distinguish between open and closed system

s.no	Open system	Closed system
1	Only heat and work will transfer	In addition to heat and work tranfer
2	System boundry is fixed ond	System boundry mayor may not change
3	Ex :piston and cylinder arrangement, Thermal power plant	Air compressor,boiler

5. Define isolated system

Isolated system not affected by the system by surrounding .There is no heat and work and mass transfer takes place .In this system total energy remains constant.

Example: Entire Universe.

6. Define specific heat capacity at constant pressure.

It is defined as the amount of heat transfer required raising or lowering the temperature of the unit mass of the substance through one degree when the pressure kept constant. It is denoted by Cp.

7. Define specific heat capacity at constant volume.

It is defined as the amount of heat transfer required raising or lowering the temperature of the unit mass of the substance through one degree when the volume kept constant. It is denoted by Cv.

8. What is meant by surrounding?

Any other matter out side of the system boundary is called as surrounding.

9. What is boundary?

System and surrounding are separated by an imaginary line is called boundary.

10. What is meant by thermodynamic property?

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.

11. How do you classify the property?

Thermodynamic property can be classified into types

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

12. Define intensive and extensive properties. **(Nov/Dec 2016)**

Intensive properties:

The properties which are independent on the mass of the system is called intensive properties

Eg: Pressure, Temperature, specific Volume.

Extensive properties:

Eg: Total energy, Total volume, weight.

13. When a system is said to be in" Thermodynamic equilibrium ?

When a system is in Thermodynamic equilibrium, it should be 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.

14. Define Zeroth law and first law of thermodynamics. **(Nov/Dec 2017) (April/May 2017)**

Zeroth law of thermodynamics states that when two system are separately in thermal equilibrium with a third system, then they themselves are in thermal equilibrium with each other.First law of thermodynamics states that when system undergoes a cyclic process, net heat transfer is equal to work transfer. dQ = dW

15. State corollaries first law of thermodynamics.

Corollaries I

There exists a property of a closed system such that a change in its value is equal to the difference between the heat supplied and the work done during any change of state.

Corollaries II

The internal energy of a closed system remains unchanged system is isolated from its surrounding.

Corollaries III

A perpetual motion machine of first kind is impossible.

16. What is meant by "perpetual Motion machine of First kind?

PMM of the 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.

17. What is mean by control volume and control surface? **(Nov/Dec 2018)**

Control Volume:

In continuum mechanics and thermodynamics, a control volume is a mathematical abstraction employed in the process of creating mathematical models of physical processes. ... At steady state, a control volume can be thought of as an arbitrary volume in which the mass of the continuum remains constant.

Control Surface:

A control volume is a fixed region in space chosen for the thermodynamic study of mass balances for flowing systems. The control surface is the boundary of the control volume.

18. Using Knudsen number define continuum. **(Nov/Dec 2018)**

The Knudsen number (Kn) is a dimensionless number defined as the ratio of the molecular mean free path length to a representative physical length scale.

19. Prove that for an isolated system, there is no change in internal energy.

For any isolated system, there is no heat, work and mass transfer.

$$Q = W = 0$$

According to the firstlaw of thermodynamics,

$$Q = W + \Delta U$$

$$\Delta U = 0$$

20. What is meant by reversible and irreversible process? **(May/June 2016)**

A process is said to the reversible, it should trace the same path in the reverse direction when the process is reversed, and 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 system is

said to be irreversible.

22. What is meant by point and path function? **(Nov/Dec 2018)**

Point function:

The quantity which is independent on the process or path followed by the system is known as point function.

Ex: Pressure, volume, temperature etc

Path function:

The quantity which is dependent on the process or path followed by the system is known as path function. Ex: Heat transfer, Work transfer.

23. What is quasi - static process?

The process is said to be quasi-static, it should proceed infinite slow and follow continuous serious of equilibrium ststes. Therefore, the quasi - static process may be a reversible process.

24. Define the term internal energy?

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.

25. What is meant by thermodynamic work?

It is the work done by the system when the energy transferred across the boundary of the system. It is mainly due to intensive properly difference between the system and surrounding.

28. Prove that the difference in specific heat capacities equal to Cp - Cv = R.

Consider a gas heated at constant pressure heat supplied, $Q = mC_p (T_2-T_1)$

Work done, $W = p (V_2-V_1) = mR (T_2-T_1)$

Change in internal energy, $\Delta U = mC_v (T_2-T_1)$

According to the first law of thermodynamics, $Q = W+\Delta U$

$$mC_p (T_2-T_1) = mR (T_2-T_1)+ mC_v (T_2-T_1)$$

$$C_p = R+C_v$$

$$C_p - C_v = R$$

29. What is the work transfer in free expansion process? And why? **(Nov/Dec 2018)**

The Joule expansion (also called free expansion) is an irreversible process in thermodynamics in which a volume of gas is kept in one side of a thermally isolated container (via a small partition), with the other side of the container being evacuated.

work is the transfer of energy between the system and surroundings when there are imbalanced forces between them. In the case of free expansion the gas expands against no force at all hence no work is done.

30. Define the terms equilibrium, path and process. **(April/May 2018)**

A thermodynamic process path is the path or series of states through which a system passes from an initial equilibrium state to a final equilibrium state and can be viewed graphically on a pressure-volume (P-V), pressure-temperature (P-T), and temperature-entropy (T-s) diagrams.

31. Write the steady flow energy equation for turbine. **(April/May 2018)**

Steady state steady flow process. For negligible change in kinetic and potential energies through the control volume, If the control volume is well insulated (i.e. adiabatic), then, q = 0. For steady flow devices, such as turbines, compressors and pumps, is power transmitted through a shaft.

32. What is a steady flow process? **(Nov/Dec 2017)**

Steady flow process is a process where: the fluid properties can change from point to point in the control volume but remains the same at any fixed point during the whole process. A steady-flow process is characterized by the following: No properties within the control volume change with time.

33. Should the automobile radiator be analyzed as a closed system or as an open system? Explain.**(Nov/Dec 2016)**

Radiator. The radiator allows the mass flow through it (hot coolant goes in and cold coolant comes out) as well as the heat transfer (hot coolant passes heat to the air). Hence a radiator will be considered as an open system. In other hand the whole cooling system allows heat transfer only, so called closed system.

Unit II Second Law

1. State the Kelvin –Planck statement of second law of Thermodynamics.

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

2. State the Clausius statement of second law of Thermodynamics

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

3. Write the two statement of second law of Thermodynamics

Kelvin –Planck statement:

It is impossible to construct an engine working on a cyclic process which converts all the heat energy supplied to it into equivalent amount of useful work.

Clausius statement:

Heat cannot floe from cold reservoir to hot reservoir without any external aid.

But heat can flow from hot reservoir to cold reservoir with out any external aid.

4. State Cornot's Theorem. **(April/May 2018)**

No heat engine operating in a cycle process between two fixed temperatures can be more efficient that a reversible engine operating between the same temperature limits.

5. What are the corollaries of cornot theorem?

i. All the reversible engines operating between the two given thermal reservoir

With fixed temperature have the same efficient.

ii.The efficient of any reversible heat engine operating between two reservoir

is independent of the nature of the working fluid and depends only on the temperature of the reservoirs.

6. What is pmm2 and why is it impossible? **(April/May 2017)**

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.

PMM2 is a fictitious machine that violates second law of thermodynamics. To produce net work in a thermodynamic cycle, heat engine has to exchange heat with two reservoir maintained at two different temperature i.e source and sink. ... Such a heat engine is called PMM2 which is impossible

7. What is different between heat pump and refrigeration?

Heat pump is a device which operating in a cycle process maintains the temperature of a hot body at a temperature of a hot body at a temperature higher that the temperature of surrounding.

8. What is meant by heat engine?

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

9. Define the term COP?

Coefficient of performance is defined as the ratio of heat of heat extracted of rejected to work input.

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

10. Define the term source, sink and heat reservoir.**(Nov/Dec 2018) (Nov/Dec 2017)**

Source:

The part where the heat to be rejected to work absorbing or work developing device Is called source.

Sink:

The part which receives heat from work absorbing from work absorbing or working developing is called sink.

Reservoir

The part which supplies or receives heat continuously without change in its temperature is called as reservoir.

11. What happens to energy entropy and energy of an isolated system? And why? **(Nov/Dec 2018)**

Entropy is the loss of energy available to do work. Another form of the second law of thermodynamics states that the total entropy of a system either increases or remains constant; it never decreases. Entropy is zero in a reversible process; it increases in an irreversible process.

12. List the causes of entropy increase. **(Nov/Dec 2017)**

If you add energy to a solid, it can become a liquid. Liquids have more energy and entropy than solids. Any chemical reaction that increases the number of gas molecules also increases entropy. A chemical reaction that increases the number of gas molecules would be a reaction that pours energy into a system

13. Define entropy? **(April/May 2018)**

Entropy is an index of unavailability or degradation of energy.

14. Define change of entropy .How is entropy compared with heat transfer and absolute temperature?

The measure of irreversibility when the energy transfer takes place within the system or between system and surrounding is called as change of entropy. It is simply known as unaccounted heat loss.

15. Why the performance of refrigerator and heat pump are given in terms of C.O.P and not in terms of efficiency?

The performance of any device is expressed in terms of efficiency for work developing machines. But heat pump and refrigerator are work absorbing machines. So the performance of those devices based on C.O.P only.

16.Write down the equation for carnot C.O.P of a heat pump which works between two heat reservoirs of temperature T1 and T2 if T1 > T2

.

$$\text{Carnot C.O.P of heat pump} = \frac{T1 - T2}{T1}$$

17.What is meant by principle of increase of entropy?

For any infinitesimal process write down the equation for carnot C.O.P of a heat pump which works between two heat reservoirs of temperature T1 and T2 if T1 > T2.

$$\text{Carnot C.O.P of heat pump} = \frac{T1 - T2}{T1}$$

18. What is meant by principle of increase of entropy?

For any infinitesimal process undergone by a system, change in entropy

$dS \geq dQ/T$

For reversible, $dQ = 0$ hence $dS = 0$

For irreversible, $dS > 0$

So the entropy of an isolated system would never decreases .it will always increase and remains constant if the pressure is reversible is called as principle increases of entropy.

19. What do you mean by “clausius inequality”?

It is impossible for a self acting machine working in a cyclic process unaided by any external to convey heat from a body at a lower temperature to a body at a higher temperature.

20. Explain briefly clausius inequality?

$\int dQ/T \leq 0$ is known as inequality of clausius.

If 1. $\int dQ/T = 0$, the cycle is reversible.

2. $\int dQ/T < 0$, the cycle is irreversible and possible.

3. $\int dQ/T > 0$, the cycle is impossible.

30. Explain the term “reversibility”

If the process traces the same path during the process reversed is called as reversibility.

31. Can entropy of universe ever decreases? Why?

Entropy of universe can not ever decrease. It will be remain constant or will increases due to irreversibility.

32. What is the essence of the second law of thermodynamics?

1. To know the feasibility of process.
2. To know about the quality of energy.

33. Define the term absolute entropy?

The change entropy of the system with respect to ambient conditions or any other standard reference conditions is known as absolute entropy.

Unit III- Properties of pure substance and Steam power cycle.

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.

6. What is meant by super heated steam? And indicate its use.

If the dry steam is further heated, then the process is called superheating and steam obtained is known as heated steam.

Uses:

1. Superheated steam has more heat energy and more work can be obtained using it.
2. Thermal efficiency increases as the temperature of superheated steam is high.
3. Heat losses be to condensation of steam a cylinder wall is reduced.

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 h_f.

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 T_{sup} 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. **(May/June 2016)**

The number of independent variable associated with multi components, 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,

Ψ = the number of phase present in equilibrium.

11. Define dryness fraction of steam OR What is quality of steam and wetness fraction? **(April/May 2018)**

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

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

Wetness fraction: a fraction expressing the ratio of the weight of free water particles to that of the whole in a quantity of wet steam.

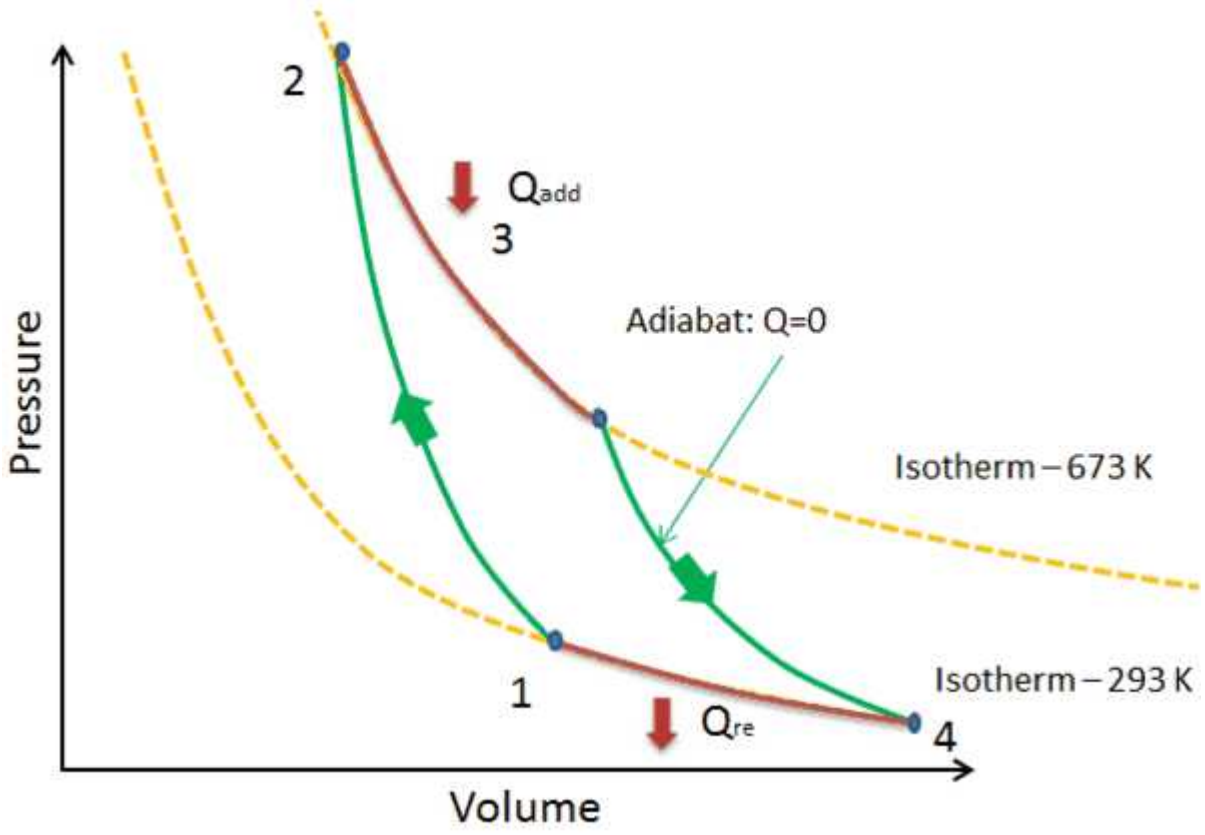
12. Explain the term: Degree of super heat, Degree of sub cooling. **(Nov/Dec 2018)**

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. What is Carnot vapour cycle? Plot the same on T-s diagram. **(Nov/Dec 2018)**



13. Define triple point and critical point for pure substance. **(Nov/Dec 2018)**

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

Entropy of super heated steam $S_{sup} = S_g + C_{ps} \log\{T_{sup} / T_s\}$

S_g - entropy of steam dry

S_{sup} – super heated temperature

S_{sup} – saturated temperature

C_{ps} - specific heat of super heated steam

16. What is meant by steam power cycles?

Thermodynamics cycle which use steam as the working fluid is called steam power cycle.

17. Define the term Efficiency ratio.

The ratio of actual cycle efficiency to that of ideal cycle efficiency is termed efficiency ratio.

$$\text{Efficiency ratio} = \frac{\text{Actual cycle efficiency}}{\text{Ideal rankine efficiency}}$$

18. What is meant by isentropic efficiency?

For an Expansion process:

$$\text{Isentropic efficiency} = \frac{\text{Actual work done}}{\text{Isentropic workdone}}$$

For a compression process:

$$\frac{\text{Isentropic work done}}{}$$

Isentropic efficiency = ----------

Actual work done

19. Define specfic steam consumption of an ideal Rankine cycle

It is defined as the mass flow of steam required per unit power output.

Steam flow in Kg/hr

Specific steam consumption = ----------

Power in kw

20. What is meant by work ratio? What is the importance of work ratio in vapour cycles?

Work ratio is defined as the ratio of network transfer to the positive work transfer.

Work ratio affects the actual cycle efficiency comparing two cycles with the same ideal efficiency, the cycle having smaller work ratio would have smaller actual efficiency.

Higher the work ratio, the SSC is lower, resulting in smaller size plant for the given output.

21. What are the effects of condenser pressure on the rankine cycle?

By lowering the condenser pressure, we can increase the cycle efficiency .the main disadvantage is lowering the back pressure increase the wetness of steam .isentropic comparison of a very wet vapour is very difficult.

22. A vapour cycle inherently has two advantages over gas power cycle .what are they?

(i) Isothermal heat transfer (evaporation and condensation) is possible in practice.

(ii)the work ratio is high is high compared it the gas power cycles

23. What are the effects of condenser pressure on the Rankine cycle?

By lowering the condenser pressure, we can increase the cycle efficiency. The main disadvantages is lowering the backpressure increases the wetness of steam Isentropic comparison of a very wet vapour is very difficult

24. Why carnot cycle cannot be realized in practical for vapour power?

The main difficult to attain the cycle in practice is that isothermal condensation is stopped before it reaches to saturated liquid conditions .There fore the compressors has to deal with a non – homogeneous mixture of water and steam .Because of the large specific volume of liquid vapour mixture before compression ,the compressor size and work input have to be large. The higher power requirement reduces the plant efficiency as well as work ratio.

25. Why reheat cycle is not used for low boiler pressure?

At the low reheat pressure the reheat cycle efficiency may be less than the Rankine Cycle efficiency .since the advantages temperature during heating will then be low.

26. What are the disadvantages of reheating?

The cost of the plant increases due to the reheater and its long connections It also increases the condenser capacity due to increased dryness fraction.

27. List the advantages of reheat cycle.

1. Marginal increase in thermal efficiency.
2. Increses in work done per kg of steam which results in reduced size of boiler and auxiliaries for same output.
3. We can prevent the turbine from erosion.

28. What is the function of feed water heaters in the regenerative cycle with bleeding?

The main function of feed water heater is to increase the temperature of feed water to the saturation temperature corresponding to the boiler pressure before it enters into the boiler.

29. When will be the efficiency of the regenerative cycle attained maximum?

The temperature of the bled steam is approximately halfway between the extreme temperatures of the primary flow cycle.

30. What are the advantages of bleeding?

It increases the thermodynamic efficiency as the heat of the bled steam is not lost in the condenser but is utilized in feed heating.

By bleeding, the volume flow at the low pressure end is considering reduced, this reduces the design difficulties of blades, and also condenser size is reduced.

31. What do you understand heat rate? **(Nov/Dec 2018)**

Heat rate is one measure of the efficiency of a generator or power plant that converts a fuel into heat and into electricity. The heat rate is the amount of energy used by an electrical generator or power plant to generate one kilo watt hour (kWh) of electricity.

32. Differentiate between saturated liquid and compressed liquid. **(Nov/Dec 2017) (April/May 2017)**

Saturated liquid:

A Liquid whose temperature and pressure are such that any decrease in pressure without change in temperature causes it to boil In other words If a substance exists as liquid at the saturation temperature and pressure it is called saturated liquid

Compressed liquid.

A compressed fluid (also called a compressed or unsaturated liquid, sub cooled fluid or liquid) is a fluid under mechanical or thermodynamic conditions that force it to be a liquid.

Compressed solid:

Solid object does not flow to take on the shape of its container, nor does it expand to fill the entire volume available to it like a gas does. ... Solids cannot be compressed with little pressure whereas gases can be compressed with little pressure because in gases molecules are loosely packed.

33. What is binary vapour cycle? **(Nov/Dec 2017)**

The vapor exiting the turbine is then condensed by cold air radiators or cold water and cycled back through the heat exchanger. A binary vapor cycle is defined in thermodynamics as a power cycle that is a combination of two cycles, one in a high temperature region and the other in a lower temperature region.

34. What are the methods for improving the performance of the ranking cycle? **(April/May 2017)**

Methods To Increase The Efficiency Of The Ranking Cycle Colored Area on TS-diagram¬ Av.Temp at which heat is transferred to steam can be increased without increasing the boiler pressure by superheating the steam to high temperatures like reheat ranking cycle and regenerative ranking cycle.

35. Is ice water a pure substance? Why? **(Nov/Dec 2016)**

When you add ice, or frozen water, to pure water, you have created a heterogeneous mixture of a pure substance. The atoms in the ice are locked in a crystalline matrix whose atoms are less densely packed than those in the liquid water, a unique property of water.

Unit IV- Ideal and real Gases Thermodynamic Relations

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 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 ".

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

5. 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.

6. What is meant by virtual expansion?

Virtual expansions are only applicable to gases of low and medium densities.

The equation state of a substance is given by

$$p = \frac{RT}{\text{-----}} + \frac{a(T)}{\text{------}} + \frac{b(T)}{\text{-------}} + \frac{c(T)}{\text{-------}} + \frac{d(T)}{\text{--------}} + \cdot\cdot\cdot\cdot$$

The coefficient of a(T) ,b(T), c(T), d(T) ….. are virial coefficients. The virial coefficient will vanish when the pressure becomes zero .Finally the equation of state reduces to the ideal – gas equation.

7. 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.

8. What are Maxwell relations equation?

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

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

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

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

9 .Define Joule – Thomson Co-efficient. **(May/June 2016)**

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

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

Importance: These coefficients are important from two standpoints; (i) intermolecular interaction, and (ii) liquefaction of gases. A given closed system contains one mole of gaseous chemical substance at temperature T and pressure p.

10. 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 in 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

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

11. What is compressibility factor? **(Nov/Dec 2018) (Nov/Dec 2017)**

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

$Z = pv/RT.$

12. What is compressibility factor value for an ideal gas at critical point?

1. Intermolecular attractive study is made.

2. Shape factor is considered.

At critical point, the Vander waal's equation.

$$\frac{P_c V_c}{RT_c} = 1 \text{ for ideal gases.}$$

13. What is Joule's Thomson coefficient? Why is it zero for an ideal gas? **(April/May 2017)**

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

$(\mu = 0)$

14. What is significance of Clasius Clapeyron Equation? **(Nov/Dec 2018) (Nov/Dec 2017)**

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

$dp/dT = h_{fg}/Tv_{fg}$

15.Write down the two Tds Equations. **(April/May 2018) (Nov/Dec 2016)**

Tds Equation are

$$Tds = Cp\, dT - T((\delta v/\delta T)p\, dp$$

$$Tds = Cv\, dT + T((\delta p/\delta T)t\, dv$$

16. 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.

17. State Helmholtz function. **(Nov/Dec 2018)**

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

.18. 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

19. State the principle of corresponding states. **(Nov/Dec 2018)**

According to van der Waals, the theorem of corresponding states (or principle/law of corresponding states) indicates that all fluids, when compared at the same reduced temperature and reduced pressure, have approximately the same compressibility factor and all deviate from ideal gas behavior to about the same degree.

20. Identify the application of clausius chaperon equation. **(Nov/Dec 2018)**

The increase in vapor pressure is not a linear process. We can use the Clausius-Clapeyron equation to construct the entire vaporization curve. .TheClausius-Clapeyron equation can be also applied to sublimation; the following example shows its application in estimating the heat of sublimation.

21. What are reduced properties? **(Nov/Dec 2016)**

1. Reduced pressure
2. Reduced temperature
3. Reduced specific volume.

Unit V- Gas Mixtures and Psychometric

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. **(Nov/Dec 2017)**

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. **(Nov/Dec 2017)**

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 $t_{w.}$

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 $t_{dp.}$

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

RH is the ratio of the mass of water vapour (m_v) 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.

$$RH = m_v / m_{vs}$$

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

$$\omega = m_v / ma.$$

8. Differentiate between absolute and relative humidity.

Absolute humidity is defined as the ratio of the mass of water vapour (m_v) 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.

$$RH = m_v / m_{vs}$$

9. Define DTP and degree of saturation. **(Nov/Dec 2018)**

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.

$$\mu = \frac{\text{Specific humidity of moist air}}{\text{Specific humidity of saturated air}} = \frac{\omega}{\omega_s}$$

10. What is dew point temperature? How is it related to dry bulb and wet bulb? Temperature at the saturation condition? **(Nov/Dec 2016)**

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. **(Nov/Dec 2018) (Nov/Dec 2016)**

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

Where

P_b = barometric pressure.

p_a = Partial pressure of dry air.

p_v = 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 the humidification process.

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

15. 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.

16. 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.

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

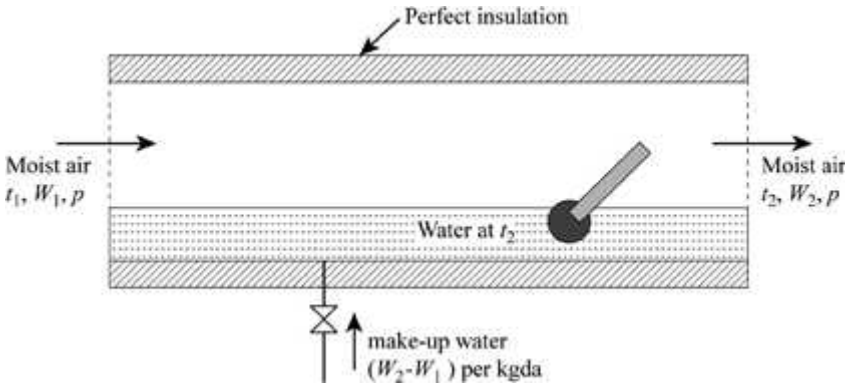
1. Surrounding is small.
2. Process is fully adiabatic.
3. There is no work interaction
4. Change in kinetic and potential energies are negligible.

18. What is meant by partial volume? **(Nov/Dec 2018)**

The partial volume effect can be defined as the loss of apparent activity in small objects or regions because of the limited resolution of the imaging system. The method to correct for the partial volume effect is referred to as partial volume correction.

19. Define adiabatic saturation temperature. **(Nov/Dec 2018)**

Adiabatic saturation temperature refers to a temperature at which water converts into air by the process of evaporation adiabatically. The device used for this type of process is known as adiabatic saturator. The adiabatic saturator device is shown below in Figure.



20. Show sensible heating and cooling process in a psychometric chart. **(April/May2018)**
(April/May 2017)

The sensible cooling of air is the process in which only the sensible heat of the air is removed so as to reduce its temperature, and there is no change in the moisture content (kg/kg of dry air) of the air. The sensible cooling processes represented by a straight horizontal line on the psychometric chart.

Sensible heating process is opposite to sensible cooling process. In sensible pheating process the temperature of air is increased without changing its moisture content. During this process the sensible heat, DB and WB temperature of the air increases while latent of air, and the DP point temperature of the air remains constant.

21. State amagats law of partial volume. **(April/May2018) (April/May 2017)**

According to Amagat's law of partial volume, the total volume of a non-reacting mixture of gases at constant temperature and pressure should be equal to the sum of the individual partial volumes of the constituent gases

22. Write the Avogadro’s law. **(Nov/Dec 2017)**

Avogadro's law states that, "equal volumes of all gases, at the same temperature and pressure, have the same number of molecules." For a given mass of an ideal gas, the volume and amount (moles) of the gas are directly proportional if the temperature and pressure are constant.

23. What is adiabatic mixing and write the equation for that? **(April/May 2016)**

The mixing of several streams of fluid is quite common in engineering practice. The process can usually be assumed to occur adiabatically. Mixing process is highly irreversible because of fluid streams.

Unit1 -Basic Concept and First Law

1 A piston and cylinder machine contains a fluid system which passes through a complete cycle of four processes. During a cycle, the sum of all heat transfers is -170 kJ. The system completes 100 cycles per minute. Complete the following table showing the method for each item, and compute the net rate of work output in kW.

Process	Q(KJ/ MIN)	W(KJ/ MIN)	ΛE(KJ/ MIN)
a-b	0	2170	-
b-c	21000	0	-
c-d	-2100	-	-
d-a	-	-	-

2.Air at a temperature of 15°C passes through a heat exchanger at a velocity of 30 m/s where its temperature is raised to 800°C . It then enters a turbine with the same velocity of 30 m/s and expands until the temperature falls to 650°C. On leaving the turbine, the air is taken at a velocity of 60 m/s to a nozzle where it expands until the temperature has fallen to 500°C. If the air flow rate is 2 kg/s, calculate a) the rate of heat transfer to the air in the heat exchanger b) the power output from the turbine assuming no heat loss and c) the velocity at the nozzle exit, assuming zero heat loss. Take enthalpy of air as h = cp.t where C_p is the specific heat = 1.005 kJ/kg K and t is the temperature.

3. Blower handles 1kg/s of air at 20°c and consumes a power of 1SKW. The inlet and outlet velocities of air are 100m/s and 150m/s respectively. Find the exit air temperature, assuming adiabatic conditions. Take Cp of air as1.005 KJ /kgK.

4. one kg of ice at -5 ºC is exposed to the atmosphere which is at 20 ºC. The ice melts and comes into thermal equilibrium with the atmosphere.(a) Determine the entropy increase of the universe.(b) What is the minimum amount of work necessary to convert the water back into ice at -5ºC? Cp of ice is 2093 J/kg K and the latent heat of fusion of ice is 333.3kJ/kg.

5. Describe in brief the steady flow energy equation with the assumptions made.

6.In an air compressor ,air flows steadily at the rate of 0.5 kg/s through an air compressor. It enters the compressor at 6 m/s with a pressure of 1 bar and a specific volume of 0.85 m^3/kg and leaves at 5 m/s with a pressure of 7 bar and a specific volume of 0.16 m^3 /kg. The internal energy of the air leaving is 90 kJ/kg greater than that of the air entering. Cooling water in a jacket surrounding the cylinder absorbs heat from the air at the rate of 60 kJ/s. Calculate:

(i) The power required to drive the compressor;
(ii) The cross-sectional areas of inlet and output pipes.

7.Derive the general energy equation for a steady flow system and apply the equation to a nozzle and derive an equation for velocity at exit.

8. In an air compressor, air flows steadily at the rate of 0.5 kg/sec. At entry to the compressor, air has a pressure of 105 kPa and specific volume of 0.86 m^3 /kg and at exit of the compressor those corresponding values are 705 kPa and 0.16 m^3 /kg. Neglect Kinetic and Potential energy change.The Internal energy of air leaking the compressor is 95 kJ/kg greater than that of air entering. The cooling water in the compressor absorbs 60 kJ/sec. of heat from the air. Find power required to derive the compressor.

Unit2- Second Law

1.Discuss about the causes of irreversibility with suitable diagrams.

2.A reversible heat engine operates between two reservoirs at temperatures of 600°c and 40°c. The engine drives a reversible refrigerator which operates between reservoirs at temperatures of 40°c and -20°c. The heat transfer to the heat engine is 2000KJ and net work output of the combined engine refrigerator plant is 360KJ.Evaluate the heat transfer to the refrigerant and the net heat transfer to the reservoir at 40°c.

3.A heat engine is used to drive a heat pump. The heat transfers from the heat engine and from the heat pump are used to heat the water circulating through the radiators of a building. The efficiency of the heat engine is 27% and the COP of the heat pump is 4. Evaluate the ratio of the heat transfer to the circulating water to the heat transfer to the heat engine.

4. A fluid undergoes a reversible adiabatic compression from 0.5MPa. $0.2m^3$ to $0.05m^3$ according to the law, $PV^{1.3}$ =constant. Determine the change in enthalpy, internal energy and entropy, and the heat transfer and work transfer during the process

5. A system at 500 K receives 7200 kJ/min from a source at 1000 K. The temperature of atmosphere is 300 K. Assuming that the temperatures of system and source remain constant during heat transfer find out: (i) The entropy produced during heat transfer; (ii) The decrease in available energy after heat transfer

6.In a steam turbine, steam at 20 bar, 360° C is expanded to 0.08 bar. It then enters a condenser, where it is condensed to saturated liquid water. The pump feeds back the water into the boiler. Assuming ideal processes, determine per kg of steam the net work and the cycle efficiency

7. Two kg of air at 500 kPa, 80°C expands adiabatically in a closed system until its volume is doubled and its temperature becomes equal to that of the surroundings which is at 100 kPa, 5°Cfor this process, determine
(i) the maximum work
(ii) the change in availability and
(iii) the irreversibility.
For air taken, C_v = 0.718 kJ/kg K, u = C_v T Where C_v is constant and P_v = mRT where P is pressure in kPa, V volume in m", *'m'* mass in kg, R a constant equal to 0.287 kJ/kg K and Temperature in K.

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

Unit3- Properties of Pure substances and steam Power Cycle

1.Draw p-v, T-s and h-s diagram of Rankine cycle used in power plants and derive a formula for the cycle efficiency

2.A fluid having a temperature of 150°C and a specific volume of 0.96 m^3 /kg at its initial state expands at constant pressure, without friction, until the volume is 1.55 m^3 /kg. Find, for 1 kg of fluid, the work, the heat transferred, and the final temperature if a) the fluid is air b) the fluid is steam.

3. A vessel of volume 0.04m^3 contains a mixture of saturated water and saturated steam at a temperature of 250°C. The mass of the liquid present is 9 kg. Find the pressure, the mass, the specific volume, the enthalpy, the entropy and the internal energy.

4.A piston -cylinder device operates 1 kg of fluid at 20 atm. pressure. The initial volume is 0.04m^3 . The fluid is allowed to expand reversibly following the process $PV^{1.45}$ = constant so that the volume becomes double. The fluid is then cooled at constant pressure until the piston comes back to the original position. Keeping the piston unaltered. Heat is added reversibly to restore it to the initial pressure. Draw the PV diagram and calculate the work done in the cycle.

5.In a steam power plant the condition of steam at inlet to the steam generator is 20 bar and 300°C and the condenser pressure is 0.1 bar. Two feed water heaters operate at optimum temperature Determine: (a) the quality of steam at turbine exhaust, (b) net work per kg of steam, (c) cycle efficiency and (d) the stream rate. Neglect the pump work.

6.A steam turbine is fed with steam having an enthalpy of 3100 kJ/kg. It moves out of the turbine with an enthalpy of 2100 kJ/kg. Feed heating is done at a pressure of 3.2 bar with steam enthalpy of 2500 kJ/kg. The condensate from a condenser with an enthalpy of 125 kJ/kg enters into the feed heater. The quantity of bled steam is 11200 kg/h. Find the power developed by the turbine. Assume that the water leaving the feed heater is saturated liquid at 3.2 bar and the heater is direct mixing type. Neglect pump work.

7. A vessel of 6 m3 capacity contains two gases A and B in proportion of 45 per cent and 55 per cent respectively at 30°C. If the value of R for the gases is 0.288 kJ/kg K and 0.295 kJ/kg K and if the total weight of the mixture is 2 kg, calculate: (i) The partial pressure; (ii) The total pressure, (iii) The mean value of R for the mixture

8. In a single heater regenerative cycle the steam enters the turbine at 30 bar, 400°C and the exhaust pressure is 0.10 bar. The feed water heater is a direct - contact type which operates at 5 bar. Find
(i) the efficiencyand the steam rate of the cycle, and
(ii) the increase in mean temperature of heat addition, efficiency and steam rate as compared to the Rankine cycle (with out regeneration) Neglect pump work.

9. One kg of steam is contained in an elastic balloon of spherical shape which supports an internal pressure proportional to its diameter. The initial condition of steam is saturated vapour at 110°C. Heat is transferred to steam until pressure reaches 200 kPa. Determine:
(i) Final temperature
(ii) Heat transferred. Take Cps = 2.25 kJ/kg K.

Unit4- Ideal and Real gases and Thermodynamic Relations

1.Deduce the 4 Maxwell's Relations.

2.A convergent-divergent nozzle has a throat area of 500mm^2 and an exit area of 1000 mm^2 .Air enters the nozzle with a stagnation temperature of 360K and a stagnation pressure of 1MPa. Determine the maximum flow rate of air that the nozzle can pass, and the static pressure , the static temperature , mach number, and velocity at the exit from the nozzle, if

a)The divergent section acts as a nozzle,

b)The divergent section acts as a diffuser

3. Determine change of Internal Energy and change of entropy when the gas obeys Vander Waal's equation.

4.Derive the Clausius- Clapreyon equation.

5.Explain the significance of Joule-Thomson coefficient

Unit 5- Psychrometry

1.Discuss about various psychometric processes used in engineering applications with schematic diagrams.

2.An air conditioning system is designed under the following conditions:

Outdoor Conditions:	30°C DBT and 75% RH
Required Indoor Conditions:	22°C DBT and 70% RH
Amount of free air circulated:	3.33 m^3 /s
Coil dew point temperature:	14°C

The required condition is achieved first by cooling and dehumidification, and then by heating. Estimate a) the capacity of the cooling coil in tons of refrigeration b) the capacity of heating coil in kW c) the amount of water vapour in kg/s

3.Atmospheric air at 1.0132 bar has a DBT of 32°c and a WBT of 26°c. Compute a)the partial pressure of water vapour, b)the specific humidity, c)the dew point temperature, d)the relative humidity, e)degree of saturation, f)density of air in the mixture , g)density of the vapour in the mixture and h)the enthalpy of the mixture.

4.Air at 20°c, 40% RH is mixed adiabatically with air at 40°c, 40%RH in the ratio of 1kg of the former with 2 kg of the latter (on dry basis). Find the final condition of air.

5.Water at 30°C flows into a cooling tower at the rate of 1.15 kg per kg of air. Air enters the tower at a dbt of 20°C and a relative humidity of 60% and leaves it at a dbt of 28°C and 90% relative humidity. Make - up water is supplied at 20°C. determine

(i) The temperature of water leaving the tower,

(ii) The fraction of water evaporated, and

(iii) Approach and range of the cooling tower.

6.The sling psychrometer in a laboratory test recorded the following readings:

Dry bulb temperature = 35°C

Wet bulb temperature = 25°C.

Calculate the following: (i) Specific humidity (ii) Relative humidity (iii) Vapour density in air (iv) Dew point temperature

Take atmospheric pressure = 1.0132 bar

7. The atmospheric air at 30°C DBT and 75% RH enters a cooling coil at the rate of 200 m^3/min. The coil dew point temperature is 14°C and the by pass factor is 0.1 determine
(i) The temperature of air leaving the coil
(ii) Capacity of the coolingcoil in TR
(iii) The amount of water vapour removed
(iv) Sensible heat factor for the process.

8. The volume flow rate of air is 800 m^3/min of re-circulated at 22°C DBT and l0 ° Cdew point temperature is to be mixed with 300 m^3/min of fresh air at 30°C DBT and 50%RH. Determine the enthalpy, Specific volume, Humidity ratio and dew point temperature of the mixture.