



Subject Code:17612

WINTER – 15 EXAMINATION

Model Answer

Important Instructions to examiners:

- 1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
- 2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
- 3) The language errors such as grammatical, spelling errors should not be given more Importance (Not applicable for subject English and Communication Skills).
- 4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.
- 5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
- 6) In case of some questions credit may be given by judgement on part of examiner of relevant answer based on candidate's understanding.
- 7) For programming language papers, credit may be given to any other program based on equivalent concept.

WINTER – 15 EXAMINATION

Subject Code:17612

Model Answer

Q.No. 1 a) (02 marks each)

i) Refrigeration :- Refrigeration is a science of producing cold or Refrigeration is a science of maintaining temperature of confined space below atmosphere by continuously removing heat.

Unit :- Unit of refrigeration is ton

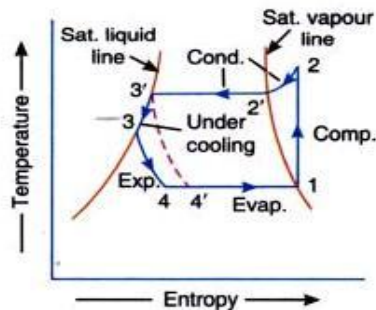
1 Ton of refrigeration = 3.517 KJ/Sec .

ii) EER : Energy efficiency ratio : Energy Efficiency Ratio, or EER, is a way to exhibit how well an air-conditioner is operating based on the power being used.

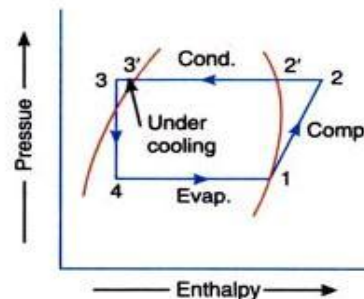
$$\text{EER} = \text{Capacity} / \text{Power}$$

Q. 1 a) (02 marks for each sketch)

ii) Vapor compression Refrigeration cycle :



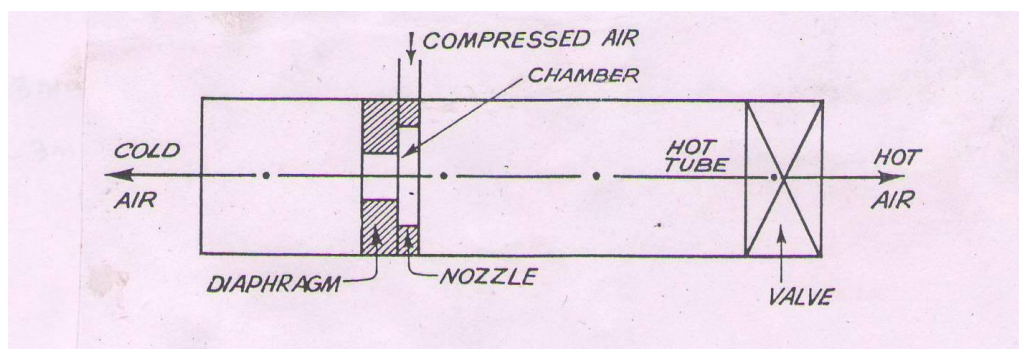
(a) T-s diagram.



(b) p-h diagram.

Q. 1 a) III) Vortex Tube

(Fig. 2 Marks, Explain -2 marks)



Vortex Tube

Principle :- Vortex tube is simple device of producing cold. A compressed air is passed tangentially through nozzle. Here air velocity increases due to expansion and particular shape of nozzle. A vortex flow is created in the chamber and air flows in spiral motion along periphery of hot side. This flow is restricted by valve. If the pressure of air near valve is increased by partly closing of valve, a reversed axial flow through the core of



WINTER – 15 EXAMINATION

Subject Code:17612

Model Answer

hot side starts from high pressure to low pressure region. During this process, energy transfer takes place between reversed stream and forward stream through the core gets cooled below the inlet temperature of the air in the vortex tube while air stream in forward direction gets heated. The cold stream is escaped through the diaphragm hole into the cold side, while hot stream is passed through the opening valve.

Que 1 a (02 marks for explanation and 02 for applications)

iv. Secondary Refrigerent

In many applications it is not desirable to carry the heat from place which is to be cooled directly by refrigerant, then it is carried by using the secondary refrigerant such as Air, Water, or Brine. The heat carried away by secondary refrigerant is given to primary refrigerant in evaporator and secondary refrigerant is circulated again and again. The secondary refrigerant circuit is used in all commercial and industrial refrigeration plants. It has advantages like maintenance of different temperatures in different zones by varying circulation of secondary refrigerant, maintenance of lower temperatures etc. Commonly used types of secondary refrigerants are,

1. **Water:** Used in Air conditioning systems for cooling, Dehumidification etc.
2. **Brine:** Used in Ice plants to maintain temperatures lower than atmospheric temperatures.

Que 1 b) 1) 03marks for classification and 03 for sketches any three)

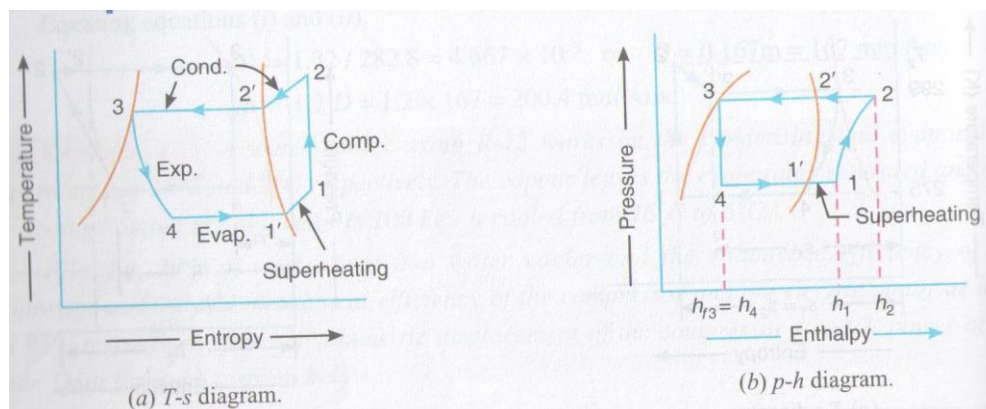
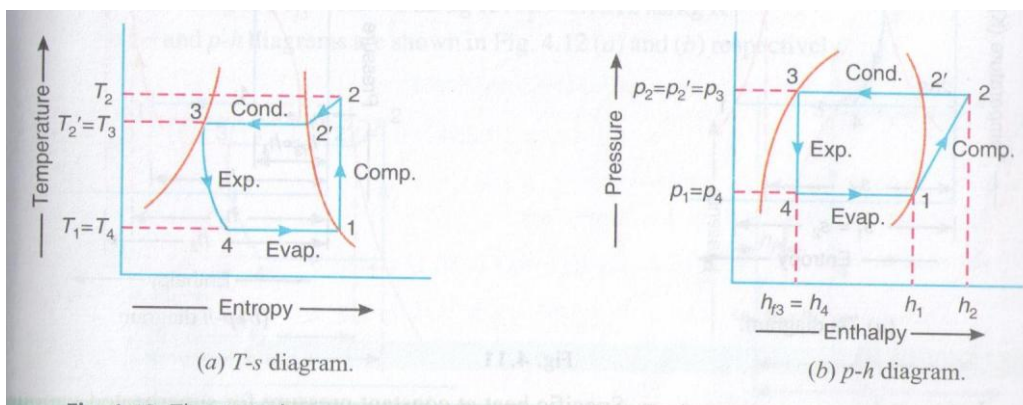
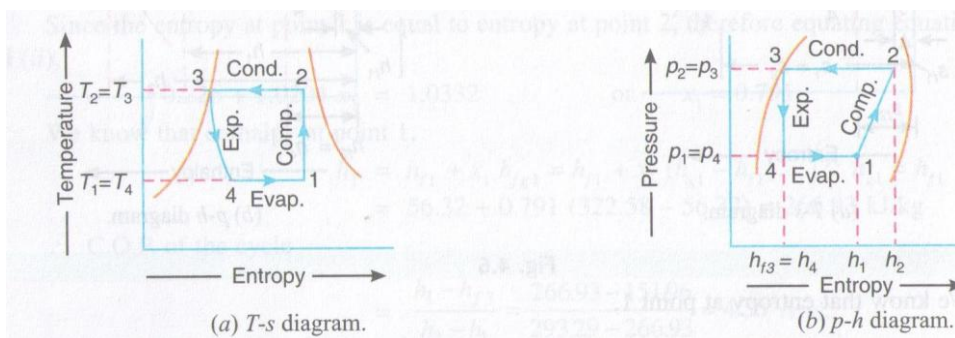
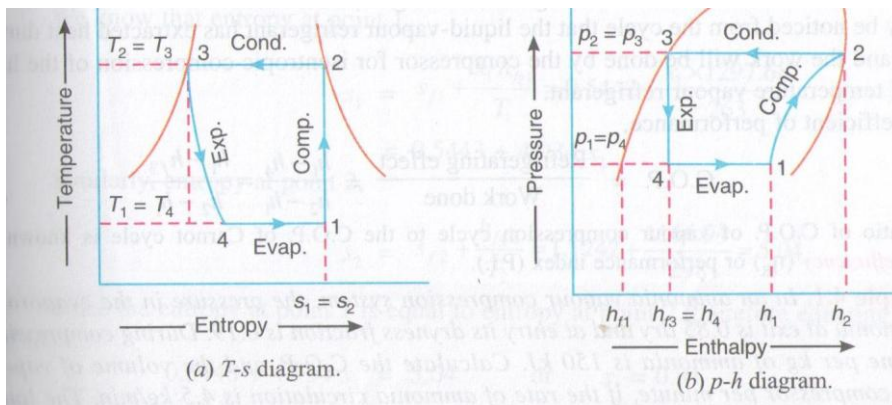
Classification of Vapor compression refrigeration :

- 1) Cycle with dry saturated vapor after compression
- 2) Cycle with wet vapor after compression
- 3) Cycle with superheated vapor after compression
- 4) Cycle with superheated vapor before compression
- 5) Cycle with undercooling or subcooling

WINTER – 15 EXAMINATION

Subject Code:17612

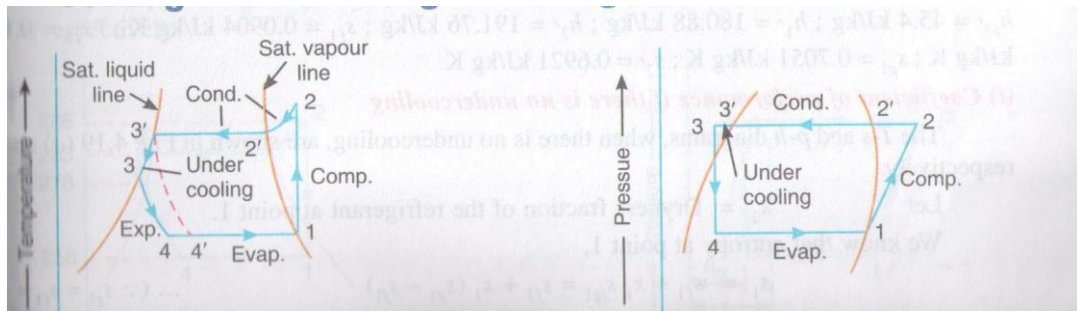
Model Answer



WINTER – 15 EXAMINATION

Subject Code:17612

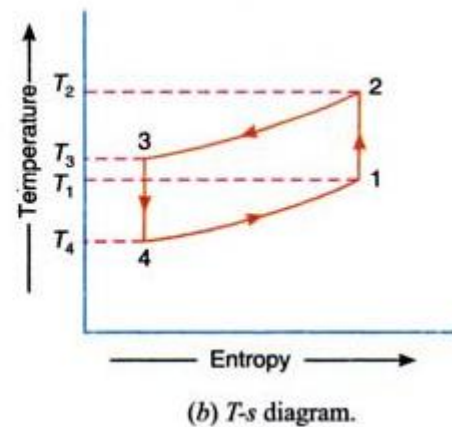
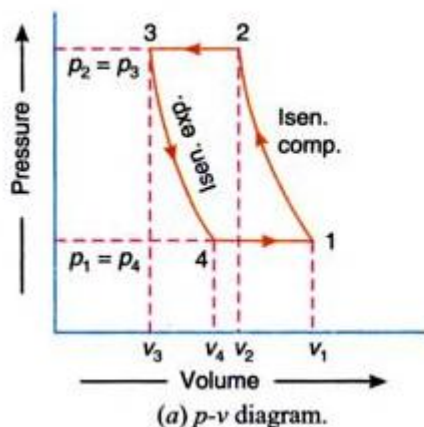
Model Answer



Que 1 b) ii) Differences between air cooled and water cooled condensers (04 marks)

	Air cooled condensers	Water cooled condensers
Power consumption	Higher power consumption per TR capacity	Lower power consumption per TR capacity
COP	Lower	higher
Noise level	Lower	Higher
Day night and seasonal performance consistency	Bad	Good

Que 2 a)



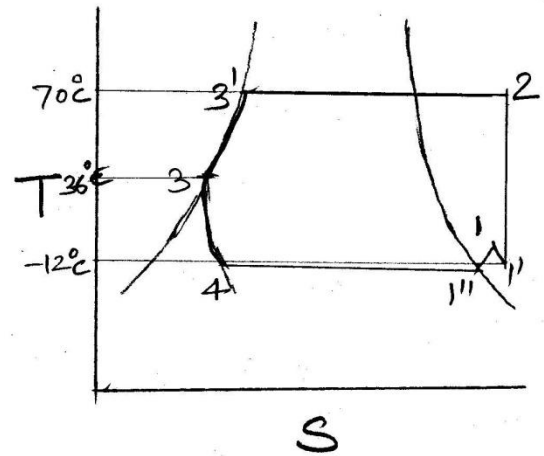
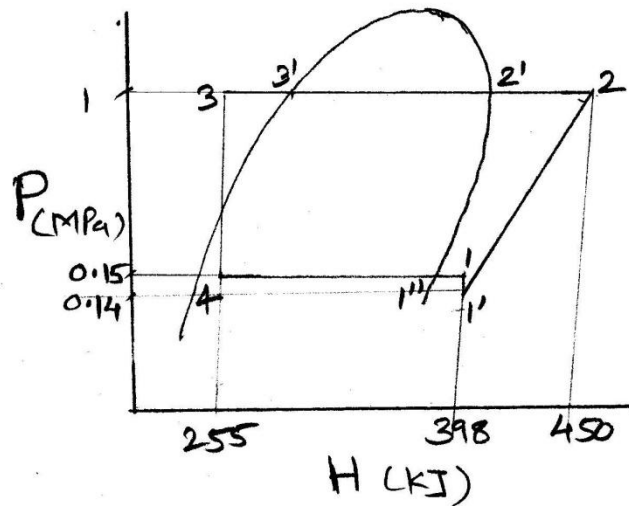
$$\begin{aligned} \text{Coefficient of performance, C.O.P.} &= \frac{\text{Heat absorbed}}{\text{Work done}} \\ &= \frac{(T_1 - T_4)}{(T_2 - T_3) - (T_1 - T_4)} \end{aligned}$$

WINTER – 15 EXAMINATION

Subject Code:17612

Model Answer

Que 2 b) (04 marks for sketch and 04 for calculations)



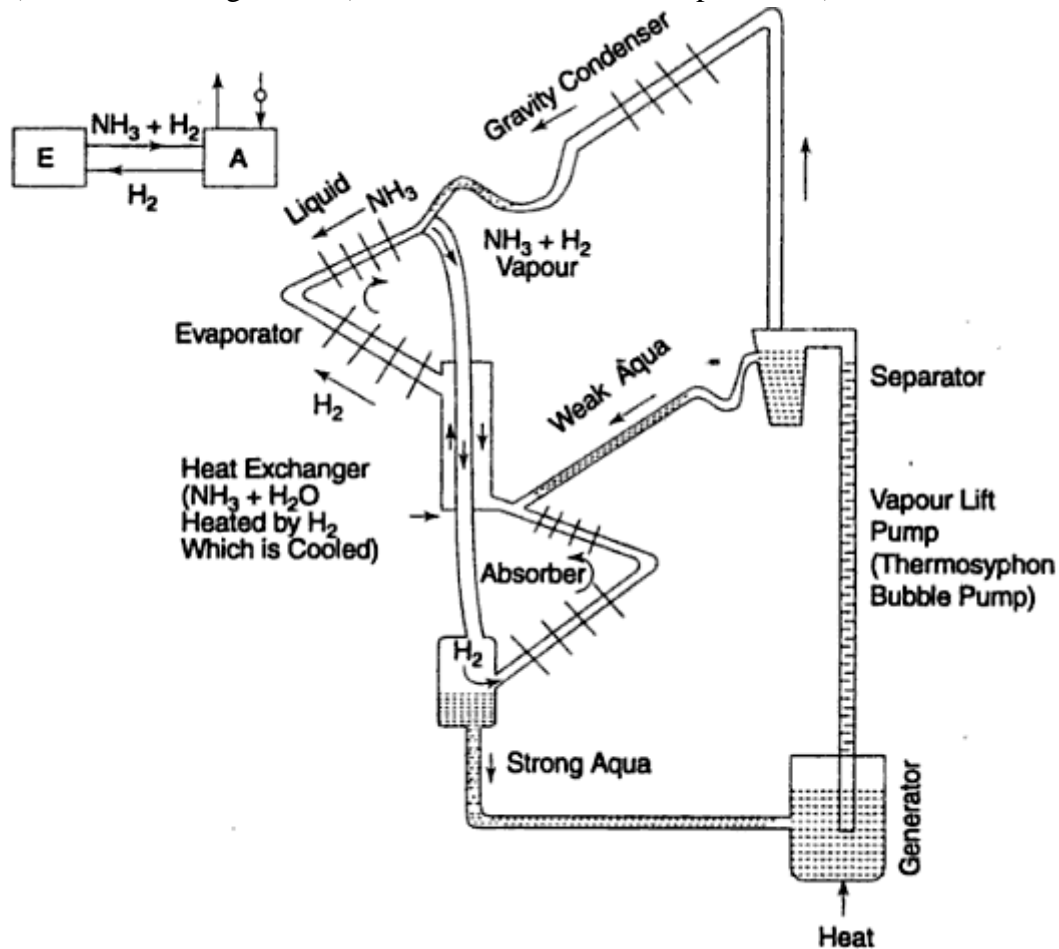
$$\begin{aligned} \text{COP} &= \frac{h_1 - h_4}{h_2 - h_1} \\ &= \frac{398 - 255}{450 - 398} \\ &= 2.75 \end{aligned}$$

WINTER – 15 EXAMINATION

Subject Code:17612

Model Answer

Que 2 c) Electrolux refrigerator (06 for sketch and 02 for explanation)



Expansion Valve is required in the refrigeration systems when high pressure is to be reduced to low pressure. But in the Electrolux refrigeration systems pressure is already low and the system is working on partial pressure of the gases, thus expansion valve is not required in the Electrolux refrigeration systems

Q.No. 3 a) Comments (02 marks each)

1) Critical Temperatures : It should be high as compared to condensing temperature. Power consumption will be reduced if critical temperature is high.

2) Latent heat of vaporization : Latent heat of vaporisation should be high to abstract more amount of heat in the evaporator. This will reduce quantity of refrigerant in the system.

Q.No. 3 b) (01 mark each)

Capillary tube is used in almost all domestic appliances as an expansion device because of the following reasons

1. The cost of Capillary tube is less than all other expansion devices

WINTER – 15 EXAMINATION

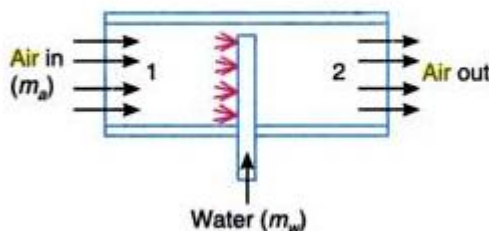
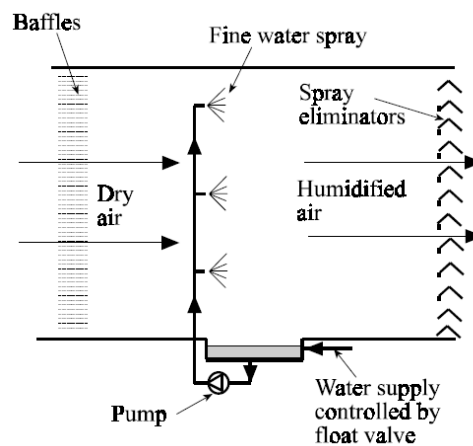
Subject Code:17612

Model Answer

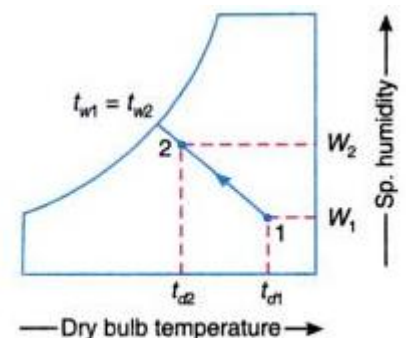
2. When the compressor stops, the refrigerant continues to flow into the evaporator and equalizes the pressure between the high side and low side of the system, this decreases the starting load on the compressor.
3. Since the refrigerant charge in a capillary system is critical, therefore no receiver is necessary.
4. Rough handling of appliances does not affect working of expansion device.

Que 3 c) (02 marks for sketch and 02 for explanation)

Air washer



Psychrometric process.



Psychrometric chart.

Air Washers are used mostly in industrial humidification. As the name implies they provide the dual function of humidifying the airstream and at the same time washing out some dust and odours. The airstream is made to flow smoothly by passing between baffle plates (as shown in figure), it then passes through a fine mist of water droplets created by a spray head. This provides the contact between the liquid water and the air necessary for evaporation to take place. Spray eliminators are placed downstream from the humidifier to prevent the carriage of liquid water further down the ducting. Evaporation of the water cools the airstream and humidifies air.

Q.No. 3. d) sketch 03 marks , location 01 mark

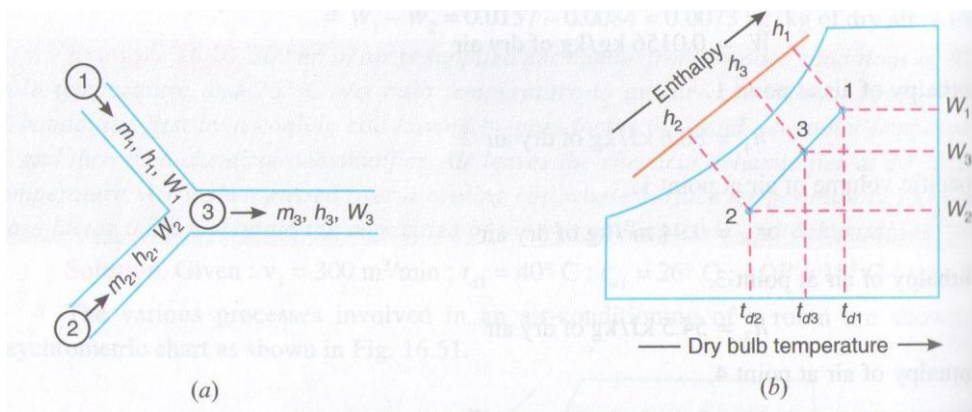
Adiabatic mixing of air streams as shown in figure (b)

Adiabatic mixing of air streams is located after conditioning of fresh air (after evaporator) and before distribution of conditioned air to space.

WINTER – 15 EXAMINATION

Subject Code:17612

Model Answer



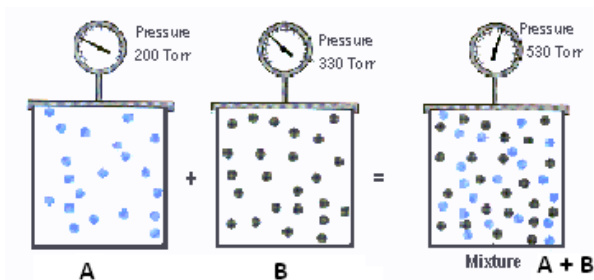
Q.No. 3. e) (02 marks for each)

i) Air conditioning

Air conditioning may be defined as simultaneous control of temperature, humidity, motion and purity of air within an enclosed space. OR It may also be defined as science which deals with supply and maintaining desirable internal atmospheric condition irrespective of external condition

ii)Daltons law of partial pressures: It states that the total pressure exerted by the mixture of gases is equal to the sum of the partial pressures which each constituents would exert if it occupies the same space individually.

$$P_t = P_a + P_b$$



Que 4 a i) (01 mark each any four)

Factors affecting human comfort:-

1. Effective temperature
2. Heat and moisture losses from human body
3. Moisture content of air
4. Quality and quantity of air
5. Air stratification
6. Air Circulation

WINTER – 15 EXAMINATION

Subject Code:17612

Model Answer

7. purity

Que 4 a ii) (01 mark each any four)

Components responsible for Sensible Heat gain for a large restaurant for air conditioning.

1) Sensible Heat load:

Sensible heat is the heat as it flows into conditioned space or produced in the conditioned space, which will tend to cause rise in temperature of conditioned space.

Sensible heat loads to the conditioned space includes.

- Heat deception through the building structure as a result of conduction, convection and radiation.
- Sensible heat brought in with the outside air by ventilation and infiltration
- Sensible heat produced by occupant.
- Sensible heat produced in conditioned space by lights, equipments, motors etc.
- Sensible heat extracted or generated by process carried out in conditioned space.
- Sensible heat coming by solar radiation.
- Sensible heat brought in by ducts
- Sensible heat load due cooking of foods.

Que 4 a iii) (04 marks)

Polyurethane foam (PUF) :

- Type of insulation : Organic fibrous insulation
- Temperature range : -220° C to 110° C
- Thermal conductivity : It has low thermal conductivity value of maximum 0.021 w/mk at 10°C.
- Vapor permeability : It is not easily ignitable and has negligible water permeability

Que 4 a iv) (02 marks for sketch and 02 for explanation)

Wick/Evaporative System



The wick system uses a paper, cloth or foam wick or sheet to draw water out of the reservoir. A fan blowing over the wick lets the air absorb moisture. The higher the relative humidity, the harder it is

WINTER – 15 EXAMINATION

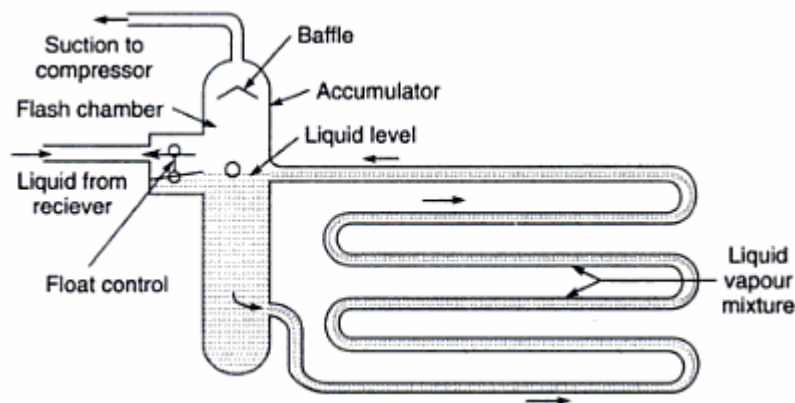
Subject Code:17612

Model Answer

to evaporate water from the filter, which is why this type of humidifier is self-regulating -- as humidity increases, the humidifier's water-vapor output naturally decreases.

:

Que 4 b i) (03 marks for sketch and 03 for explanation)



Flooded type of evaporator feeds excess of liquid refrigerant so that the exit of evaporator will be mixture of liquid and vapour refrigerant.

In flooded type of evaporator coil remains completely filled with liquid refrigerant as shown in figure. The level of liquid refrigerant is maintained constant in surge chamber by using float control. The liquid refrigerant enters into evaporator coil from surge chamber. In evaporator coil part of liquid refrigerant boils and converts into vapour. The vapour formed is collected at the top of surge chamber and remaining liquid refrigerant is returned to surge chamber. From top of surge chamber refrigerant vapours are drawn in suction line of compressor. In flooded type evaporator rate of heat transfer is very high as whole evaporator coil remains in contact with liquid refrigerant but this type of refrigerant requires large amount of refrigerant.

Applications of flooded type evaporator:- This type of evaporator are used for

- 1) Large installations, where refrigerating capacity is high.
- 2) In a refrigeration system where load fluctuation are higher.
- 3) For multi evaporator system.

Que 4 b ii) (06 marks)

The different types of heat sources considered for the estimation of the cooling load of a cinema theatre for air conditioning are Sensible Heat and Latent Heat.

1) Sensible Heat load:

Sensible heat is the heat as it flows into conditioned space or produced in the conditioned space, which will tend to cause rise in temperature of conditioned space.

Sensible heat loads to the conditioned space includes.

- i) Heat deception through the building structure as a result of conduction, convection and radiation.

WINTER – 15 EXAMINATION

Subject Code:17612

Model Answer

- j) Sensible heat brought in with the outside air by ventilation and infiltration
- k) Sensible heat produced by occupant.
- l) Sensible heat produced in conditioned space by lights, equipments, etc.
- m) Sensible heat extracted or generated by process carried out in conditioned space.
- n) Sensible heat coming by solar radiation.
- o) Sensible heat brought in by ducts

(03 Mark)

2) Latent Heat load:

Latent heat is transferred whenever there is change of phase. It is in the form of moisture change (change in relative humidity) taking place at constant temperature.

Latent heat load includes.

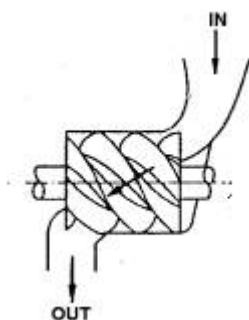
- a) Latent heat of ventilation and infiltration air coming in conditioned space.
- b) Latent heat of occupant.
- c) Latent heat load from food products brought in by occupants.

The total of all these loads is considered for the estimation of the total heat load of a large restaurant for air conditioning.

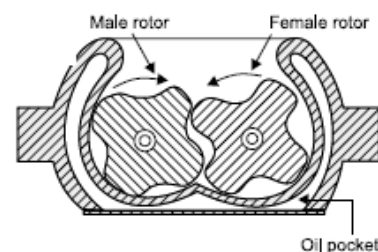
(03 Mark)

Q. 5 a) SCREW TYPE COMPRESSOR

(Sketch 02 marks, Advantages 02 marks)



or



Advantages of screw compressor : Any four

- 1) Volumetric efficiency is high
- 2) Uniform and continuous flow of refrigerant
- 3) Elimination of suction and discharge valve
- 4) Low power consumption

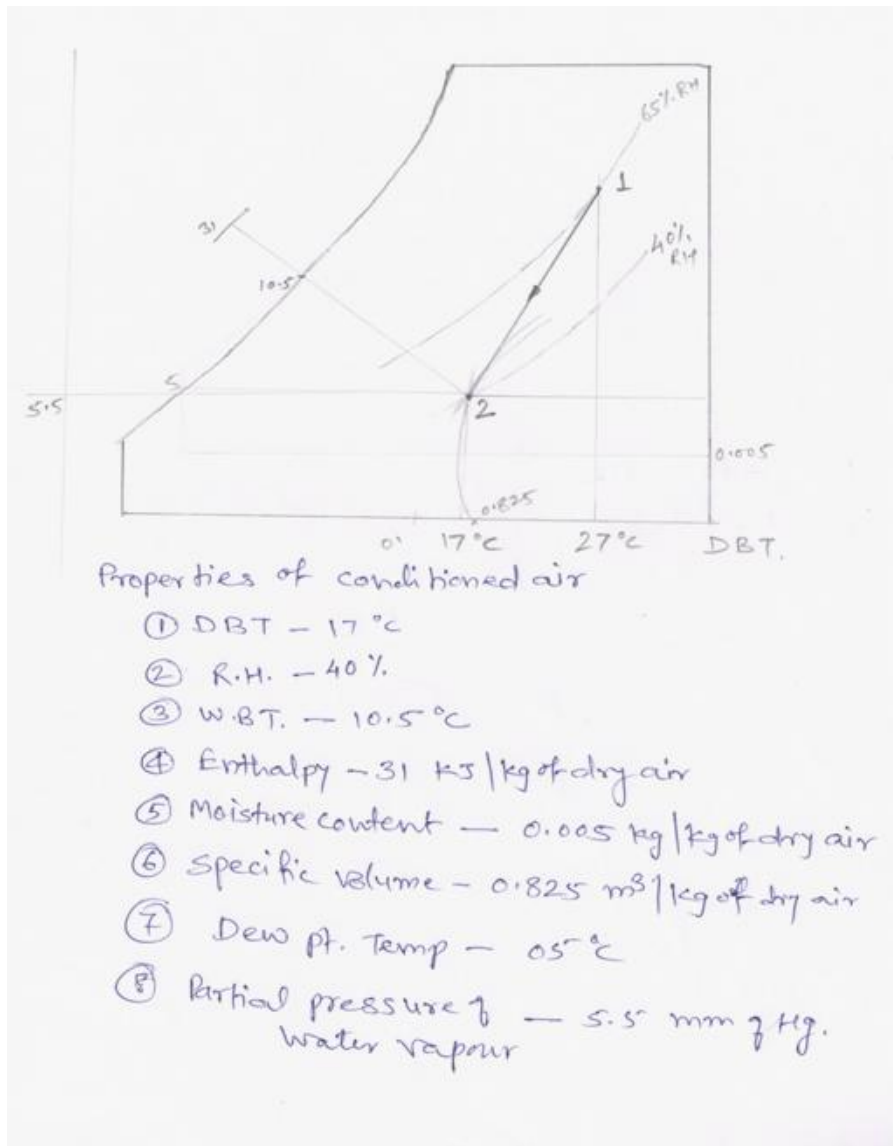
WINTER – 15 EXAMINATION

Subject Code:17612

Model Answer

- 5) Directly coupled to prime mover
- 6) High torque
- 7) Purely rotary motion

Q.NO 5 b) (03 marks for sketch and 05 for properties Any five)



Q.NO 5 c) (Three marks for figure and three for explanation)

Year round air conditioning system:

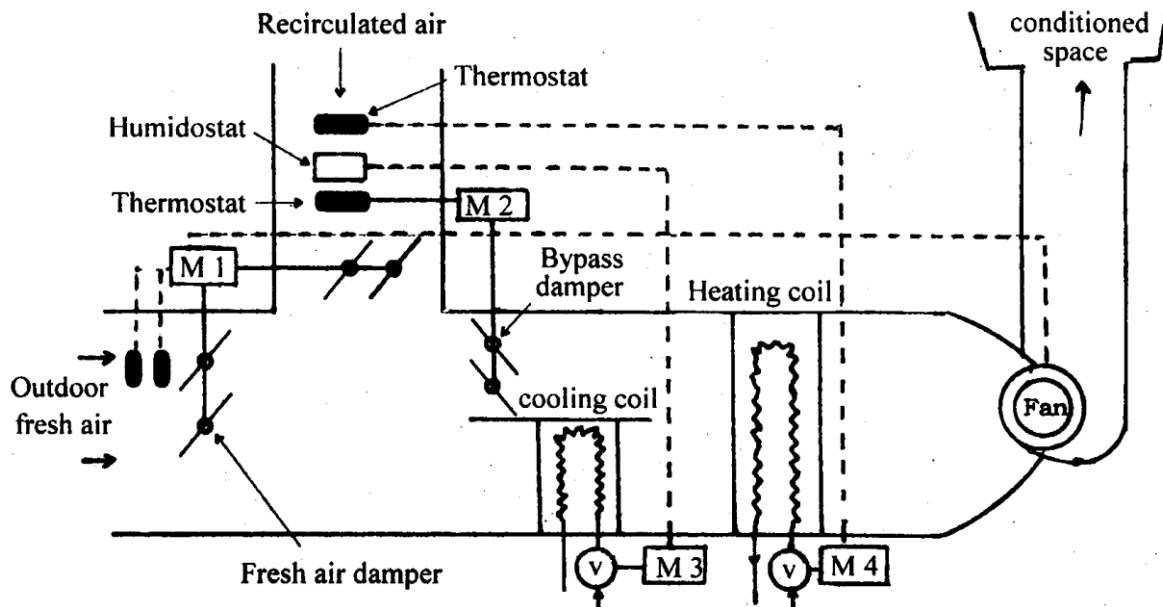
The arrangement of year round air conditioning system is shown in figure. The amount of outdoor fresh air and recirculated air is controlled by motor. The air conditioner is designed such that when outdoor air temperature is either above or below a certain selected value, it assumes the season as summer or winter. In summer by pass damper is almost closed and most of air passes through

WINTER – 15 EXAMINATION

Subject Code:17612

Model Answer

cooling coil which may be evaporator or coil through which chilled water is passed. All air is passed through heating coil. In winter season by pass damper is in almost open position. Most of the air is directly passed to heating coil by passing cooling coil.



- Que 6 a) (02 marks for sketch and 02 for explanation)

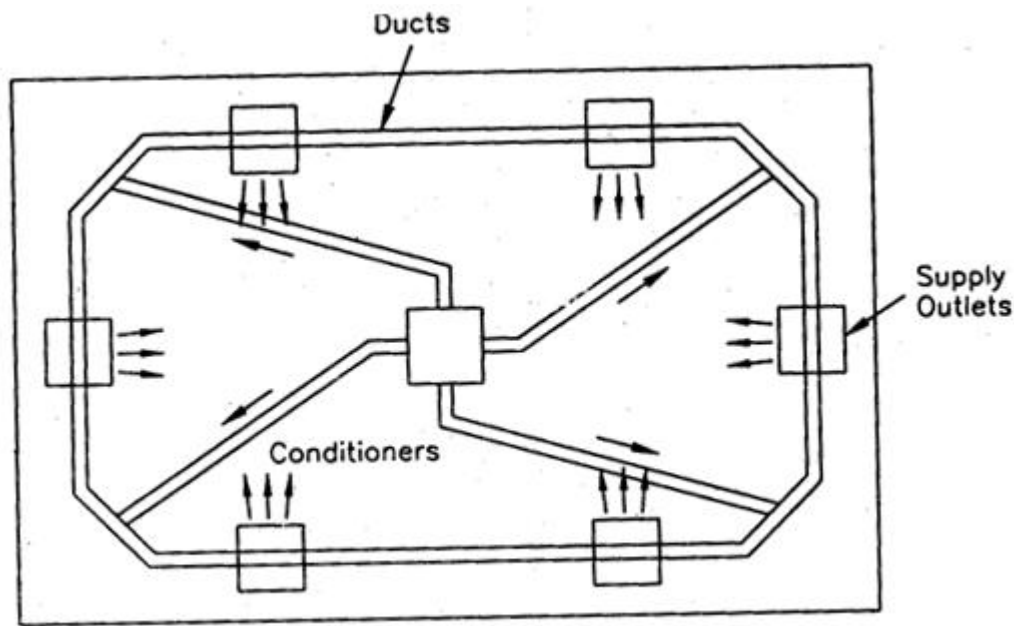
Closed perimeter duct system:

The perimeter duct system may be of closed loop or radial type. The figure shows closed Perimeter duct system. In this system the conditioner is usually placed in the basement and it is located near the geometric centre of all outlets. The supply outlets are placed close to the ceiling level. The ducts runs through the basement building foundation slab, the floor and connect the air conditioner to the outlet grills are generally located on the bottom side of the inside wall. This arrangement is commonly used for the residential systems.

WINTER – 15 EXAMINATION

Model Answer

Subject Code:17612



Perimeter loop system

Que 6 b) (Any four one mark each) Basic types of insulating materials are

1. Flake insulation :- Vermiculite and mica
2. Fibrous insulation :-Glass wool , rock wool slag wool, asbestos etc
3. Granular insulation : cork, silicate of calcium and magnesium etc.
4. Cellular insulation: Rubber plastic etc.
5. Natural insulation : Cork Board celotes hair felts insulating paper etc.
6. Special insulating material : Polystyrene, urethane etc

Que 6 c) Necessity of refrigeration in ice factory : (04 marks)

Freezing point of water is zero degree celcius. This temperature can be obtained by refrigeration only. Production of ice in ice factory is done by refrigeration system.. The ice produced needs refrigeration system for storage. Hence refrigeration system is needed in ice factory.

Que 6 d) Classification of duct :

Ducts are classified as :

- 1) According to cross section of duct
 - a) Circular duct.
 - b) Rectangular duct.
 - c) Square duct.
- 2) According to type of air it carries.
 - a) Supply air duct.
 - b) Return air duct.

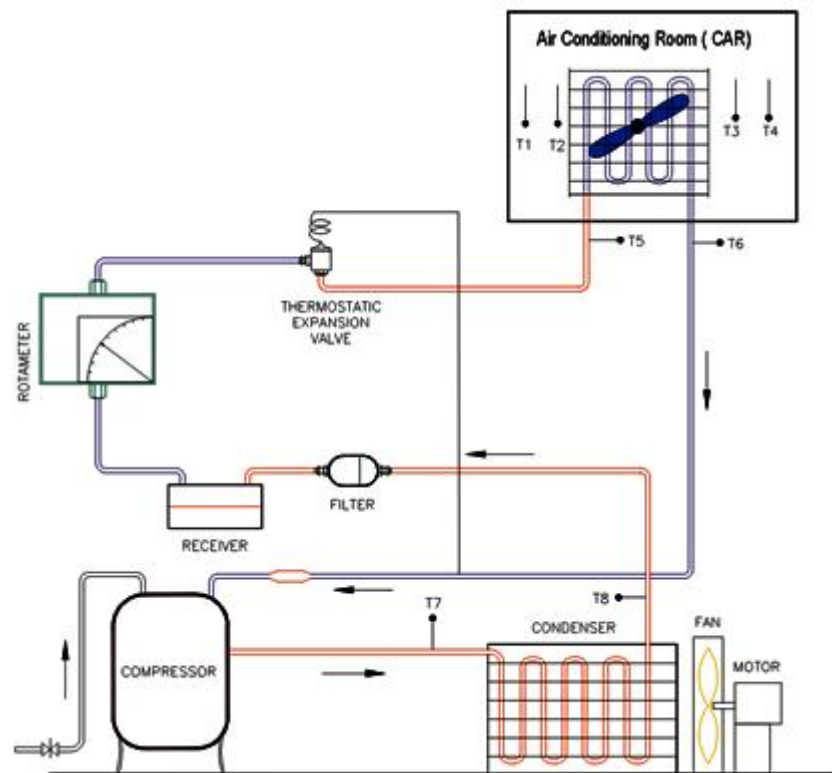
WINTER – 15 EXAMINATION

Subject Code:17612

Model Answer

- 3) According to velocity of flow in duct.
 - a) Low velocity duct.
 - b) High velocity duct.
- 4) According to pressure in duct.
 - a) Low pressure duct.
 - b) Medium pressure duct.
 - c) High pressure duct.

Que 6 e)

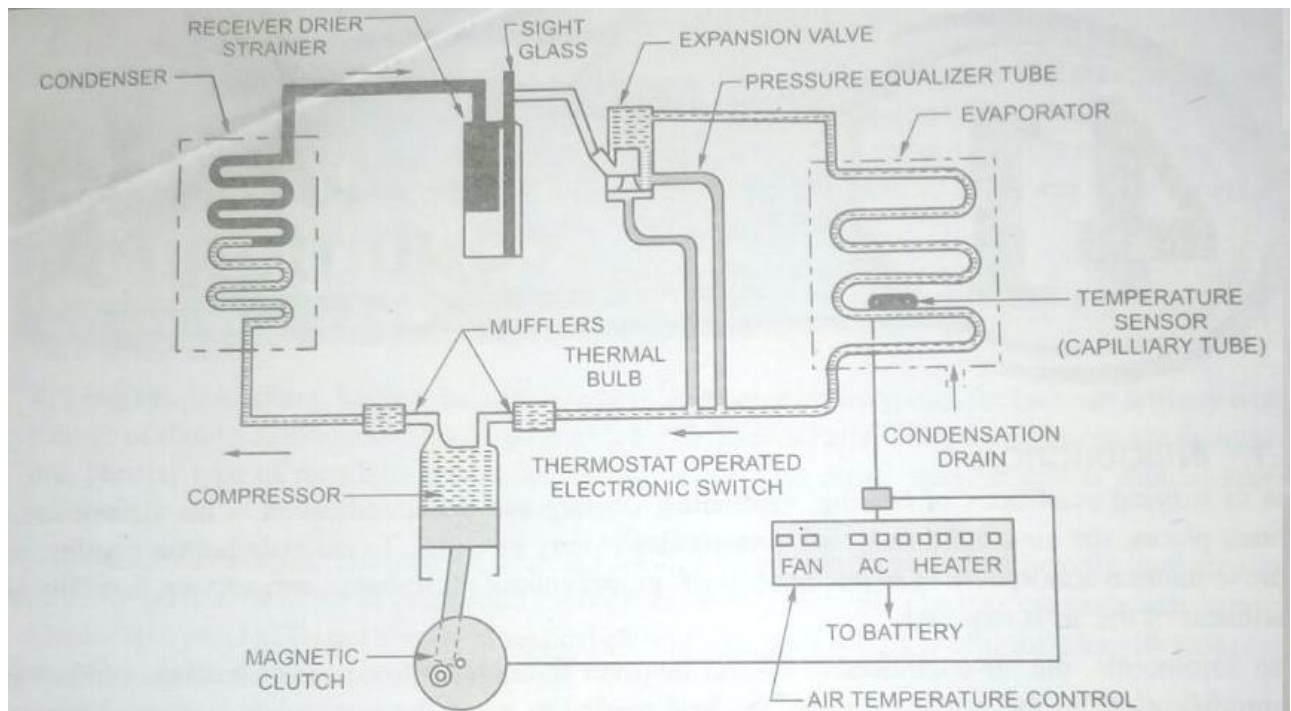


Or

WINTER – 15 EXAMINATION

Subject Code:17612

Model Answer



The compressor is driven by a belt attached to the vehicle's engine which is engaged by an **electromagnetic clutch called the compressor clutch**. This is right behind the radiator. When the clutch is engaged the compressor pumps the refrigerant.